AAIB
Air Accidents Investigation Branch

AAIB Bulletin 6/2020

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AAIB Special Bulletins and Interim Reports

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

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AAIB Bulletin S1/2020 SPECIAL

SERIOUS INCIDENT

Aircraft Type and Registration:	Airbus A321-211, G-POWN
No & Type of Engines:	2 CFM CFM56-5B3/3 turbofan engines
Year of Manufacture:	2009 (Serial no: 3830)
Date & Time (UTC):	26 February 2020 at 0009 hrs
Location:	London Gatwick Airport
Type of Flight:	Commercial Air Transport (Non-Revenue)
Persons on Board:	Crew - 7 Passengers - None
Injuries:	Crew - None Passengers - N/A
Nature of Damage:	Fuel system contamination
Commander's Licence:	Airline Transport Pilot's Licence
Commander's Age:	28 years
Commander's Flying Experience:	5,059 hours (of which 4,855 were on type) Last 90 days - 87 hours Last 28 days - 17 hours
Information Source:	AAIB Field Investigation

Introduction

At 0009 hrs on 26 February 2020, G-POWN took off from London Gatwick Airport for a flight to London Stansted Airport. At approximately 500 ft agl in the climb, there was a loud noise and flames were seen coming from the tailpipe of the No 1 engine as it surged. The crew made a MAYDAY call and turned right to return to the airport. Two minutes later, parameters relating to the No 2 engine began to fluctuate and the crew received an indication that the engine had stalled. The aircraft landed at 0020 hrs.

This Special Bulletin contains facts which have been determined up to the time of issue. It is published to inform the aviation industry and the public of the general circumstances of accidents and serious incidents and should be regarded as tentative and subject to alteration or correction if additional evidence becomes available.

The AAIB classified the event as a serious incident and began an investigation on 26 February 2020 in accordance with established international arrangements. The AAIB is being assisted by Accredited Representatives appointed by the Bureau d'Enquêtes et d'Analyses pour la Sécurité de l'Aviation Civile in France, the National Transportation Safety Board in the USA, and the Aircraft Accident and Incident Investigation Board in Cyprus. The Accredited Representatives are supported by Technical Advisors from the aircraft and engine manufacturers.

This Special Bulletin contains preliminary information about the investigation and is intended to highlight the importance of using correct procedures when dosing fuel with biocide to combat microbial contamination.

History of the flight

In the 24 hours preceding this serious incident, G-POWN suffered engine abnormalities across four flights and with two sets of flight crew. The serious incident occurred on the final flight.

The crew who experienced the serious incident (crew A) operated the first of the four flights, positioning[1] G-POWN from London Stansted Airport (Stansted) to London Gatwick Airport (Gatwick). At around 0520 hrs, they started the No 2 engine normally, but experienced problems starting the No 1[2]. Commander A reported that an engineer, who was assisting with the engine starts via an external headset, advised them to attempt another start on the No 1 engine, which was successful. There were no further engine abnormalities during that flight.

At Gatwick, crew A rested at a hotel while a different crew (crew B) operated G-POWN on a return charter trip to Krakow International Airport (Krakow), Poland. Crew A were scheduled to re-position the aircraft back to Stansted later that night, along with five members of cabin crew.

The engines functioned normally on the outbound flight to Krakow. However, the No 1 engine required more than one attempt to start successfully for the return flight, at around 2000 hrs. Commander B stated that he notified the operator of the starting problem via a datalink[3] message from the aircraft after departure from Krakow.

Later in the flight, the Electronic Centralised Aircraft Monitoring (ECAM) system displayed the message ENG 2 STALL momentarily on two occasions. Crew B felt vibration in the airframe; on the second occasion the message occurred during the descent when the N_1[4] was around 66%. The engine control indications appeared normal but because crew B perceived the vibration to be less at lower thrust settings, they attempted to maintain the N_1 below 50%.

Footnote

1 Positioning flight – a flight without passengers.
2 The No 1 and No 2 engines are on the left and right respectively (looking forwards). The No 2 engine is often started first.
3 Datalink – A system of text messaging between aircraft and ground stations.
4 N_1 – the engine's fan speed, shown on a gauge in the cockpit.

On arrival at Gatwick, at around 2230 hrs, commander B phoned the operator's Technical Control department to report the No 2 engine stall event. An EASA Part-66 B1 licensed engineer then attended the aircraft[5], and commander B recorded the defect in G-POWN's technical log.

When crew A returned to the aircraft, commander A liaised with crew B, the Gatwick engineer, and Technical Control regarding the engine abnormalities. The Gatwick engineer had completed a troubleshooting procedure during which no fault had been apparent. He signed off the engine stall defect and the Certificate of Release to Service in G-POWN's technical log. Commander A agreed with Technical Control that he would accelerate the engines to 50% N_1 for longer than usual before taking off[6] to check the engine control indications.

At 2349 hrs, crew A started the No 2 engine normally but experienced difficulties starting the No 1, and commander A telephoned Technical Control. They suggested that the No 1 engine's abnormalities were associated with starting only and to attempt another start – which was successful.

Crew A reported accelerating the engines to 50% N_1 against the footbrakes on Runway 26L (Rwy 26L). The engine control indications appeared normal, so they commenced the takeoff at 0009 hrs (the flight is shown in Figure 1).

At around 500 ft agl, the No 1 engine began banging and surging. Commander A recalled that the engine's control indications were fluctuating, and the aircraft was "yawing… and fishtailing… all over the place". There was no accompanying ECAM message. Data recorded on the flight data recorder subsequently showed that the No 1 engine N_1 reduced below 40% for a period of approximately 25 seconds despite the thrust levers remaining in the FLEX/MCT[7] detent.

A number of cabin crew saw flames coming from the No 1 engine's tailpipe and attempted to contact crew A using the interphone.

Commander A transmitted a MAYDAY call, requesting a return to Rwy 26L and issued an alert call[8] to the cabin crew. He disengaged the autopilot and turned right, downwind. He moved the No 1 engine's thrust lever to idle. At one stage after doing so, he recalled seeing the No 2 engine's control indications begin to fluctuate.

Just after commencing descent from around 3,600 ft agl, the ECAM message ENG 2 STALL was displayed three times in quick succession. This prompted commander A to move the No 1 engine's thrust lever forward out of idle. He commented that both engines appeared more stable when the thrust was reduced while descending, and he aimed to maintain each engine's N_1 at around 49%.

Footnote

[5] This engineer is referred to as the Gatwick engineer throughout the report.
[6] A procedure used to check engine control indications before applying takeoff thrust.
[7] The FLEX/MCT detent is a gate into which the thrust levers were moved for takeoff.
[8] A standard procedure to alert the cabin crew in an emergency.

Co-pilot A prepared the aircraft's flight management guidance system for a return to Rwy 26L, and commander A positioned the aircraft on a 9 nm final approach. He opted to fly slightly above the glidepath in order to minimise the thrust required by the engines, and so he could glide the aircraft to the runway if the engine problems worsened. The aircraft landed at 0020 hrs, with the reverse thrust appearing to function normally.

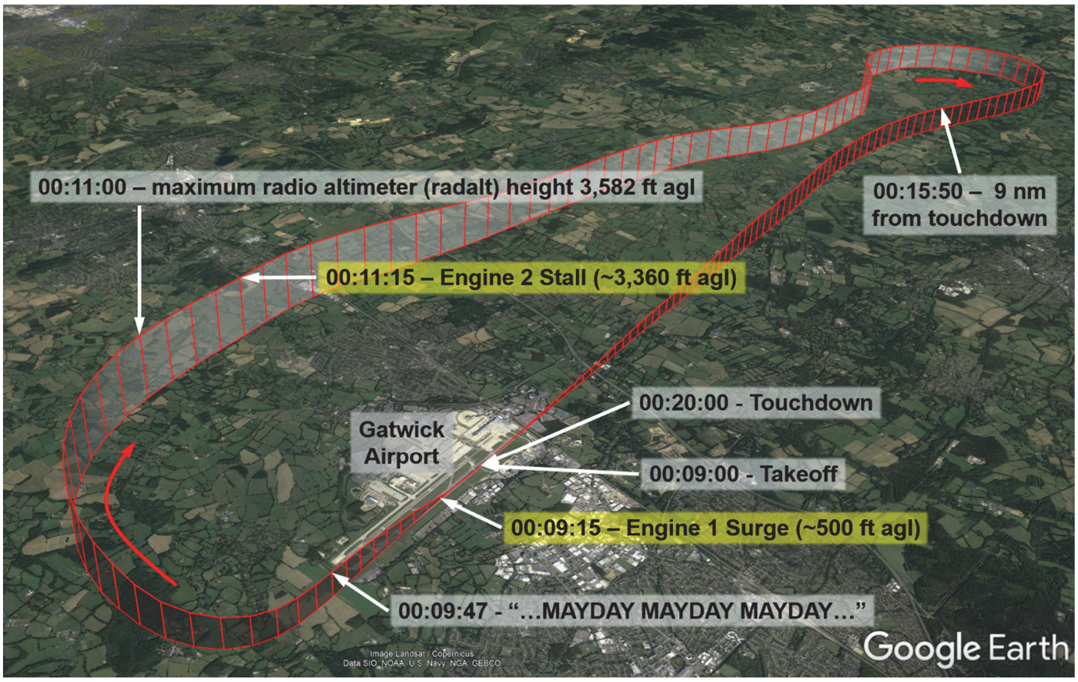


Figure 1

Radar track of G-POWN with timing of significant events highlighted

Maintenance actions

Scheduled maintenance

G-POWN was scheduled to enter a period of extensive maintenance in late January 2020 with an EASA Part-145 Approved Maintenance Organisation (AMO). As a pre-requisite, on 23 November 2019 the operator took fuel samples from the aircraft tanks to be tested for microbial contamination, in accordance with the Aircraft Maintenance Manual (AMM) Task 12-32-28-281-003-A, *Sample Fuel for Microbiological Contamination Analysis*. The samples were sent to a laboratory and it was determined that there was moderate contamination[1]. The AMM task states that a second test is required no more than 10 days

Footnote

[1] Definition of contamination levels:

Contamination	Water Sample	Fuel Sample
	Colony Forming Units / ml	
Negligible	<1000	<4000
Moderate	>1000 <10,000	>4000 <20,000
Heavy	>10,000	>20,000

after the first test and, should this show positive, then biocidal treatment should be applied to the fuel tanks within a further 10 days. A work card for the treatment of the tanks was raised by the operator and sent to the AMO on 8 January 2020 for inclusion in the scheduled maintenance. No further microbiological testing was performed.

The aircraft entered the AMO's hangar on 23 January 2020 and the maintenance started. For most of this time, all the fuel tank access panels were open to allow work to be carried out inside the fuel tanks until 19 February 2020 when the aircraft was moved outside. Once outside, the fuel tanks were leak-checked and treated for moderate microbial contamination.

The operator's work card called for biocidal shock treatment for moderate contamination with fuel mixed with Kathon FP1.5 biocide (Kathon) in accordance with AMM Task 28-11-00-600-008-A01, *Biocidal Shock Treatment for Moderate Contamination - With Fuel Mixed with Kathon Biocide*. The biocidal treatment was not designated a 'Critical'[2] maintenance task by the AMO. The task states that fuel should be mixed with Kathon biocide at a concentration of 100 parts per million (ppm) by volume and then the aircraft pressure-refuelled using the onboard automatic control functionality in accordance with AMM Task 12-11-28-650-003-A, *Pressure Refuel with Automatic Control*. The Kathon-dosed fuel should remain in the aircraft fuel tanks for 24 hours.

The EASA Part-66 B1 licensed AMO engineer[3] was not familiar with the term 'ppm'. It was not written in expanded form anywhere in the AMM Task or glossary, and the AMM task did not provide instructions about how to perform the calculation of how much Kathon to use. He therefore searched the internet for a definition and conversion calculator. The AMO engineer knew that he would be uploading 6,200 kg of fuel into each wing tank and, using an internet calculator, he calculated a quantity of 30 kg of Kathon for each wing tank. There was 150 kg of Kathon available in the AMO stores and so he made a material requisition for 60 kg of Kathon.

To achieve a concentration of 100 ppm by volume, the following calculation should be made:

Fuel uplifted: 6,200 kg with a Specific Gravity of 0.808[4] = 7,678 litres

100 ppm = 0.0001

7,678 x 0.0001 = 0.768 litres of Kathon

Using a Kathon Specific Gravity of 1.04 = 0.799 kg per wing tank.

In the AMM there are four tasks for the shock treatment for moderate contamination: two tasks with Kathon biocide; and two with Biobor JF (Biobor), which is not currently registered for use in the European Union. For each biocide there is a task for mixing it with fuel prior to

Footnote

2 EASA Part M, AMC1 M.A.402(h) Performance of maintenance CRITICAL MAINTENANCE TASKS. https://www.easa.europa.eu/sites/default/files/dfu/Annex%20I%20to%20Decision%202016-011-R.pdf Accessed 07 April 2020.

3 This engineer is referred to as the AMO engineer throughout the report.

4 DEF STAN 91-091 Issue 11 states an allowable range of JET A-1 density at 15°C of between 775.0 –840.0 kg/m^3. For the purposes of the calculation used in this report, the mean of these allowable density values, 807.5 kg/m^3, has been used. This mean value equates to a Specific Gravity of 0.808.

the mixed fuel then being uplifted to the aircraft, and a second, alternative, task for adding the biocide via a metering rig during the refuelling process. The manufacturer does not provide instructions for a method of mixing the biocide with fuel. The biocide dosing task was to be combined with the fuel tank leak check, and the AMO engineer responsible for the task used the overwing refuel aperture to add the Kathon[1]. The AMO engineer added 30 kg of Kathon to the left wing tank through the overwing aperture and a further 30 kg of Kathon to the right wing, also through its overwing aperture, whilst he uplifted 6,200 kg of fuel into each wing tank. The Kathon-dosed fuel, at 3,750 ppm (by volume), approximately 37 times the recommended dose, was left in situ for 24 hours in accordance with the AMM task, and the engine and APU fuel filters where changed.

The next day 6,400 kg of fuel was transferred from the wing tanks to the centre fuel tank and again left in situ for 24 hours. After this time the task card was stamped as complete, with a further task opened to perform a biological contamination check within 10 days but after at least 5 flights. The aircraft departed the AMO and returned to the operator's base on 24 February 2020.

Troubleshooting at Gatwick

After the aircraft arrived at Gatwick from Krakow, the operator's Technical Control instructed an EASA Part-66 B1 licensed engineer to attend the aircraft to troubleshoot the No 2 engine stall. The Gatwick engineer worked for an EASA Part-145 AMO that provided line maintenance at Gatwick for the operator.

The troubleshooting manual (TSM) was provided using the manufacturer's online system *AIRBUS World: AirN@v Maintenance*. This system included two different applications: *AirN@v* and *airnav^X* which was recently introduced to replace *AirN@v*.

The operator had granted the AMO access to the operator's data on *AirN@v* but not *airnav^X*, so the Gatwick engineer used *AirN@v* to try and access the applicable troubleshooting procedure. The design of *airnav^X* requires the user to filter data to a specific aircraft before going through the troubleshooting process but *AirN@v* does not. The Gatwick engineer did not filter the TSM for the specific aircraft registration, fleet serial number or effectivity for G-POWN but accessed the procedure using the TSM table of contents. In doing it this way, it was possible to access the procedures for all the operator's Airbus aircraft.

Airbus recommended that the TSM must always be filtered for a specific aircraft registration, fleet serial number or effectivity and that the TSM should be accessed using the '*Start Troubleshooting*' function in *AirN@v* (Figure 2) and the '*Troubleshooting*' tab in *airnav^X* (Figure 3).

Footnote

[1] An optional modification was offered by the manufacturer to include an overwing refuel aperture to facilitate gravity refueling of the aircraft. This modification had been embodied on G-POWN and was fitted to both wings.

Figure 2

Airbus recommended way to access the TSM in AirN@v v3, '*Start Troubleshooting'* function

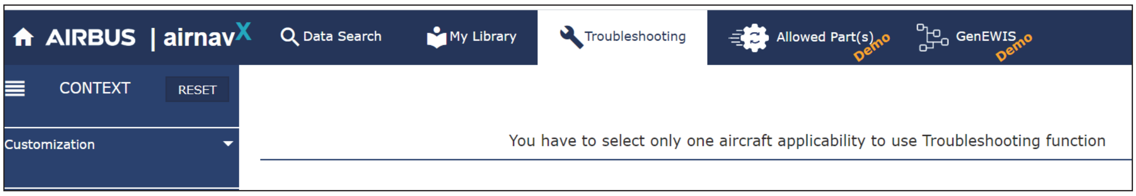


Figure 3

Airbus recommended way to access the TSM in airnav^{X}, '*Troubleshooting'* tab

The Gatwick engineer printed and followed TSM procedure 77-11-00-810-815-A, *Stall above idle on engine 1(2),* which applied to LEAP-1A32 engines. However, G-POWN was fitted with the CFM56-5B3/3 engine and the applicable TSM procedure for this engine is 73-00-00-810-866-A, *Stall of engine 1 or 2 in flight.* This TSM procedure requires an extensive examination of the engine, including borescope inspections of the high pressure and Stage 1 low pressure turbine blades.

No fault was found during the troubleshooting, so the Gatwick engineer released the aircraft to service. The reasons why the Gatwick engineer selected the troubleshooting procedure for the LEAP engine, and any impact of this on the sequence of events in the subsequent serious incident will be investigated further.

Aircraft damage

Fuel samples

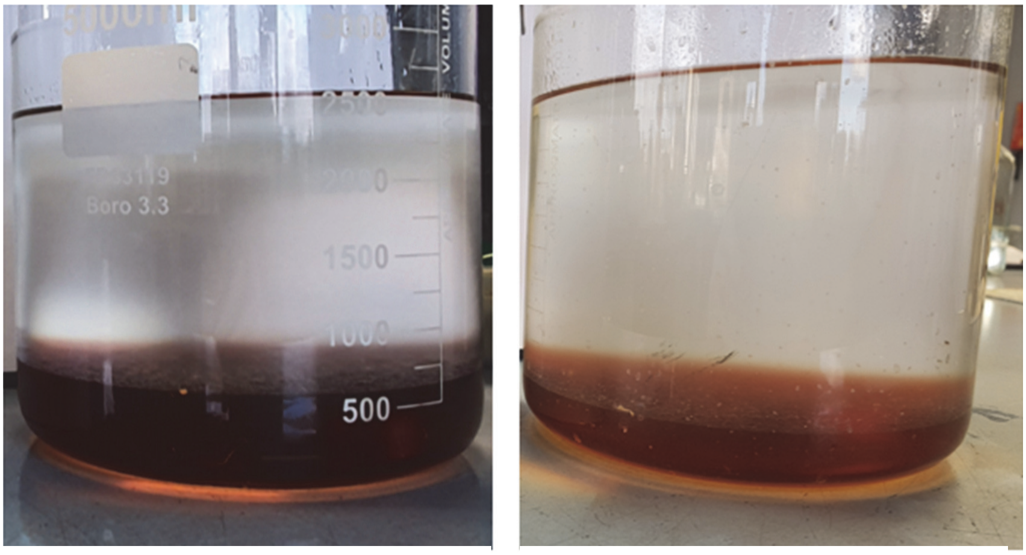
Following the serious incident, fuel samples were taken from the left and right wing fuel tank water drain valves and were subjected to laboratory analysis. When the fuel was tested it was found not to comply with the JET A-1 specification requirements[2] for appearance

Footnote

[2] DEF STAN 91-091 Issue 11 and AFQRJOS Check List Issue 31.

and water separation characteristics (MSEP[1]). The fuel samples, once the contents had settled out under gravity, contained a separate brown liquid layer beneath the main fuel layer (Figure 4). Trace element results of the fuel and the bottom brown layer showed similar spectra to a reference Kathon sample, but with a higher water content. The laboratory that conducted the fuel testing commented that:

> *'The results indicate contamination with undissolved Kathon. It was noted that the bottom layer that is mostly Kathon plus some unknown products and water, suspected to be causing the darker colour than the reference Kathon sample. This is likely due to the glycol type solvent used in Kathon product dissolving polar materials from the fuel and fuel tank surfaces. This may be analogous to observations with another similar glycol additive, FSII (Fuel System Icing Inhibitor), which is used in military jet fuels. It is colourless but forms brown additive/water layer in tank bottoms.'*



Left wing tank **Right wing tank**

Figure 4

Fuel samples drained from left and right wing fuel tanks

The engines' fuel filter and filter bowl fuel samples were also analysed. The fuel filters were clean in appearance and generally free from debris, however chemical analysis of the small amount of filter debris present indicated unusually high levels of magnesium, a constituent element present in Kathon.

Footnote

1 Water Separator Index Modified (MSEP).

Engines

The aircraft's engines were examined visually using a borescope and both exhibited similar findings. There was no significant damage evident to the fan, low-pressure compressor or high-pressure compressor components, and any minor defects that were identified were within AMM damage limits. The combustion chambers, and high-pressure and low-pressure turbine blades were coated in a thin layer of white material that was observed on the turbine blades' convex surfaces (Figure 5). The high-pressure turbine nozzle guide vanes were also coated in the white material.

Figure 5

White material deposits on No 2 engine high-pressure turbine blades
(No 1 engine similar)

Significant deposits of a brown material were evident on all the combustion chamber swirl cups, adjacent to the fuel spray nozzles, in both engines (Figure 6).

Figure 6

Brown material deposits in No 2 engine combustion chamber swirl cups
(No 1 engine similar)

It was not possible to remove samples of the white and brown materials from within the engines at the time the borescope inspections were performed. Additional examinations are planned that will include inspection of the engines' fuel system components, including the hydromechanical units (HMUs).

Discussion

During biocidal shock treatment, an excessive quantity of Kathon biocide was introduced into the aircraft's wing fuel tanks, equating to 37 times the maximum permitted dosage in the AMM. The AMO engineer who carried out this task had not performed it before and did not recognise that he was using an excessive quantity of biocide. The task had not been designated as a critical task, and therefore no additional measures were used to check that it was performed in accordance with the AMM Task. The reasons for this and the impact on the sequence of events in the subsequent serious incident will be investigated. No control measures were in place at the AMO stores or planning departments to prevent unusually large quantities of chemicals being issued to AMO staff. In addition, the AMM task instructions used the term 'ppm' for which there was no definition within the AMM glossary, and no additional guidance was provided of how to perform the biocide fuel dosing calculation.

The biocide application method used was for a manually-calculated dose to be applied directly to the fuel tanks through the overwing aperture. This was not an approved process within the AMM. It was performed in this manner to enable the biocide application to be accomplished in the absence of a fuel metering cart or separate fuel bowser that would have allowed the biocide to be pre-mixed with fuel prior to pressure-refuelling the aircraft, as required by the AMM.

The excessive level of Kathon in the aircraft's fuel system is suspected to have caused the subsequent problems with the aircraft's engines, including those experienced during the incident flight. The AAIB is also aware of other events where engine performance was affected by over-dosing of fuel with biocide. Visual inspection confirmed the presence of abnormal deposits within both engines downstream of the fuel spray nozzles. The influence of the over-dosed fuel on the engines' HMUs and other fuel system components is subject to the ongoing AAIB investigation.

Before the incident flight, there were start-up difficulties with the No 1 engine and momentary ENG 2 STALL messages associated with the No 2 engine on descent into Gatwick. An engineer was tasked with troubleshooting the engine stall messages. This intervention was a potential opportunity to detect the abnormal deposits on the high pressure and low pressure turbine blades. It is considered likely that a borescope inspection would have detected these deposits and, had it done so, it is unlikely that the aircraft would have been released to service. The engineer was not tasked with investigating any issues with the No 1 engine. The symptoms presented by each engine were different and no one considered there to be a possible common cause.

When using the computer-based aircraft manual for troubleshooting, the Gatwick engineer did not filter the TSM for the aircraft he was working on and accessed troubleshooting procedures using the table of contents. This differed from the manufacturer's recommended method of using the TSM. Consequently, the engineer selected a procedure for a different type of engine to that fitted to G-POWN. The Gatwick AMO did not have access to the manufacturer's most recent computer based application for manuals, *airnav^X*, which is designed to ensure engineers filter the TSM for a specific aircraft. This later application would have reduced the chance of the engineer selecting the wrong procedure.

The Gatwick engineer followed the procedure he had selected, which did not require a borescope inspection, and found no fault, so he released the aircraft to service. The reasons why the incorrect procedure was selected, and the differences between this and the correct procedure, are part of the ongoing AAIB investigation.

