AAIB
Air Accidents Investigation Branch

AAIB Bulletin 12/2018

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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:	BAE Systems (Operations) Ltd ATP, SE-MHF
No & Type of Engines:	2 Pratt & Whitney Canada PW126 turboprop engines
Year of Manufacture:	1989 (s/n 2013)
Date & Time (UTC):	14 December 2017 at 0606 hrs
Location:	On approach to East Midlands Airport
Type of Flight:	Commercial Air Transport (Cargo)
Persons on Board:	Crew - 2 Passengers - None
Injuries:	Crew - None Passengers - N/A
Nature of Damage:	None
Commander's Licence:	Airline Transport Pilot's Licence
Commander's Age:	29 years
Commander's Flying Experience:	2,089 hours (of which 1,854 were on type) Last 90 days - 82 hours Last 28 days - 29 hours
Information Source:	AAIB Field Investigation

Synopsis

The aircraft was conducting an ILS approach to Runway 27 at East Midlands Airport (EMA). At around 800 ft agl (approximately 670 ft aal) the co-pilot attempted to disconnect the autopilot but it did not appear to disconnect. The crew made several further attempts to disconnect the autopilot before initiating a go-around at 230 ft aal. An uneventful, manually flown, circuit and landing was completed afterwards.

Although the crew perceived that the autopilot disconnected while the aircraft was climbing during the go-around, recorded flight data indicated that it disconnected at approximately 425 ft aal during the approach.

No defects or abnormalities were identified with any units associated with the autopilot.

Following this incident (and two earlier similar events), the manufacturer decided to review the Emergency Checklist to see whether it should be amended to address the condition where crews are unable to disengage an autopilot.

History of the flight

First sector

The crew reported for duty at EMA at 2250 hrs on 13 December 2017 for a cargo flight to Belfast Aldergrove Airport (BFS) scheduled to depart at 0020 hrs. The co-pilot had been called from a standby duty commencing at 1200 hrs on 13 December. The aircraft required de-icing and the departure was delayed. De-icing started at 0228 hrs, the aircraft took off from EMA at 0301 hrs and landed at BFS at 0406 hrs.

Second sector

The aircraft departed from BFS at 0503 hrs for the return sector to EMA; the co-pilot was designated as the pilot flying (PF). The crew reported that the weather conditions en route were mainly clear and, although the aircraft may have passed through some light cloud, they did not encounter any sustained icing conditions. The weather conditions at EMA had improved; the arrival ATIS recorded at 0549 hrs indicated Runway 27 in use, runway surface wet, surface wind from 230° at 11 kt, visibility more than 10 km and few cloud at 1,700 ft.

The crew briefed for an ILS approach to Runway 27. It was anticipated that the approach would be conducted in visual conditions and, in accordance with the operator's Standard Operating Procedures (SOPs), was planned to be stable by a minimum of 500 ft agl.

On the ILS approach, with autopilot 2 (AP2) engaged, the aircraft descended through 1,000 ft in a normal (gear down, flaps 15°) but not yet stable configuration. The co-pilot decided to disconnect the autopilot earlier than usual to take advantage of the manual handling opportunity. He recalled using the control wheel autopilot disconnect button at between 1,000 ft and 800 ft agl[1], but the autopilot remained engaged. He then tried using the control wheel trim switch, which should also have disconnected the autopilot, but that was similarly ineffective. He commented aloud that he couldn't disconnect the autopilot but the commander interpreted the comment as confirmation that he was disconnecting it and acknowledged the comment, not having realised that the autopilot was still engaged.

As the aircraft approached 500 ft agl (approximately 425 ft aal), when it was required to be stable, the commander became concerned that the aircraft was not yet configured for landing and prompted the co-pilot to make the landing flap selection. Landing flaps (20°) were selected and the co-pilot again advised the commander that he was unable to disconnect the autopilot. The commander tried the autopilot disconnect switch on her control wheel but the autopilot appeared to remain engaged and she called for a go-around. The co-pilot, concerned about how to go around while working against the autopilot, recalled information he learned after a previous incident on one of the operator's aircraft[2] and used the synchronisation (sync) switch on his control wheel[3] (Figure 1). As he pressed the switch he felt a 'release' of control wheel pressure which enabled him to take control and pitch to a nose up attitude for the go-around.

Footnote

1 Referenced to radio altitude (RA).

2 AAIB investigation to BAe ATP, G-BUUR '*Go-around due to autopilot issue and subsequent elevator control problems, on approach to Guernsey Airport, 26 January 2016'.* Available at: https://www.gov.uk/aaib-reports/aaib-investigation-to-bae-atp-g-buur.[accessed October 2018].

3 The sync switch de-energises the elevator, elevator trim and aileron clutches.

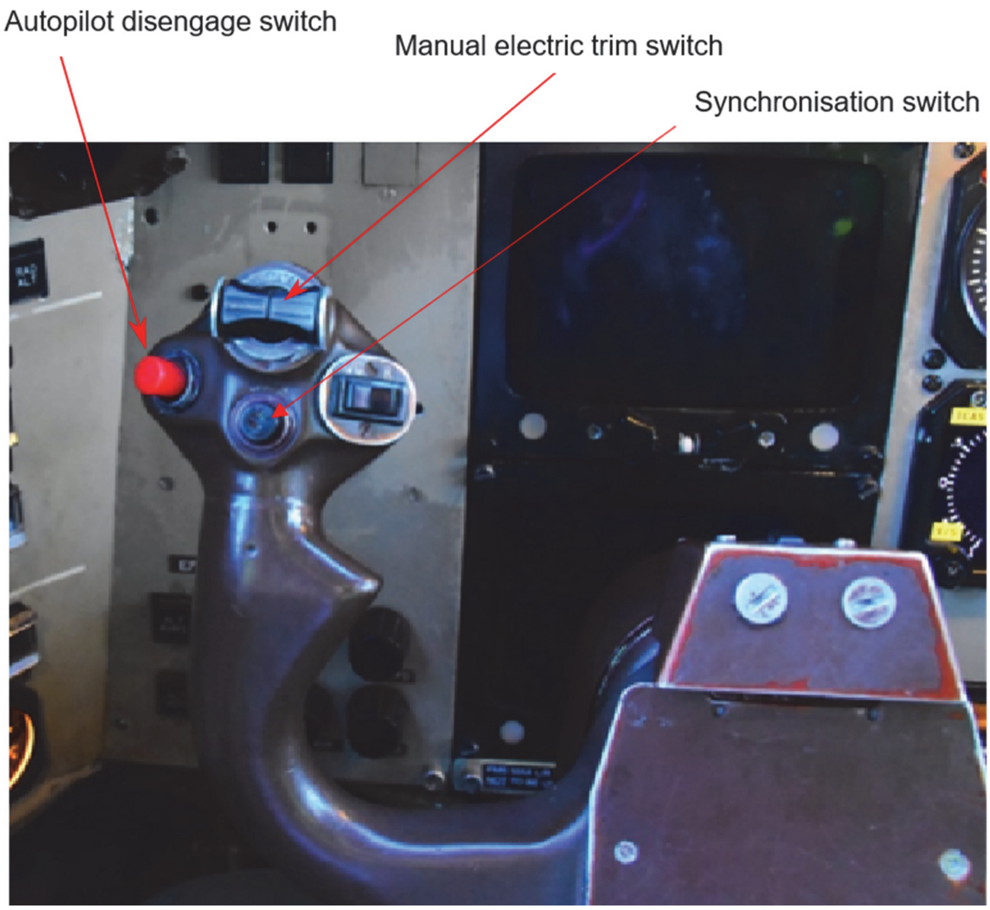

Figure 1

Control wheel switches (captain's control wheel)

The flight data showed that flap 20° was selected at 350 ft aal and that a go-around was initiated at 230 ft aal. During the go-around both pilots noticed that AP 2 was no longer indicating as engaged on the Primary Flying Display (PFD), although neither of them had heard an autopilot disconnect audio warning. The co-pilot continued to fly the aircraft manually and completed an otherwise uneventful circuit, approach and landing at EMA.

Pilot information

The commander started flying the BAe ATP in October 2011 as a co-pilot and completed command upgrade training in October 2016.

The co-pilot had a total of 2,500 hours flying experience, which included 700 hours on type. He had flown 65 hours in the preceding 90 days, 20 hours in the preceding 28 days. His previous duty, on 12 December 2017, was also a standby duty at 1200 hrs, from which he was called for a 1400 hrs report and went off duty at 2139 hrs.

Following his flight on 13/14 December he was scheduled to change aircraft fleet; he commented that because of this he had chosen to disconnect the autopilot earlier than usual and fly manually, his normal practice being to disconnect it at around 400 ft agl.

Post incident crew comment and analysis

The crew reviewed the event after the flight and realised that there had been a mis-communication between them concerning the autopilot status. The co-pilot believed he had informed the commander there was a problem with the autopilot disconnection, but the commander had received a different message and did not realise. In hindsight, the co-pilot thought that he may have been questioning rather than assertive when stating there was a problem. The misunderstanding was resolved when the commander became concerned that the approach might not be stable by the required 500 ft agl and started to prompt the co-pilot to complete the pre-landing actions.

The co-pilot noted afterwards that he had been confused by not being able to disconnect the autopilot and by an apparent lack of concern from the commander. He reported that for a while he was focussed on repeatedly trying to disconnect the autopilot and became absorbed by the problem. Although he anticipated he would have to go around, he was not sure how to achieve this. Then, when the commander prompted him for the before-landing actions, and realising that the approach should by now be stable, he again voiced his inability to disconnect the autopilot. The commander called for a go-around and the co-pilot, recalling having practised using the sync switch in training after the previous event in one of the operator's aircraft[4], pressed and held the sync switch and gained control to carry out the go-around.

Recorded information

SE-MHF was equipped with a 30 minute duration, tape-based, Cockpit Voice Recorder (CVR) and a tape-based Flight Data Recorder (FDR) with a capacity of 25 hours. Both of these devices were removed from the aircraft and successfully downloaded at the AAIB.

The CVR contained a discussion of the event between the flight crew after the aircraft had landed, but coverage of the actual event had been overwritten due to the elapsed time since the initial approach.

The FDR data for SE-MHF's approach and go-around, is shown below in Figure 2.

The data showed that AP2 was engaged with the aircraft in a gradual descent approaching 2,000 ft amsl as it aligned with the inbound course for Runway 27 at EMA. Flap 7 was selected with the airspeed reducing towards 154 kt and engine torque at 27.5% and 32.5% for engines 1 and 2 respectively. SE-MHF's pitch attitude then decreased, and a descent was started[5]. Engine power remained unchanged and, after a temporary increase in airspeed as the aircraft began to descend, Flap 15 was selected. SE-MHF's airspeed then began to reduce, reaching a minimum of 107 kt at 500 ft aal recorded after a period of 113 seconds. During this time, as the airspeed reduced, both the elevators and the pitch trim provided increasing nose-up inputs. An additional 13-14% of torque

Footnote

[4] AAIB investigation to BAe ATP, G-BUUR Guernsey Airport, 26 January 2016. Available at: https://assets.publishing.service.gov.uk/media/57ac5f91e5274a0f5200007e/BAe_ATP_G-BUUR_09-16.pdf [accessed October 2018].

[5] SE-MHF was flying an ILS approach with the autopilot coupled, the descent would be consistent with capturing the glideslope.