Safety actions

Following this serious incident, the following safety action was taken:

Action by regulators

The EASA issued Safety Information Bulletin SIB 2020-06[1] on 20 March 2020, to notify affected stakeholders of recent air safety-related events involving Kathon biocide and to remind aircraft owners and operators to ensure that the correct method and dosage is used for approved biocide treatment of aircraft fuel systems. The FAA issued Special Airworthiness Information Bulletin SAIB NE-20-04[2] on 25 March 2020 that contained similar regulatory guidance.

Action by the manufacturers of the biocide and engines

The manufacturer of Kathon discontinued the use of its product for aviation fuel applications on 10 March 2020.

On 16 March 2020, CFM, the manufacturer of the G-POWN's engines, issued Alert Service Bulletin 73-A0296 recommending that operators of CFM56-5B engines suspend the use of Kathon during aircraft fuel system biocide treatments. Similar instructions were issued for other variants of the CFM56 engine family, as well as all General Electric turbofan engines.

Note: the discontinuation of Kathon for aviation applications, combined with the inability to use Biobor within the EU presently, leaves aircraft operators in the EU without an approved biocide treatment.

Action by the AMO that performed the biocide treatment

The AMO that performed the biocide treatment on G-POWN has introduced a new role of 'technical engineer'. The technical engineer will be an EASA Part-66 B1 licensed engineer, outside of the management chain within the organisation, who will be available to assist other licensed engineers and mechanics with technical queries, such as calculations.

The AMO will also introduce usage limits in stores so that staff will not be able to withdraw chemicals in quantities that significantly exceed the maximum permitted.

Footnote

1 https://ad.easa.europa.eu/ad/2020-06 (accessed 9 April 2020).
2 https://rgl.faa.gov/Regulatory_and_Guidance_Library/rgSAIB.nsf/dc7bd4f27e5f107486257221005f069d/05f721d6c7272c0986258536005bbe41/$FILE/NE-20-04_Corrected.pdf (accessed 9 April 2020).

Action by the Operator and the AMO at London Gatwick Airport

In consultation with the manufacturer, the operator granted the Gatwick AMO access to the airnav^{X} system.

The Gatwick AMO issued a safety and compliance notice highlighting the importance of filtering maintenance data to the specific aircraft.

Further work

The investigation will consider the relevant operational, technical, organisational and human factors which might have contributed to this serious incident. In particular, it will consider:

a. Why the AMO procedures did not ensure that the biocide treatment was performed in accordance with the relevant AMM task.

b. The influence of the over-dosed fuel on G-POWN's engine HMUs and other fuel system components.

c. Why and how the troubleshooting procedure for the LEAP engine came to be used at Gatwick, and confirm what impact using the correct procedure might have had on subsequent events.

A final report will be published in due course.

Published: 21 April 2020.

AAIB Field Investigation Reports

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

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

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

SERIOUS INCIDENT

Aircraft Type and Registration:	Airbus A319-111, G-EZNM
No & Type of Engines:	2 CFM56-5B5/P turbofan engines
Year of Manufacture:	2005 (Serial no: 2402)
Date & Time (UTC):	11 May 2019 at 0630 hrs
Location:	En route to Bristol Airport
Type of Flight:	Commercial Air Transport (Passenger)
Persons on Board:	Crew - 6 Passengers - 107
Injuries:	Crew - None Passengers - None
Nature of Damage:	None
Commander's Licence:	Airline Transport Pilot's Licence
Commander's Age:	41 years
Commander's Flying Experience:	9,159 hours (of which 5,737 were on type) Last 90 days - 54 hours Last 28 days - 26 hours
Information Source:	AAIB Field Investigation

Synopsis

The lenses of both pilots' oxygen masks misted when donned during a smoke and fumes event, obscuring their vison. The commander removed his mask so he could see the flight instruments. The aircraft diverted to Birmingham and landed without further event.

The investigation found that the masks misted up due to a combination of the environment in which they were stowed and the condition of the lenses. The source of the smoke was probably an accumulation of dust in the transformer rectifier unit (TRU).

The aircraft manufacturer has added a cleaning procedure for the TRU in the Aircraft Maintenance Manual. The operator has added a practical demonstration on the use of the mask and its selectors during its recurrent training cycle.

History of the flight

The aircraft was on a scheduled flight from Newcastle International Airport to Bristol Airport. The co-pilot was PF for the sector and the commander was PM.

About 30 minutes after takeoff, while in the cruise at FL290 and about 80 nm north-north-west of Bristol, the co-pilot noticed an acrid burning smell. Upon looking to the rear of the flight deck both crew members observed smoke in front of the flight deck door and rising to shoulder height behind their seats. They donned their oxygen masks, and the commander took control of the aircraft and continued to communicate with ATC; the co-pilot actioned the *'SMOKE/FUMES/AVNCS* [avionics] *SMOKE'* checklist in the quick reference handbook (QRH). The commander transmitted MAYDAY to ATC, selected the emergency transponder code, and the crew started an emergency descent towards the final approach for Runway 27 at Bristol Airport.

About 90 seconds after the pilots donned them, their oxygen masks misted up, obscuring their vision. The co-pilot was able to read the checklist by holding it close to the mask, but could not read his flight instruments. The commander removed his oxygen mask so he could see the flight instruments, having first informed the co-pilot that he would do so and agreeing this was the least risk option.

Upon removing his mask the commander noticed the smoke had dissipated. He then gave the senior cabin crew member a NITS[1] briefing over the interphone, informing her of their intent to continue to Bristol. Upon looking at the aircraft's navigation display, which was now visible, it was noted that Birmingham was a closer option. The pilots decided to divert to Birmingham, and informed ATC and the cabin crew of their revised plan.

During the descent the crew made an announcement to passengers informing them of the situation. After this the smoke became perceptible in the cockpit again. The commander then informed the co-pilot that he felt "A LITTLE BIT WOBBLY" but well enough to continue. As his oxygen mask had cleared he refitted it, and it did not mist up again.

The aircraft subsequently landed at Birmingham and stopped on the runway, without further event and with the RFFS in attendance. After a review of the situation, the commander removed his mask and discovered no perceptible smoke or fumes in the cockpit. The aircraft was then taxied onto a stand and shutdown.

Pilots' comment

The commander believed the condensation formed on the lenses because they were stowed in a compartment that was relatively cold compared to the flight deck. After he removed the oxygen mask from his head, he placed it on his lap, when it probably warmed towards ambient temperature. He reported that his breathing rate was high when he first donned the mask, because of the stress of the situation.

The commander commented that he was proficient in operation of the mask, but while he was aware of the emergency pressure selector[2] on the mask, his knowledge on the use of it was probably incomplete. He added that he could not be certain if he had selected it during the event. The co-pilot did not select the emergency setting.

Footnote

1 A standard form of briefing that considers the Nature of the situation, Intentions, Timings and Special instructions (NITS).

2 See *Crew oxygen masks* section for a description of the masks and the oxygen regulator controls.

Crew oxygen masks

Description

The mask type fitted to G-EZNM was a 'MF10' full-face mask-regulator that provides protection during depressurisation and smoke events, while allowing the pilots to communicate with each other. The window has two lenses with an air gap between them. The internal lens has an anti-fogging coating (Figure 1).

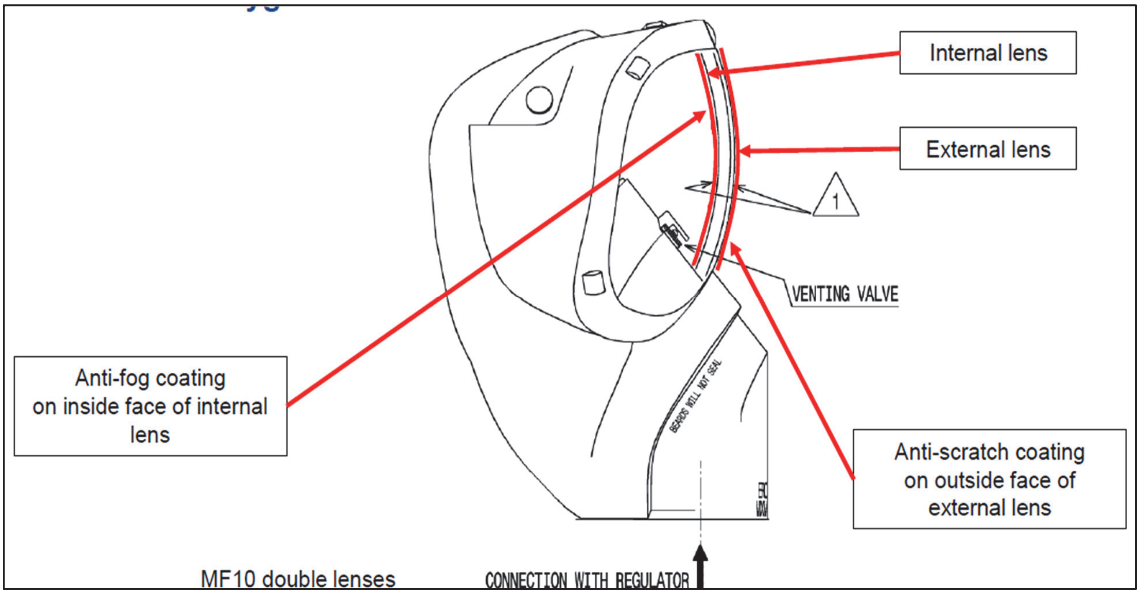


Figure 1

Mask lens arrangement

Pushing the N/100% (N - normal flow) selector into the 100% position, on the regulator control, supplies 100% oxygen (item 3 in Figure 2). After pushing the N/100% rocker into 100% position, rotating the emergency pressure selector in the direction of the arrow to the EMERGENCY position provides 100% oxygen with an overpressure (item 2 on Figure 2). The overpressure eliminates condensation or fogging of the mask, and prevents smoke, smell or ashes from entering the mask.

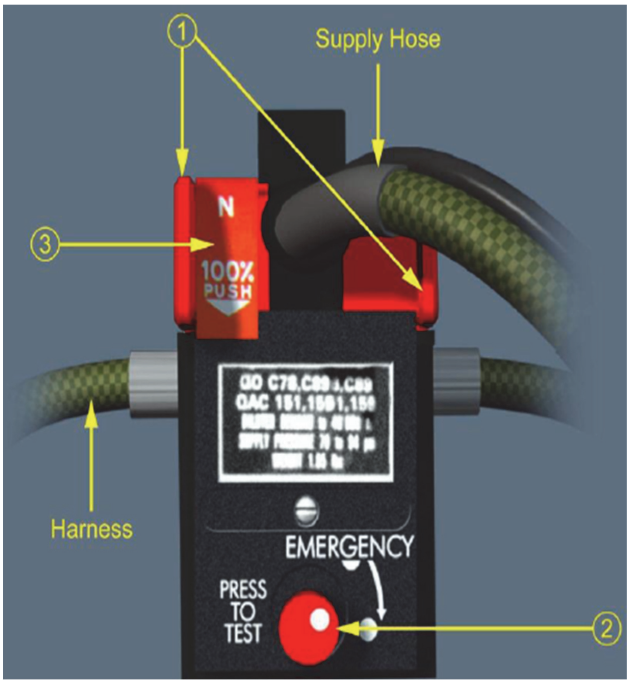


Figure 2

Oxygen regulator controls

SMOKE/FUMES/AVNCS SMOKE checklist

The QRH checklist for 'SMOKE/FUMES/AVNCS SMOKE' was as follows:

SMOKE / FUMES / AVNCS SMOKE

Applicable to: ALL

LAND ASAP

IF PERCEPTIBLE SMOKE APPLY IMMEDIATELY:

CREW OXY MASKS (if required) ... USE/100%/EMERG

VENTILATION BLOWER .... OVRD

VENTILATION EXTRACT .... OVRD

CAB FANS .... OFF

GALY & CAB .... OFF

SIGNS .... ON

CKPT / CAB COM .... ESTABLISH

- **If smoke source immediately obvious, accessible, and extinguishable:**

  FAULTY EQPT .... ISOLATE

- **If smoke source not immediately isolated:**

  DIVERSION .... INITIATE

  DESCENT TO FL 100 / MEA-MORA .... INITIATE

Additionally, the aircraft's Flight Crew Operating Manual, which is a support document for crews, contained additional information. It stated, under the heading '*CREW OXY MASK…*':

> *'Turn the emergency knob to remove condensation or smoke from the mask.'*

Oxygen masks examination

The crew's masks were examined by the manufacturer under AAIB supervision.

Visual inspection

Both masks were in a generally good condition.

The commander's external and internal lenses were reported to be in a "good condition". The inner surface of the internal lens was sensitive to fogging (uniform blurring), and fogging remained for a few seconds on the inner surface of the internal lens after exhaling on it.

The co-pilot's external and internal lenses were reported to be in a "bad condition", with scratches present. The inner surface of the internal lens was sensitive to fogging (with non-uniform blurring reported), and fogging remained for a few seconds on the inner surface of the internal lens after exhaling on it. When fogging appeared on the inner surface of the internal lens, elongated shapes were visible that looked as though the surface had been wiped (Figure 3).

Figure 3

Co-pilot's mask showing fogging and marks on internal lens

Both masks had 100% selected and the emergency pressure selector had not been rotated in the direction of the arrow; a state in which no overpressure was provided.

An exemplar mask was also tested. Its internal lens was not sensitive to fogging, and fogging disappeared instantly after exhaling on it.

A test of the emergency mode pressure was performed on a universal test bench. Values for the emergency pressure demand was within the acceptable range for both masks.

Fogging test

A fogging test was performed in the manufacturer's cockpit simulator room. This reproduced an aircraft cockpit and supplied pressurised oxygen to a mask via a stowage box. It did not replicate the relative temperature environment of the stowage or the cockpit.

The fogging test simulated the masks being worn for 10 minutes and breathing in different configurations of oxygen flow. The objective was to determine in which configuration it was possible to reproduce the fogging described during the incident on the visor.

Neither mask exhibited any fogging in either N, 100% or EMERGENCY oxygen flows.

Recurrent pilot training

Some of the operator's type rating examiners reported that some crews were unfamiliar with the correct use of the oxygen masks, particularly in the selection of the various oxygen flows. Accordingly, the operator has added a practical demonstration on the use of the mask and its selectors during its next recurrent training cycle.

Aircraft Maintenance Manual

A detailed inspection of the masks is required every 24 months. The Aircraft Maintenance Manual (AMM) contains the process to be followed if they require cleaning.

The extant AMM stated in its Subtask 35-12-41-160-050-A, '*Cleaning of the Full-Face/ Quick-Donning Oxygen Mask on Aircraft*':

> '(1) *Clean the mask of the Inter technique MF10 series as follows:*
> *…*
> *(b) …*
> *Do not let the Disinfectant and cleaner-Oxygen Mask- (Material No. 11CKA1) touch the surfaces of the visor of the mask.*
> *…'*

At the operator's request, the aircraft manufacturer has moved the above warning to the beginning of the procedure and highlighted it as follows:

> ***'CAUTION: BE CAREFUL NOT TO PUT DETERGENT SOLUTION, DISINFECTANT OR WATER ON THE MASK VISOR. IF YOU DO, DAMAGE TO THE ANTI-MIST LAYER OF THE MASK VISOR CAN OCCUR.'***

This was incorporated into the February 2020 revision of the AMM.

Source of the smoke and fumes

Initially the operator's maintenance control remotely diagnosed the source of the smoke as a faulty recirculation fan but, upon inspection, both fans were found to be in a "very good condition".

As the source of the smoke was not positively identified, and based on previous experience with burnt smells in the cockpit, the transformer rectifier units (TRU) were suspected as being the source. In previous cases of electrical burnt smells in the cockpit, dust contamination of the TRUs was identified as the cause.

G-EZNM's records showed neither TRU had been replaced since the aircraft was manufactured, since when it had accumulated more than 40,000 flying hours. Upon inspection, the TRU ventilation grids and hot air exhaust ducts showed light dust accumulation and no other abnormal findings. They were cleaned and reinstalled.

As a result, the aircraft manufacturer has introduced a cleaning procedure for the TRUs in the AMM. This was incorporated into the May 2019 revision of the AMM revision.

Analysis

The crew experienced a smoke and fumes event in the cockpit and subsequently initiated and completed a successful diversion to Birmingham.

About 90 seconds after donning their masks both of the crew's masks became obscured by condensation. The misting obscured the flight instruments leading the commander to remove his mask. While this decision was judged to achieve the greatest overall aircraft safety in the circumstances, it exposed the commander to potentially hazardous fumes.

Both emergency pressure selectors were found not to have been rotated to the EMERGENCY position. The commander was unable to recall if he had selected EMERGENCY. However, if they both had, even for a short period, it is likely the condensation would have been removed, enabling the commander to keep his mask on and breath 100% oxygen during the remainder of the flight. This would probably have improved the physiological condition he reported, which may have been caused by inhaling fumes. Removing the condensation in this way would also have allowed the co-pilot to properly monitor the aircraft's flight path. The option to select EMERGENCY was stated in the QRH checklist. The Flight Crew Operating Manual (though not as readily accessible) contained the additional information that this selection would remove condensation.

The results of the fogging test conducted after the event were inconclusive because the simulator did not replicate the cockpit environment and the testers were not exposed to the stress and increased breathing rate probably experienced during the incident.

The masks are likely to have misted up during the event due to a combination of the cold stowage compartment, a relatively warm cockpit, damage to the anti-fog coating and the crews' higher breathing rate.

This incident highlights the importance of fully understanding mask operation, including what selections are available and how to use them.

Conclusion

The aircraft had a smoke and fumes event that was probably a result of dust accumulation on its TRUs. The pilot's oxygen masks misted up shortly after donning, due to a combination of the environment in which they were stowed, the crews' breathing rate and the condition of the lenses. This left them unable to see the flight instruments, resulting in the commander removing his mask. Selecting the emergency pressure setting helps clear a mask and reduced exposure to any remaining smoke and fumes.

Safety actions

The operator has taken safety actions in the following areas as a result of this incident:

> The operator has added a practical demonstration on the use of the mask and its selectors during its recurrent training cycle.

The aircraft manufacturer has taken safety actions in the following areas as a result of this incident:

> At the operator's request, the aircraft manufacturer has moved the relevant warning to the beginning of the procedure and highlighted it as follows:
>
> ***'CAUTION: BE CAREFUL NOT TO PUT DETERGENT SOLUTION, DISINFECTANT OR WATER ON THE MASK VISOR. IF YOU DO, DAMAGE TO THE ANTI-MIST LAYER OF THE MASK VISOR CAN OCCUR.'***
>
> This was incorporated into the February 2020 revision of the AMM.
>
> The aircraft manufacturer introduced a cleaning procedure for the TRUs in the AMM. This was incorporated into the May 2019 revision of the AMM.

Published: 21 May 2020.

ACCIDENT

Aircraft Type and Registration:	Britten-Norman Islander, VP-MNI
No & Type of Engines:	2 Lycoming 0-540-E4C5 piston engines
Year of Manufacture:	1971 (Serial no: 183)
Date & Time (UTC):	23 September 2019 at 2020 hrs
Location:	John A Osborne Airport, Montserrat
Type of Flight:	Commercial Air Transport (Passenger)
Persons on Board:	Crew - 1 Passengers - 6
Injuries:	Crew - None Passengers - None
Nature of Damage:	Left tailplane spar and elevator bent, left wingtip and aileron damaged
Commander's Licence:	Commercial Pilot's Licence with Montserrat Certificate of Validation
Commander's Age:	30 years
Commander's Flying Experience:	660 hours (of which 303 were on type) Last 90 days - 85 hours Last 28 days - 21 hours
Information Source:	AAIB Field investigation

Synopsis

The aircraft was flying from Antigua to Montserrat, which was experiencing a heavy rain shower. After the shower had passed the aircraft made a normal approach in a light tailwind to Runway 10, which was still wet from the rain. The pilot made a positive touchdown and applied appropriate braking but was unable to stop the aircraft. The pilot steered the aircraft to the right but it skidded through 180° and departed the level surface of the airfield backwards, down a steep incline at the end of the runway, before coming to a stop when the tail caught in the airport security fence. The pilot and passengers were able to exit the aircraft and the airport rescue and firefighting service responded promptly.

No aircraft defects were found that would have contributed to the outcome. The touchdown groundspeed was 79 kt, which was higher than appropriate, either because the approach was flown at an airspeed greater than the normal 65 kt, or because of a significant change in windspeed and direction during the approach. This, combined with a wet runway and skidding, resulted in the aircraft requiring more distance to stop than was available on the runway. Three Safety Recommendations are made regarding aircraft operation, access for rescue and firefighting vehicles, and a means of arresting aircraft that overrun the runway.

History of the flight

The pilot had flown the aircraft from Montserrat Airport to Antigua earlier in the day and was on the scheduled return flight to Montserrat Airport. The weather was good but with heavy rain showers passing over the destination, the progress of which the pilot was monitoring using an aviation weather service. With all six passengers ready, the aircraft departed early, with the intention of holding close to the island and waiting for any rain showers to pass through.

The normal pre-flight checks were carried out, including an external inspection of the wheel brake systems and functional checks prior to and during the taxi to the runway. The brakes operated normally as they had done on the previous flight. Before starting the engines, the pilot gave a safety briefing covering all the required items, including the use of seat belts and emergency exits. The departure was normal, and the aircraft climbed in VMC to a transit altitude of 2,000 ft, but it was not possible to fly a direct track due to the rain showers. The aircraft held to the north of the island where the pilot could maintain visual contact with the surface of the sea. This required the aircraft to descend on occasions to remain clear of cloud but in sight of the surface, in turbulent conditions.

As the showers moved away the rain cleared, and the island became visible. There was some low stratus, reported as FEW[1] clouds at 100 ft, and with wind indicated as 140° at 6 kt, the pilot obtained a clearance to join left hand downwind for Runway 10. The runway edge lights were illuminated, and the pilot established on the final approach describing the weather as ‘rough’, with full flap selected and an approach speed of 65 KIAS by 1,000 ft above the airfield elevation. The air traffic controller passed an updated surface wind of 210° at 6 kt, stated that the runway was wet and offered Runway 28 for landing. The pilot elected to continue for Runway 10 and made the normal 6° glidepath approach, touching down positively but, according to several witnesses, faster than normal. The aircraft was not fitted with GPS equipment and no groundspeed information was available.

The pilot applied the toe brakes with the pressures appearing normal and then released them momentarily, as they had little effect, before applying them again. The aircraft was not slowing down and as it passed the taxiway intersection, the brakes were applied much harder, again with little effect. With the end of the runway approaching, the pilot applied full right aileron and right rudder, intending to turn onto the grass area alongside the runway in order to avoid going off the end. The aircraft entered a skidding motion and turned through 180° to the right before going backwards over the edge of the airfield, stopping when the tail section struck the perimeter security fence (Figure 1). The pilot selected the engine mixture levers, magnetos, fuel and electrical master switch all off. After the pilot had established that none of the passengers were hurt, all the occupants evacuated the aircraft through the normal doors and made their way back onto the airfield where the RFFS was in attendance.

Footnote

1 Obscuring up to a quarter of the sky.

Accident site

Faint scald marks made by the tyres on the runway showed the aircraft skidded approximately 150 m before veering on to the grass approximately 19 m from the end of the runway. The aircraft continued across the grass whilst braking, leaving discoloured tyre marks in the grass. The right main wheels struck one of the runway threshold lights. During the transit across the grass the aircraft rotated through 180° immediately before dropping backwards down the sloping side of the ravine at the end of the runway. The aircraft's rearward motion was slowed by dense reeds and bushes on the sides of the ravine. It stopped when the left tailplane and wingtip hit the barbed wire and chain link perimeter fence approximately 8 m below the level of the runway. As the aircraft stopped the Bendix-King KX165 Nav-Comm unit fell out of its rack mount onto the cockpit floor. Figure 1 shows the aircraft after the accident held by the fence and at an approximate angle of 30°.

Figure 1
Aircraft accident site

Recorded information

A CCTV camera was mounted on the ATC tower and recorded the latter stages of the final approach and touchdown. From these images, the touchdown groundspeed was estimated to be 79 kt. Figure 2 shows a single frame of the recording at the point of touchdown with the wet runway and water spray being produced by the main landing gear wheels.

Figure 2
VP-MNI at the point of touchdown on Runway 10

Aircraft information

The Islander is an all metal twin piston engine high wing monoplane. It has fixed tricycle landing gear with a single nosewheel and twin main wheels. It is fitted with conventional mechanical flying controls and electrically driven flaps. VP-MNI can carry up to nine passengers and has a baggage hold at the rear with a maximum load of 400 lb.

Access to the cabin is via a door on the left side rear of the fuselage for the rearmost two rows of seats. A door on the right side of the fuselage opposite the engine nacelle gives access to the two rows of seats immediately behind the pilot's seats. The left and right pilot's seats are accessed via a door in the front left side of the fuselage. The doors are held closed by latches operated by lockable handles and, in the case of the pilot's door, have an interlock preventing them from being opened when the magnetos are ON. All the doors are available as emergency escape routes and their windows can be jettisoned in the case of a door jamming closed.

Wheel brake system

The wheel brake system consists of a single disk attached to each wheel with multi piston callipers. Master cylinders and fluid reservoirs are attached to each pedal on the rudder bar. The brakes are operated by foot pressure acting on the upper articulated part of the foot pedal. Each pedal can be operated independently to facilitate differential braking. The brake operating system is duplicated on the co-pilot (right) side of the aircraft. The wheel brakes are not fitted with an anti-lock or anti-skid system and there is no indication to the pilot of brake pressure or force when the brakes are applied.

Tyres

The aircraft was fitted with tubeless pneumatic tyres and on the main wheels have a normal inflation pressure of 35 psi.

Aircraft examination

Most of the damage was to components and structure at the rear of the aircraft. The left side of the tailplane main spar had broken at the root and was bent upwards (Figure 3). The elevator structure had also been damaged and bent in the same way. The rear anti-collision light had been displaced and was held only by its wiring. The left wingtip fairing and outer end of the aileron was dented and distorted.

Figure 3
Tailplane damage

The landing gear and wheel brakes were undamaged. The tyres did not deflate but the nose and right inner mainwheel had tufts of grass trapped between the tyre bead and rim. Blistering was present on three of the mainwheel tyres; the right outer tyre rolling surface showed evidence of blistering, approximately 75 to 100 mm long, at its edges and to a lesser extent on its centre tread (Figure 4). In general, the tyres showed wear commensurate with normal use.

The right main landing gear strut appeared to have been displaced outwards very slightly and had displaced the rubber seal between the strut fairing and lower rear engine cowl panel.

The nav-comm unit mounting rack and its Allen head locking screw did not appear to be damaged.

The rear covering panel of one of the passenger seats had detached during the accident. This was found to have occurred when one of the passengers hurriedly exited the aircraft.

Figure 4
Tyre wear and damage

Weight and balance

The aircraft was below its maximum landing weight and within the required CG limits.

Landing performance

The landing performance for the aircraft is obtained from the Aircraft Flight Manual, Performance section. At the estimated landing weight of approximately 6,220 lbs, the Landing Distance Required (LDR)[2] for a dry, level runway with no head or tailwind component at an elevation of 550 ft and an OAT of 30°C, is 448 m. For a wet runway, 15% must be added giving an LDR of 515 m. This is predicated on the approach speed of 65 KIAS being reduced to a threshold speed of 58 KIAS.

The operator stated that it expects its pilots to touch down as close as safely possible to the threshold of the runway, to make the maximum use of the LDA.

Footnote

[2] The LDR obtained from the AFM includes a safety factor of 1.3. The LDR is from a height of 50 feet above the Touch Down Point (TDP) and not the length of the ground run.

Aerodrome information

Montserrat John A Osborne Airport is operated by the Government of Montserrat under the Air Navigation (Overseas Territories) Order with regulatory safety and security oversight and inspection provided by UK based Air Safety Support International Limited. Aircraft movements are only permitted by day under Visual Flight Rules. Strict operating conditions are applied to the classes of aircraft which may use the airport and on pilot training, experience and qualification to operate them at the airport.

The airport is sited on a hill with a single runway orientated 10/28 (Figure 5). The thresholds of Runway 10 and 28 are 550 ft amsl. Runway 10 has Precision Approach Path Indicators (PAPIs) set to an approach angle of 6° and Runway 28 has Abbreviated PAPIs (APAPIs) set to an approach angle of 4°.

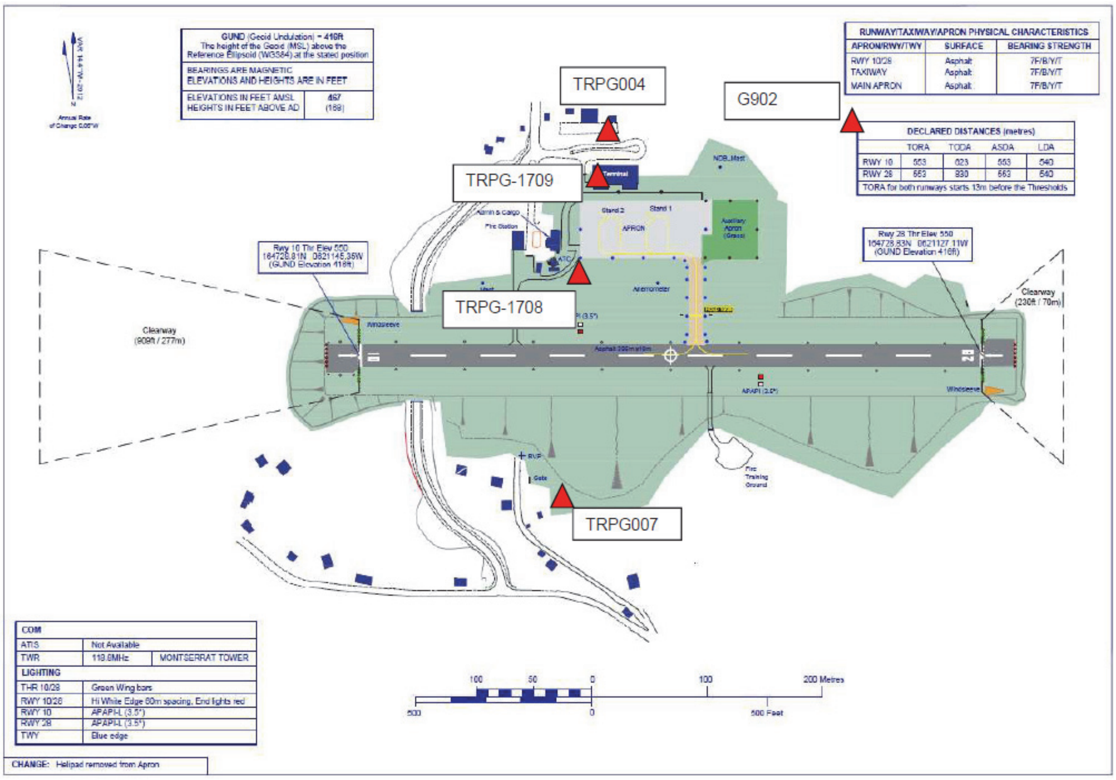


Figure 5

The Aeronautical Information Publication chart for Montserrat, John A Osborne Airport

A significant aspect of the airport and its surroundings is the graded, downslopes at both ends of the runway, which in the event of an overrun have the potential to cause damage to an aircraft and injury to those onboard. Runway 28 has a clearway of 277 m and an open departure towards the sea; Runway 10 has a clearway of 70 m over a ravine, at the end of which is a hill rising to 67 ft above the threshold elevation, 350 m from the end of the runway.

The airport is affected by variable wind direction and the resulting turbulence from the surrounding terrain, hence the steep approach angle of the PAPIs on Runway 10 and the stringent pilot qualification requirements for operating there.

Figure 6 shows the airport from south-west of the Runway 10 threshold end, revealing the proximity of the graded bank to the runway end and the hill at the far end.

Figure 6

Montserrat John A Osborne Airport looking towards the north-east

Runway condition

The runway has an asphalt on concrete surface 596 m long and 18 m wide. Over most of the runway surface the asphalt has been applied uniformly but showed evidence of mis-application and wear in some areas, examples of which are shown in Figure 7.

Airfield staff carry out regular runway surface friction testing in accordance with the maintenance policy using a friction test trailer (Grip Tester GT625) towed behind a large pick-up truck. The testing is done at 65 km/h along the landing distance available (LDA) on the runway. The Grip Tester produces data which is shown on a colour coded friction map, with runway friction characteristics shown as blue, green, yellow or red blocks on the map (Figure 8).

At the time of the accident the runway surface was described as 'wet', which is defined as the surface being soaked but with no standing water. Observers who visited the scene of the accident later in the day whilst the runway was still damp, described some of the areas at the ends and edge of the runway as "slippery under foot".

Figure 7

Examples of areas of surface degradation on the runway

Figure 8 shows that the runway surface friction varied over its length. ICAO Annex 14 - *'Aerodromes'*, Section 10.2.5 states that:

> *'Corrective maintenance action shall be taken to prevent the runway surface friction characteristics for either the entire runway or a portion thereof from falling below a minimum friction level specified by the State.'*

Guidance for evaluating runway surface conditions is contained within ICAO Doc 9137, Airport Services Manual Part 2. The numerical results from the friction test trailer towed at 65 km/h should be interpreted against the figures set out in Table 3-1 of this manual and are as follows:

- Minimum design objective for a new surface 0.74
- Maintenance planning level 0.53
- Minimum friction level 0.43

(These band are not the same as those in the colour key produced by the Grip Tester)

The test on 24 September 2019 showed that 54% of the surface was 'green' with a reading of above 0.63. There was insufficient information available to determine how much, if any, of the surface was also above the minimum design objective level of 0.74. 31% of the surface was 'yellow' with a reading between 0.55 and 0.63, indicating that it was above the minimum of 0.53 below which corrective maintenance activity should be considered. 15% of the surface was 'red' between 0 and 0.55. There was insufficient information available to determine how much of that surface was below the 0.53 maintenance planning level, and how much was below the minimum friction level.

Figure 8

Runway surface friction map (24 Sep 19) and colour key

Overseas Territories Aviation Circular (OTAC) 139-23 – *'Runway pavement characteristics and maintenance'*, issued on 15 January 2020, states:

> *'7.1 The aerodrome operator should review the results of each runway friction assessment and take the following action.*
>
> - *If the friction level value falls below the Maintenance Planning Level, maintenance should be arranged to restore the relevant friction level to a value greater than the Maintenance Planning Level or ideally, to a value equal to or greater than the Design Objective Level.*
> - *If the friction level value falls below the Minimum Friction Level, maintenance should be* ***urgently*** *arranged in order to restore the relevant friction level value at least to a value greater than the Maintenance Planning Level and, ideally, to a value equal to or greater than the Design Objective Level.*
> - *If the friction level value falls below the Minimum Friction Level it is important that pilots are warned that aircraft performance calculations may no longer be valid. In this case the aerodrome operator must issue a NOTAM advising only that the runway may be slippery when wet.*
> - *If a runway friction assessment indicates that the friction level falls below the Maintenance Planning Level or the Minimum Friction Level, the aerodrome operator should increase the frequency of runway friction assessments in order to enable any further or rapid deterioration of the runway surface friction characteristics to be identified and, if appropriate, for additional action to be taken.*
> - *If a runway friction assessment falls below the Minimum Friction Level and remedial action cannot be conducted urgently the aerodrome operator should consider withdrawing the runway from use for take-off and/or landing.'*

OTAC 139-23 states that *'The friction level values produced by different CFME vary slightly for any given runway surface friction characteristics.'*

Given the runway surface condition there was a plan to resurface the runway in the future. At the time of the event, the runway had a NOTAM in place warning pilots that the runway may be slippery when wet. Pilots were asked for their impression of the braking action on each landing and these assessments were logged with ATC.

Aerodrome rescue services

The airfield usually provides a Category 2 RFFS during Islander operations. The RFFS has two fire appliances, a Category 2 tender and a Category 5 tender[3]. At the time of the accident the Category 5 tender was unserviceable awaiting spares. Twin Otter aircraft occasionally operate at the airfield and require an enhanced fire and rescue capability. This is achieved by an additional fire fighter who is 'loaned' from the civil fire service based in the nearby town of Brades.

When an incident or accident occurs, regardless of the aircraft type, the airfield fire service receives backup from the civil fire service, which automatically deploys a tender. This was the case for the VP-MNI accident response.

Organisational information

The aircraft departed the level surface of the airfield and moved backwards down the vegetation covered slope at the end of Runway 10, adjacent to the Runway 28 threshold. This area is considered 'Difficult Environs' within the meaning of ICAO Annex 14, which states the following concerning the content of the Airport 'Emergency Plan':

> *'Emergencies in difficult environments*
>
> *9.1.14 The plan shall include the ready availability of, and coordination with, appropriate specialist rescue services to be able to respond to emergencies where an aerodrome is located close to water and/or swampy areas and where a significant portion of the approach or departure operations takes place over these areas.*
>
> *9.1.15 Recommendation.- At those aerodromes located close to water and/or swampy areas, or difficult terrain, the aerodrome emergency plan should include the establishment, testing and assessment at regular intervals of a predetermined response for the specialist rescue services.*
>
> *9.1.16 Recommendation.- An assessment of the approach and departure areas within 1,000 m of the runway threshold should be carried out to determine the options available for intervention.*
>
> *Note.- Guidance material on assessing approach and departure areas within 1,000 m of runway thresholds can be found in Chapter 13 of the Airport Services Manual (Doc 9137) Part 1.'*

Footnote

[3] OTAR Part 139 and ICAO Annex 14 sets out the categories of rescue and firefighting services required by an aerodrome. Category 2, required for aircraft from 9 m to 12 m in length, involves a fire tender with three crew and capable of delivering foam at 370 lt/min.

ICAO Document 9137, *The Airport Services Manual,* Part 1, Chapter 13 states:

> *'Consideration should be given to the following:*
>
> *a) provide direct access to the operational runway(s);*
>
> *b) designate access routes to the response area (consider debris and casualties);*
>
> *c) maintenance of roads and access routes (including construction activities);*
>
> *d) mitigate the possibility of any public and/or private non-emergency vehicle blocking the progress of responding emergency vehicles;*
>
> *e) take into account the gross weight and maximum dimensions of the RFFS vehicle(s) expected to use them; or any other responding vehicles;*
>
> *f) that roads are capable of being traversed in expected conditions;*
>
> *g) exit/access gates or frangible sections in the security fence that are constructed to allow RFFS vehicles to safely pass through with minimal delay;*
>
> *h) exit/access points will need to be clearly identified. Retro-reflective tape or markers will be of assistance where the aerodrome may need to be accessible during the hours of darkness or conditions of low visibility;*
>
> *i) the mitigation of impediments to RFF vehicle mobility; and*
>
> *j) provide sufficient vertical clearance from overhead obstructions for the largest RFFS vehicle/s.'*

Airport Emergency Plan

Chapter 3 of the Airport Emergency Plan for John A Osborne Airport sets out procedures for responding to an accident within the 1,000 m 'Difficult Environs'. An exercise of the airport Emergency Plan is held every two years, involving the emergency service and other stakeholders.

Included in this chapter are the actions required of the RFFS, which includes:

> *'3.2.2 Airport Rescue and Fire Fighting Service shall:'*
>
> > *'a) Proceed via the most suitable access routes to the off-airport accident site in co-ordination with the police responsible for ingress and egress roads;'*

Whilst the airport area is level and accessible to vehicles and fire and rescue personnel, the surrounding area within the 1,000 m requirement has differing levels of access. Regarding a runway overrun, as with this accident, both the undershoot areas for Runway 10 and 28 thresholds have steep inclines of about 45˚ in places.

The Runway 10 undershoot can be reached from the airfield boundary from above and by vehicles accessing the base of the slope from below. There are various level or gently sloping areas navigable by RFFS vehicles, and access roads in the immediate area of the base of the slope. The Runway 28 undershoot has a ravine, some 260 m across, and is more difficult for vehicle access, which is limited to the level area of the airport and possibly as far as the security fence. Any other access to the ravine would be by rescue and firefighting personnel only, with hand carried equipment. Figure 9, shows the airport runway (North is at the top of the figure) with the yellow centrelines extending 1,000 m from each runway threshold.

Figure 9

John A Osborne Airport, showing centrelines extended 1,000 m from each runway threshold

This investigation has focussed on an aircraft in the landing or abandoned takeoff phase of flight being unable to stop in the remaining distance available[4].

Previous accident

On 17 April 2011, VP-MNI was also involved in a landing accident, which on that occasion was due to failure of the right brake system. The runway was dry and the touchdown

Footnote

[4] The BN2A Islander is a Performance Group B aircraft and no accelerate/stop distance information is provided in the Flight Manual.

normal, but when the pilot applied the brakes, there was no resistance from the right brake pedal. The pilot tried pumping the right brake pedal, but it had no effect on the right brake. To avoid departing the end of Runway 10, the pilot applied full left brake and allowed the aircraft to veer left onto the grass alongside the runway where it struck a low bank at low speed and came to a stop.

Personnel information

The pilot commenced flying training in Trinidad and was issued with a PPL/A in November 2013, then completed a Professional Pilot's course and was issued with a CPL/IR. From November 2015 until joining the current operator the pilot operated light twin engine Piper Seneca III and Cessna 421 aircraft on inter island flights around the Caribbean. In November 2018 the pilot was issued with a Montserrat Certificate of Validation and commenced line training as a First Officer (FO) with the Montserrat based operator. After completing all the requirements for operating from John A Osborne Airport the pilot flew 172 hours as an FO before a transition to aircraft commander was completed on 4 May 2019, after another 45 hours flight time. At the time of the accident, the pilot had flown 445 hours on multi piston-engine aircraft.

Other information

Aquaplaning

Aquaplaning is a phenomenon which affects tyre grip on a surface where standing water is present having a 1 mm or greater depth over the entire surface or where there are multiple areas of puddled water.

Aquaplaning occurs at higher speeds when the weight of the aircraft becomes wholly supported by the dynamic reaction of water so the tyre rolling surface loses contact with the ground and instead rides on the surface of the water. In this situation braking and steering are significantly affected, and loss of directional stability and control is highly likely. The speed at which it occurs is a derivative of tyre pressure and a numerical constant; for a rotating wheel, $V_a=9\sqrt{p}$ and for a non-rotating wheel, $V_a=7\sqrt{p}$. V_a is in knots and p, tyre pressure, is in pounds per square inch (psi).

Calculations for this aircraft type, based on the normal tyre pressure of 35 psi, show that the minimum aquaplaning speed for a rotating wheel is 53 kt. For a locked non-rotating wheel, it is 41 kt.

Analysis

Operations

Before departing Antigua, the pilot had reviewed the weather and had planned to remain clear of Montserrat in VMC until the rain shower had passed. The aircraft was being operated within the permitted maximum landing weight and was fully configured for the landing on Runway 10, which with the wind passed by ATC of 210° at 6 kt, gave a small tailwind component of about 2 kt. The LDR was 515 m and the LDA was 540 m with no head or tailwind component. The pilot's recollection was that the approach airspeed was indicating about 65 KIAS with no reduction to the threshold speed of 58 KIAS, but the touchdown groundspeed determined from the control tower image recording was 79 kt. At that speed on a wet runway, the LDR would have increased significantly and when combined with skidding, led to the aircraft overrunning the end of the runway. The pilot was aware of the hazard presented by the ravine and made a positive turn to the right in an attempt to avoid it. This succeeded in turning the aircraft around and probably reducing the speed at which it left the level surface of the airport and entered the downslope. The descent was then arrested by the security fence preventing further movement and possible damage. The pilot of the aircraft involved in the 2011 right brake failure event responded similarly, and on that occasion avoided overrunning the end of the runway by turning left, probably because only the left brake was working.

Due to its elevated position and the surrounding terrain, the airport does present significant challenges due to the local variation in wind direction and strength, which may have contributed to the accident. Therefore, the following Safety Recommendation is made:

Safety Recommendation 2020-014

It is recommended that Air Safety Support International Ltd ensure that pilots and operators intending to use John A Osborne Airport take account of local wind variations, and require operators to demonstrate how they will achieve this.

Aircraft systems, wheels tyres and brakes

The damage sustained by the aircraft during the accident is consistent with it skidding off the paved area of the runway onto the grass and being arrested by the bushes, reeds and the airfield perimeter fence. The landing gear, wheels, brakes and tyres were in good condition and operated correctly in accordance with the demands made by the pilot.

Of note was the avionic unit unshipping from its rack. The sudden rearward deceleration as the aircraft was brought to a stop and the 30° angle it came to rest, caused it to release from its rack within the instrument panel. The absence of apparent damage to the nav-comm unit rack and locking screw, suggest that the locking screw may not have been correctly engaged. Although this was undesirable, it only manifested itself as an issue in the unusual circumstances of this accident and is therefore not of any consequence.

Runway surface

The Grip Tester map (Figure 8) shows that the friction characteristics of part of the runway may have been below the maintenance planning level or below the minimum friction level, especially to the right of the centre line on Runway 28 adjacent to the '28' marking. Surface friction was not uniform and the surface preparation was wearing out, so plans were in place for resurfacing. A NOTAM was issued warning pilots the runway may be slippery when wet

Landing and skidding

The evidence derived from the CCTV recording shows the aircraft to be landing at 79 kt. On landing the wheel brakes were applied but were ineffective. The tyre marks on the runway, the very faint white tyre edge lines, show the tyres were locked and skidding on the tarmac surface. They were generating enough heat to scald and blister the vulcanised rubber of the tyres. The tyres were therefore in contact with the surface and created superheated steam from the moisture present hence the white marks. This evidence leads to the conclusion that the aircraft was skidding but not aquaplaning but is consistent with the description of the runway being 'wet'.

Skidding was inevitable when the aircraft touched down at this higher than normal speed, at which a significant proportion of the aircraft weight is supported by wing lift. Therefore, contact pressure exerted by the tyres on the runway is greatly reduced. This probably remained the case until such time that the speed reduced to below approximately 50 kt but by this time, the aircraft would had travelled further along the runway all the time encroaching on the required stopping distance. In this situation the distance travelled was made worse by the reduced retardation produced by a locked and skidding tyre rather than a rotating tyre under braking.

Rescue and location

Due to the topography of the airfield location, the land falls away steeply at the runway ends. This aircraft travelled down the 45° slope at the end of the runway and was brought to a stop by the vegetation and fence. Had this not been the case the aircraft could have travelled a considerable distance further down into the ravine. The forces on the aircraft and its occupants could have been significantly higher and may have led to more significant damage to the aircraft and increased the risk of fire had the fuel system been compromised.

Immediate rescue would have been much more difficult due to the potential problems in accessing the aircraft. The two fire appliances at the airfield do not have the capability to be driven down into the ravine. Therefore, they would have to apply foam firefighting media from above with a risk that it would not reach or be affective on a crashed aircraft.

In the scenario, getting to a crashed aircraft on foot is potentially difficult and in the case of an aircraft fire, would put those individuals trying to approach the aircraft in a dangerous position. This is because the escape route for rescuers and injured survivors would be made difficult or even prevented by the overgrown and steep terrain.

The steep slopes and terrain at each end of the runway present significant hazards to an aircraft if it fails to stop in the distance available. Significant damage is possible, with the associated risk of fire and injury to those onboard. Dense vegetation and difficult terrain present the airport RFFS with considerable difficulty reaching a crashed aircraft in the immediate undershoot area of the Runway 28 threshold and may cause significant delay in rescue and firefighting operations. Access to the ravine beyond is severely restricted, with no roads available for RFFS vehicles. Accordingly, the following Safety Recommendation is made:

Safety Recommendation 2020-015

It is recommended that the operator of John A Osborne Airport provide adequate access to the Difficult Environs at the east end of Runway 10 to ensure that emergency services can reach expeditiously the location of an aircraft which has overrun the end of the runway.

Whilst the immediate area of the Runway 10 undershoot has better access for RFFS, the risk of serious damage, fire and injury to those onboard an aircraft departing during a landing or abandoned takeoff, is the same for both ends, indicating that it is necessary to limit the progress of an aircraft that is unable to stop in the distance available. Therefore, the following Safety Recommendation is made:

Safety Recommendation 2020-016

It is recommended that the operator of John A Osborne Airport install a means of arresting the progress of an aircraft that has overrun either end of the runway in order to minimise the risk of injury to those onboard and to ensure that emergency services can reach them expeditiously.

Conclusion

There were no faults or malfunctions of systems or equipment within the aircraft contributory to this accident. It appears that either increased airspeed over the normal approach speed of 65 kt was used or a significant change in windspeed and direction led to an increased tailwind component, causing a touchdown groundspeed of 79 kt. This, combined with a wet runway and skidding, greatly increased the LDR beyond that available and led to the overrun.

Safety recommendations are made regarding aircraft operations at John A Osborne Airport, access for rescue and firefighting vehicles, and a means of arresting aircraft that overrun the runway.

Published: 21 May 2020.