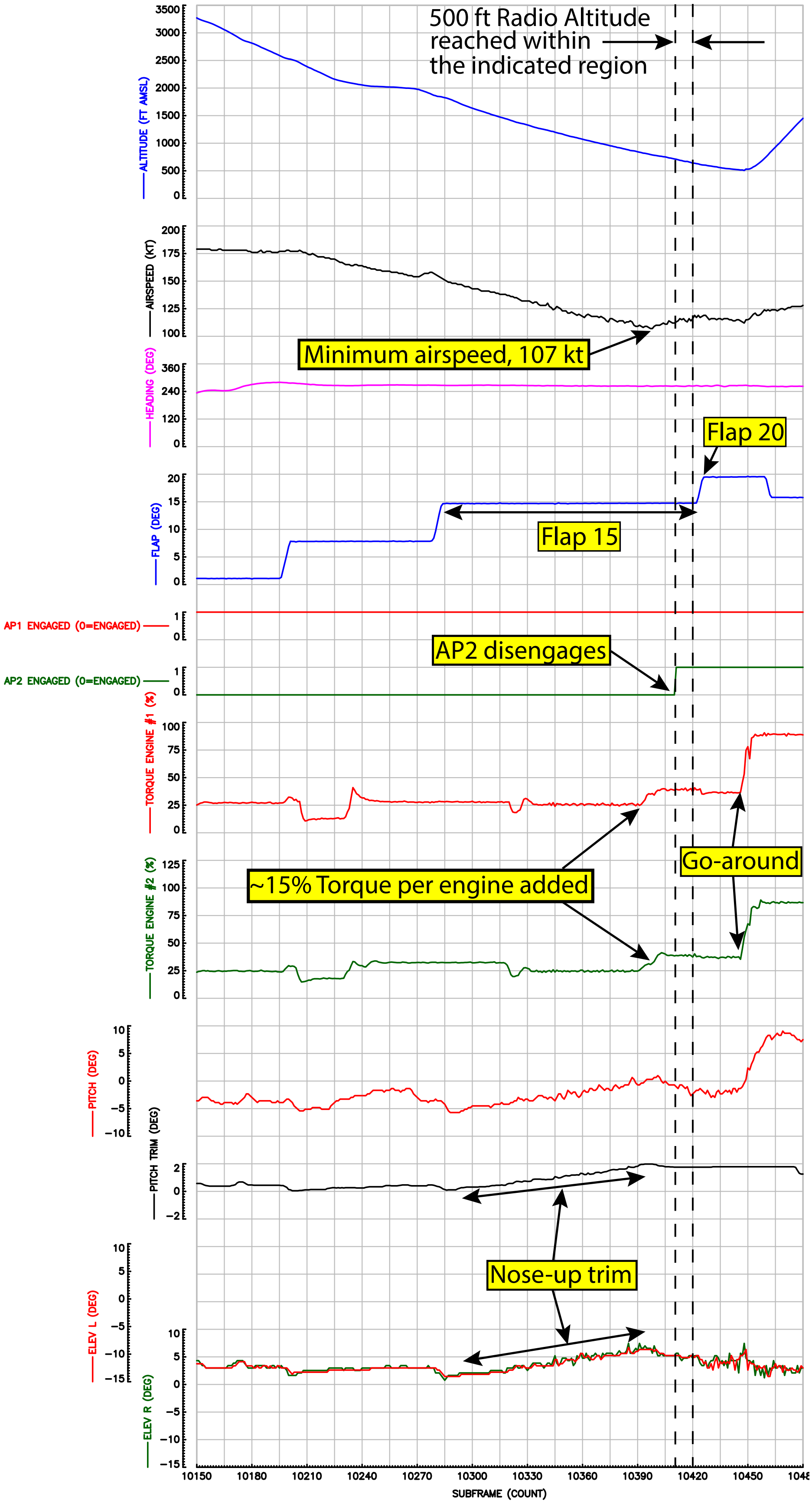

Figure 2

The initial approach and go-around at East Midlands Airport per engine was applied just prior to the point of minimum airspeed and, subsequently, the airspeed increased to 113 kt. The data then shows that AP 2 disengaged[6] at 425 ft aal (approximately 500 ft radio altitude (RA)) and, thereafter, that the airspeed stabilised around 117 kt. The increase in airspeed of SE-MHF was accompanied by a corresponding decrease in aircraft pitch, but after AP2 disengaged no further pitch trim activity was seen in the data. Flap 20 was selected at 350 ft aal and a go-around was initiated at 230 ft aal.

Aircraft information

The aircraft has a common autopilot controller which, through dual circuits, interfaces with either the No 1 or No 2 autopilot system. A 'fly through' facility is available whereby an autopilot servo motor can be overridden by means of a slipping clutch. This requires a force in excess of 50 lb on the control column but does not disengage the autopilot, and any opposing force must be sustained. A spring-loaded sync switch located on each pilot control wheel, when held pressed, de-clutches the pitch, pitch trim and roll servo motors allowing the pilot to adjust the aircraft attitude without disengaging the autopilot.

Autopilot engagement/disengagement

An autopilot is engaged by the selection of an autopilot switch on the autopilot controller (Figure 3). The indication on the controller is an AP/YD[7] annunciation and illumination of a SYS 1/SYS 2 light. If No 1 autopilot is engaged, AP1 is shown in green on the left (Captain's) PFD and in white on the right (First Officer's) PFD. The situation is reversed when the First Officer is controlling the aircraft using No 2 autopilot (AP2 is shown in green on the right PFD and white on the left).

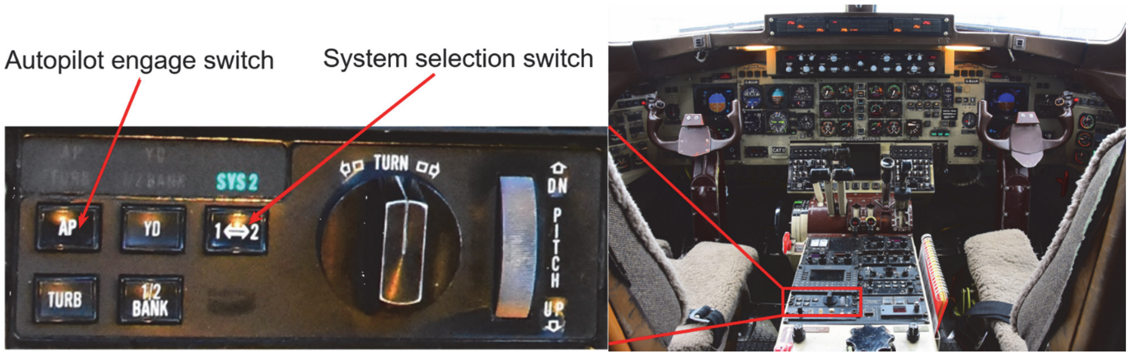

Figure 3

Autopilot controller

Footnote

6 FDR installation on SE-MHF recorded the engagement status of each autopilot but did not record the inputs to the autoflight system that are used to trigger disengagement of the autopilot(s).

7 Autopilot/Yaw Damper.

There are multiple methods by which an autopilot can be disengaged, shown in Table 1:

Action	Location
Activation of autopilot disconnect button	Pilot control wheels
Activation of either electric trim switch	Pilot control wheels
Activation of either Go around button	Power levers
Operation of A/P System 1-2 select switch	Centre console
Circuit breakers AP No.1 flight controller and No.2 flight controller	Left and Right side distribution panel respectively

Table 1

Methods for autopilot disengagement

When an autopilot disengages automatically, the AP/YD annunciations on the autopilot controller are removed and the AP1/AP2 indications on the PFDs are replaced with a red AP/FD[8] indication. At the same time, a continuous audio 'cavalry charge' multiple tone is provided to each pilot's headset and the cockpit speakers if they are selected ON. The tone can be cancelled by pressing either of the AP disengage switches.

When an autopilot is disconnected manually, AP/YD annunciations on the autopilot controller are removed and the AP1/AP2 indications disappear from the PFDs. A one second 'cavalry charge' audio tone is generated. There are no indications if the autopilot is already disengaged and further attempts are made to disconnect.

Landing data

The calculated landing weight was 16,778 kg, with the centre of gravity within the allowable range. The manufacturer's operating publications provide speed data for landing with flaps 20° or 29° and it is recommended the landing flap setting is selected before 250 ft aal. The approach speeds for a flap 20° landing are referenced to V_{AT} 20° (98 kt for 17,000 kg); speed data are provided on a landing card.

Emergency procedures

The Emergency & Abnormal Checklist does not provide a procedure for an autopilot which does not disengage.

Aircraft examination

Based on the details of the incident, the aircraft manufacturer recommended a package of tests to verify the serviceability of the aircraft's autoflight system which were completed by the operator's engineers at EMA. The only defect identified during these tests was that the No 1 autopilot computer failed to disengage within the required time during the autopilot disconnect test. As a result, the possibility was considered that the No 1 autopilot, although

Footnote

[8] Autopilot/Flight Director.

not the active autopilot during the incident, could have affected the behaviour of the No 2 autopilot. The aircraft manufacturer carried out an analysis of the data transfer within the autoflight system which confirmed that there is no data exchange between the autopilot computers.

All the avionics associated with the auto flight system were removed and replaced. The units removed from the aircraft were transported to the AAIB for further tests. Both autopilot computers, the autopilot control panel, both Flight Director mode control panels, the tone generator and the signal summing unit were tested by the Original Equipment Manufacturers (OEM), under AAIB supervision. No defects or abnormalities were identified with any of the units.

The operator confirmed that there were no further defects relating to the aircraft's autoflight system reported between its return to service and the end of the investigation.

Airfield information

The aerodrome elevation at EMA is 306 ft and the threshold elevation of Runway 27 is 282 ft. The terrain under the approach path to Runway 27 rises gradually from the east towards the aerodrome. The effect is that RA on approach does not correspond to the height of an aircraft above the runway threshold. This is shown in Table 2.

Distance from threshold Runway 27 (nm)	Altitude (amsl ft)	Radio Altitude (RA ft)	Above threshold elevation (ft)
3	1,290	1,152	1,008
2	970	815	688
1.4	780	620	500
1	650	450	368

Table 2

Effect of ground surface on radio altitude (RA)

Human factors

On 12 December 2017, the co-pilot finished his duty at 2139 hrs; he reported that after this he achieved a normal night's sleep. On 13 December, he was called from a 1200 hrs standby duty and reported that he did not sleep after being called. He also said that, at times, he felt very tired during the flight. The commander did not report feeling unduly tired during the flight. The incident occurred at 0606 hrs on 14 December.

The EASA Guidance Material for Flight Time Limitations at '*GM1 CS FTL.1.225(b)(2) Standby*' includes the following reference:

> *'AWAKE TIME -- Scientific research shows that continuous awake time in excess of 18 hours can reduce the alertness and should be avoided.'*

Alertness and performance are affected by two neurobiological processes: homeostatic sleep drive and circadian rhythms. The homeostatic sleep drive is a biological pressure for sleep. It is low shortly after waking and builds over the time a person is awake until it becomes difficult or impossible to resist sleep[9]. Homeostatic sleep drive starts to be evident as sleepiness or performance deficits after approximately 16 hours[10].

Circadian rhythm modulates many physiological and neurobehavioural human functions, including alertness and sleep patterns. The lowest point of this rhythm, on average, in people who are entrained in a stable 24-hour light and dark cycle is between 0300 and 0600[9]. The extent to which individuals suffer from performance deficits caused by a lack of sleep is highly variable[11].

The effects of sleepiness on performance include: increased periods of not responding or delayed responding on attention-based tasks; slowed information processing; increased reaction time; reduced accuracy of short term memory[12]; difficulties in problems solving; and perseveration[9,13].

Organisational information

The operator's stabilised approach policy is stated in their Operations Manual:

> *'The intention of the stabilised approach is that all flights shall be stabilised when passing 1000' AAL unless in VMC conditions where 500' AAL applies, otherwise a go-around shall be performed. It should be noted that radio altitude (RA) is used to give an approximation of height above the airfield without the potential confusion of referring to different barometric altitudes during the approach.'*

and

> *'There may be instances where the radio altitude varies greatly from height above the airfield – such as approaches made over the sea. In these cases, crew should take this into account in order to adhere to the intentions of the stabilised approach.'*

Footnote

[9] Mallis, M.M., Banks, S. and Dinges, D.F. (2010). Aircrew Fatigue, Sleep Need and Circadian Rhythymicity. In E. Salas and D. Maurino (Eds.*) Human Factors In Aviation*, *2nd Edition*, Academic Press: Amsterdam 401-436.

[10] Van Dongen, H.P.A, Maislin, G., Mullington, J.M. and Dinges, D.F. (2003). The Cumulative Cost of Additional Wakefulness: Dose-Response Effects on Neurobehavioral Functions and Sleep Physiology From Chronic Sleep Restriction and Total Sleep Deprivation. *Sleep,* 26 (2), 117-126.

[11] Van Dongen, H.P.A, Maislin, G. and Dinges, D.F. (2004). Dealing with inter-individual differences in the temporal dynamics of fatigue and performance: Importance and techniques. *Aviation, Space, and Environmental Medicine,* 75 (3), A147-A154.