ACCIDENT

Aircraft Type and Registration:	Standard Cirrus 75, G-DDGX
No & Type of Engines:	No engines
Year of Manufacture:	1975 (Serial no: 619)
Date & Time (UTC):	27 July 2019 at 1130 hrs
Location:	Gwernesney Airfield, Monmouthshire
Type of Flight:	Private
Persons on Board:	Crew - 1 Passengers - None
Injuries:	Crew - 1 (Fatal) Passengers - N/A
Nature of Damage:	Aircraft destroyed
Commander's Licence:	British Gliding Association (BGA) Certificate with B Badge Endorsement
Commander's Age:	54 years
Commander's Flying Experience:	Total hours not determined 182 flights totalling 41 hours since August 2015 (of which 2 hours and 20 minutes were on type) Last 90 days - 3 hours and 42 minutes Last 28 days - 1 hour and 38 minutes
Information Source:	AAIB Field Investigation

Synopsis

The glider was undertaking an aerotow launch to the west at Gwernesney Airfield which was operated by the resident gliding club. During the early stages of the ground roll the horizontal tailplane (tailplane) detached from G-DDGX and fell to the ground. Club members assisting with the launch signalled for the takeoff to be aborted but the message did not reach the aerotow tug pilot; the accident pilot did not appear to hear or see the stop signals either. The glider became airborne and climbed rapidly, before the tow cable released and the aircraft's nose dropped. The glider descended steeply and struck the ground nose first. It came to rest inverted pointing in an easterly direction. First responders extricated the pilot from the aircraft before he was airlifted to hospital. He died five days later from complications related to injuries sustained in the accident.

The investigation determined that the tailplane had not been correctly attached when the glider was rigged and this condition was not detected prior to the flight. Several possible mis-rigging scenarios were identified during the investigation, but the precise manner in which the tailplane had been mis-rigged could not be determined.

Two Safety Recommendations are made relating to communication for glider launching and detecting incorrect alignment of tailplane locking features. In addition, the gliding club has

undertaken several safety actions regarding launch signalling and detection of incorrect tailplane locking on other Standard Cirrus gliders.

History of the flight

A club member reported that, when they arrived at the airfield at 0750 on 27 July 2019, the accident pilot was already on site. By then he had prepared the club's ground equipment and carried out daily inspections (DI) on the club's tractor and the winch used for launching gliders. The pilot was reported to be in good spirits and looking forward to flying. This was to be his fifth flight in G-DDGX.

After helping to prepare the club's own gliders the accident pilot began to rig G-DDGX, which was stored dis-assembled in its trailer at the airfield. Shortly after he had removed the fuselage and wings from the trailer the pilot attended the 0900 hrs morning briefing in the clubhouse. On returning to the glider the pilot sought the assistance of two club members to help attach the wings. He then declined offers of further assistance and completed the rigging process, including fitting the tailplane, on his own. Later that morning a different club member helped the pilot conduct positive control checks on the aircraft. Nothing untoward was noted during the control check process. The aircraft was later moved to the aerotow queue for a westerly launch.

When it was G-DDGX's turn, the aerotow tug pilot positioned the tug aircraft near the glider and radioed for people to assist with connecting the tow cable and to help with the launch. One club member attached the cable to the glider before assuming the role of wingtip holder. Another member took up the position as forward signaller, standing approximately halfway between the tug (G-AVXA) and the clubhouse (Figure 1). The assisting ground personnel directed the tug pilot to take up the cable slack. When the glider pilot was ready, the wingtip holder signalled 'all-out'[1] and this was relayed by the forward signaller.

After the 'all-out' signal had been received, the tug pilot's attention was focused on a safe takeoff. In addition to monitoring engine parameters, the tug pilot needed to keep the aircraft straight and to ensure a safe departure with due consideration for the trees at the far end of the airfield. The forward signaller was very quickly out of their primary visual field.

The wingtip holder was supporting G-DDGX's left wingtip as the glider started to move and noticed that the tailplane had started to "wobble." Coincident with full power propwash from the tug reaching the glider, the leading edge of the glider's tailplane began to lift. The whole tailplane assembly then flipped up and backwards off the fin. The wingtip holder shouted "stop" and let go of the wingtip to send the visual stop signal[2] to the forward signaller. The tug pilot, who was concentrating on the takeoff roll, did not see the relayed signal. The tow cable remained attached to the glider throughout its "shorter than normal" ground roll.

Footnote

1 The executive command for the tug to start the takeoff roll.
2 Both arms raised.

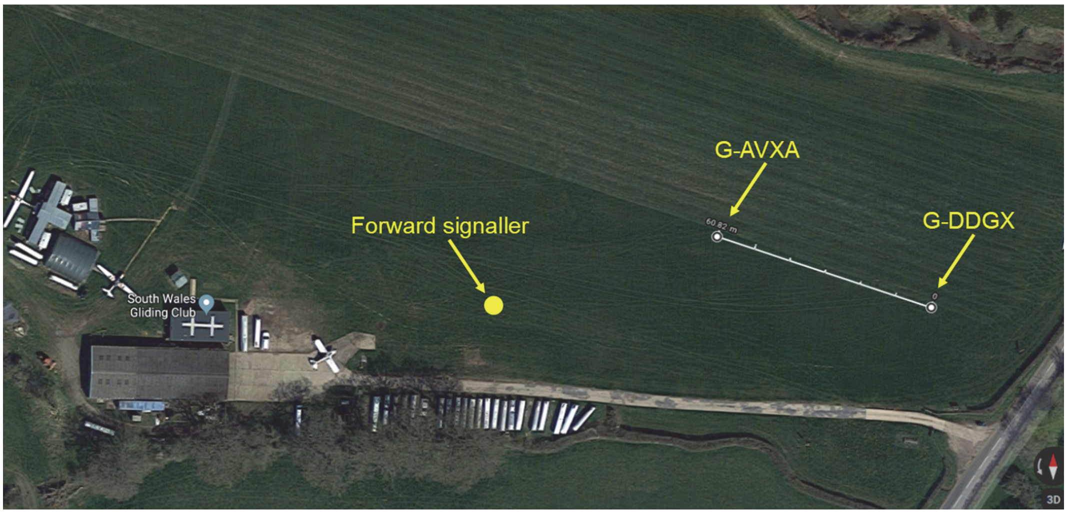


Figure 1

Approximate disposition of G-AVXA, G-DDGX and forward signaller before takeoff

Once airborne the glider climbed rapidly while the tug was still on the ground. The tug pilot felt the tail of the aircraft being pulled upwards and looked in the mirrors. G-DDGX was seen in the mirrors in planform behind the aircraft and significantly higher than would be expected at that stage of the takeoff. The tug pilot immediately aborted the launch and allowed the tug to roll to a halt.

Whether by the glider pilot's actions or by it back-releasing, the tow cable detached from G-DDGX during the climb. Eyewitnesses reported that the glider reached a maximum height of between 30 and 80 ft before its nose dropped and it descended steeply to the ground. After impact, the glider came to rest inverted, pointing in an easterly direction. The canopy had detached, and the pilot was restrained in the cockpit by the harness straps. The first club member on the scene reported that the pilot was initially unconscious but came around a short while later. Emergency Services were on site within 10 minutes of the accident. The pilot was released from the straps and the glider was lifted clear. The pilot was airlifted to hospital in Cardiff. He died five days later from complications arising from his injuries.

Meteorology

At the time of the accident, good weather prevailed and there was a light north-north-westerly breeze.

Airfield information

Gwernesney Airfield is situated on flat ground to the east of the Usk Valley in Monmouthshire. It is aligned broadly east-west and bordered to the north by a tree-lined stream. Due to the presence of trees in the overshoot, aerotow launches to the west often require a left turn after takeoff to make full use of the clear ground track available (Figure 2). The glider site sits within Class G airspace.

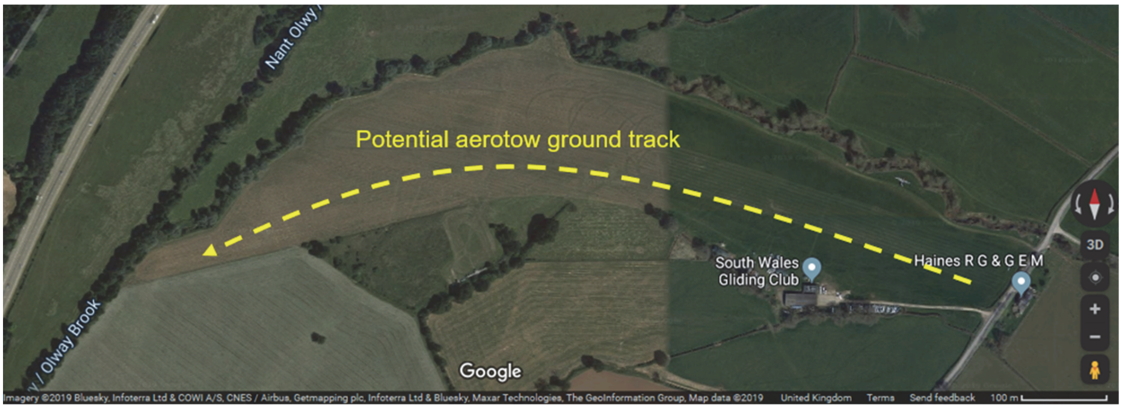


Figure 2

Overview of Gwernesney Airfield

Personnel

The accident pilot had started gliding as a teenager but had not flown for many years before joining the club at Gwernesney in 2015. Fellow club members described him as a cautious and competent pilot. They reported that he was studying for his Bronze Endorsement and was hours-building with a view to eventually becoming a gliding instructor.

Onsite examination

The glider had struck the ground in a steep nose-down attitude abeam the clubhouse. The nose of the glider and cockpit area were severely disrupted. The vertical fin had suffered damage in the impact and remained attached to the fuselage only by the rudder and tailplane pushrods.

The tailplane had come to rest close to the launch point, approximately 237 m from the main wreckage. It was immediately apparent that, although the tailplane safety pin was installed, the tailplane locking lever was forward of, rather than the normal position aft of, the safety pin (Figure 3).

Description of the glider

Ownership

G-DDGX was jointly owned by two syndicate members, one of whom was the primary owner (referred to hereafter as the owner). Two additional pilots had joined the syndicate as '*insurance shares*,'[3] the first began flying the glider in 2018. The second insurance share was the accident pilot who had been a member of the syndicate for two months. G-DDGX was not equipped with a radio.

Footnote

3 Whereby the individual contributes to the cost of insuring the glider in return for being allowed to fly it.

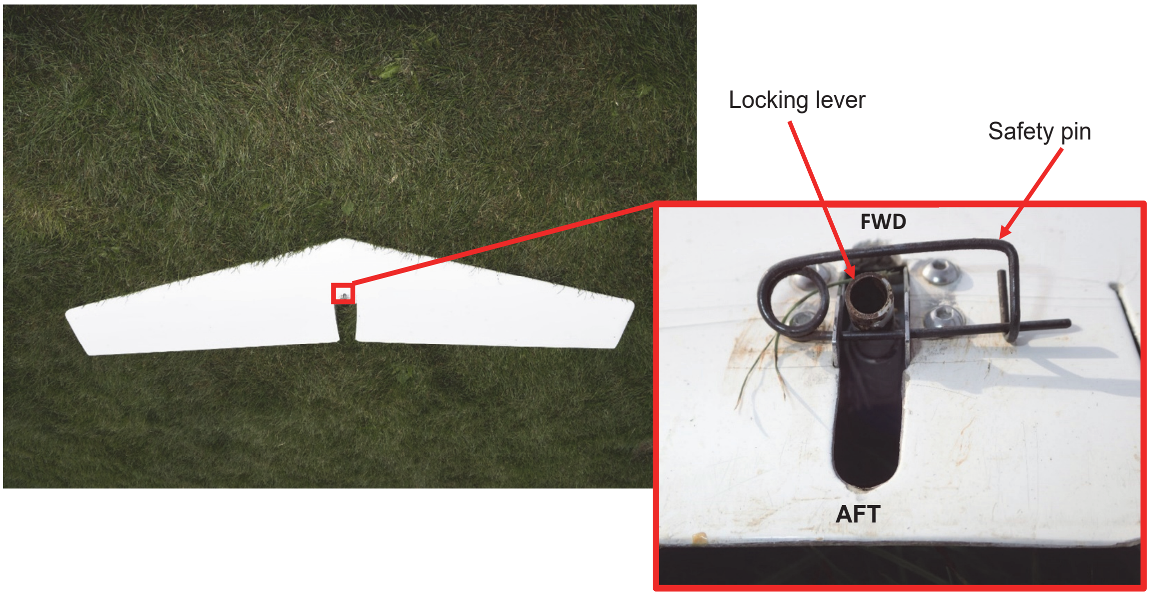


Figure 3

G-DDGX tailplane (as found condition)
with inset showing locking lever forward of safety pin

General

The Standard Cirrus glider is a single-seat standard class glider with a 15 m wing span, which was designed and manufactured by Schempp-Hirth[4] and first flew in 1969. It is of predominantly glass fibre composite construction and is equipped with a retractable mainwheel, a single towing hook and an all-moving tailplane[5] mounted on top of the fin. The flight control systems for the aileron, airbrake, rudder and tailplane are of the pushrod type. The tow hook release and wheel brake control systems are operated by cables.

Several variants of the Standard Cirrus were built. G-DDGX, built in 1975, was a Standard Cirrus 75 which incorporated redesigned wing fairings, a longer nose, larger airbrakes and a modified tailplane attachment fitting.

Tailplane control system

The tailplane (elevator) control system on the Standard Cirrus 75 comprises a horizontal pushrod which runs from the control stick quadrant, through the length of the fuselage to the base of the tail fin, where it is connected via a bellcrank to another pushrod running vertically through the fin. This pushrod is connected to the underside of a fitting mounted at the top of the fin (Figure 4), which pivots around its axle in response to movement of the control stick. At the forward end of the fitting is a tapered bolt, which engages with a lug, known as the 'front fitting,' on the underside of the tailplane.

Footnote

4 Some Standard Cirrus's were built under licence by other organisations, including Vazduhoplovno Tehnicki Centar (VTC) based in the former Yugoslavia.

5 The horizontal tailplane on the Standard Cirrus series of gliders is an all-moving tailplane which provides pitch control without the need for a separate elevator control surface. The tailplane attachment mechanism provides structural and control connection.

The corresponding mechanism in the tailplane comprises two locking hooks on a pivoting bar which is mounted on a bracket on the aft face of the tailplane spar (Figure 5).

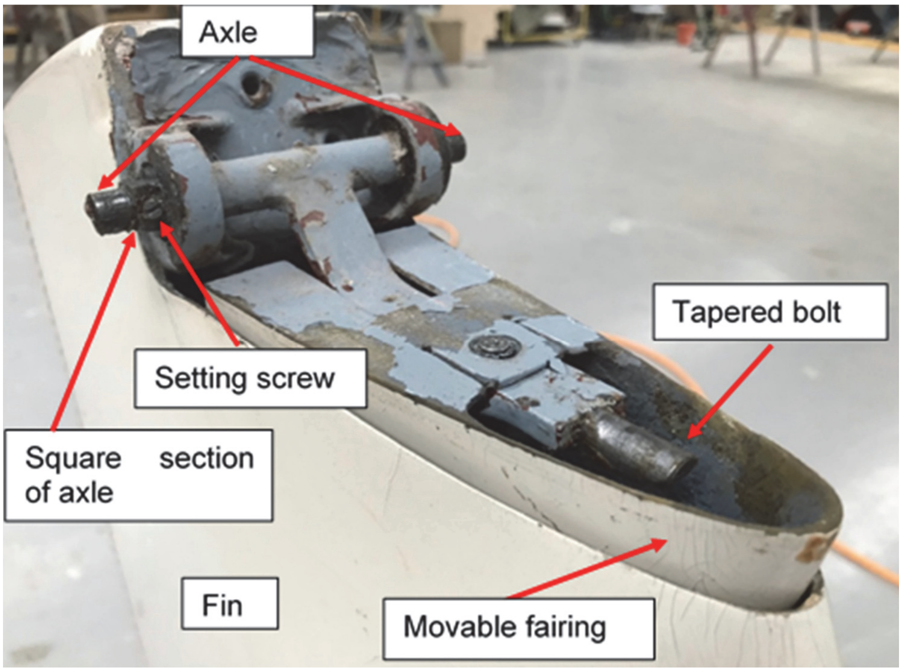


Figure 4

Standard Cirrus 75 Modified tailplane attachment fitting at top of fin

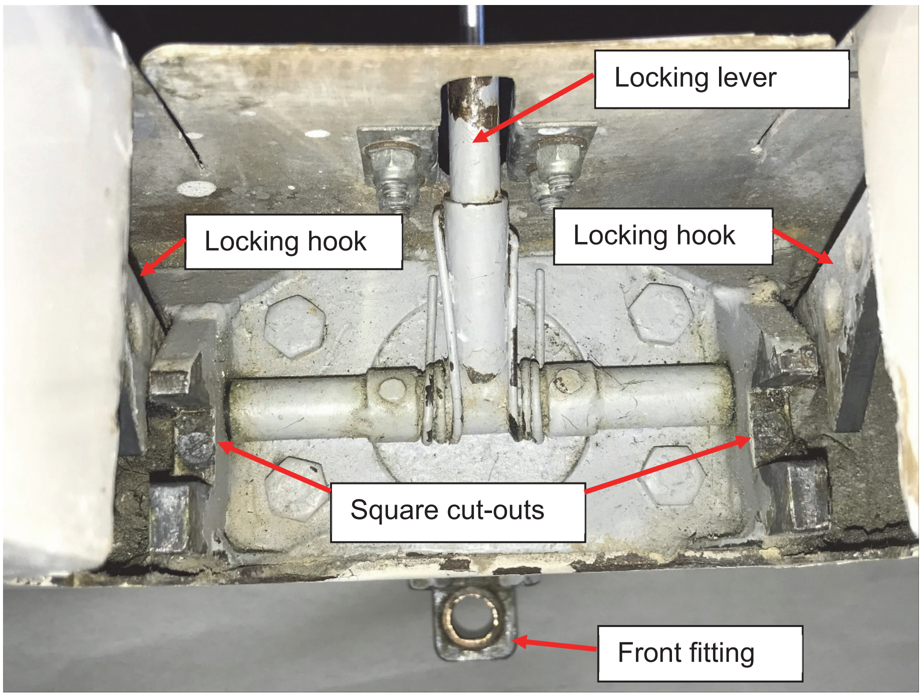


Figure 5

Standard Cirrus 75 Modified tailplane attachment mechanism
(view looking forward)

When the tailplane is placed on top of the fin, square cut-outs in the mounting bracket engage with the square sections of the axle on the fin fitting, to locate the tailplane. Two adjustable setting screws on the square axle sections are used to remove any tangential play in the mechanism. The locking hooks engage with the circular ends of the axle. The hooks are spring-loaded to the closed position and are operated by a locking lever.

When the tailplane is attached, the locking lever protrudes through a slot in the top surface of the tailplane. The locking lever is hollow, and a rigging tool can be inserted for ease of movement. To lock the tailplane in place, the locking lever is moved to the aft end of the slot. A safety pin is then inserted forward of the locking lever to prevent it moving forward towards the unlocked position (Figure 6). To de-rig the tailplane the safety pin is removed, and the locking lever is moved forward to release the locking hooks from the axle.

Figure 6

Locking lever when tailplane attached (left image)
and when locked with safety pin inserted (right image)

Evolution of Standard Cirrus tailplane rigging design

General

Previous models of the Standard Cirrus had a tailplane attachment mechanism known as the 'T-fitting.' In this arrangement, the vertical pushrod in the fin terminated in a hook, which engaged between two bearings in the tailplane.

In 1975, the modified tailplane attachment mechanism was introduced by Technical Notice (TN) 278-15 *'Attachment and control connection of the horizontal tailplane'* (Figure 7). The reason for the modification was described as *'Simplification of the mounting, easy checking of the mounting, adjustable tangential backlash of the elevator control.'* Later models of the Standard Cirrus, including G-DDGX, were manufactured with TN 278-15 already embodied.

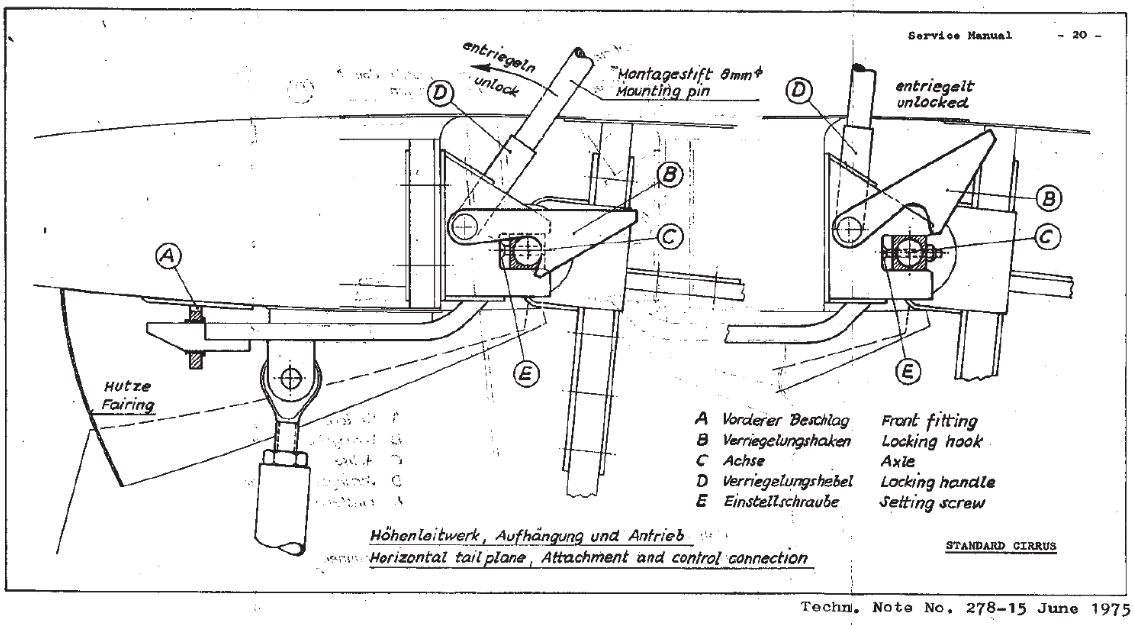


Figure 7

Tailplane attachment and control connection from TN 278-15 and Standard Cirrus flight manual

Rigging instructions

For gliders with TN 278-15 embodied, the Standard Cirrus flight manual provides the following instructions for tailplane assembly. The letters in parenthesis refer to the items labelled in Figure 7.

> *'The tailplane should be mounted by one person only.*
>
> *Put the plane from the front onto the fin so that the front bolt bearing fitting (A) is just dipping into the upper opening of the moveable glass fibred fairing on top of the fin.*
>
> *Push the tailplane slightly down until its lower surface is fully lying on the fairing. Push the tailplane backwards until a clear audible "CLICK" indicates that the locking hooks (B) are engaged onto the axle (C). Move the locking handle (D) using a mounting pin of 8 mm dia in order to lock the hooks (B) tightly up to the rear stop.'*

And disassembly:

> *'When taking off the horizontal tailplane it is advisable to do it from the rear.*
>
> *Unlock the hooks (B) by pushing the locking handle (D) forward using the 8mm dia pin. Push the plane simultaneously forward about some mm [sic] (about one inch) while knocking against the trailing edge until the bolt is disengaged from the bearing fitting (A).'*

Additional safety device

TN 278-36 *'Safety device for the locking lever of the tailplane attachment,'* was introduced on 24 November 1994 and was subsequently mandated by Airworthiness Directive 95-015[6] dated 15 December 1994. It was required to be embodied before 31 March 1995. The reason for the modification was described as: *'Due to the lack of maintenance or because of wear, the locking hook on the tailplane attachment bracket became disengaged in a number of cases, so that the horizontal tailplane was no longer securely attached to the fin.'* The actions required by TN 278-36 included: *'Re-adjustment of the set screws on the tailplane attachment bracket to eliminate any tangential play … Installation of a safety device* [pin] *for the locking lever…Check of the rigged and secured horizontal tailplane for full and free movement up to the stops.'* It did not stipulate any amendments to the existing rigging instructions in the flight manual. An illustration from TN 278-36 is shown in Figure 8.

TN278-36 was also applicable to certain examples of the Nimbus 2, Janus, Mini Nimbus HS7 and Nimbus 2M gliders which have similar tailplane locking mechanisms.

The glider manufacturer was unable to provide details of the incidents referenced in TN 278-36 that had prompted the introduction of the modification.

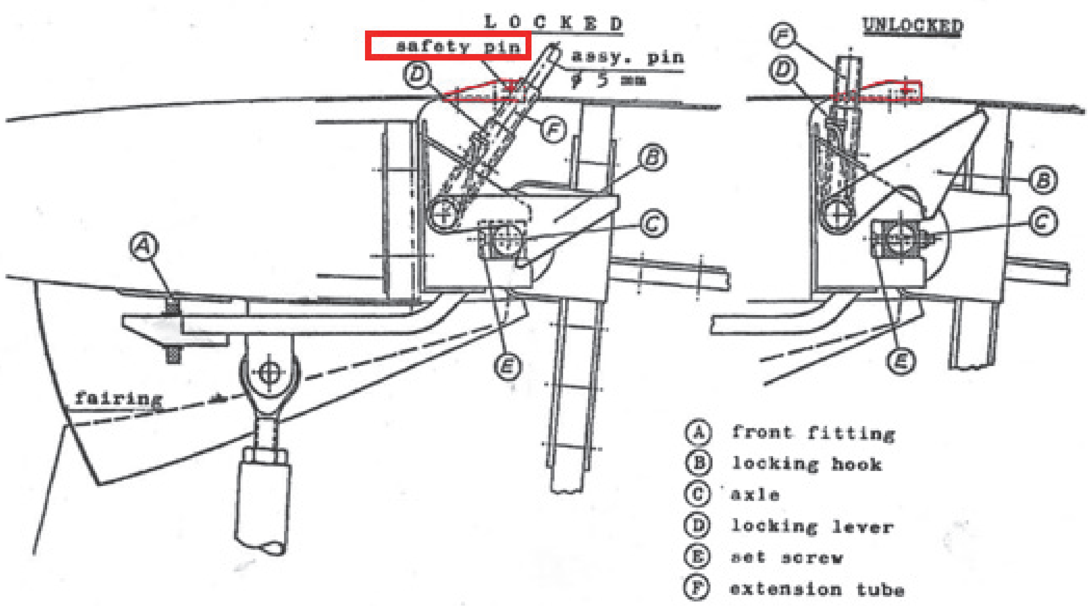


Figure 8

Tailplane attachment and control connection from TN 278-36
showing addition of a metal bracket and safety pin

Footnote

6 Issued by the Luftfahrt Bundesamt (LBA), the German national airworthiness authority.

Flight manual

G-DDGX Flight manual

G-DDGX's flight manual included illustrations showing both the original T-fitting tailplane attachment mechanism and the modified tailplane fitting incorporated on G-DDGX. The tailplane assembly/disassembly instructions were relevant only to the original T-fitting mechanism and were not relevant to the actual tailplane configuration on G-DDGX.

The illustration of the original T-fitting mechanism predated G-DDGX's manufacture and the labelled components were identified in English and German. The illustration of the modified tailplane fitting did not include any reference to TN 278-15, was not dated and the labelled components were identified in Croatian. This suggested that this page may have been from the flight manual of a VTC-manufactured Standard Cirrus. This illustration did not show the safety pin on the locking lever introduced by TN 278-36, however a copy of TN 278-36 was found elsewhere in the G-DDGX's document folder.

The owner indicated that the flight manual was provided when he purchased G-DDGX, and that he relied on the BGA inspector to identify any flight manual updates.

The front cover of G-DDGX's flight manual listed its serial number as 169, rather than 619.

Generic Standard Cirrus flight manual

The other pilot with an insurance share in G-DDGX had downloaded a generic Standard Cirrus flight manual from a popular enthusiasts website, in preparation for flying G-DDGX. This version of the flight manual contained assembly instructions relevant to the modified tailplane mechanism configuration on G-DDGX but although these instructions referenced an illustration of the tailplane mechanism, the manual did not include any such illustration.

Pilot's flight manual

It was not determined what, if any, version of the Standard Cirrus flight manual the accident pilot may have had.

Information from the manufacturer

The glider manufacturer advised that every glider is delivered with the correct flight manual relevant to its production configuration but if, after delivery of the glider, a modification (technical note) is embodied, which results in changes to the flight manual, the relevant pages of the flight manual must be replaced. The manufacturer is not normally informed when a technical note is embodied on each glider and therefore it is the responsibility of the owner to keep the flight manual for their glider up to date. Owners can download technical notes relevant to their glider from a portal on the manufacturer's website.

The glider manufacturer stated that it was not aware of any tailplane rigging accidents involving Standard Cirrus's with the modified tailplane attachment mechanism.

G-DDGX maintenance history

G-DDGX was manufactured in 1975 and was initially operated in the UK by the Army Gliding Association until 1990, when it was purchased by a private owner. The current owners purchased G-DDGX in 2010. Maintenance records show that TN 278-36 was embodied on G-DDGX in May 2000.

G-DDGX underwent its most recent annual inspection and Airworthiness Review Certificate (ARC) renewal on 21 April 2019. A review of glider documents during the ARC renewal indicated that the flight manual had been reviewed in depth, that it was applicable to the aircraft configuration and that it reflected the latest applicable revision status.

Following its annual inspection, G-DDGX flew 16 flights over nine separate days and had accumulated 3,186 hours and 3,176 launches at the time of the accident.

Owner's experience of rigging G-DDGX

G-DDGX was stored in a trailer and was rigged prior to each day's flying. The owner reported that when in the trailer, it was his custom to store the tailplane with the locking lever in the neutral position (sprung closed) and the safety pin inserted in its bracket. The rigging tool, a steel tube with a ball on the end, used to move the locking lever, was stored separately in the trailer.

The owner indicated that he was not overly familiar with the rigging instructions and illustrations in G-DDGX's flight manual and instead relied on the practical demonstration of the rigging that he had received when he first purchased G-DDGX, and his own experience of rigging the glider since then.

He estimated that he had rigged G-DDGX approximately 70 times. He described the tailplane rigging as a straightforward process, during which he had never experienced any difficulties. He normally stood in front of the fin facing aft towards the tail. He would firstly remove the safety pin from its bracket, so that when the tailplane was positioned on the top of the fin, the locking lever was free to move. He reported that the mechanism made an audible "clunk" when the locking hooks engaged on the axle and described the tailplane as being quite securely attached at this point, even before the locking lever was moved aft to the locked position. When moving the lever towards the locked position he described feeling the mechanism tightening up or locking. The safety pin was then inserted forward of the locking lever.

The owner stated that he was always cautious when rigging the tailplane, having been made aware of previous accidents relating to tailplane rigging on the Standard Cirrus. Although, he believed these to be related to gliders with the original tailplane attachment configuration, he adopted a cautious approach. It was his custom to shake the tailplane after rigging, as a secondary check to ensure it was properly attached.

Prior to the accident pilot's first flight in G-DDGX on 25 May 2019, the owner described and demonstrated the rigging of the glider to him. The owner ensured that the pilot carried out all the rigging actions, so that he would become familiar with them. The owner supervised the rigging, checked the connections afterwards and signed the DI book. He communicated his own cautious approach to the pilot. He reported that there was no indication that the pilot had been uncertain about any aspects of the rigging procedure and the owner advised the pilot to call him or to speak with the club technical officer, if he was ever uncertain about the rigging. The owner was not present on the subsequent occasions when the pilot rigged G-DDGX, including the day of the accident.

The other pilot with an insurance share in G-DDGX reported that the owner had demonstrated the rigging to him on two occasions. He recalled the owner emphasising that the locking lever needed to be in the correct position when rigging the tailplane. This pilot reported that on each of the three occasions he had rigged G-DDGX, he had asked the club technical officer to perform a secondary check of the rigging.

Pilot's rigging experience

All the pilot's gliding in G-DDGX took place at the gliding club. Based on records from the gliding club, the pilot had flown G-DDGX four times on four separate days between 25 May 2019 and 13 July 2019. He had signed G-DDGX's DI book four times, including for the accident flight. In addition to rigging G-DDGX with the owner on 25 May 2019, he would have rigged the glider a further three times, with the rigging on the day of the accident being his fifth time. G-DDGX was last flown on 21 July 2019 by the owner.

The club technical officer indicated that he had discussed the intricacies of rigging the glider with the pilot when he first started flying G-DDGX and had offered to perform secondary checks on his rigging of G-DDGX. The pilot had taken him up on this offer on one occasion, but not on the day of the accident.

Detailed aircraft examination

Disruption to the top of the tail fin caused by the impact, meant that the moveable fairing around the tailplane attachment mechanism had separated, but the mechanism was otherwise intact. There was no evidence of grease on the mechanism, but it rotated freely. No tangential play was evident in the mechanism and the setting screws had several threads wound out, indicating that they had previously been adjusted.

Both the vertical tailplane pushrod in the fin and the horizontal pushrod within the fuselage had been bent during the impact and were cut to facilitate recovery of the wreckage and operation of the mechanism. As a result, the mechanism at the top of the fin was no longer connected to the remainder of the control run and was therefore unrestrained. The vertical pushrod was moved up and down to simulate forward and aft movement of the control stick.

The tailplane was undamaged. The locking lever was protruding through the slot in the upper surface of the tailplane and was resting against, and forward of, the safety pin. Upon removal of the safety pin, the locking lever sprang back to its neutral position. The top of the locking lever in the area where it was in contact with the safety pin showed evidence of missing paint and surface corrosion, the extent of which was greater on the rear face of the lever (Figure 9). In normal operation the lever moves freely within the slot and does not come into contact with any other structure.

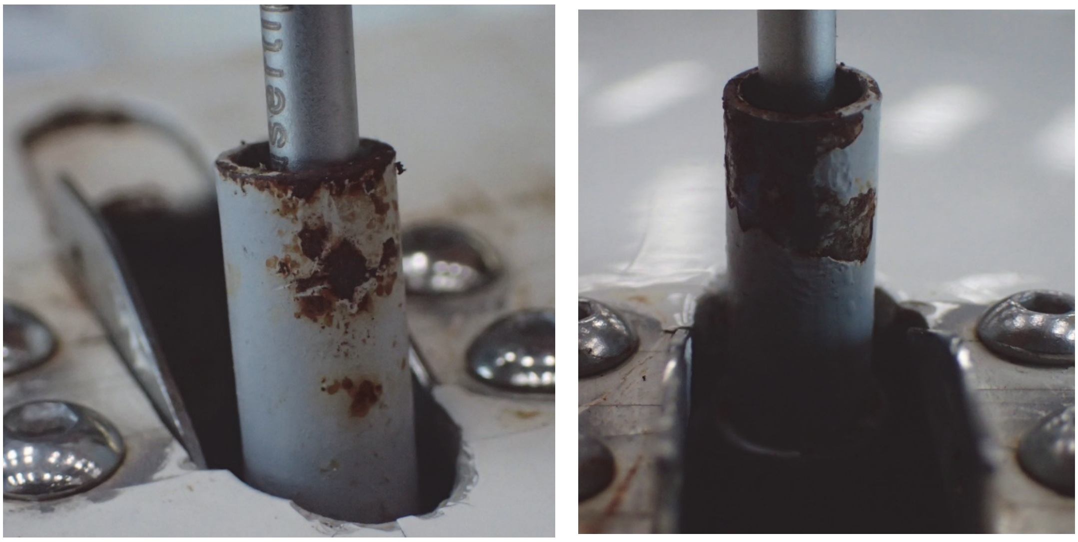


Figure 9

Missing paint and surface corrosion on forward face (left image) and rear face (right image) of the locking lever on G-DDGX

Rigging trials

A number of tailplane rigging trials were conducted on G-DDGX and on another Standard Cirrus 75 with the same tailplane attachment configuration, to assist in understanding potential mis-rigging conditions. An access panel was cut in G-DDGX's tailplane so that the locking hooks of the rear mechanism could be observed.

When the tailplane was attached to the fin, an audible 'clunk' was heard as the mechanism engaged, as described in the flight manual. The locking lever came to rest directly in-line with the attachment hole for the safety pin and the safety pin could not be inserted without first moving the locking lever. To correctly secure the tailplane the locking lever is moved aft to the (fully locked) position (Figure 10).

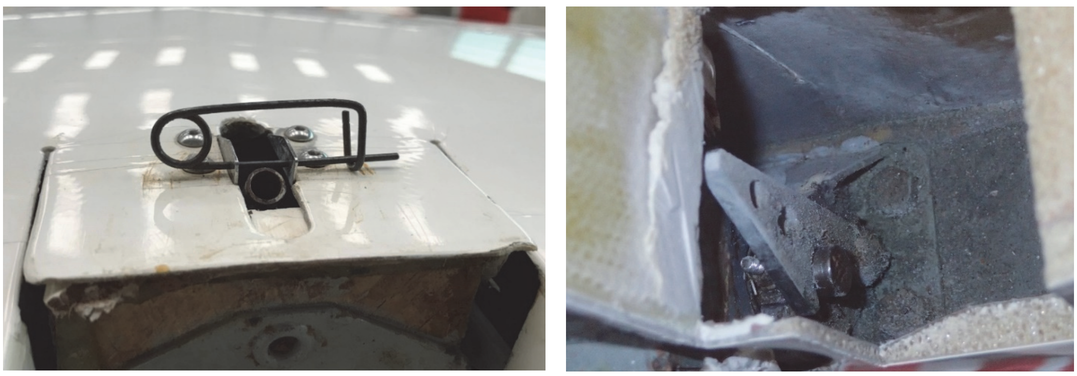


Figure 10

Position of locking lever and locking hooks in fully aft (locked) position.
Note: only right hook shown

If the locking lever was moved forward instead of aft, the safety pin could be inserted behind it and the lever would then spring back to rest against the pin when released. The same condition could be achieved by installing the tailplane in the as-found condition, with the locking lever already resting forward of the safety pin. In both cases this resulted in the rear mechanism being engaged but not locked, as the pin prevented the lever from travelling aft to the fully locked position (Figure 11). In this condition the locking hooks were not fully engaged on the axle but the tailplane felt secure and could not be dislodged.

Figure 11

Position of locking lever and locking hooks with lever forward of safety pin.
Note: only right hook shown

It was not possible to attach the tailplane if the safety pin was installed in its bracket and the locking lever was in the neutral position, because the pin prevented the lever moving sufficiently to open the locking hooks.

With the lever forward of the safety pin, it was possible to fold the safety pin forward such that the locking lever rested against the 'free' unrestrained arm of the safety pin (Figure 12). The lever was in a forward position and the locking hooks were not engaged on the axle, with the effect that the rear mechanism was entirely unlocked and the tailplane could easily separate from the fin. In this condition, the position of the unrestrained arm of the pin was somewhat tenuous as the spring force of the lever was acting to push it out of the way. It was demonstrated that movement or light force could cause the unrestrained arm of the pin to be dislodged, such that the lever sprung back against the restrained arm of the pin. Nonetheless a positive control check could be conducted without revealing any anomalies.

Figure 12

Position of locking lever and locking hooks when safety pin folded forward.
Note: only right hook shown

If the tailplane was offered up to the fin in a trailing-edge down orientation, it was possible to achieve full engagement of the locking hooks on the axle and move the lever aft to the fully locked position, while the tapered bolt was not engaged in the lug of the front fitting. If the locking lever was already resting forward of the safety pin when this was done, it was possible to achieve a condition where the rear mechanism was engaged but not locked (as previously described) and the front fitting was entirely disengaged. In both cases a large gap was present between the leading edge of the tailplane and the moveable fairing, where it was visually evident that the tapered bolt was not engaged in the front fitting (Figure 13). These two scenarios were demonstrated on the comparison glider but could not be replicated on G-DDGX.

Figure 13

Rear tailplane mechanism partially engaged, front fitting disengaged

However, it was possible on G-DDGX to achieve a condition where the locking lever was in the fully forward position and the tapered bolt was only partially engaged in the front fitting (Figure 14). In this condition neither the rear mechanism nor the front fitting were properly

Figure 14

Position of locking lever and locking hooks when lever in fully forward position (safety pin not shown) and forward fitting partially engaged.
Note: only right hook shown

In all of the mis-rigging conditions demonstrated, a positive control check did not result in any unusual observations or sensations when resisting the movement of the tailplane.

Aerotow tug aircraft

The club's aerotow tug aircraft was a Piper Pawnee, G-AVXA (Figure 15). It was equipped with a 60 m retractable tow cable. The aircraft was fitted with a radio but, due to noise levels in the cockpit when at full power, this was not used during the launch phase of aerotows.

Figure 15

Piper Pawnee G-AVXA, the club's aerotow tug aircraft

BGA publications

The BGA is the governing body for the sport of gliding in the UK and, among other things, is responsible for managing training standards and ongoing airworthiness of the UK glider fleet. The BGA publishes a Safety Briefing Leaflet *'Is your glider fit for flight?'* which highlights the importance of preparing gliders correctly for flight, offers guidance on how to do so and indicates some of the glider types and mechanisms that are vulnerable to rigging errors. To avoid flying with an 'incompletely prepared' glider, the leaflet indicates that rigging should be directed by a person experienced on the type and in accordance with the flight manual. This should be followed by a Daily Inspection (DI), conducted by a person experienced on the type. Both tasks should be completed without interruption or distraction.

It states:

> *'When you have rigged your glider, ensure that it is checked. This should ideally be done with fresh eyes by another, qualified, person, but at least by someone with a fresh frame of mind: some pilots walk briefly away from the glider so that they approach the checks with a clear new focus.'*

And:

> *'Rigging errors, and other errors and omission in preparing a glider for flight, are frequently caused by interruption, distraction, forgetfulness, and making unwarranted assumptions.'*

Further, it describes the positive control check as follows:

> *'Taking care not to apply excessive force, each control surface should be restrained while an attempt is made to move the control, and the direction of motion checked. It only takes a couple of minutes for a helper to advise the rigger whether movement of the cockpit controls generates the correct responses at the control surface.'*

The leaflet identifies the Standard Cirrus as one of the glider types that are vulnerable to mis-rigging of the tailplane or elevator, but all incidents referenced in the leaflet occurred to gliders fitted with the original tailplane mechanism.

EASA Safety information bulletin

EASA Safety Information Bulletin (SIB) 2019-07 *'Sailplane rigging – procedures, inspections and training'* issued 30 April 2019 references several previous glider accidents that were caused by improper execution of rigging procedures, including some relating to tailplanes/ elevators not being correctly connected.

The SIB indicates that these accidents can be broadly grouped according to the following factors: interruptions or distractions during rigging procedure, leading to omission of important steps; rigging procedure not correctly followed; person conducting rigging not familiar with procedure; mechanical principles of the connection not understood by the person conducting the rigging; connections and/or securing not, or not correctly, inspected; and, absence of positive control check.

The SIB recommends that familiarisation with a new type of glider should include rigging and recommends that even if the flight manual offers detailed instructions on how to perform the rigging, familiarisation should be provided by a person familiar with the type.

Organisational information

The gliding club based at Gwernesney Airfield has the status of a community amateur sports club and is managed by a board of directors. It is affiliated to the BGA and is required to comply with their laws and regulations as well as those of the EASA. The club publishes an Operations Manual (ops manual) which details site-specific information, guidance and direction for gliding operations at the airfield. The club offers winch and aerotow launches to its members and to visiting pilots.

Following the accident, the club conducted a review of its operations with a particular focus on the circumstances surrounding this event. The club timed aerotows to determine how long a 'normal' westerly takeoff ground roll was. It found that from the 'all out' to a glider passing abeam the clubhouse took approximately five seconds. Its review concluded that:

- Due to the voluntary nature of attendance at the club, it was impractical to require all rigging activities at the airfield to be overseen by a third-party qualified to supervise the process.
- The location of the forward signaller should be formalised to ensure they were in the tug pilot's eyeline for longer after the 'all-out' signal. They should also increase their visibility to the tug pilot by using a winch-launch signalling bat rather than relying on hand signals.
- Where it would be beneficial to do so, tell-tale marks should be added to gliders at the club to make it easier to detect incorrect alignment of rigging levers (Figure 16).
- Due to the speed with which the situation unfolded, radios would not have been an effective barrier in this accident sequence. They did not perceive the need to change club radio procedures.

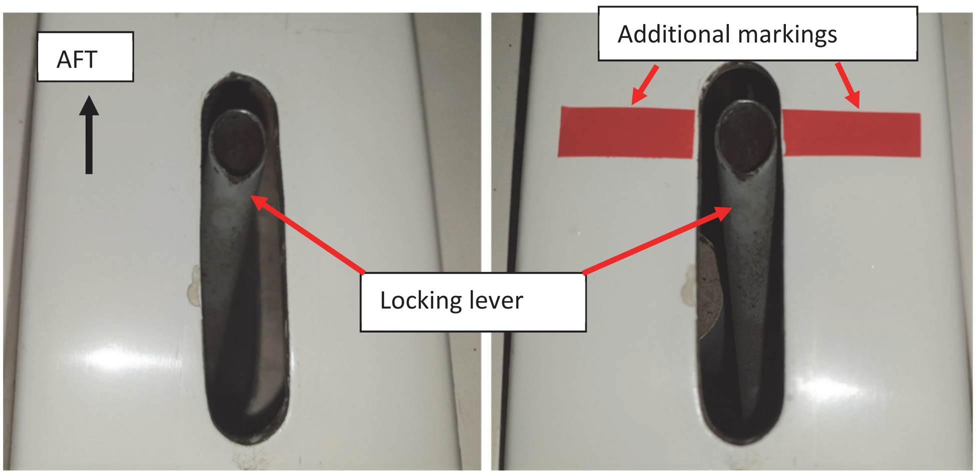


Figure 16

Standard Cirrus tailplane (original T-fitting elevator connection) with and without (left) locally-applied indicator for correct locking lever alignment

Glider launching information

Emergency tow cable release

The ground roll of any launch is a high-risk phase of flight. One of the major risks is that if a glider's wingtip touches the ground it can pivot the aircraft into an uncontrollable cartwheel. It is instilled in glider pilots that, if they cannot keep the wings level during takeoff, they should release the tow cable before a wing touches the ground. To facilitate a swift reaction, they are taught to keep their hand on the cable release control throughout the takeoff roll. The club's ops manual specifically directs that '*the pilot should have his hand on the* [cable] *release mechanism throughout the launch*.'

Glider pilots are also taught to release the tow cable immediately if they climb significantly above the tug aircraft or become un-sighted on it.

Use of radios

Implementing Regulation (EU) No 923/2012[7] and the Standardised European Rules of the Air[8] issued by EASA detail the regulatory requirement for the use of radios in different classes of airspace. Aircraft operating under visual flight rules inside Class G airspace which has not been declared a Radio Mandatory Zone (RMZ) are not required to use a radio. The airspace surrounding Gwernesney is not a designated RMZ.

In the UK, managing the VHF aeronautical communications frequency spectrum is the responsibility of the CAA. They have identified nine frequencies[9] for recreational aviation that are '*pre-assigned*' on a non-protected basis and are shared between users. These frequencies are not guaranteed any protection against mutual signal interference. In agreement with the CAA and Ofcom, the BGA has assigned eight of those frequencies to be used by the UK gliding community. The frequency allocations are detailed in the BGA Managing the Flying Risk publication[10]. Each frequency is assigned for a specific purpose, for example, 129.980 MHz is a '*Common Glider Field Frequency* [to be used] *within 10 nm radius and up to a height of 3,000 ft above certain approved airfields.*'

The BGA provides guidance on the benefits and use of radios[11]. It does not mandate their use and not all gliders are equipped with radios. G-DDGX did not have a radio fitted.

Footnote

7 Commission Implementing Regulation (EU) No 923/2012 adopted 26 September 2012. Available at https://www.easa.europa.eu/document-library/regulations/commission-implementing-regulation-eu-no-9232012 [accessed November 2019].

8 Easy Access Rules for Standardised European rules of the Air (SERA) published December 2018. Available at https://www.easa.europa.eu/document-library/general-publications/easy-access-rules-standardised-european-rules-air-sera [accessed November 2019].

9 Aeronautical Radio Stations, Frequency Assignments. Available at https://www.caa.co.uk/Commercial-industry/Airspace/Communication-navigation-and-surveillance/Aeronautical-radio-stations [accessed November 2019].

10 Managing Flying Risk: Guidance for Pilots and Clubs Version 10 effective 26 April 2019. Available at https://members.gliding.co.uk/library/bga-requirements-guidance/managing-flying-risk-guidance [accessed October 2019].

11 BGA Laws and Rules: Radio Guidance v1.1 effective 3 Jan 18. Available at https://members.gliding.co.uk/library/bga-requirements-guidance/radio-guidance [accessed November 2019].

While not a regulatory requirement, radios are used to support launch operations at some glider sites within the UK. Other clubs routinely use radios for communication between the tug and the glider being towed. At least one other club uses radios for coordinating the launch preparation, but at the 'all-out' call radio responsibility is transferred to the pilots engaged in the aerotow. In the event of a critical failure during a launch, releasing the tow cable would be a glider pilot's highest priority over and above any radio communication.

The gliding club at Gwernesney used radios primarily for passing information on glider type to the winch launch vehicle, but all operational signalling was done by hand, signal bat or lights. Use of the radio is specified as follows in the club's ops manual:

> *'Radio communication between the launch point and the winch using air band transceivers must be made on a frequency of 129.980 MHz. Members must only use the radio for brief and necessary communication between the launch point and the winch and all radio 'chatter' should be avoided.'*

Aerotow launch signallers at the club do not have a radio nor is there a radio-equipped safety observer monitoring takeoffs.

Launch communication

The BGA Operational Regulation 34[12] requires that '*an adequate system of communication must exist between the person in charge of launching and the winch or tow-car driver or tug pilot*.' It does not specify the minimum requirements or operational expectations of an '*adequate system of communication*.'