[12] Dinges, D.F. (1995). On overview of sleepiness and accidents. *Journal of Sleep Research,* 4, Suppl. 2, 4-14.

[13] Tendency to repeat or prolong an action, thought, or utterance after the stimulus that prompted it has ceased.

The stabilised approach criteria for an approach in visual conditions are shown in Table 3.

Criteria	RA (ft)
On the correct flight path	500
Landing gear	1,000
Landing Checks	500
Rate of Descent - Maximum 1000 fpm	1,000
Landing flaps	500
IAS 150 kt or less, but not less than VAT / Vref,	500
VAT / Vref to VAT / Vref + 20 kt	500
Power setting appropriate for the landing configuration	500

Table 3

Criteria for stabilised approach in visual conditions

Other information

Previous similar events

Two previous events are recorded where flight crew have reported an inability to disconnect the autopilot on the ATP aircraft. The first was 27 May 1991:

> *'The commander of an ATP, G-BTPJ, stated that in the early stages of an approach the autopilot failed to disengage using any of the usual means. The crew eventually disengaged the system by pulling the autopilot circuit breaker. A fault was later found on the co-pilot's electric trim switch and there is no record of the problem recurring.'*

The second event was on 26 January 2016 and concerned ATP registration G-BUUR[14]. On this occasion no technical explanation for the event was found. Following the event, the operator (the same operator as for this event) issued '*Flying Staff Instruction No 175 Autopilot Disconnect*'. A pre-flight test was prescribed and, in the event of a failure to disconnect the autopilot on approach, a procedure for carrying out a go-around was provided:

> 1. *Prior to every flight, the normal method of autopilot disconnect must be verified as operational.*
>
> 2. *Should the autopilot not disconnect whilst carrying out an approach, an immediate 'go around' must be carried out using the following actions:*
>
>   - *The autopilot must be overpowered using moderate force (but as much as is required) in order to gain manual control of the flight path.*

Footnote

[14] AAIB investigation to BAe ATP, G-BUUR Guernsey Airport, 26 January 2016. Available at: https://assets.publishing.service.gov.uk/media/57ac5f91e5274a0f5200007e/BAe_ATP_G-BUUR_09-16.pdf [accessed October 2018].

- *Crew can expect an 'SCS' caption immediately when overpowering the autopilot.*
- *The autopilot should disengage resulting in an 'ELEVATOR ENGAGE' caption on the SCS panel, but either pilot will have control of the aircraft as required.*
- *If the autopilot does not disengage, moderate force will be required to manually fly the aircraft.*

The co-pilot advised that during his recurrent simulator training an alternative method of managing an engaged autopilot had been practised, by using the sync switch.

The operator did not advise the AAIB of any changes to procedures following this latest event. However, the manufacturer decided to review the Emergency Checklist to see whether an additional item should be incorporated to address the condition where crews are unable to disengage an autopilot.

Analysis

At the time of the approach at EMA, it is likely the crew were operating at a low point of their circadian rhythm which could have adversely affected their alertness. Additionally, the co-pilot had been awake in excess of 18 hours which might have reduced his capacity for attention-based tasks. However, the crew were both accustomed to operating night duties.

The co-pilot thought that his first attempt to disconnect the autopilot was at between 1,000 and 800 ft. The operator's procedure is for heights below 1,000 ft to be referenced from the radio altimeter, thus, providing this reference was being used, the initial attempt to disconnect would have been at between 2.5 nm and 2 nm on the approach. If the co-pilot was still using the pressure altimeter as a reference, then the aircraft would have been about 1 nm closer to the runway. In either case, there was an opportunity to resolve the discrepancy at this early stage but the communication was ineffective and it was missed.

It was only as the aircraft was approaching 500 ft RA, the height by which the approach was required to be stable, that the commander became concerned and started to prompt the co-pilot. The misunderstanding between the crew about the difficulty in disconnecting the AP was then resolved. Thus, the requirement for a stable approach was an effective barrier, alerting the crew to the situation and preventing the incident from becoming more serious.

Once aware of the problem the commander tried to disconnect the AP and also concluded that it would not disengage. When an AP is already disengaged, there are no new indications when there is an additional attempt to disconnect it. It is therefore possible that repeated attempts were perceived as unsuccessful because there was no associated feedback. In the confusion, the aircraft continued to descend below the stabilised approach height of 500 ft RA before go-around action was taken. As the RA was indicating height over the lower terrain to the east for the runway, the aircraft actually descended to 230 ft aal before a go-around was initiated. The crew perception was that the AP disconnected at some time when the aircraft was climbing during the go-around, whereas the flight data indicated that it disconnected during the approach at approximately 425 ft aal.

No defects or abnormalities were identified with any units associated with the autopilot.

Conclusion

The crew reported that the autopilot would not disengage when commanded during the approach despite repeated attempts, but the recorded flight data indicated that it disengaged at around 500 ft RA (approximately 425 ft aal). It is possible that one or both pilots was affected by fatigue which affected intra-crew communication and their perception of the status of the autopilot. However, a similarity with a previous event suggested there may be something about the characteristics of the autopilot disconnect feedback which can result in uncertainty as to its status.

If an autopilot does remain engaged, there is a risk that an approach will be continued below minima, possibly resulting in unintended ground contact through crew distraction or a late, or ineffective go-around. There have been three reported events where the flight crew have not been able to disengage the autopilot but there is no Emergency Checklist procedure available for this condition.

Safety action

> As a result of this serious incident, and the two similar preceding events, the manufacturer decided to review the Emergency Checklist to see whether an additional item should be incorporated to address the condition where crews are unable to disengage an autopilot.

Bulletin correction

Prior to publication information was received from the aircraft manufacturer resulting in Table 1 and the following paragraph being amended.

The online version of the report was amended prior to publication on 13 December 2018.

Full details of the correction can be found on the AAIB website [https://www.gov.uk/aaib-reports/aaib-investigation-to-bae-systems-operations-ltd-atp-se-mhf] and in AAIB Bulletin 1/2019.

SERIOUS INCIDENT

Aircraft Type and Registration:	BAE Systems (Operations) Ltd ATP, SE-MHE
No & Type of Engines:	2 Pratt & Whitney Canada PW126 turboprop engines
Year of Manufacture:	1989 (Serial no: 2012)
Date & Time (UTC):	14 February 2018 at 0700 hrs
Location:	In flight from East Midlands to Guernsey Airport
Type of Flight:	Commercial Air Transport (Cargo)
Persons on Board:	Crew - 2 Passengers - None
Injuries:	Crew - None Passengers - N/A
Nature of Damage:	None
Commander's Licence:	Airline Transport Pilot's Licence
Commander's Age:	42
Commander's Flying Experience:	8,500 hours (of which 6,500 were on type) Last 90 days - 84 hours Last 28 days - 22 hours
Information Source:	AAIB Field Investigation

Synopsis

The aircraft was carrying out a cargo flight from East Midlands Airport to Guernsey Airport. As the aircraft commenced its descent from FL180, the ball in the slip indicator moved out to the left as normal and the pilot under training attempted to trim it back into the centre. He was unable to do so, and the autopilot disconnected automatically, causing a significant left bank and a nose-down attitude. The commander took control, closed the power levers and returned the aircraft to a safe flightpath. He had difficulty moving the flight controls and could not advance the power levers, believing both to have frozen due to ice. As the aircraft descended, the flight controls and power levers returned to normal and a safe landing was carried out.

It is possible that the initial control upset was the result of the crew applying aileron trim instead of rudder trim whilst attempting to correct the yaw. Although the cause of the stuck power controls could not be established definitively, it is possible that the left power lever was restricted because of wear in the roll-over lever locking mechanism, although this would not explain the locking of the right power lever reported by the pilots.

Action was taken by the manufacturer to improve the effectiveness of both an existing Service Bulletin, relating to wear in the locking mechanism, and an electronic Service Information Leaflet, relating to the purging of moisture from engine control cables.

History of the flight

The flight was a Commercial Air Transport cargo flight from East Midlands Airport to Guernsey Airport, Channel Islands. Both pilots reported for duty at 0345 hrs after three days free of flight duty during which they had adequate rest. The pilot who would occupy the left seat was a direct entry captain undergoing line training after type conversion who had a total of 4,100 flying hours of which 12 hours were on type. The pilot who would occupy the right seat was a line training captain who was experienced on the type. They carried out the pre-flight inspection of the aircraft together and, as it had areas of frost on it, de-icing was carried out.

The commander was to be the Pilot Flying (PF) for the sector and, following normal checks and procedures, the aircraft departed from Runway 27 at 0551 hrs. It followed the Daventry 3N Standard Instrument Departure, with the crew engaging the autopilot at an altitude of 1,000 ft and continuing to a cruising level of FL 180. There were no visible signs of icing during the flight with the Total Air Temperature (TAT) and Outside Air Temperature (OAT) recorded in the cruise as -14°C and -22°C respectively.

Just before the top of the descent into Guernsey, control was handed to the pilot under training in the left seat in order to give him experience in the strong (22 kt) crosswind being experienced at the airport. He reduced power by moving the power levers back, without any restriction or difficulty, setting approximately 50% torque on each engine. He used the autopilot pitch trim wheel to pitch the aircraft nose-down and at 210 kt he engaged the IAS mode which gave a rate of descent (ROD) of about 1,000 fpm. He then selected the Vertical Speed mode (VS), which maintained the ROD and resulted in an IAS of between 200 and 215 kt. As normal, the ball in the slip indicator moved out to the left and the PF stated later that the rudder trim was used in an anticlockwise direction in an attempt to bring the aircraft back into balanced flight. Despite this, the ball remained out to the left. The PF continued to trim but the TRIM caution light illuminated[1] and, shortly afterwards, the autopilot disconnected automatically.

The aircraft immediately rolled to the left some 45° and pitched nose-down. The commander took control, closed both power levers, levelled the wings and raised the nose. He noticed that the elevator control was normal but the rudder was stiff. He tried to operate the rudder and aileron trims but they were also stiff, although the pitch trim was working. The crew had just changed frequency to Guernsey approach and they transmitted a MAYDAY stating that they had "CONTROL PROBLEMS" which was later expanded to explain that they were unable to increase power. Guernsey radar cleared the aircraft to descend to 3,000 ft and gave radar vectors for Runway 27. The weather was, surface wind 170/22, visibility 25 km, FEW at 2,500 ft, SCT at 4,800 ft with showers in the vicinity, OAT +6°C, dew point 0°C, and QNH 1005 hPa. ATC also offered Alderney at 9 nm and Cherbourg at 30 nm as alternative airports but the crew elected to continue for Guernsey. Shortly afterwards, the commander informed ATC that everything was back to normal.

Footnote

1 The TRIM caution light indicates an out of trim condition in either pitch or roll and it illuminates when a pre-defined threshold has been achieved.

During the descent, the commander believed that the flight and engine controls were restricted due to icing of the systems. The crew tried to find a checklist which dealt with frozen controls but were unable to do so[2]. They attempted to operate the standby power controls, but this would not increase power either. The commander stated that he tried to move the power levers independently, but they would not move. He also operated the roll-over levers[3], entering the beta[4] range, before returning them to the FLIGHT IDLE position, but the power levers would still not move. Approximately three minutes later he was able to advance the power levers, initially in small, 'notchy' movements but then normally.

Having all controls back to normal, the crew were radar vectored by ATC, descended for an ILS approach to Runway 09, which was the duty runway, and made an uneventful landing at 0701 hrs.

Crew background and experience

The pilot under training (PUT) began flying in 1999 and, having obtained a Flight Instructor's qualification, carried out instructional flying on a number of different types. He obtained his commercial qualifications and began flying the Shorts 330 and 360 in 2003. He flew the Shorts 330 until 2004, when it was phased out, but continued to fly the Shorts 360 until July 2006. After that he flew the Citation Bravo from August 2006 until October 2010. He had a break from flying until 2015 after which he flew the Shorts 360 until January 2017 when he began converting to the ATP.

The Line Training Captain (aircraft commander) started flying in 1998 and obtained his commercial licence before operating Beech 90 and then Beech 200 King Air aircraft. He also flew the Piper Cheyenne, and Dassault 2000 and 2000 EX before moving to the ATP in 2008. He flew the ATP as a Line Training and Line Check Captain for 10 years before joining the operator in February 2018.