BGA Operational Regulation 36 requires that, where radios are used, '*a means must exist for making an emergency stop signal which can be received, notwithstanding the noise of the engine*' in the launch traction vehicle. There is no requirement for communication between the person in charge of launching and the pilot of the glider being launched nor is it required to have a dedicated radio-equipped safety observer for launches.

The BGA-published guidance notes for aerotowing[13] includes the following advice regarding radios and the limitations of visual signalling for aerotowing:

> *'Launch signalling is best done by the radio. Not all clubs will have the facility, but it is strongly recommended that it is obtained... Hand signals from behind are difficult to see and it is unlikely that the tug pilot will be able to react quickly to a stop signal. Forward signallers are rarely put far enough forward and are usually in danger of being hit by a glider ground-looping on takeoff.'*

Footnote

[12] BGA Laws and Rules: BGA Operational Regulations Version 1, effective 8 Mar 2015, revised 25 October 2016. Available at https://members.gliding.co.uk/library/bga-requirements-guidance/operational-regulations-of-the-bga [accessed 19 December 2019].

[13] British Gliding Association Aerotowing Guidance Notes, 2nd Edition June 2008. Available at https://members.gliding.co.uk/library/power-flying/aerotowing-guidance-notes [accessed December 2019].

Visual signalling

The type of signalling used by the gliding community has parallels with that used for train departure signalling in the rail industry. To signal to the driver that their train is secure for departure a signaller holds up a white circular bat. Once the driver sees that signal, the focus of their attention shifts to looking ahead to look for track-side signals and to ensure that the rails are clear. If the departure signaller needs to alert the driver to a problem, they lower their bat. Similarly, with a gliding forward signaller one of the main problems associated with this system is that of attracting the driver/pilot's attention when the signal is not in their primary field of view. For glider pilots on aerotow, their visual attention is almost exclusively focused on keeping wings level and maintaining alignment behind the tug, rather than looking for ground-based signals.

While both gliding and rail stop signals involve a dynamic transition to the alert state, they become static thereafter. Static objects in an observer's peripheral vision do not command attention. For such a signal to have the best chance of being detected it needs to be of sufficient size, visually distinct and to be moving rather than stationary.

Experience from the rail industry shows that adding bright LED lights to the signal bat increases the probability that the driver's peripheral vision alerting mechanism will detect it.

BGA aerotow statistics

The BGA held statistics showing that 11.9 million aerotows had been conducted in the UK since 1974. During that time, it had only recorded five previous aerotow incidents involving an unsecured tailplane. Of those incidents, three were not detectable by observers on the ground. One, which involved a Ventus glider, was seen and stop calls were made by an observer with a radio, by which time the pilot had already detected the fault and self-released the tow cable. On the remaining incident, the glider pilot noticed an abnormality with the elevator control and disconnected the tow cable while still on the ground. The accident to G-DDGX was the only event involving a Standard Cirrus 75 in the BGA aerotow statistics.

Analysis

Introduction

The accident pilot held an insurance share in the syndicate that owned and operated the glider and he was qualified to fly it. It was the pilot's fifth flight in G-DDGX. Prior to the day of the accident, he had rigged G-DDGX four times, including once under the supervision of the owner. On one previous occasion he had asked the club technical officer to check his rigging of G-DDGX but did not do so on the day of the accident.

Tailplane rigging on the day of the accident

Other than receiving help fitting the wings, the accident pilot had rigged the glider without assistance. It was therefore not determined precisely how he attached the tailplane to the fin, or whether he encountered any difficulties in doing so.

The BGA Safety Briefing Leaflet *'Is your glider fit for flight?'* and EASA SIB 2019-07 highlight that interruption, distraction, lack of familiarity with the rigging procedure and lack of understanding of the mechanical principles of the connection can be factors in mis-rigging events. It was not determined whether the pilot had encountered any interruptions or distractions while rigging the tailplane, nor to what extent he was familiar with the mechanical principles of the tailplane attachment mechanism. Having only recently started to fly G-DDGX and rigged it four times previously, it is likely that the pilot had not yet developed extensive experience in the rigging process for this glider type.

Opportunities to detect the mis-rig

Other than the locking lever, the tailplane attachment mechanism is not visible once the tailplane has been fitted. Therefore, the only potential opportunities to detect the mis-rig condition after completion of the rigging may have been during the DI or a secondary rigging check, during a positive control check or during a full-and-free check of the controls prior to flight. The pilot signed the DI book prior to the accident flight, which suggests that he undertook the DI himself.

Another club member assisted the pilot to carry out positive control checks, but they did not reveal any rigging anomalies. Although the tailplane was not securely attached to the fin, it must have had the appearance of being so. Additionally, it must have been attached in such a way that it was capable of moving in response to control stick inputs during the positive control check and remaining attached during the tow to the launch point.

It was not established whether the pilot carried out a full-and-free check of the controls before the launch and, as the precise nature of the mis-rigging was not established by the investigation, it was not determined whether it would have been detectable by such a check.

The BGA leaflet states that rigging should be directed, and the DI conducted, by a person experienced on type. It advocates the benefits of a post-rigging inspection being done by another qualified person. Although the pilot had previously requested assistance for a post-rigging check, he did not do so prior to the accident flight. It is possible this was because he felt sufficiently familiar with the rigging process. The gliding club's post-accident review concluded that it was impractical to require all rigging activities at the airfield to be overseen by a qualified third-party, due to the voluntary nature of the club.

Launch signalling

G-DDGX's tailplane was not securely attached and separated from the glider shortly after the aerotow ground roll began. A stop signal was made as soon as the rigging failure was detected by the wing runner. The signal was relayed by the forward signaller, but the tug pilot did not see it. Given his training, ops manual direction and the known takeoff risks, it is considered likely that the glider pilot had one hand on the cable release lever during the takeoff roll. That the tow cable remained attached until after the glider was airborne, strongly suggests that the accident pilot did not hear or see either stop signal. It was not determined whether the tow rope back-released from the glider or if the accident pilot operated the cable release mechanism.

Had the stop signal been received and the cable released from the glider or the launch aborted sooner by the tug pilot, it is possible that the glider would not have got airborne. In any event, an earlier cable release or launch abort could have resulted in reduced height gain and a potentially survivable accident.

It was not club policy to use radios for launch safety signalling. There was no requirement for G-DDGX to be equipped with a radio or for one to be used to coordinate the aerotow or for launch safety calls.

BGA Operational Regulation 34 required an '*adequate signalling system*' for launch control and safety. A stop signal was made but did not reach its intended recipients therefore the signalling system was not effective in this case. The BGA regulations do not specify a minimum standard for an '*adequate*' system.

After the tug began its takeoff roll the forward signaller ceased to have an effective function. They were out of the tug pilot's primary visual field and the noise from the tug's engine drowned out their stop call. Relocating the forward signaller and equipping them with a signalling bat would increase their visibility, but the attention of both pilots would remain primarily forward focused during any launch.

Visual signals can only ever be effective if they are seen by the intended recipient. Experience from the rail industry suggests that a stop signal that involved movement as well as bright lighting would increase the likelihood of it attracting the attention of pilots during a takeoff roll.

The BGA's guidance notes highlight the limitations of hand signals and '*strongly*' recommend that radios are used during aerotows. While pilot-to-pilot communications would not have prevented this accident, intervention by a radio-equipped launch observer, as occurred in the Ventus glider incident, may have influenced the outcome.

Therefore, to provide greater assurance for glider launching safety, the following Safety Recommendation is made:

Safety Recommendation 2020-012

It is recommended that the British Gliding Association specifies in its Operational Regulations the minimum requirements for an 'adequate system of communication' for glider launching.

Accident outcome

After the tailplane had detached, the pilot was unable to control the pitch attitude of the glider, and once airborne, he had no means of effecting a safe landing.

Despite a timely response by the emergency services and air ambulance transfer to hospital, the pilot succumbed to complications arising from the injuries he sustained in the accident.

Nature of the mis-rigging

Those assisting with the launch reported that the tailplane started to wobble as soon as the glider started to move on the takeoff roll, and the leading edge began to lift and detach as the propwash from the tug reached the glider. At this point the tailplane would have been experiencing minimal air loads, therefore it is evident that it was only tenuously attached.

As the tailplane was found with the locking lever forward of the safety pin, the investigation determined that either the tailplane was fitted with the locking lever already positioned forward of the safety pin; or that after fitment of the tailplane, the lever was moved forward rather than aft to insert the safety pin. The owner described that he normally stored the tailplane in G-DDGX's the trailer, with the locking lever in the neutral position and the safety pin installed in its bracket. As he was the last person to fly G-DDGX prior to the accident flight, it is quite possible that the tailplane was stored in this way. As such the safety pin would have needed to be removed before installing the tailplane on the fin.

Missing paint and the presence of surface corrosion on the rear face of the locking lever may have been incidental or may have been indicative of more frequent contact between the lever and the safety pin.

Regardless of how the locking lever came to be forward of the safety pin, in this condition the lever would rest against the safety pin under spring force, such that the locking hooks would be engaged on the axle of the rear mechanism but not fully locked. Nonetheless, in this condition, it was demonstrated that the locking hooks appeared to provide a reasonable degree of attachment and the tailplane could not be dislodged. Although an undesirable condition, with a correctly engaged front fitting, this condition alone may not have accounted for the separation of the tailplane.

It was demonstrated that the locking lever could remain in a forward position, either in isolation or because the safety pin was folded forward. In this condition the locking hooks were not engaged on the axle, and thus the rear mechanism was entirely unlocked.

Rigging trials also demonstrated that it was possible to achieve partial engagement of the rear mechanism (locking lever forward of safety pin), while the tapered bolt was entirely disengaged from the front fitting. Although visually identifiable due to a large gap between the tailplane and moveable fairing, in this condition it is possible the tailplane could pivot upwards, applying spring force to open the locking lever and hooks.

Several mis-rigging scenarios demonstrated on the comparison glider could not be replicated on G-DDGX. This may have been due to differences in the amount of play in the respective mechanisms, or because G-DDGX's tailplane control run was unrestrained, having been cut to facilitate recovery and for detailed inspection of the wreckage.

In summary, the investigation identified and demonstrated several potential mis-rigging conditions, but it was not determined which of these conditions, or combination of conditions, occurred during the rigging of G-DDGX.

Tailplane attachment mechanism

The design of the tailplane attachment mechanism on the Standard Cirrus has undergone several modifications since the type was first introduced. The most recent of these was the safety locking device (safety pin) introduced by TN 278-36 in 1994. This accident has shown that effectiveness of the safety pin is entirely reliant on its correct installation. Additional training or revisions to maintenance documentation have typically been shown to be ineffective in preventing incomplete or improper installation of components. Instances of glider mis-rigging broadly fall within this category of occurrences. In general, such occurrences can only be reliably prevented by design solutions, or an error-tolerant design from the outset.

Following this accident, for gliders with similar tailplane locking features to that of the Standard Cirrus 75, the gliding club introduced tell-tale markings to show the approximate required position of the locking lever and make it easier to detect incorrect alignment. The EASA recommended that such markings indicating the correct position for locking levers should be green in colour. Similar tailplane attachment mechanisms are known to be used on other types of glider and therefore, the following Safety Recommendation is made:

Safety Recommendation 2020-013

It is recommended that the European Union Aviation Safety Agency require a means to detect incorrect alignment of the tailplane locking lever on gliders with locking features similar to the Standard Cirrus 75.

Flight manual

G-DDGX's copy of the flight manual contained rigging instructions which were not relevant to the actual configuration of the tailplane attachment mechanism and illustrations of both the original and modified mechanism. As TN 278-15 was embodied on G-DDGX at the time of manufacture, the original flight manual provided would have included relevant rigging instructions for the modified tailplane mechanism. It is not uncommon for flight manuals to be lost or require replacement over time and it is possible that at some point G-DDGX's flight manual had been replaced with a version that did not accurately reflect its tailplane configuration. The checklist from the recent ARC renewal indicated that the flight manual had been reviewed in depth but neither the discrepancy with the rigging instructions, nor the incorrect serial number were identified.

When TN 278-36 was introduced to add the safety pin, the manufacturer deemed that it did not require any updates to be made to the flight manual. As such, even a correctly updated Standard Cirrus flight manual would not contain any reference, either in the rigging instructions or accompanying illustration, to how the safety pin should be inserted.

G-DDGX's owner demonstrated the practical aspects of the tailplane rigging to the accident pilot. It is not known what, if any, version of the flight manual the pilot had access to, but none of them would have provided guidance on the correct installation of the safety pin.

Conclusion

The glider tailplane was mis-rigged in such a way that it passed positive control checks but was not secure for flight. It detached early in the ground roll and the aircraft became airborne with no pitch control available to pilot. Stop signals were relayed by the forward signaller but they were not effective in alerting either pilot to the failure.

Effective signalling, radio or visual, might have prevented the glider taking off or reduced the severity of the outcome.

Safety Actions/Recommendations

Safety Actions

As a result of this accident the club undertook the following safety actions.

- The forward signaller position was formalised in the club's Operations Manual and their use of a white winch-signalling bat was made mandatory.
- Where appropriate, lever alignment marks were to be added to gliders at the club as additional confirmation that rigging had been completed correctly.

Safety Recommendations

The following Safety Recommendations are made:

Safety Recommendation 2020-012

It is recommended that the British Gliding Association specifies in its Operational Regulations the minimum requirements for an 'adequate system of communication' for glider launching.

Safety Recommendation 2020-013

It is recommended that the European Union Aviation Safety Agency require a means to detect incorrect alignment of the tailplane locking lever on gliders with locking features similar to the Standard Cirrus 75.

Published: 28 May 2020.

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.

SERIOUS INCIDENT

Aircraft Type and Registration:	Agusta Westland AW189, G-OENC
No & Type of Engines:	2 General Electric Co CT7-2E1 turboshaft engines
Year of Manufacture:	2017 (Serial no: 89002)
Date & Time (UTC):	25 March 2019 at 1600 hrs
Location:	Forties Charlie platform, Northern North Sea
Type of Flight:	Commercial Air Transport (Passenger)
Persons on Board:	Crew - 2 Passengers - 4
Injuries:	Crew - None Passengers - None
Nature of Damage:	None
Commander's Licence:	Airline Transport Pilot's Licence
Commander's Age:	49 years
Commander's Flying Experience:	14,000 hours (of which 600 were on type) Last 90 days - 16 hours Last 28 days - 16 hours
Information Source:	Aircraft Accident Report Form submitted by the pilot

Synopsis

While operating to the Forties Delta platform the pilots misidentified and landed on the visually similar Forties Charlie platform.

The operator has issued a safety notice detailing the lessons learned from the incident and a Flying Staff Instruction amending the guidance in the Operations Manual on the Avoidance of Wrong Deck Landings.

History of the flight

The pilots reported for duty to conduct a multi-sector flight carrying passengers and freight to the platforms in the Forties field. The routing was Aberdeen/Dyce (Aberdeen) Airport – Forties Delta platform (40D) – Forties Alpha platform (40A) – Forties Bravo platform (40B) – Forties Echo platform (40E) – Aberdeen Airport (Figure 2). The operator had allocated an AW189 helicopter, registration G-OENC, to the flight.

The pilots shared the planning duties covering all the aspects outlined in the operator's defined MATE briefing format[1], which included discussion of the routing and the payload; they determined that there would be no requirement to re-fuel offshore. However, there was

Footnote

[1] See section MATE brief.

no detailed discussion that the similarity of the platforms could result in misidentification of the destination, nor means to mitigate this possibility. The pilots decided that the commander would carry out the PM role from the left seat, while the co-pilot would carry out the PF role from the right seat, enabling the co-pilot to gain further experience. They did not identify at this stage which of them would be conducting the deck landing for each of the helidecks.

During the cruise at 3,000 ft, the PM contacted the Forties field on the logistics frequency[2] to confirm routing and payloads. The pilots then elected to make an early en route descent and the PM transferred the flight-watch[3] to the traffic frequency[4] of the Forties field. As they were passing 1,500 ft in the descent, the pilots were able to identify all the platforms in the field including the 40D platform, which they confirmed as the destination, with the 40A platform in alignment behind. The pilots determined that the pilot in the left seat would conduct the landing on 40D, requiring a handover of control at a later stage, since the wind direction and deck orientation favoured an approach from the right. Once level at 500 ft with about 15 nm to the platform, the pilots carried out the approach checks.

Shortly afterwards, the PF commented on the unusually elevated position of the crane on the Forties Charlie (40C) platform, which was offset forward and left of track. The pilots then discussed the crane's position and the implications for an approach and landing.

With under 5 nm to the destination, the pilots completed the landing checks. However, they did not read the platform name on the helideck. While the PM was occupied making a radio call, the PF focused inside the cockpit and selected heading mode for the autopilot. On looking back up outside, the PF then made a left turn into wind towards the platform that he saw out to the left, which he identified as the destination platform (but was in fact the 40C platform).

The pilots identified that the crane by the helideck was not in the stowed position and represented a potential hazard beyond the far edge of the helideck. The PM made a radio call on the traffic frequency to the Helideck Landing Officer (HLO) of the 40D platform requesting that the crane be stowed. The HLO advised that this would close the deck and result in a delay while he mustered the crane operator to move the crane out of the way. The pilots discussed the implications and performance of the aircraft and elected to continue the approach and land.

Footnote

2 The Logistics frequency is used by the crews to communicate with the destination platform to pass logistical and administrative information. (This is a unique frequency common to all platforms within a specified area.)

3 Flight watch is normally provided by ATC, but when coverage is poor or absent, pilots will pass information to the traffic frequency to include callsign, helicopter type, souls on board, position and distance and time to go to destination. This enables 2-way radio communication with an agency to be maintained and enhances the awareness of crews of the activity in-field or at nearby installations.

4 The traffic frequency is used in-field to provide radio communication in-field and at low level when ATC coverage is poor or absent. (This is a unique frequency common to all platforms within a specified area.)

Once the helicopter was established on the final stage of the approach, the commander in the left seat took over the role as PF and carried out the landing on the helideck of the 40C platform. On completion of the landing checks, the pilots noticed that no deck-crew approached the helicopter and it was at this stage the pilots noticed the 'Forties Charlie' name on the helideck.

The pilots informed the 40D platform that they had landed on the 40C platform and requested that a helideck crew muster on the platform to carry out safety checks and provide fire cover; they also requested the crane to be repositioned. The pilots briefed the passengers, completed the deck turnaround checks and continued to the 40D platform.

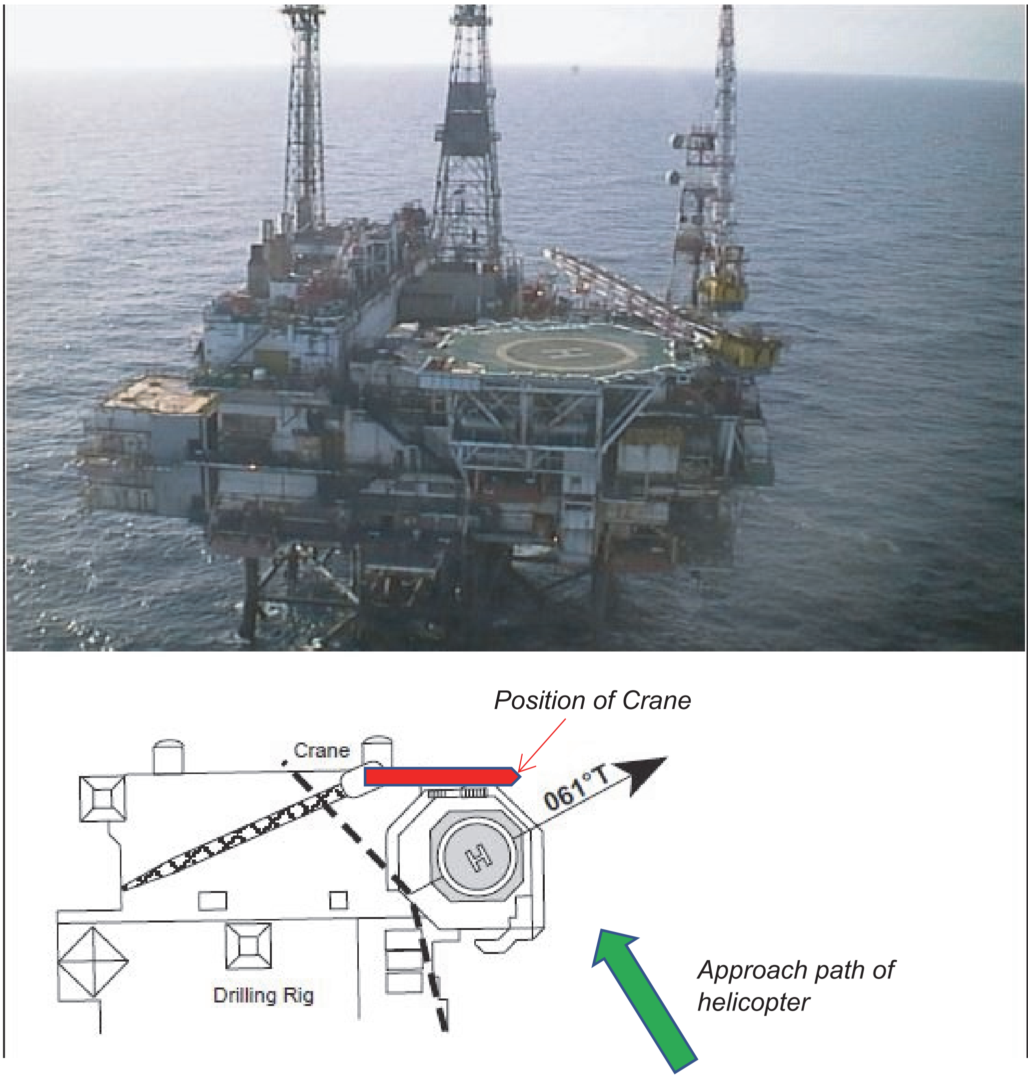


Figure 1

Forties Charlie (40C) platform

Forties field

The Forties field (Figure 2) is situated between 103 and 109 nm east of Aberdeen Airport and consists of five platforms. When viewed from height while approaching from Aberdeen, four of the platforms appear grouped in an elongated diamond with the 40C to the west, and the 40A to the east. The 40B is to the north and the 40D to the south, while the 40E lies to the east of this main group; the BP Unity platform is situated a few miles to the west.

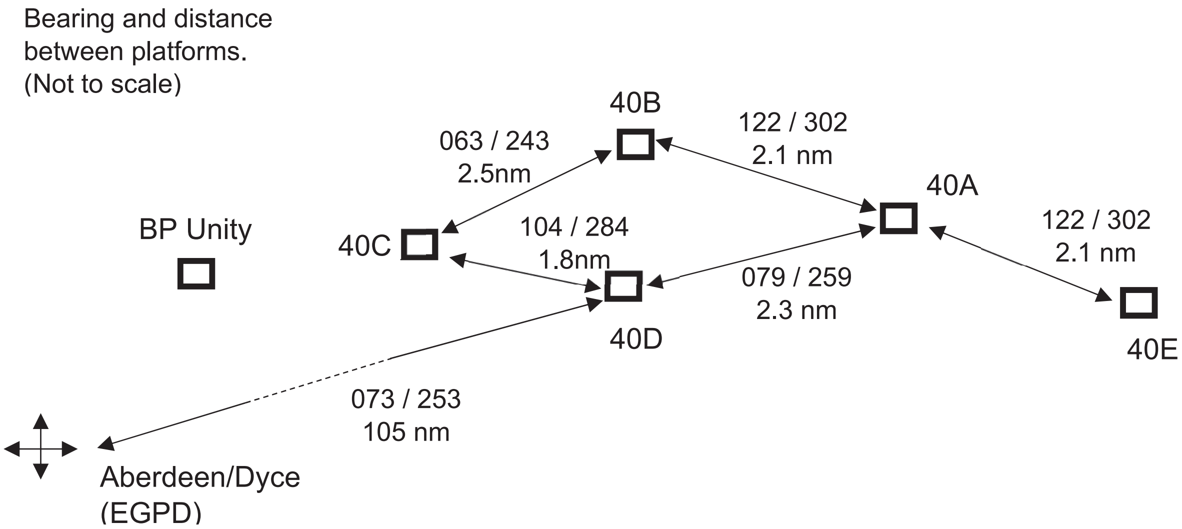


Figure 2

Forties field layout

Forties platforms

The 40A, 40B, 40C and 40D platforms look almost identical, with the helideck located on the north-east corner of the platforms, a central derrick and a vertical flare-stack on the south-west corner. Each has a crane on the northern edge of the platform adjacent to the helideck. The 40A platform is distinguishable from the other three by the addition of a bridge to a satellite platform on its western side. Both the 40C (Figure 1) and 40D (Figure 3) have their helidecks aligned on an identical heading of 061ºT.