Commander's recollection of the incident

When the commander saw the ball in the slip indicator moving more and more to the left, he said to the PUT "you need to trim more", maybe three times, and put his hands on the control yoke. When the AP disconnected, which was coincident with him pressing the disconnect button on the control yoke, he took control of the aircraft. The aircraft was out of trim, very stiff on the aileron and pitching down with a left bank. In order to prevent the airspeed from exceeding the maximum limit, he retarded the power levers fully. Simultaneously, he trimmed the aircraft using aileron and rudder trim which were both very stiff to operate.

He attempted to use some asymmetric power to assist with trimming the aircraft but when he advanced the left thrust lever, he found it jammed. He immediately tried to advance the

Footnote

2 The Emergency and Abnormal Checklist contains a decision flow-chart under the title: '*Engine Control Levers Malfunction'*. Part of the flow-chart considers the possibility that the power levers are restricted due to icing, in which case it recommends descending the aircraft into warmer air.

3 See later section: *Engine power levers and roll-over levers.*

4 Beta control: control mode for a normally automatic propeller in which the pilot exercises direct command of pitch for braking and ground manoeuvring.

right engine but found it was also jammed. He attempted to use the standby engine control system, but this did not increase engine power. This caused him great concern because he had just moved the power levers aft and could not move them forward again, and the aircraft was descending through 17,000 ft amsl at 1,800 fpm.

He recalled that both engines were indicating zero torque with the aircraft diving, and the abnormal check list did not cover the situation. Since he had experienced icing on the power 'Bowdenflex' cables before, he tried every 20 seconds to operate the standby engine control system and the power levers. He hoped that they would move at a lower altitude, where the temperature would be higher, which they eventually did. During this activity the crew prepared for a glide approach into Guernsey. ATC offered other, alternative airfields but he elected to continue to Guernsey. He adjusted the pitch to achieve a glide airspeed of 150 kt (135 kt plus 15 kt for icing). With the resulting groundspeed and rate of descent he estimated the aircraft could glide 46 nm and Guernsey airport was 43 nm away. With the wind increasing from the south, he thought it was tight but possible.

With a workable plan in place he elected to check the quadrant safety on the roll-over levers, which he was able to move, but this did not free the power levers and so he concentrated on flying the aircraft.

When he felt the power lever cables were "unfreezing", feeling notchy but allowing him to advance the power levers slightly and making some power available, he felt sure that the aircraft would be able to reach Guernsey. He informed ATC of the improvement and suggested a slightly wider vectoring to get back to a normal descent path angle. On touch down, the power levers and flight controls were moving normally.

These recollections were supported by the captain under training.

Recorded information

SE-MHE was equipped with a cockpit voice recorder (CVR) that recorded 2 hours of audio, during which this event occurred. It was also fitted with a tape-based flight data recorder (FDR) and solid-state quick access recorder (QAR), which replicated the 25 hours of data on the FDR and older recordings. Each of these recorders was removed from the aircraft and taken to the AAIB where they were successfully downloaded and their recorded information analysed.

Flight data

Figure 1 is a plot of the salient parameters for the event with extracts from the CVR relating to the use of trim. Due to the age of the FDR installation there were no requirements to record certain parameters, such as the position of the control column and wheel, roll and yaw trim, and power levers, that would have been useful for the investigation. Also, the aileron, elevator and pitch trim position recordings vary between aircraft, so small biases exist in the data presented; however, these did not affect the analysis of the recorded data for this investigation.

Figure 1 starts with the aircraft stable on descent towards Guernsey, with the autopilot engaged, passing through 16,500 ft amsl, with the propeller speed at about 82% (of the maximum 1,200 rpm), and engine torques of about 55%. In summary, the data indicates the following:

UTC (hh:mm:ss)	Event
06:39:48	Aircraft starts to roll slowly to the left - aileron movement was not observed in the data until about 6 seconds later[1]. No movement in rudder position.
06:39:51	Commander states "YOU NEED MORE [TRIM]" Over the following 12 seconds, the aircraft continues to roll to the left.
06:39:55	Pilot Under Training states "IT NEEDS A LOT DOESN'T IT"
06:39:57	Commander states "YOU NEED RUDDER TRIM OR SOMETHING … LOOK"
06:39:59	Commander states "YOU WILL DISCONNECT IT NOW"
06:40:01	Commander states "BE CAREFUL BE CAREFUL BE CAREFUL"
06:40:03	Autopilot disconnects – continuous cavalry charge sounds in cockpit – with aircraft 9.3° left wing down, 1.4° pitch nose-down, vertical acceleration 1.1g, airspeed 213 kt, altitude 16,039 ft amsl. Rudder immediately moves to the right and aircraft pitches down and rolls to the left reaching a peak value of 48° five seconds later.
06:40:11	Aircraft begins to pitch up from 8° nose-down. 1.8g recorded vertical acceleration during pitch up.
06:40:13	Commander states "I HAVE CONTROL"
06:40:14	Engine torque (and N_H and N_L[2]) reduce. Propeller speed momentarily reduces before recovering back to about 82%. Landing gear config horn sounds in cockpit (for the next 24 seconds).
06:40:23	Cavalry charge stops sounding.
06:40:38	Config horn stops sounding (not shown).
06:40:42	Engine torques nominally zero (where they remain until 06:43:22) – propeller speed still about 82% (not shown).
06:41:02	Propellers taken in and out of beta range over eight seconds (not shown).

Table footnotes

1 This was because of limitations in the resolution of the data recording.

2 N_H and N_L: High pressure and low pressure rpm engine speed respectively.

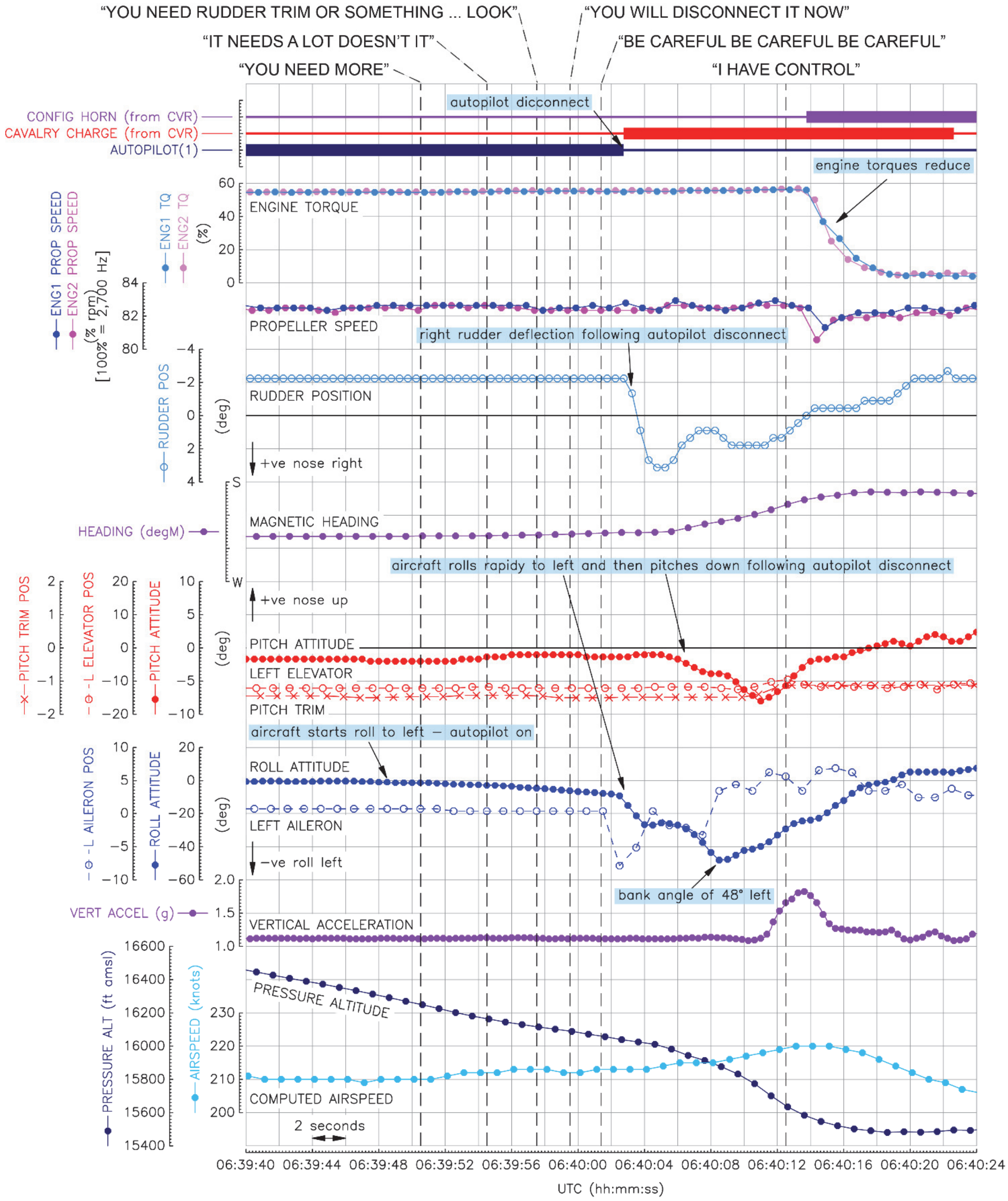

Figure 1

Salient parameters during the event with extracts from the CVR relating to use of trim

Aircraft description

The British Aerospace[5] Advanced Turbo Prop (ATP) was derived from the Hawker Siddeley 748. The aircraft is a low-wing turboprop with a conventional tail configuration and two Pratt and Whitney Canada PW126 turboprop engines, driving six-bladed variable-pitch propellers. ATPs were produced in a passenger configuration and modified to a cargo configuration.

System descriptions

Autopilot

Automatic flight control is provided by two independent autopilots, only one of which can be engaged at any time. The autopilot controls the aircraft by means of electrically actuated servomotors and it is a two-axis system (pitch and roll) with a yaw damper.

Autopilot manual disengagement

The autopilot can be disengaged by pressing the red 'instinctive' autopilot disengage switch on either of the pilots' control wheels. This results in a one-second audible 'cavalry charge' warning.

Autopilot automatic disengagement

An autopilot safety circuit monitors the roll angle and normal acceleration. The autopilot will automatically disengage if the roll angle is greater than 35° or if the normal acceleration is less than 0.4g or greater than 1.6g.

The autopilot will automatically disengage if specific failure conditions are detected. Failure conditions include any autopilot servomotor drawing excessive current eg due to a short circuit or high load on the respective flying control surface.

Automatic disengagement of the autopilot results in a continuous audible cavalry charge warning, which can be cancelled by pressing either of the autopilot disengage switches.

Flying controls - trim

There are three manual trim wheels on the centre console in the cockpit. The elevator trim wheel is on the left side of the console, the rudder trim wheel is on top of the console and the aileron trim wheel is on the rear of the console (Figure 2).

Footnote

5 BAE Systems (Operations) Ltd is the design Type Certificate holder.

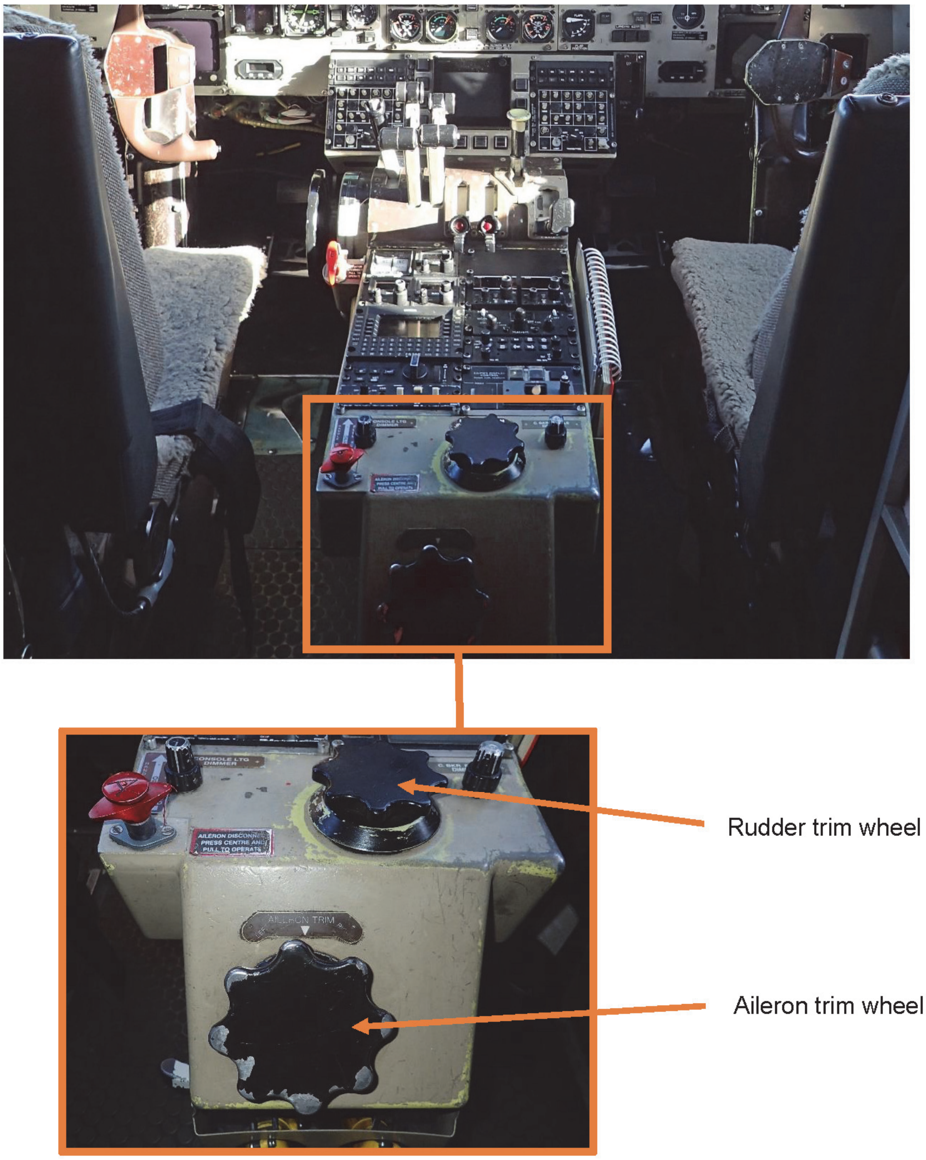

Figure 2

Position of the rudder and aileron trim wheels

If the autopilot is engaged, pitch and roll ‘out-of-trim’ indicators are deflected proportionally to the respective autopilot servomotor electrical current. If the current exceeds a pre-determined threshold for greater than either 2 seconds in pitch or 12 seconds in roll, an amber TRIM light, adjacent to the out-of-trim indicators, illuminates (Figure 3).

Figure 3

TRIM light and associated pitch and roll out-of-trim indicators

Engine power levers and roll-over levers

The power levers for each engine are on the centre console and each lever has a subsidiary roll-over lever (Figure 4).

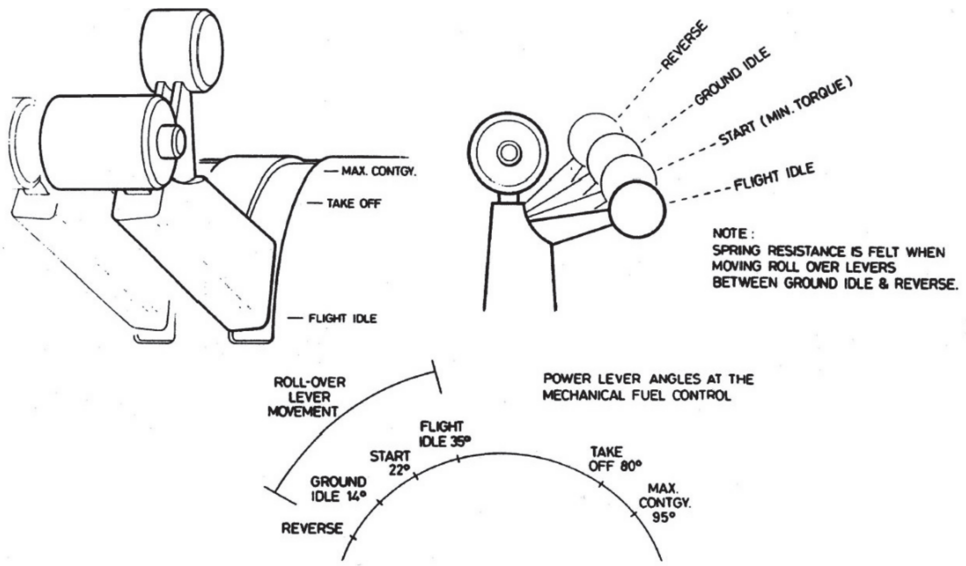

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Figure 4

Schematic of the main power lever and roll-over lever

The main power lever controls engine power between FLIGHT IDLE and MAXIMUM CONTINGENCY. The roll-over lever controls engine power and propeller pitch in the beta range, between FLIGHT IDLE and REVERSE. The roll-over levers are interlocked with their respective power levers so that a power lever can only be advanced above FLIGHT IDLE when the respective roll-over lever is fully forward and locked into its FLIGHT IDLE position.

If the landing gear is up, the flaps are not greater than 15°, and a power lever is retarded to FLIGHT IDLE without the associated propeller condition lever being selected to FEATHER, the landing gear configuration warning horn will sound.

Engine controls

Engine power demands are transmitted to the engine by means of mechanical control rods and metallic cables beneath the cabin floor and along the leading edge of the inboard wing sections (Figure 5). The power levers and the roll-over levers use the same control runs and are not independently connected to the engines.

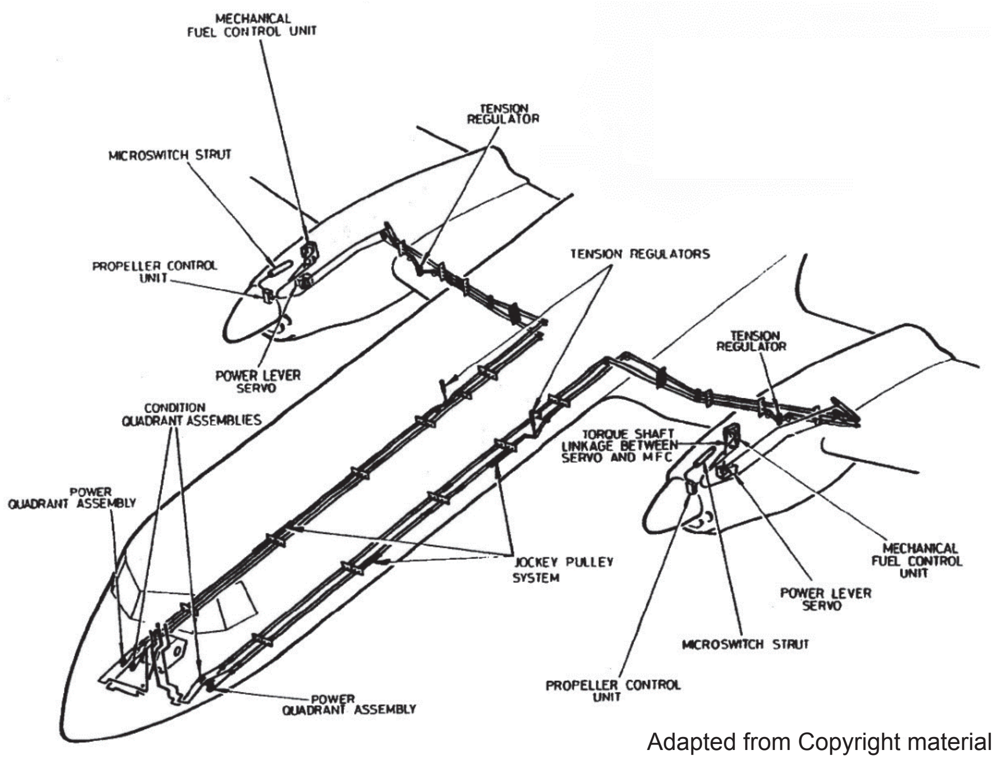

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Figure 5

Schematic depicting the engine control runs

Standby power controls

Each engine has its own electrically actuated standby control system that provides emergency control over the full power lever range. Two switches, immediately behind the power lever quadrant, can be used to increase or decrease engine power by means of a stepper motor on each engine (Figure 6). The system caters for a break in the control cable but cannot be used if the power levers are physically jammed.

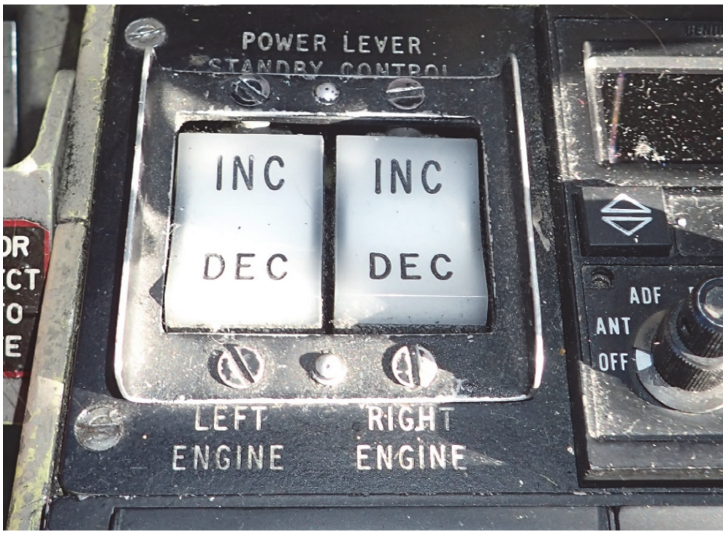


Figure 6

The power lever standby controls

SE-MHE

SE-MHE was manufactured in 1989 and had accrued 28,969 cycles, which equated to 26,416 hours. It was originally configured for passenger transport but was converted for cargo operations in 2007.

According to the operator, the aircraft did not have a history of flying control or engine problems.

Aircraft examination in Guernsey

The aircraft was examined under the supervision of the AAIB.

General external examination

Examination of the aircraft external surfaces and flying controls found no anomalies and there was no evidence of de-icing residue build-up.

Flying controls

The flying controls were operated throughout their range of movement without undue force or restriction. Extensive checks and inspections of the aileron and rudder trim control runs found no problems.

Power levers and engine control runs

The power levers were found to operate normally, and examination of the control runs identified no anomalies.

Both engine control cables were removed for further examination and testing[6] but no faults were found.

Footnote

6 See later section: *Previous ATP power lever problems and engine power cable modification.*

Standby power controls

Both systems were found to operate throughout their normal range but the right system was occasionally observed to be 'notchy', possibly indicating excessive resistance in the system or that the stepper motor was under-performing. The operator returned the aircraft into service without installing a replacement stepper motor. The right system was subsequently found to be non-operational when the aircraft was examined again three months after this incident and a replacement motor was installed.

Previous ATP power lever problems and engine power cable modification

Between 2014 and 2018, the operator recorded six events on their ATP fleet where pilots reported '*restricted*', '*stiff / notchy*' or '*frozen*' power levers. There was no confirmed link between the events but the engine power 'Bowdenflex' control cables were cited as a possible cause because of their apparent susceptibility to moisture ingress and freezing; the control cables are under the engine cowls (Figure 7).