Recorded information

The length of the flight resulted in the CVR being overwritten by the time the aircraft had completed the tasking. Flight data was available from the helicopter's quick access recorder and enabled the flight path to be recreated.

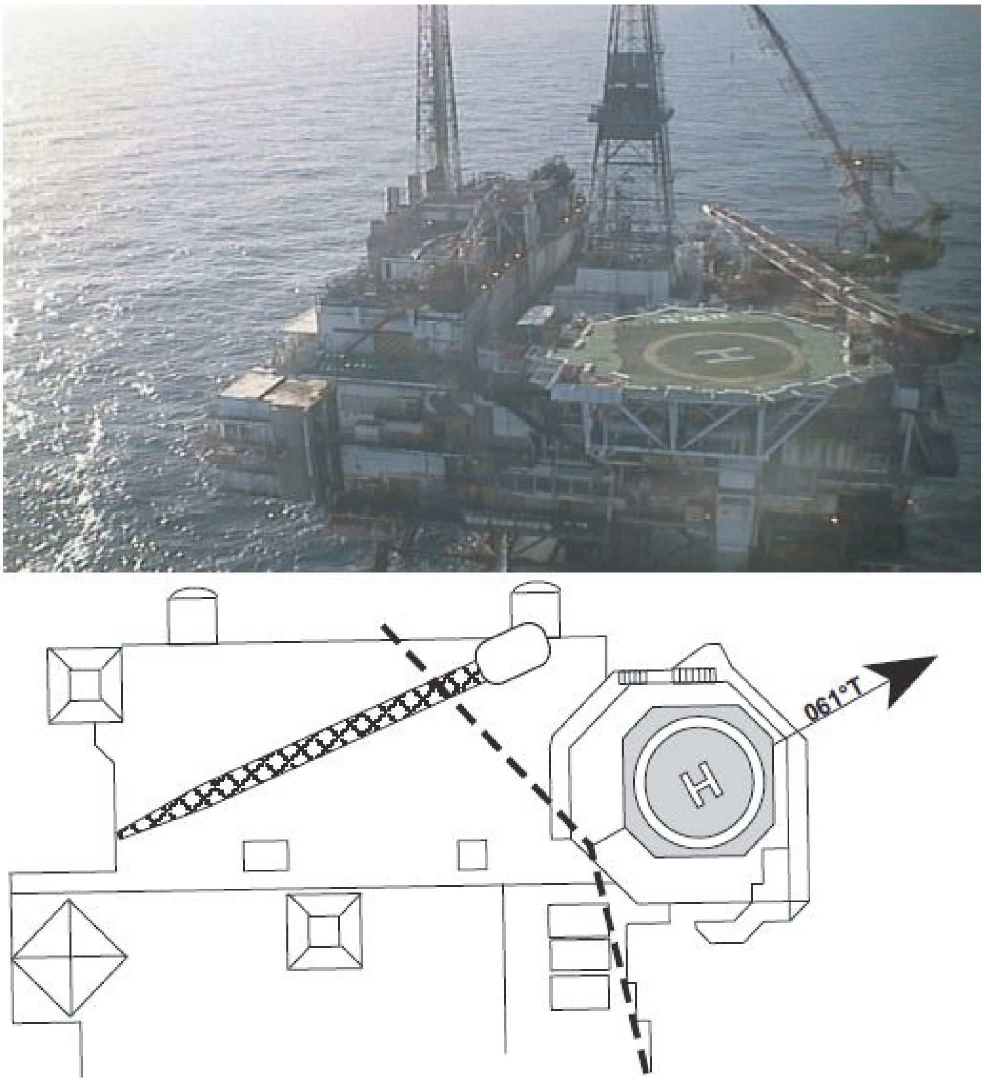


Figure 3
Forties Delta (40D) platform

Aircraft cockpit displays

The AW189 cockpit has four multi-functional displays (MFD) allowing a variety of configurations. The standard configuration is for the outer MFD on each side to have the Primary Flight Display (PFD) selected (Figure 4). The upper part of the PFD, known as the Primary Flight Indicator (PFI), displays the artificial horizon and other flight instrumentation including IAS, groundspeed, height, altitude and vertical speed information. The lower centre part of the PFD is the navigation display area which can be selected to display a compass rose in Horizontal Situation Indicator (HSI) mode, Map mode or Hover mode. In HSI mode, the compass rose has a course deviation bar which indicates whether the helicopter is deviating left or right of the track of the planned route. Below the PFI and to the bottom left of the HSI display is the Navigation Information, where the waypoint name and distance to the waypoint are displayed. Rotor instrumentation is displayed below the PFI and to the right of the compass rose, and the engine, gearbox hydraulic and fuel indications are displayed on the let below the Crew Alerting System which is itself to the left of the PFI. (The PFD also displays annunciations for the automatic flight control system and radio frequencies).

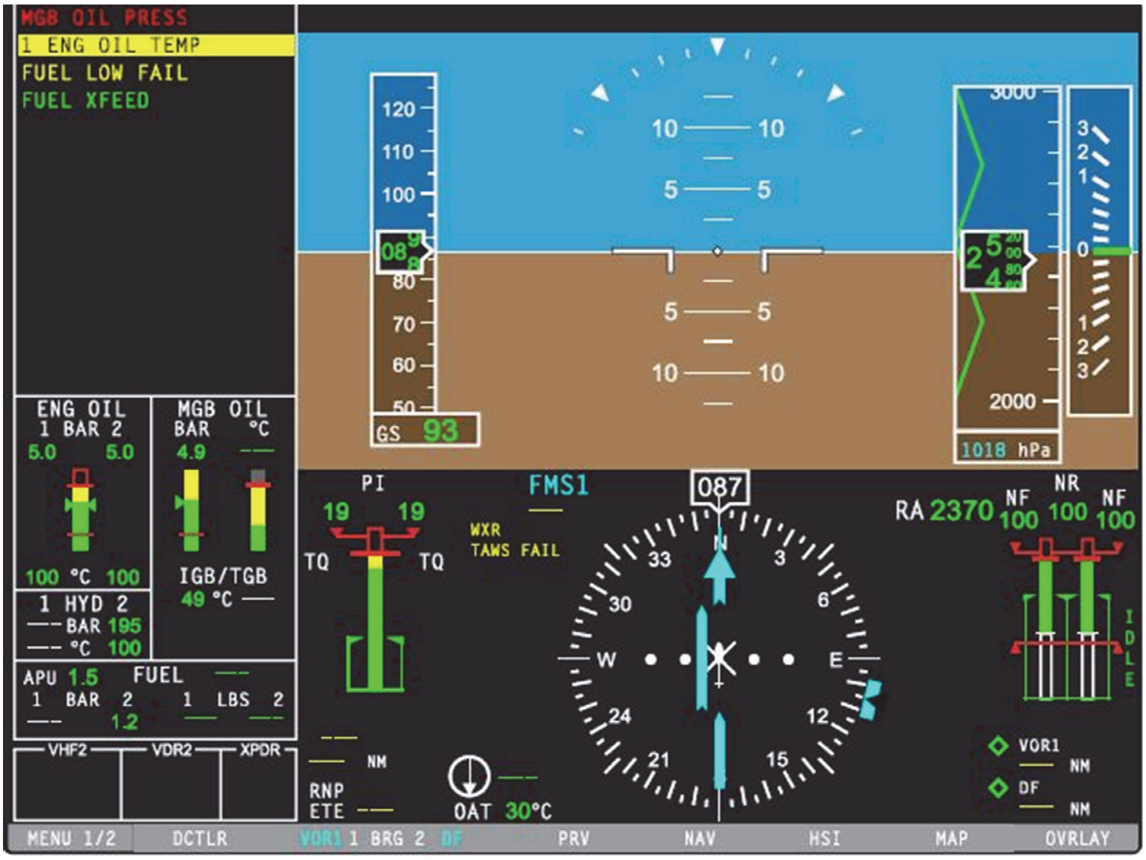


Figure 4

AW 189 Primary Flight Display

The inboard MFD can be selected to display several functions including the FPLN (flight plan) page or the P-PLANT (powerplant) page. The FPLN page displays the route of the helicopter as defined by the flight plan entered into the flight management system (FMS), while the P-PLANT page displays engine, rotor and electrical parameters.

Use of automation and the flight management system

The pilots used automation in accordance with the operator's procedure, with the FMS as the navigation source. At the time of the incident, the pilots had correctly programmed the route into the FMS and had selected the 40D platform as the destination with a 'fly-over'[5]. Once the pilots had swapped roles, the PM in the right seat selected the P-PLANT page on the inboard MFD. This resulted in the loss of the display of the FMS navigation data on the inboard MFD to the PM.

Footnote

5 Selection of 'fly-over' is the means by which the FMS routing can be forced to overfly the waypoint. This prevents the aircraft from flying a 'smart turn' prior to the waypoint to intercept the track of the next sector.

Meteorology

There was good visibility in the Forties field at the time of the incident with medium-level cloud and the wind direction was 320 °T at 22 kt.

Personnel

The commander was an experienced helicopter commander in the offshore oil and gas role who had recently returned from a period of absence and completed a return-to-work package including simulator and line training. This was his first flight as commander since his return. The co-pilot had operated offshore in the North Sea for over eight years.

Human factors

A report from a study into the causal factors that contribute to the occurrence of wrong deck landings categorised three types of wrong deck landings[6]. The study analysed and identified the factors that led to misidentification and the incorrect selection of platforms as the destination and why crews subsequently were not able to break their confirmation bias.

Organisational information

Since the operator has a single contract for the AW189, the group of AW189 pilots is small. Consequently, flights are regularly rostered with the same pilots, who operate primarily to the Forties field conducting multi-sector flights, often more than once, on an almost daily basis.

MATE brief

The operator employs a pre-flight planning process called a 'MATE' brief, which covers Meteorology, ATC and Airspace, Airframe, Times and en route considerations. The aim is to ensure pilots consider all the potential threats and errors, including wrong deck landings (WDL), that may arise during flight for the conditions that exist that day.

Standard operating procedures

Prevention of WDLs are specifically addressed in the Operations Manual Part A 8.2.10, *'The Avoidance of Wrong Deck Landings'*, using a 5-stage process:

1. *As part of the pre-flight planning process discuss the routeing in relation to the other platforms or rigs nearby and the possibility of a WDL. This should include approach directions and deck orientations. If the destination is a NUI[7], then consideration must be given to completing a pre-landing orbit to confirm identity, weather permitting.*

2. *Always put the full route in the FMS, using route discontinuities to ensure the next destination is held. Where possible, add other nearby locations*

Footnote

[6] Jarvis, S (2015) *Wrong Deck Landings Research and Investigation Report*, Jarvis Bagshaw Ltd.
[7] Normally unmanned installation.

to improve situational awareness. What is possible will depend upon aircraft type and guidance will be added to each Part B.

3. *Confirm that the route as planned matches the route manifested by the client and the route programmed into the FMS.*

4. *Pilot monitoring to use the HCA[8] app on company iPads as part of the approach brief. A quick review of the picture, layout and any limitations serve as a useful prompt.*

5. *Finally, read the name on the destination and cross-check with the other pilot against GPS/FMS bearing and distance. This really is the final barrier and has prevented a number of WDL's. Pilots need to be wary of 'expectation bias'; i.e. seeing what you expect to see.'*

The last item on the final approach checklist is to identify the platform and carry out a position cross-check using the GPS. The pilots did not do these checks on their approach to the helideck.

Analysis

Factors that facilitated mis-selection of the 40C platform destination

Familiarity

Repetitive tasking for pilots on the AW189 fleet means that the field layout, platform characteristics and other factors such as turbulent or restricted sectors, become familiar, allowing them to identify the potential threats quickly during the planning phase. However, it may also result in reduced scrutiny at the pre-flight planning stage. The MATE brief seeks to assist pilots to overcome familiarity by ensuring all relevant threats are considered, but such familiarity makes it more difficult for pilots to anticipate the circumstances that might lead to a WDL.

The co-pilot's familiarity with the field and its platforms prompted him to comment on the unusually high elevation of the crane on the 40C, which triggered the discussion about the implications for the approach and landing of the position of the 40C crane.

Weather

The visibility was sufficient to enable the pilots to see the platforms relative to each other from over 15 nm away, allowing the commander to refamiliarize himself with the field layout. It is likely the pilots initially identified and correctly selected the 40D platform as the destination, and that they shared an accurate understanding of the locations of each platform. However, in good visibility pilots may place reduced emphasis on the electronic aids that can help maintain their situational awareness, thereby increasing the likelihood of confusion arising from platform similarities.

Footnote

8 Helideck Certification Agency.

Crane discussion

The discussion about the position of the crane on the 40C distracted the pilots and probably diverted their attention from the 40D to the 40C platform.

Field layout

The field layout means that, approaching from Aberdeen, the 40A platform is behind the 40D platform, with the 40C platform in front and slightly offset to the left. Once at 500 ft, the field will present a different visual perspective from that at height. Crucially, the 40A platform is likely to have been largely obscured behind the 40D platform and the pilots would only see one platform ahead, rather than the two they would expect, with the 40C platform offset to the left. It is possible they thought they saw the 40A platform ahead with the 40D platform offset to the left, when in fact the 40D platform lay ahead and the 40C platform was offset to the left. If so, this would have contributed to the subsequent mis-selection by the pilots and strengthened their expectation that the 40C platform was the destination platform.

Flight path

The wind direction and the identical helideck alignment meant that the approach to both the 40D and 40C platforms would have been the same: offset to the south of the platform followed by a left turn onto the final approach path. Also, on approaching the 40D the pilots would have expected to offset the flight path to the right of track to facilitate the left turn on to final. Therefore, the actual flight path flown, and the picture presented by the position of the platforms, matched the pilots' expectations.

Platform characteristics

The platform infrastructure on the 40D and the 40C is almost identical.

Effectiveness of prevention controls

Use of electronic aids

Before turning onto the final approach path the course deviation bar (CDB) displayed on the HSI would have shown a cross-track error, with the aircraft offset to the right. This offset would have matched the visual picture that the pilots saw in relation to the position of the 40C platform. At the point where the PF turned the aircraft towards the 40C, the distance to the 40D displayed by the FMS would have seemed to the pilots to be a reasonable match for the actual distance to the 40C. The lack of surrounding topography made accurate visual judgement of distance offshore challenging.

In the absence of a relevant standard operating procedure, crews had been encouraged during training to select the P-PLANT page on the inboard MFD to display engine parameters, which were considered relevant information to be displayed during the final stages of an approach and landing. This meant FMS navigation data was not displayed to the PM, whereas with the HSI mode displayed on the PFD the CDB would have indicated that the aircraft was left of track, highlighting that it was heading to the wrong destination.

HLO radio call

The crane on the 40C was not stowed as expected for flight operations, but this did not on its own reveal that the 40C was the wrong deck because the crane on the 40D was similarly not stowed.

Checks on final approach

Once the turn on to the final approach was complete the focus for the PF was primarily external, with the PM focusing on the key performance instruments (N_R, IAS, engine torque), rather than FMS navigation data. Selecting the P-PLANT page during the final stages of the approach encouraged a greater focus on engine parameters and probably led to the omission of the GPS cross-check.

The PF was focused on the external hazards; in particular, that of the crane. This was the most probable explanation for not reading the name of the platform on the helideck. The PM in the right seat was unable to read the name on the helideck because the nose-up attitude of the AW189 in the final stages of the approach obscures the deck and other visual cues from that side of the helicopter.

Confirmation bias

Once the pilots had switched their attention to the 40C platform and mis-selected it as the destination, several factors may have reinforced their perception and diminished their ability to identify this misidentification. These included the similar flight path, the identical platform characteristics, visibility of signage, the cranes on both the 40C and 40D platform not being in the stowed position, and the task focus that led to the omission of the GPS cross-check and the reading of the name on the helideck. Even if the pilots had paid greater attention to the FMS track and distance, it is unlikely these cues would have been powerful enough to challenge and break the mental model which the crews had developed – that the 40C, to which they were heading, was the correct destination.

Prevention controls

The operator encourages a structured approach to threat and error management, and the use of the 'MATE' brief, to help pilots identify the correct platform. Platform identification through use of electronic aids and reading the name on the helideck prior to the committal point are considered essential amongst several prevention controls. However:

> *'Pilots will always prioritise aircraft control which means the task of [platform] identification will receive little attention and may be dropped without the pilots being fully aware that they have done so.'*[9]

Footnote

9 Jarvis, S (2015) *Wrong Deck Landings Research and Investigation Report*, Jarvis Bagshaw Ltd page 6.

Evidently, these prevention controls have been proven not to be sufficiently robust to be relied upon as the final prevention control, since these are internal controls reliant upon the flight crew.

> *'Error traps involving just flight crew do not prevent all WDLs from occurring.'*[10]

Once the mis-selection has occurred, more robust external controls, capable of breaking the confirmation bias and mental model of the pilots, are required to be put in place to act as the final barrier to the occurrence of a WDL.

Conclusion

The pilots landed the helicopter on the Forties Charlie (40C) platform having misidentified it as the destination platform (40D). Controls in place at the time proved inadequate to break the confirmation bias of the pilots.

Discussion between the pilots about the position of the crane on the 40C platform probably resulted in them switching their attention incorrectly to this platform and away from the 40D platform. The crane was not stowed on either platform, so did not serve as a distinguishing feature.

The pilots' familiarity with the Forties field, the physical similarity of the platforms, and the identical approach and landing flight path to each of them served to reinforce their selection of the wrong deck.

The pilots did not verify they were approaching the correct platform by cross-checking the position of the platform against the FMS bearing and distance to the destination or reading the platform name on the helideck before committing to land.

Safety actions

The operator has carried out the following two safety actions:

> The operator has issued a Safety Notice to pilots highlighting four lessons learned from the incident, detailing:
>
> - when to hand over control to the landing pilot
> - the importance of pilots monitoring and cross-checking the GPS/FMS bearing and distance
> - that pilots must read the platform name before committing to landing
> - that pilots should wait for the cranes to be stowed even if this incurs a delay

Footnote

[10] Ibid page 42.

The operator has issued a Flying Staff Instruction amending the guidance for the '*Avoidance of a Wrong Deck Landing'* given in the operations manual to emphasise the importance of the following actions:

- the need for pilots to highlight the risk of a wrong-deck landing at both the pre-flight planning and the approach brief phase
- the need for pilots to ensure the route is fully and correctly entered into the FMS
- the use of GPS/FMS needle bearing and distance guidance to the point that the platform name is read
- the need for pilots to read the platform name and cross-check with the GPS/FMS bearing and distance prior to committing to landing on the heli-deck

SERIOUS INCIDENT

Aircraft Type and Registration:	DHC-8-402 Dash 8, G-PRPH
No & Type of Engines:	2 Pratt & Whitney Canada PW150A turboprop engines
Year of Manufacture:	2010 (Serial no: 4323)
Date & Time (UTC):	10 January 2020 at 1956 hrs
Location:	Leeds Bradford Airport
Type of Flight:	Commercial Air Transport (Passenger)
Persons on Board:	Crew - 4 Passengers - 51
Injuries:	Crew - None Passengers - None
Nature of Damage:	None reported
Commander's Licence:	Airline Transport Pilot's Licence
Commander's Age:	49 years
Commander's Flying Experience:	10,541 hours (of which 10,163 were on type) Last 90 days - 187 hours Last 28 days - 28 hours
Information Source:	Aircraft Accident Report Form submitted by the pilot

Synopsis

After a normal engine start the Auxiliary Power Unit (APU) was switched off, however the 'APU STARTER' light illuminated. The aircraft systems were shut down and a re-start attempted using a ground power unit. During this time smoke was seen emanating from the rear of the aircraft so the crew initiated a rapid passenger disembarkation. Examination of the aircraft found that the APU starter/generator had overheated probably as a result of an APU contactor failure.

History of the flight

The aircraft was completing a normal turnaround at Leeds/Bradford Airport with the Auxiliary Power Unit (APU) running. Approximately 5 minutes before pushback a strong smell, described by the crew to be like a burning clutch, was apparent in the flight deck and the front of the cabin. The captain asked the dispatcher to check the rear of the aircraft for evidence of anything unusual and nothing was found. The smell cleared within 10 to 15 seconds and was considered to have been associated with a truck which had passed the aircraft around that time.

The aircraft pushed back at 1956 hrs and successfully started the right engine in preparation for a single engine taxi. Once the engine had started and all electrical systems were powered, the APU was switched off. During the subsequent '*AFTER START'* checks it was identified that the starter light had illuminated on the APU panel, even though all the switches were in the OFF position.

The captain immediately referred to the Quick Reference Handbook for *'APU STARTER FAILURE'* drills. As he went through the drills other caution lights began to appear on the primary flight displays, the engine display and the central warning panel, with the APU starter light remaining illuminated throughout. The aircraft and engine were therefore shut down. The captain then contacted maintenance control who suggested re-setting the system using a ground power unit (GPU). This was called for and when it arrived the captain requested that the senior cabin crew member (SCCM) open the forward left door. This would then allow communication with the ground crew from the flight deck if electrical power was lost.

After the GPU was connected and operating correctly, the aircraft batteries were turned back on. After about 5 seconds the batteries began to discharge rapidly and three display screens on the flight deck went blank, however the APU starter light remained illuminated. The captain informed maintenance control that he intended to completely shut down the aircraft. As he was having this discussion, the ground crew informed the flight crew that smoke was rising from the tail of the aircraft. ATC was informed and the fire crews were called. There was no smoke reported in the cabin or flight deck, however the fire crews, after arriving at the aircraft, saw smoke rising from its rear and recommended via ATC that a controlled evacuation be initiated.

The captain switched off the battery master switch and gave the order to the SCCM to initiate a rapid disembarkation. As the aircraft systems had been shut down, this was done without use of the PA. The passengers left the aircraft via the forward left door quickly and orderly, leaving their belongings behind.

Aircraft examination

Examination of the aircraft by engineering staff from a Part 145 maintenance organisation at the airport identified that APU starter/generator showed signs of heat damage. The starter/generator and the K26 contactor, which connects the starter/generator to the right main bus, were replaced and the aircraft returned to service.

Discussion

The cause of the failure was not determined but the description of the event and experience highlighted by the aircraft manufacturer suggests that the main contacts within the K26 contactor may have welded themselves together. This would have resulted in the starter/generator remaining powered whenever the right main bus was live.

With this known problem, the manufacturer has introduced a procedure to inspect the main surfaces of the contacts within the contactor at every C check. An assessment of the aircraft's maintenance records was not possible and therefore it could not be determined whether the contacts had been checked during G-PRPH's last C check.

ACCIDENT

Aircraft Type and Registration:	Cessna 182RG, M-GOLF
No & Type of Engines:	1 Lycoming O-540-J3C5D piston engine
Year of Manufacture:	1980 (Serial no: FR18200046)
Date & Time (UTC):	13 March 2020 at 1449 hrs
Location:	Private airstrip, Mount Rule, Isle of Man
Type of Flight:	Private
Persons on Board:	Crew - 1 Passengers - 1
Injuries	Crew - None Passengers - None
Nature of Damage:	Damaged beyond economical repair
Commander's Licence:	Private Pilot's licence
Commander's Age:	75 years
Commander's Flying Experience:	600 hours (of which 300 were on type) Last 90 days - 5 hours Last 28 days - 4 hours
Information Source:	Aircraft Accident Report Form submitted by the pilot

Synopsis

The accident occurred during a baulked landing and go-around. Shortly after touching down the pilot applied full power but reported that the aircraft did not accelerate or climb as expected. The aircraft struck farm gates before touching down in a field where it overturned and came to rest inverted.

History of the flight

The pilot and a passenger, who was also a pilot, were flying from Ronaldsway Airport where the aircraft was based, to a private airstrip at Mount Rule on the Isle of Man. The pilot had not landed at the airstrip before, but the passenger had landed there many times, but not in M-GOLF.

The takeoff appeared normal and there were no technical issues noted with the aircraft whilst en route. Upon arrival, the pilot flew three circuits, with one at low level, in order to familiarise himself with the airstrip before positioning to land on grass Runway 28. This was about 530 m in length and had an uphill slope. At the end of the runway were several farm gates that led to an adjacent field, bounded by a hedge, that was used for livestock. The reported wind was from 100° at 7 kt. The pilot recalled configuring the aircraft for the approach with the propeller set to its fine position, carburettor mixture fully rich and flown at a speed of 60 kt. The pilot stated that the flaps were set at an intermediate position between 20° and full flap.

A witness standing next to Runway 28 recorded video footage of the aircraft as it landed. The final sequence was not recorded, but the footage showed that the aircraft touched down about halfway along the runway. It remained on the ground for a further six seconds before the video ended. At this point it was estimated that the aircraft was about 110 m from the end of the runway.