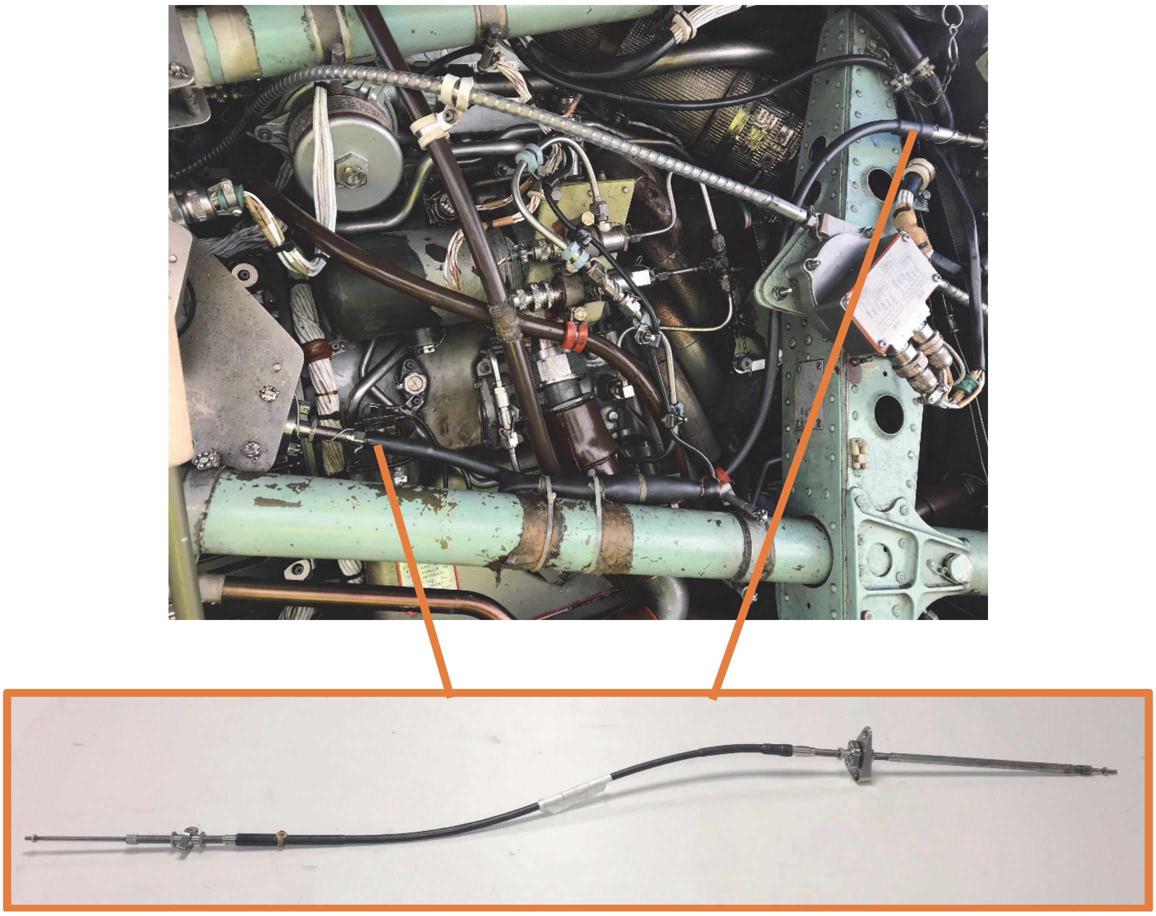


Figure 7

Bowdenflex cable

In June 2014, the aircraft manufacturer issued Service Bulletin (SB) ATP-76-022 to introduce flexible heat shrink sleeving on the engine power control cables because "*There* *have been a number of reports that moisture ingress together with low temperatures has led to cables becoming difficult to move*". The configuration change was optional and formally approved under modification JDM60170A. As part of the investigation following the incident on SE-MHE, the operator checked the modification status of their operational fleet and found that some aircraft were post-modification, some were pre-modification and some were of mixed build standard.

In 2016, the operator introduced a Technical Instruction '*To reduce delays and cancellations due to frozen power lever cables on the northern routes*'. The instruction describes the use of '*a power lever heating kit*', which was commissioned by the operator and is available for use at three airports in Norway and Sweden; the equipment is used (if deemed necessary) to direct warm air onto the engine power control cables when the aircraft is on the ground. Concurrently, the operator introduced a procedure to purge moisture from the cables using low pressure nitrogen or air. The cables are purged every 400 flying hours, but the procedure is not applicable if the heat shrink sleeving has been installed.

In December 2017, the manufacturer introduced an electronic Service Information Leaflet (eSIL) 76-ATP-800-1, recommending operators to periodically purge moisture from the cables using low pressure nitrogen or air. The manufacturer recommended a periodicity of 150 flights but stated that operators should amend the frequency based on their in-service experience and operational environment.

The aircraft manufacturer monitored events in service and, in June 2017, reported to the European Aviation Safety Agency (EASA) that '*the trend constitutes a potential unsafe condition*'[7]. The manufacturer stated it would assess the effectiveness of eSIL 76-ATP-800-1 and consider possible options for long term corrective action with a report to EASA on completion.

Both engine control cables on SE-MHE were post-modification standard with heat shrink sleeving applied. Irrespective of this, however, they were removed for further examination and testing. The harnesses were subjected to freezing conditions but showed no evidence of restricted movement.

Further examination of SE-MHE at East Midlands Airport

Having assessed the recorded data and reviewed the event with the crew, the AAIB revisited the aircraft to examine the power lever installation in more detail. In the time since the incident occurred, the aircraft had completed 112 flights, equating to approximately 120 flying hours. There had been no additional reports of power lever or flying control anomalies.

Visual examination of the power levers and roll-over lever interlocks found no evidence of damage caused by a physical restriction. There was no Foreign Object Debris (FOD) or obvious anomalies inside the area of the centre console through which the controls pass.

Footnote

[7] File number AR.EU-EASA-2018-000040 '*Frozen Engine Controls*'.

Repeated operation of the roll-over levers found that the left lever did not always lock down when it was returned to the forward position; it sometimes 'bounced' out of position and remained unlocked. With the left roll-over lever in this condition, the associated power lever could not be advanced from FLIGHT IDLE. The 'feel' and operation of the right roll-over lever was different and it always 'positively' locked down when returned to the forward position (Figure 8). The anomaly was not always apparent but could be repeated with relative ease. Examination of another aircraft found that both catches showed positive locking.

Figure 8

The left roll-over catch did not always lock (left)
The right roll-over catch always showed positive locking (right)

The maintenance agency reported that the roll-over lever 'bounce' was rectified by installing a replacement engine cable harness. The reason for this was unclear because the item that was removed was the harness that had been installed when the aircraft was recovered after the incident. The maintenance records for the recovery of the aircraft did not mention any anomalies relating to the left roll-over lever operation. However, they showed that the right engine cable harness was changed twice because the first replacement item had 'high internal friction'.

Further checks involving the operation of the standby control system found excessive wear in the roll-over mechanism and the locking catch was replaced. Wear is not monitored in service.

Roll-over latch wear

In 2012, the manufacturer issued a Service Bulletin (ATP-76-021) to check for wear in the roll-over locking mechanism. EASA issued an Airworthiness Directive (2014-0007), mandating a one-off check. This check was introduced because the crew of an ATP had unintentionally entered the beta range in flight, resulting in a significant propeller overspeed and engine failure several weeks later. The crew had reduced power to FLIGHT IDLE to increase their rate of descent and were attempting to reduce excessive residual engine torque using the standby power lever controls. Despite the roll-over levers being in the locked position, wear in the locks was such that the crew entered the beta range in flight.

In the light of the AAIB's findings at East Midlands Airport the manufacturer decided to introduce a periodic check for wear in the roll-over mechanism.

Human performance – operation of an incorrect control

Performance shaping factors for the operation of an incorrect control

Human performance is variable. At any time, there is a chance that someone may perform an incorrect action, such as inadvertently operating the wrong control. This is the case regardless of the situation and the level of expertise of that person. Human performance is influenced by 'performance shaping factors' which are present within an individual, the equipment, the environment and the organisation. If performance shaping factors are not favourable, human performance is reduced and the probability of performing an incorrect action is increased.

Different performance shaping factors influence different types of performance to different extents. Manual actions are particularly influenced by design and situational factors.

When someone needs to select a control by touch, the control needs to be identifiable by touch. The ease of identification is a design performance shaping factor. It depends on the following attributes of the control and the controls in proximity to it:

- Position – Where the control is in relation to the user and to other controls.
- Space – The distance between controls.
- Operation – The means by which the control is used including how it is manipulated (eg gripped, pushed, pulled or turned), how the control feels to operate and the limits of its movement.
- Shape – The external form of the control.
- Size - How big the control is.
- Orientation – The positional and directional relationships between the control, surrounding controls, the control mounting and the user.
- Texture – The tactile surface characteristics, or how the control feels to the touch when not being operated.

The more different controls are on these factors, the easier they are to identify by touch. The more similar they are, the more likely it is that an incorrect control will be selected.

The probability of performing a manual action incorrectly is also increased when someone is distracted or experiencing high workload. Experienced people tend to operate manual controls without conscious thought. Novices may still need to consciously think about it.

In high workload or distracted situations, the attentional resource available to plan, execute and check manual actions is reduced and people must rely more on automatic task performance. Novices are therefore particularly vulnerable in high workload situations because their skill to reliably operate controls automatically has not yet fully developed.

The user's experience with a system and other similar systems also influences performance. People apply previously learned skills in new contexts. Skills that have been used frequently over a long period of time will tend to be used in preference to newly learned skills. When the contexts are similar, but with subtle differences, there is a risk that previous learning will be applied inappropriately. This risk further increases if other performance shaping factors, such as high workload, affect the individual's ability to pay conscious attention to the requirements of the new context.

Performance shaping factors for recovery from the selection of an incorrect control

To be able to recover from the inadvertent selection of an incorrect control, the user needs to be able to detect and understand the situation. Success in doing this depends on both the user and the system.

The system needs to provide feedback that is accurate, noticeable and easy to interpret. If feedback is not provided or is not accurate, noticeable and easy to interpret then the user is less likely to be able to correctly understand the problem.

Successful recovery also relies on the readiness and capability of the user to receive and interpret feedback. When monitoring and checking is an explicit part of the role (e.g. in the case of a pilot monitoring), this increases readiness to receive feedback and increases performance. Similarly, a high level of experience and expertise increases capability. It is more difficult for an individual to do this successfully in unexpected or highly unfamiliar situations or when they are experiencing high workload.

Analysis

Autopilot disengagement and initial flight upset

The flight progressed normally and without incident until the commencement of the descent into Guernsey. The power was reduced to 55% torque on both engines and, as normal, the slip indicator ball migrated to the left. The PF reported that he began to retrim the aircraft in yaw and he commented about the amount of trim that he was applying because it was having no effect. The FDR data showed no change in rudder position which indicated that the rudder trim was not being used. The data showed the aircraft rolling slowly to the left and, approximately 12 seconds later, the commander said "YOU WILL DISCONNECT IT NOW", shortly followed by "BE CAREFUL BE CAREFUL BE CAREFUL". The crew recalled that the TRIM warning light was illuminated, which indicated that the aircraft was out-of-trim in pitch or roll.

Almost immediately after the commander expressed his words of caution, the autopilot disconnected and the CVR recorded a continuous cavalry charge warning. The aircraft rolled left and pitched nose-down before the commander took control and restored a safe attitude with normal use of the flying controls. The continuous cavalry charge warning indicated that the autopilot disconnected automatically, and the movement of the flying controls indicated that they were not frozen.

No faults were found when the autopilot was tested, and the FDR data showed that the aircraft was operating inside the limits of the safety circuit when the autopilot disconnected. It is possible that the autopilot disconnected because the aircraft was being trimmed in roll instead of yaw. In this case, the current demanded by the aileron servomotor would increase as it tried to resist the effect of the increasing trim tab deflection, and the TRIM warning light would illuminate when the appropriate threshold was exceeded. Further application of aileron trim would cause the autopilot to automatically disconnect and trigger a continuous 'cavalry charge' alert. With the autopilot disconnected, the ailerons would immediately deflect causing a rapid roll to the left. This scenario is consistent with the data and the way the autopilot operates, but both pilots believed that they had operated the rudder trim wheel correctly.

Possible action on the incorrect trim control

The following section considers aspects of human performance which might have influenced events had the aileron trim been used instead of the rudder trim. The reasons why the incorrect trim control might have been used, and the reasons why the situation might not have been corrected before the autopilot disconnected, might be explained by considering the performance shaping factors present during the event.

The rudder and aileron trims are in the same part of the flight deck and are separated by only a small distance. They are operated in the same way, and have the same shape, size and texture. They are, however, orientated differently, being set in different planes. The similarities in these design performance factors, perhaps outweighing the orientation factor, might have increased the probability that an incorrect control would be selected.

The PF had only 12 hours flying the aircraft type out of his total 4,100 flying hours, and his workload while undergoing line training in an unfamiliar aircraft was likely to have been high. Although by no means a novice pilot, he could be considered a novice on type and, therefore, more vulnerable in high workload situations to operating an incorrect control. After a relatively short period on type, he might not yet have developed the automatic task performance skills which would normally be relied upon to avoid mistakes in high workload circumstances.

Successful recovery from the inadvertent selection of an incorrect control requires system feedback to the operator. The pilot thought he was using the rudder trim but was not seeing the appropriate response from the rudder trim indicator. This feedback would have been accurate but confusing. He might even have been encouraged to continue turning the trim wheel, as opposed to stop turning it, by the feedback from pilot in the right seat saying: "YOU NEED MORE [TRIM]".

Had the pilot been using aileron trim with the autopilot disengaged, the aircraft would have rolled to the left. The pilot would have noticed this feedback and probably realised immediately that he was using the incorrect trim. However, the autopilot was controlling the aircraft and would have been resisting any tendency to roll. The pilot would therefore have been denied this feedback indicating that he was using the incorrect trim wheel.

The commander, as the supervising pilot, would probably have had an elevated readiness to receive system feedback because of the nature of that role, and it appeared from the CVR and his recollection of events that he received enough feedback to understand that the autopilot would soon disconnect. However, he was unable to prevent it from happening in the 15 seconds between the aircraft beginning to roll and the autopilot disconnecting.

Power levers

The crew reduced engine power prior to the descent and both power levers were retarded to FLIGHT IDLE after the autopilot disconnected. In both cases, the levers moved without restriction. This indicated that the power levers were not frozen or restricted.

The commander reported that the power levers were stuck at FLIGHT IDLE after he regained control of the aircraft and he believed them to have frozen. He stated that he attempted to control the engines by advancing the power levers, which would not move, and by using the standby control system, but neither method was effective. He briefly pulled the roll-over levers into the beta range and the engines responded with speed and torque increasing accordingly.

The roll-over levers use the same control runs as the engine power levers, so the fact that the commander successfully entered the beta range indicated that the control runs were not restricted or frozen. He deselected the beta range and succeeded in advancing the power levers approximately three minutes after retarding them to FLIGHT IDLE.

Examination of the aircraft in Guernsey identified no explanation for the power lever restriction. When the aircraft was subsequently examined at East Midlands Airport, the left roll-over lever had excessive wear and therefore did not always lock down when it was returned to the FLIGHT IDLE position. The effect of this was that the left power lever could not be advanced from its FLIGHT IDLE position. Had the left roll-over lever been unlocked during this incident, it might have felt like both power levers were physically restricted when the pilot tried to advance them together (even though only the left would have been). However, in these circumstances the right power lever should have been free to move had it been operated independently. The commander stated that he was unable to move the levers by hand or control the engine by using the standby control system. The investigation could not explain why the right power lever might have been jammed.

Conclusion

Shortly after top of descent, the aircraft developed a significantly out-of-trim condition which, when the autopilot automatically disconnected, caused a rapid and significant roll to the left accompanied by a nose-down pitch. The evidence supported the likelihood that the crew used aileron trim instead of rudder trim to balance the aircraft in yaw, leading to the autopilot disconnecting automatically and the initial in-flight upset.

The commander corrected the attitude changes with difficulty but found that both power levers were stuck at FLIGHT IDLE. Approximately three minutes later, he successfully advanced the power levers and the engines responded accordingly. The commander considered that the most likely scenario was icing of the engine controls but this was unlikely. Although the cause could not be established definitively, it is possible that the left power lever was restricted because of wear in the roll-over lever locking mechanism, although this would not explain the jamming of the right power lever reported by the pilots.

Safety action

The manufacturer stated that it:

- Would introduce a periodic wear check of the roll-over lever locking mechanism to supplement the previous one-off check that was introduced in Service Bulletin ATP-76-021.
- Would assess the effectiveness of eSIL 76-ATP-800-1 (to periodically purge moisture from the cables using low pressure nitrogen or air), consider possible options for long term corrective action, and would report to EASA on completion of the assessment.

ACCIDENT

Aircraft Type and Registration:	Piper PA-28-161 Cherokee Warrior III, G-WAVS
No & Type of Engines:	1 Lycoming O-320-D3G piston engine
Year of Manufacture:	1998 (Serial no: 2842035)
Date & Time (UTC):	8 January 2018 at 1232 hrs
Location:	Bredon Hill, Overbury, Worcestershire
Type of Flight:	Training
Persons on Board:	Crew - 2 Passengers - None
Injuries:	Crew - 2 (Fatal) Passengers - N/A
Nature of Damage:	Aircraft destroyed
Commander's Licence:	Commercial Pilot's Licence
Commander's Age:	52
Commander's Flying Experience:	5,700 hours[1] Last 90 days - 131 hours Last 28 days - 18 hours
Information Source:	AAIB Field Investigation

Synopsis

The aircraft struck trees on isolated high ground in conditions of poor visibility and was destroyed. The pilot, a senior instructor, and the student pilot suffered fatal injuries. '*The Skyway Code*', published by the CAA, describes the hazards of flight in these circumstances and steps that can be taken at the planning stage to help avoid them.

History of the flight

The aircraft was being flown by an instructor of a flying school at Coventry Airport. He had conducted some local instructional flying earlier in the day and was then asked by the operations staff if he would deliver the aircraft to its maintenance base at Gloucester Airport. Such movements were a routine and regular aspect of the school's operation. The pilot was heard to express some concerns about the weather and appeared anxious to start the trip as soon as possible.

The plan was for two Coventry based aircraft, G-WAVS and G-USAA, both of which required engineering input, to fly to Gloucester at around the same time, each with two pilots aboard. All four pilots would then return to Coventry in another aircraft whose maintenance was concluded.

The instructor on the accident aircraft was accompanied by a student, who was approaching the navigation phase of his training, for whom this flight would provide some additional

Footnote

[1] Approximate total. The last logbook entry identified by the AAIB was made in December 2015.

exposure. The student prepared a route on a 1:500,000 scale aeronautical chart (Figure 1) following a standard route used by the school for such ferry flights. The highest terrain along or immediately adjacent to the route was shown as 1,048 ft amsl, and the maximum elevation figure was 1,400 ft amsl. Both crews conducted briefs and consulted the weather independently. There was no combined brief and no supervision by the flying school management (none was required). The crew of the accident aircraft did not use GPS navigation or flight planning software.

Figure 1

Part of aeronautical chart with track line

Prior to departure a pilot, believed to be the instructor of the accident aircraft, contacted Wellesbourne Airfield to check the weather conditions there. He was informed that an aircraft airborne in the vicinity had reported cloud overcast at 800 ft agl.

G-USAA departed Coventry Airport at 1206 hrs. G-WAVS, the accident aircraft, departed at 1208 hrs. Both turned south-west towards Stratford-upon-Avon and flew close to Wellesbourne Airfield, which they called by radio. They were aware of their relative proximity and the pilots transmitted air-to-air position checks to ensure their separation.

Southwest of Stratford, the two aircraft followed a very similar track, both maintaining an altitude of approximately 1,000 ft. The cloudbase in the area was approximately 1,000 ft amsl with freezing conditions forecast in cloud. The crew of G-USAA stated later that visibility reduced as the aircraft flew further south and west, and reported having to make frequent use of carburettor heating.

Close to Evesham the aircraft tracks diverged, with G-WAVS flying further to the north. At around 1230 hrs an aircraft believed to be G-WAVS was seen manoeuvring and flying very low in the Evesham area. Radar data indicated this occurred at altitudes between 700 and 1,000 ft amsl.

The aircraft was seen flying south-west toward Elmley Castle. Witnesses in that area described the weather as “quite foggy”. They said they heard an aircraft flying “low” before appearing out of the cloud. One witness remarked that it seemed to be “pulling up”. The witness lost sight of the aircraft as it continued southwest. Shortly afterwards the aircraft struck trees near the summit of Bredon Hill at an elevation of approximately 940 ft and came to rest in a field further south-west.

Following calls to the emergency services the air ambulance was launched at 1240 hrs from the helicopter emergency medical service (HEMS) base at Strensham Services on the M5. The helicopter pilot reported a cloud base of 500 ft agl and 3 km visibility. These were the minimum conditions for HEMS operations and the air ambulance launched in order to assist. It could not reach the accident site itself, which was significantly above the cloud base, and landed beside the nearby village of Overbury. Farm vehicles drove the medical personnel to the accident site.

Both occupants had suffered fatal injuries.

Accident site

The accident site was near the summit of Bredon Hill at an elevation of approximately 940 ft. There is a mast on the summit with an elevation of 1,046 ft, which is marked on the aeronautical chart. An aerial view of the site is at Figure 2.

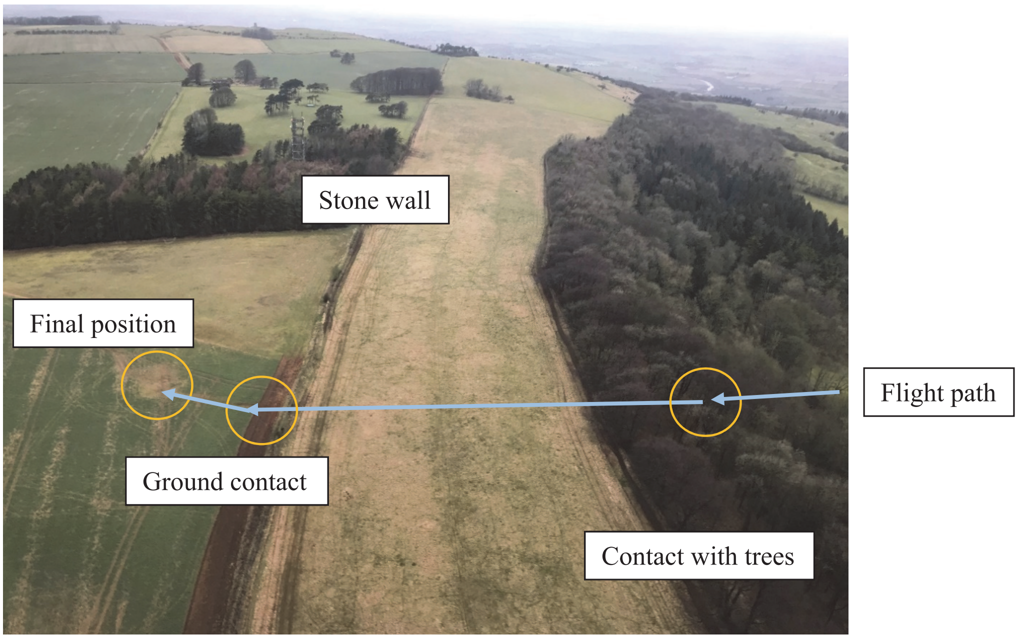


Figure 2

Accident site and Bredon Hill mast

Inspection of the accident site and wreckage indicated that the aircraft struck the top of trees near the summit of Bredon Hill on a heading of approximately 230°. This initial impact detached a portion of the outer left wing approximately 1.8 m in length, and part of the left aileron. The remainder of the aircraft then rolled to the left and descended to the ground approximately 170 m past the trees landing on its left side in a nose-down attitude causing further substantial damage. The aircraft contacted the surface close to and past a stone wall, which had not been contacted, and then quickly came to rest. This indicated that the final descent had been steep and at a slow forward speed.

Preliminary examination of the wreckage, and in particular damage to the propeller, indicated that the engine was producing power at the time of the impact. Both fuel tanks had been ruptured and no fuel remained but initial responders reported a strong smell of fuel which indicated fuel had been present. No pre-accident defects were identified.

Recorded information

Radar tracks were obtained for both G-WAVS and G-USAA. These covered both aircraft from initial climb from Coventry until G-USAA was on final approach to Gloucester, and for G-WAVS until the last radar return 200 m from the accident site. Figure 3 shows an overview of both tracks.