The pilot stated that, as the aircraft touched down, he saw a horse appear near the end of the runway[1] and almost immediately initiated a baulked landing. At the same time, the passenger also verbalised the need to go around as the aircraft had landed further along the runway than intended. The pilot stated that he then set the flaps to 20° and advanced the throttle to the full power position but the aircraft did not accelerate as expected. As the aircraft approached the end of the runway it started to become airborne but then hit the farm gates. The aircraft subsequently touched down in the adjacent field where it overturned and came to rest inverted (Figure 1). The pilot and passenger were uninjured and vacated the aircraft unaided, but the aircraft was damaged beyond economic repair.

The pilot considered that the aircraft did not accelerate and climb as expected because of a possible loss of engine power or malfunction with the constant speed propeller.

Figure 1

M-GOLF after the accident

Footnote

1 When the pilot initially saw the horse, it was not clear to him if it was within the boundary of the airstrip. After the accident, the pilot confirmed that the horse had been in the field beyond the end of the runway and behind the closed farm gates that the aircraft subsequently hit.

SERIOUS INCIDENT

Aircraft Type and Registration:	Diamond DA 42 NG Twin Star, G-SLCT
No & Type of Engines:	2 Austro E4-B piston engines
Year of Manufacture:	2005
Date & Time (UTC):	4 March 2020 at 1310 hrs
Location:	Stapleford Aerodrome, Essex
Type of Flight:	Training
Persons on Board:	Crew - 2 Passengers - None
Injuries:	Crew - None Passengers - None
Nature of Damage:	Nosewheel, left and right propellers damaged
Commander's Licence:	Commercial Pilot's Licence
Commander's Age:	49 years
Commander's Flying Experience:	2,312 hours (of which 784 were on type) Last 90 days - 63 hours Last 28 days - 11 hours
Information Source:	Aircraft Accident Report Form submitted by the pilot

Synopsis

On the first touch-and-go of a circuit training detail, the aircraft ballooned during landing and the instructor took control. He retracted flaps and applied full power for takeoff. During the ensuing takeoff roll the aircraft travelled past the point where the runway surface changed from asphalt to grass. Due to recent inclement weather the ground condition was soft. Despite continuing to apply full power, the aircraft did not accelerate and the instructor elected to bring the aircraft to a stop. While decelerating, the aircraft's nosewheel sunk into the soft earth and separated from the aircraft.

History of the flight

The aircraft was undertaking a circuit training detail on Runway 21L at Stapleford Aerodrome, Essex. The wind was reported as calm, from an East-South-Easterly direction. The instructor reported that during the touchdown on the first touch-and-go, the student pilot 'slightly ballooned' the aircraft. The instructor did not consider it necessary to prompt or initiate an immediate go-around, and instead took control to stabilise the aircraft on the ground roll. He then applied full power and retracted the flaps, having assessed that there was sufficient runway remaining to complete the takeoff. While he was attempting to achieve 'unstick,' the aircraft passed the point where the runway surface transitions from asphalt to grass. This initially caused the aircraft to decelerate, preventing takeoff, but thereafter the airspeed remained constant. The instructor assessed that there was still adequate runway remaining to safely complete the takeoff and continued to apply full power to try and accelerate the aircraft, but the airspeed did not increase. Not having achieved the desired increase in airspeed, he closed the throttles and applied gentle braking to bring the aircraft to a controlled stop. During the latter part of the deceleration, the aircraft nosewheel sank into the soft grass and separated from the aircraft. The nose lowered, both propellers struck the ground and the aircraft subsequently came to rest close to the end of the runway (Figure 1 and 2). Both occupants were uninjured and exited the aircraft without assistance.

Figure 1
G-SLCT after coming to rest

Figure 2
G-SLCT's nosewheel

Airfield information

Stapleford Aerodrome is a licensed airfield with three runways: grass Runway 10/28, grass Runway 03L/21R and grass/asphalt Runway 03R/21L.

Runway 21L is 1,077 m long, with the first 600 m having an asphalt surface and the remainder being grass. The asphalt section is comprised of a 23 m starter extension, and a displaced threshold of 177 m. There is also a 50 m clearway at the end of Runway 21L. The declared Takeoff Run Available (TORA), Takeoff Distance Available (TODA) and Landing Distance Available (LDA) are therefore 1,100 m, 1,150 m and 900 m respectively. The elevation is 115 ft at the Runway 21L threshold and 185 ft at the 03R threshold, giving a +1.98% upslope on Runway 21L.

Instructor's comments

The instructor commented that excessive rainfall throughout winter and particularly in the days immediately prior to the incident, had led to soft ground conditions. Additionally, the absence of a headwind component and the high aircraft weight due to it being fully fuelled, both served to increase the required landing distance and takeoff run.

The student was in the early stages of undertaking training for a multi-engine piston rating and training continuity had been interrupted due to recent poor weather. Their most recent experience had been on tailwheel aerobatic aircraft. The instructor considered that during the flare and hold-off, the student had reverted to a technique more appropriate to the type they had most recently flown. This caused the aircraft to balloon on landing and as a result increased the takeoff run required for the touch-and-go.

Based on the ground conditions, the instructor considered that in future faced with similar circumstances, he would:

- Abort the takeoff if the aircraft transitioned, or he assessed that it could transition, onto the grass section of Runway 21L.
- Set the flaps to the approach setting, in accordance with the procedure for short field departures in the aircraft flight manual.
- Not conduct circuit training details if there was no headwind component.

Conclusion

While performing a touch-and-go the aircraft ballooned on landing, increasing the landing distance required and causing the instructor to take control. During the ensuing takeoff roll the aircraft travelled past the point where the runway surface changed from asphalt to grass. The soft ground conditions on the grass surface prevented the aircraft from accelerating sufficiently to achieve takeoff speed. As the aircraft was being brought to a stop the nosewheel detached.

ACCIDENT

Aircraft Type and Registration:	Glos-Airtourer 150, G-AXIX
No & Type of Engines:	1 Lycoming O-320-E2A piston engine
Year of Manufacture:	1969 (Serial no: A527)
Date & Time (UTC):	25 March 2020 at 1619 hrs
Location:	Almeley Wootton, Herefordshire
Type of Flight:	Private
Persons on Board:	Crew - 1 Passengers - 1
Injuries:	Crew - None Passengers - None
Nature of Damage:	Nosewheel, propeller, wing and canopy damaged
Commander's Licence:	Private Pilot's Licence
Commander's Age:	73 years
Commander's Flying Experience:	1,101 hours (of which 760 were on type) Last 90 days - 3 hours Last 28 days - 2 hours
Information Source:	Aircraft Accident Report Form submitted by the pilot

The pilot and passenger were flying from Shobdon Airport in Herefordshire to a grass airstrip near Almeley Wootton (approximately 5 nm south-west of Shobdon). After flying in the local area for an hour the pilot made an approach to land on the north-westerly runway. The wind was approximately 5 kt across the runway.

The pilot reported he landed on the main wheels but as the nosewheel touched down the aircraft started to oscillate in pitch. The nosewheel detached, the propeller struck the ground and the aircraft came to a sudden stop. Neither occupant was injured and they were both able to exit the aircraft normally.

The pilot believes the accident was caused by a slightly higher groundspeed than he was use to, due to the lack of headwind, and him closing the throttle slightly early causing the aircraft to drop onto the runway. He was aware he was landing on a short runway so did not want to land too far along it.

The pilot reported that as the aircraft came to a sudden halt the fire extinguisher, which was mounted at the back of the baggage compartment, came loose and travelled past the passenger's head and through the windscreen. When the aircraft is repaired, he intends to relocate the fire extinguisher behind the seats to ensure it is secure.

Figure 1
G-AXIX after the accident

ACCIDENT

Aircraft Type and Registration:	Piper PA-28-161 Cherokee Warrior II, G-BODB
No & Type of Engines:	1 Lycoming O-320-D3G piston engine
Year of Manufacture:	1982 (Serial no: 2816042)
Date & Time (UTC):	1 December 2019 at 1551 hrs
Location:	Sherburn in Elmet Airfield, Leeds
Type of Flight:	Private
Persons on Board:	Crew - 1 Passengers - 1
Injuries	Crew - None Passengers - None
Nature of Damage:	Dent to left side of aircraft wing
Commander's Licence:	Private Pilot's Licence
Commander's Age:	31 years
Commander's Flying Experience:	115 hours (of which 13 were on type) Last 90 days - 1 hour Last 28 days - 0 hours
Information Source:	Aircraft Accident Report Form submitted by the pilot

The aircraft was parked close to the airfield fuel pump installation. The pilot carried out his pre-flight inspection and, having boarded his passenger, started the engine. He taxied the aircraft forward before making a right turn during the latter stages of which the outboard section of the left wing leading edge struck the fuel pump. The pilot immediately shut down the aircraft and inspected the wing, which had a small dent on the leading edge.

Having inspected the damage, which he considered was minimal, the pilot considered that it would be safe to fly. It was late in the afternoon and he had to complete the flight before night, but he did not want to disappoint his passenger and so he pushed the aircraft back, restarted the engine and departed. Due to the delay, however, he subsequently landed about 15 to 20 minutes into night-time. He reported to the flying club both the contact with the fuel pump and having flown at night. The flying club made clear to the pilot the correct action he should have taken by getting the damage inspected and curtailing his flight to avoid flying at night.

Accident

Aircraft Type and Registration:	Chaser S 447, G-MYBU	
No & Type of Engines:	1 Rotax 447 piston engine	
Year of Manufacture:	1992 (Serial no: CH837)	
Date & Time (UTC):	4 July 2019 at 1300 hrs	
Location:	Mendlesham Airfield, Suffolk	
Type of Flight:	Private	
Persons on Board:	Crew - 1	Passengers - None
Injuries:	Crew - 1 (Minor)	Passengers - N/A
Nature of Damage:	Extensive damage to airframe; monopole broken; keel, seat tubes and base bar bent; spats broken.	
Commander's Licence:	National Private Pilot's Licence	
Commander's Age:	56 years	
Commander's Flying Experience:	240 hours (of which 6 were on type) Last 90 days - 8 hours Last 28 days - 2 hours	
Information Source:	Aircraft Accident Report Form submitted by the pilot	

Synopsis

Just after takeoff, the front strut of the microlight trike separated from the forward mounting point. The pilot recognised that structural integrity was severely compromised and attempted to return to the runway. There was insufficient height to achieve this and the aircraft landed in crops alongside the runway. The microlight trike was extensively damaged, and the pilot sustained minor injuries.

History of the flight

The pilot, who had not owned the aircraft for long, had rigged the aircraft the day before the accident, following a wing cleaning. It was the first time that the pilot had rigged the aircraft, so he asked for assistance from a friend he considered to be very experienced with this type of aircraft. The friend believed he had secured the front strut from the wing structure to the trike body. The strut is secured to the nose of the aircraft by a pin which passes through the tube of the strut and through holes on the mounting point on the aircraft nose (Figures 1 to 3).

On the day of the accident the local hang-gliding club was flying. The hang gliders were lined up for launch along the left side of the runway and the winch launch towline was also laid out on that side. After a discussion with the hang glider club, the accident pilot agreed to use the right side of the runway to avoid the parked hang gliders and to ensure that his takeoff would be visible to the winch driver.

As soon as the pilot took off, he turned right to clear the runway and be more into wind. Almost immediately he became aware that the front strut was no longer attached to the nose of the aircraft and was dangling from the wing attachment hang point.

Aware that the structural integrity of the aircraft was now severely compromised, the pilot attempted an immediate landing. Given the low altitude, he was unable to return to the runway and the aircraft struck crops to the right of the landing surface, sustaining extensive damage to the landing gear and trike body.

The hang glider pilots ran to the accident site to offer help, but by the time they arrived the pilot had vacated the aircraft. An air ambulance attended the scene, but the pilot's injuries were not sufficiently serious to warrant his transfer to hospital by air. He was taken to hospital by ground ambulance and treated for minor injuries.

Aircraft Information

The Chaser S 447 is a single-seat deregulated aircraft. It is a weight-shift microlight with a trike body suspended from the wing structure. All maintenance activity on the aircraft was conducted by the owner.

The front strut is secured to the trike by means of a pin which passes through both the tube of the strut and the attachment point. A correctly routed pin locks the strut to the attachment point, and the correct fastening of the strut is shown in Figure 2.

Figure 1
Attachment location

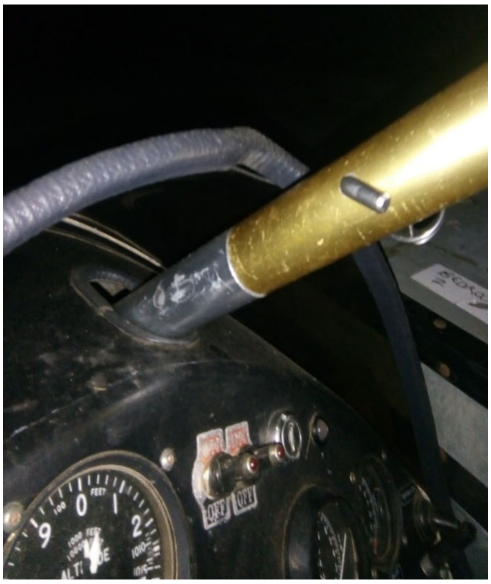


Figure 2

Correct attachment

In this case, the pin passed through the strut tube but not through the attachment point. The holes on the attachment point would have remained visible, indicating an insecure strut, but this was not noticed either during rigging or pre-flight checks. The incorrect attachment is shown at Figure 3.

Figure 3

Incorrect attachment

Once in flight the aerodynamic forces of the wing caused the strut to separate.

Conclusion

An incorrectly rigged strut separated immediately after takeoff. The structural integrity of the aircraft was severely compromised and the aircraft struck crops during the pilot's attempted landing.

Accident

Aircraft Type and Registration:	DJI Inspire 2 (UAS registration n/a)
No & Type of Engines:	4 DJI 3512 electric motors
Year of Manufacture:	2016 (Serial no: 095XDAX002024M)
Date & Time (UTC):	8 February 2020 at 1328 hrs
Location:	Sampson House, London
Type of Flight:	Aerial Work
Persons on Board:	Crew - N/A Passengers - N/A
Injuries:	Crew - N/A Passengers - N/A
Nature of Damage:	Extensive damage
Commander's Licence:	N/A
Commander's Age:	39 years
Commander's Flying Experience:	More than 1,000 hours (of which 430 were on type) Last 90 days - 30 hours Last 28 days - 7 hours
Information Source:	Aircraft Accident Report Form submitted by the pilot

Synopsis

During an operation to take photographs at height on a construction site the drone became erratic. The remote pilot attempted to land the drone immediately, but it became uncontrollable. The remote pilot then attempted to fly the drone away from obstructions, but it collided with a concrete structure on the site and was catastrophically damaged.

It is likely the loss of control and collision were caused by the drone not correctly setting the 'home-point' despite this appearing to the remote pilot to be correctly positioned on the transmitter screen. This combined with poor GPS and compass following from the beginning of the flight lead to erratic manoeuvring and a subsequent attempt at a fly away.

Despite the confined nature of the construction site within a heavily built up area, the operator had taken all the required mitigations and safety measures to ensure that there was no risk to any other persons even when control of the drone was lost.

History of the flight

The remote pilot had completed five flights at the site on the day of the accident from a takeoff and landing area (TOAL) at the north of the site (Figure 1). To ensure safe flight in relation to a crane, the TOAL was then moved to the south quadrant. Pre-flight checks on the drone indicated that a full GPS signal had been acquired and that the new 'home-point' had been set correctly. However, during the initial flight checks the drone became erratic. The remote pilot attempted to land the drone immediately but when the landing gear was lowered, control of the drone deteriorated further. An attempt was made to climb the drone and direct it towards the River Thames away from railways, roads and buildings close to the site, but it collided with a concrete core at the centre of the site where it fell within the sterile area. Figure 1 shows the TOAL for the first five flights (in blue), the TOAL used for the accident flight (in yellow), and the concrete core into which the drone collided. Figure 2 shows the damage to the drone after it fell to the ground.

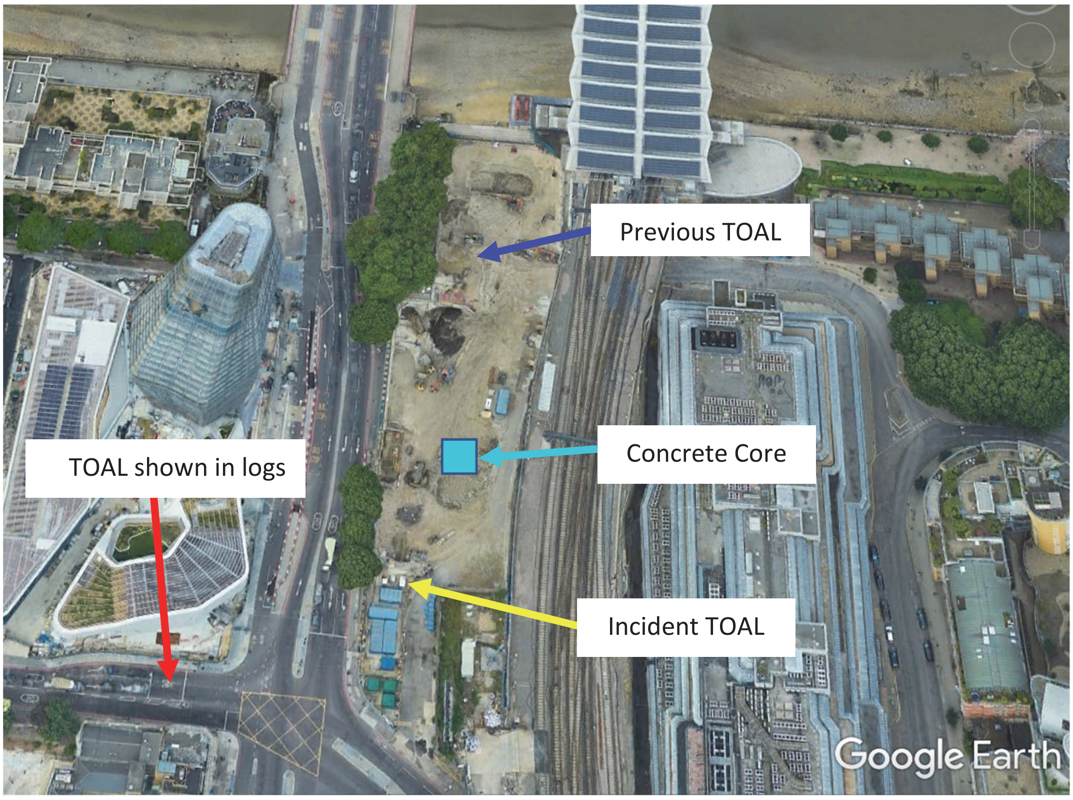


Figure 1

The area of operation of the drone showing the TOALs for the flights and the collision structure

Subsequent examination of the flight logs showed that the 'home-point' set by the drone for the accident flight was outside of the site (shown in red in Figure 1). The data showing distance flown was also incorrect. The logs showed that the GPS and compass had poor signal strength once the flight had commenced. The remote pilot commented that he may have missed that the drone was showing the incorrect home position before takeoff as he may have relied on the messages showing the drone was ready for flight provided on the interface and the navigational lighting.

Figure 2
Damage to the drone

Accident site

The site is a construction site in central London which is constrained to the north by the River Thames, to the east by railway tracks, and by numerous roads and buildings to the south and west. The site is also located on the edge of Restricted Area EGR 158 airspace which required specific permission for the flight. During the preparation for the flights the remote pilot had gained the correct permissions for flight using the NATS Air User Portal[1]. He had also stationed staff members outside the site to ensure that no vehicles or pedestrians were present during takeoff, low altitude flight or landings. The construction site was sterile with only minimal staff and no work occurring in the operational zone of the drone. All these safety preparations ensured that when control of the drone was lost and it collided with a structure, no persons or vehicles were put at risk.

Analysis

Due to a position error, as well as poor GPS and compass signal strength, the drone became erratic and uncontrollable after takeoff before colliding with a concrete structure within the sterile zone of the operation.

Due to the significant pre-flight preparation and planning, as well as safety mitigations in place for the flight, the loss of control and subsequent collision did not cause any risk to people on the ground despite the built-up nature of the surrounding area.

Footnote

1 https://aup.nats.aero/ [accessed 16 April 2020]

ACCIDENT

Aircraft Type and Registration:	DJI Matrice M210 V2, (UAS registration n/a)
No & Type of Engines:	4 electric motors
Year of Manufacture:	2019 (Serial no. 17TDGN0032651)
Date & Time (UTC):	5 March 2020 at 2220 hrs
Location:	Mill Lane, Ludlow
Type of Flight:	Emergency services operations
Persons on Board:	Crew - N/A Passengers - N/A
Injuries:	Crew - N/A Passengers - N/A
Nature of Damage:	Damage to motor arms, propellers, batteries, gimbal bracket and cameras
Commander's Licence:	Not applicable
Commander's Age:	49 years
Commander's Flying Experience:	19 hours (of which 4 were on type) Last 90 days - 3 hours Last 28 days - 1 hour
Information Source:	Aircraft Accident Report Form submitted by the pilot

The accident occurred on a dry, clear night, when the drone was at an extended range of approximately 590 m. The pilot was using first person view and the drone was within visual line of sight. Analysis of the fight data indicated that the UAS probably struck a tree while flying sideways after the pilot applied a right roll input. The Matrice 210's obstacle avoidance system is only capable of detecting approaching objects in front of the aircraft so it would have been unable to detect the tree.

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 March - April 2020

15-Nov-19	**Gulfstream American GA-7 Couger**	**G-BOOE**	Retford Gamston Airport, Nottinghamshire

The aircraft suffered a landing gear failure and performed a gear-up landing.

04-Dec-19	**Piper Seneca**	**G-BABK**	Stapleford Aerodrome, Essex

During taxi, following a normal landing, the nose gear collapsed due to a fracture of the main attachment tube at the right-hand attachment area.

05-Feb-20	**Escapade Jabiru(1)**	**G-CECF**	Wolverhampton/Halfpenny Green Airport, West Midlands

During the landing roll, the passenger's shoelaces jammed the rudder pedals and the aircraft subsequently ground looped and departed the side of the runway. The left tyre, wheel and landing gear were damaged.

26-Feb-20	**Eurofox 912(IS)**	**G-CIWG**	Aston Down Airfield, Gloucestershire

While taxiing, a gust of wind lifted the wing and tipped the aircraft onto its nose damaging the propeller and nose cone.

11-Mar-20	**Piper PA-28-181**	**G-BGWM**	Wellesbourne Mountford Airfield, Warwickshire

The aircraft suffered a heavy landing. Damage was found to the nose gear and engine mountings during subsequent maintenance inspections.

16-Mar-20	**SD-1 Minisport**	**G-CLDY**	Plaistow Airfield, Hertfordshire

Gusts on short finals pushed the aircraft off course. The pilot was unable to prevent the right wing colliding with a tree and a subsequent uncontrolled landing. The right wing and tailplane were damaged by the collision with the tree and the nosewheel collapsed during the landing. The pilot was not injured. He had a total of 45 minutes flight time on the type.

22-Mar-20	**EV-97 TeamEurostar UK**	**G-CFGX**	Sandown Airport, Isle of Wight

The aircraft was landing in a crosswind when a gust of wind caused the left wing to drop and strike the ground. The aircraft suffered minor damage to the wingtip and left aileron

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

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

Published September 2014.

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

Published July 2015.

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

Published August 2015.

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

Published October 2015.

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.

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
DFDR	Digital Flight Data Recorder
DME	Distance Measuring Equipment
EAS	equivalent airspeed
EASA	European Aviation Safety Agency
ECAM	Electronic Centralised Aircraft Monitoring
EGPWS	Enhanced GPWS
EGT	Exhaust Gas Temperature
EICAS	Engine Indication and Crew Alerting System
EPR	Engine Pressure Ratio
ETA	Estimated Time of Arrival
ETD	Estimated Time of Departure
FAA	Federal Aviation Administration (USA)
FIR	Flight Information Region
FL	Flight Level
ft	feet
ft/min	feet per minute
g	acceleration due to Earth's gravity
GPS	Global Positioning System
GPWS	Ground Proximity Warning System
hrs	hours (clock time as in 1200 hrs)
HP	high pressure
hPa	hectopascal (equivalent unit to mb)
IAS	indicated airspeed
IFR	Instrument Flight Rules
ILS	Instrument Landing System
IMC	Instrument Meteorological Conditions
IP	Intermediate Pressure
IR	Instrument Rating
ISA	International Standard Atmosphere
kg	kilogram(s)
KCAS	knots calibrated airspeed
KIAS	knots indicated airspeed
KTAS	knots true airspeed
km	kilometre(s)
kt	knot(s)

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