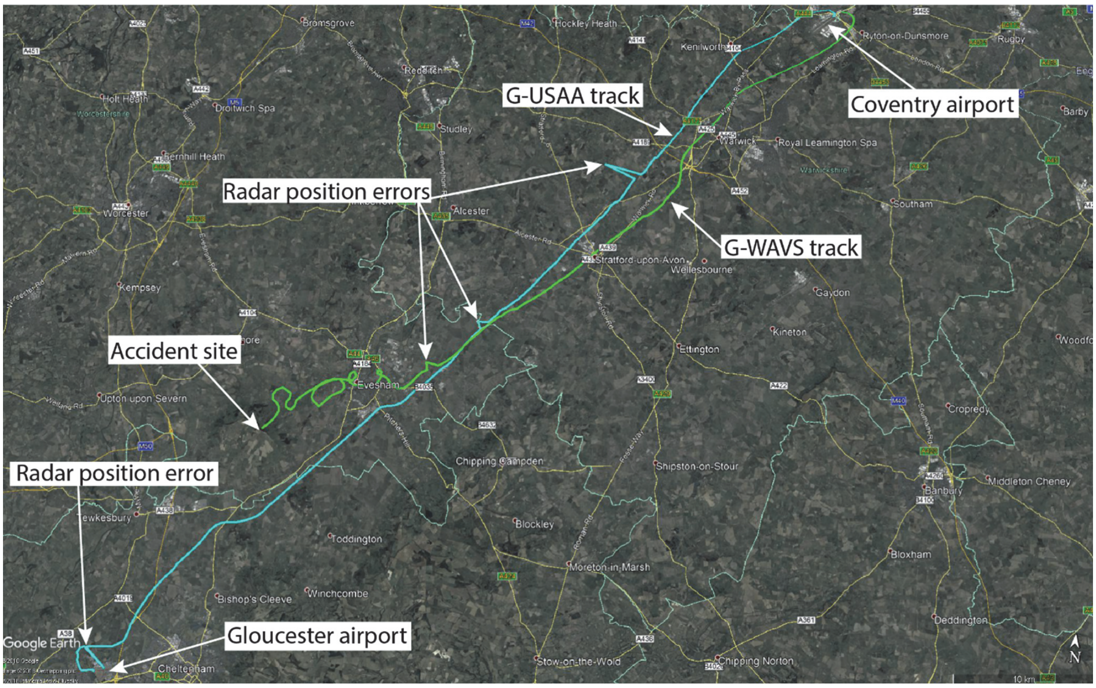


Figure 3

Radar tracks of G-WAVS & G-USAA

The radar data shows G-WAVS flew from Coventry towards Warwick and Stratford-upon-Avon, flying between approximately 800 ft and 900 ft amsl. G-USAA initially tracked to the north of G-WAVS, maintaining a separation of between 1 and 2 nm, but at a higher altitude of approximately 1,100 to 1,200 ft amsl. Both aircraft descended approximately 300 ft when south of Stratford-upon-Avon, and their tracks converged. G-WAVS then turned towards the north-west, away from the track of G-USAA, and several low-level orbits were flown near Evesham before the aircraft flew towards Bredon Hill. Figure 4 shows the final track of G-WAVS and the altitude returns received from the aircraft's transponder, corrected to show altitude in feet amsl.

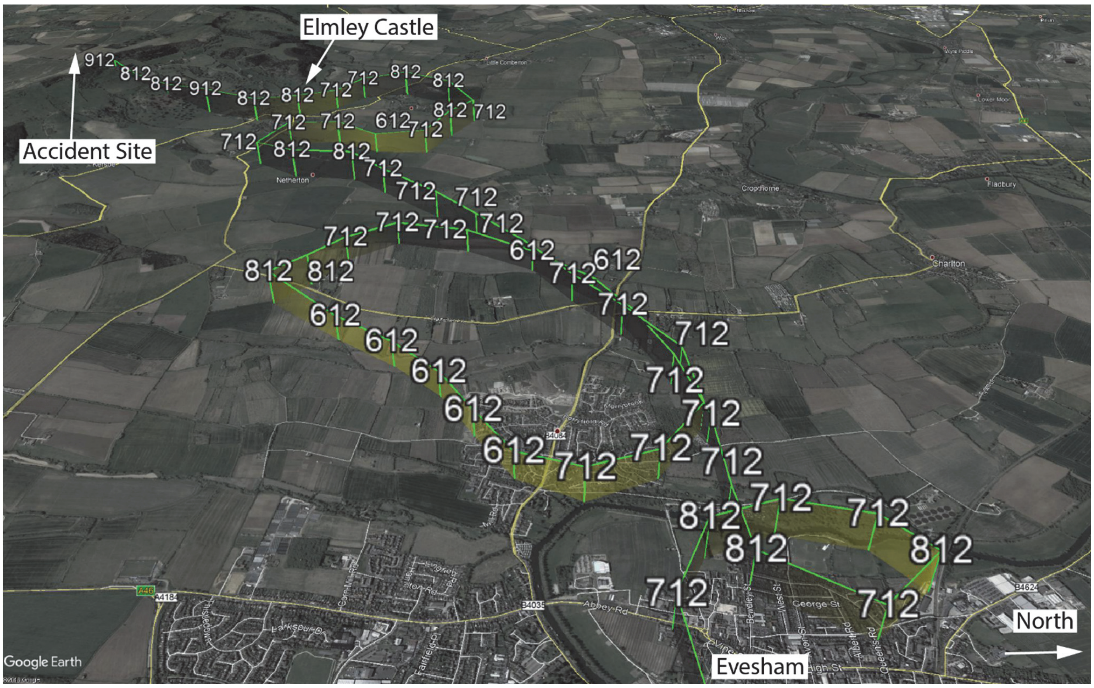


Figure 4

The final track and altitude returns from G-WAVS

The aircraft was equipped with a panel mounted GPS system. The unit was selected ON. No data was retrieved from this unit relating to the accident flight route, but it had stored its last known position, which was the accident site.

Radio contact between G-WAVS and Gloucester ATC was recorded. Both pilots' voices were audible on the recording and the content of the calls was routine. The last voice transmission was at 1225 hrs whilst the aircraft was manoeuvring near Evesham.

Aircraft information

The PA-28 is a low wing monoplane of conventional design, constructed primarily of aluminium and has four seats. It is powered by a carburetted, four-cylinder piston engine driving a fixed pitch propeller. A pilot-selectable carburettor heat system, using heat from the engine exhaust, is fitted to protect against carburettor icing. Fuel is carried in two integral wing tanks, one in each wing. The pilot can select either tank or OFF using a selector in the cockpit. The aircraft was equipped for flight in IFR conditions and was fitted with a GPS, VOR and ADF navigational equipment. The aircraft was not fitted with any de-icing equipment and therefore was not approved for flight in icing conditions.

The aircraft was maintained by the operator’s own maintenance organisation and a review of the maintenance records showed that the aircraft had been maintained as required. The maintenance organisation had issued the aircraft with an extension, which allowed it to operate for a defined short period after the normal due date of a maintenance inspection. This extension expired on 9 January 2018. A review of other extensions issued by the maintenance organisation indicated that there had only been four other extensions issued between 1 January 2017 and the time of the accident, two of which were to move an aircraft’s annual inspection date to coincide with its Airworthiness Review Certificate renewal date and the other two to allow the aircraft to complete a flight to the maintenance organisation. There had been over 360 maintenance inputs for scheduled maintenance in the same period.

Aircraft examination

The aircraft wreckage was recovered and taken to the AAIB facilities at Farnborough, Hampshire for further examination. This and examination of the aircraft log books did not reveal any pre-existing defects or anomalies with the aircraft or its instruments that may have contributed to the accident. The appropriate pressure setting,1022 hPa, had been set on the altimeter.

Meteorology

The forecast and actual weather reports for the Coventry area showed light winds from the north-east with a cloud base of approximately 1,000 ft. The Gloucester weather for the period of the accident also showed a light north-easterly wind with visibility reducing to 3,500 m in drizzle and mist and a cloud base of approximately 600 ft. The low-level forecast chart is at Figure 5. The crew of the accident aircraft are believed to have consulted this chart, a copy of which was found on the instructor’s desk at Coventry Airport. The instructor is believed to have contacted Wellesbourne Airfield to check the en route weather. He was told that a pilot had reported a cloudbase of approximately 800 ft agl. Wellesbourne Airfield does not produce TAFS or METARS.

The Met Office analysed the conditions as follows:

> *‘The chart shows that at 1200 UTC, the area of interest was covered by area C. The weather conditions in this area was* [sic] *associated with the warm front with general visibility around 20KM, but also widespread haze giving 7KM visibility. Isolated patches of light drizzle, or even snow grains were also possible which would reduce the visibility to 4000 M. It was a cloudy area with Broken or Overcast skies, bases of the cloud between 800-1300FT and tops 2500-4000FT. Any hills over 800FT would see foggy conditions.’*

Weather information for Birmingham and Gloucester airports was found after the accident on the pilot’s desk at the airport.

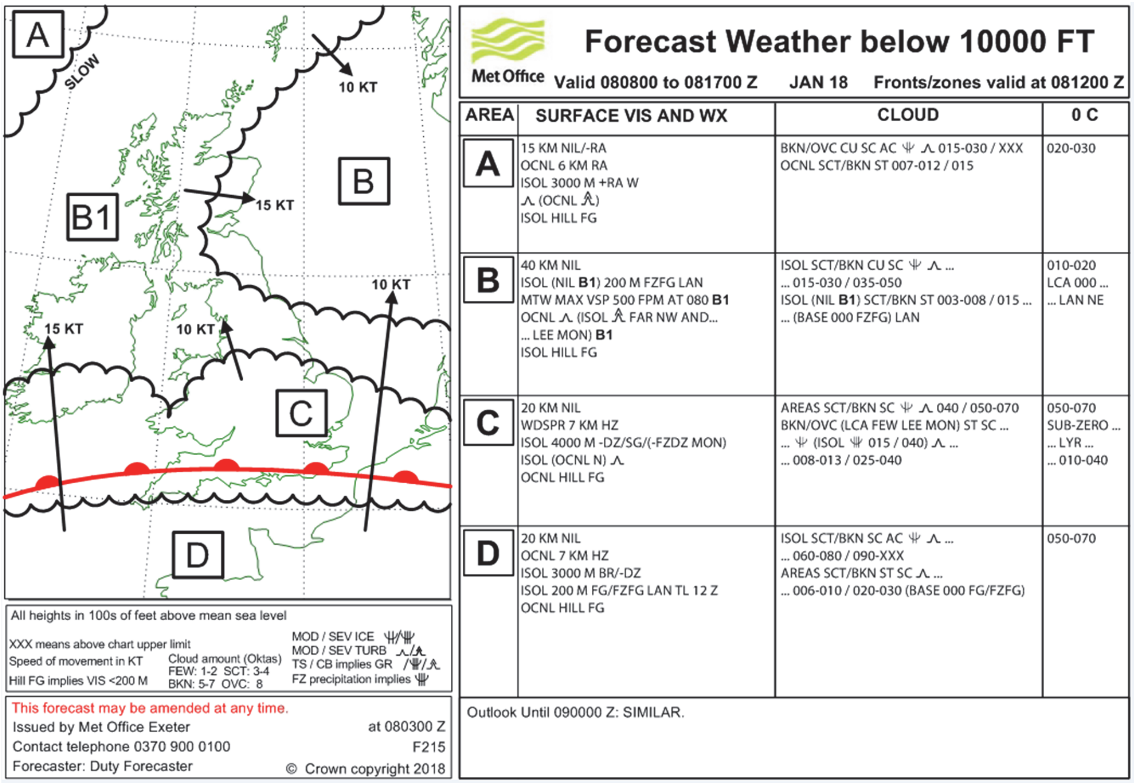


Figure 5

Forecast weather below 10,000 ft

Aids to navigation

The ADF equipment on the aircraft was tuned to the NDB at Gloucester, with its "ANT" selector button depressed. In this configuration the ADF could receive the NDB identification code but would not have indicated its location.

The VOR equipment was tuned to Daventry VOR and the course deviation indicator on the display was selected to the 258 radial. This did not align with the aircraft's course.

Several flight planning and mapping applications exist which can be used on mobile devices including tablets and mobile telephones. When suitably configured and provided with a GPS input these applications can improve a pilot's awareness of their position, especially in relation to nearby airspace and terrain, but may not meet the requirements for certification as a terrain awareness warning system.

A screenshot from one such application, which was used to simulate the approximate track of G-WAVS from Evesham towards Bredon Hill, is shown in Figure 6, below. The yellow aircraft symbol at top centre of the screenshot represents the simulated aircraft's position. In this image, the application's terrain warning feature is enabled and shows hazardous terrain in red. The white line with markers drawn ahead of the aircraft symbol represents the aircraft's predicted position at intervals in the future.

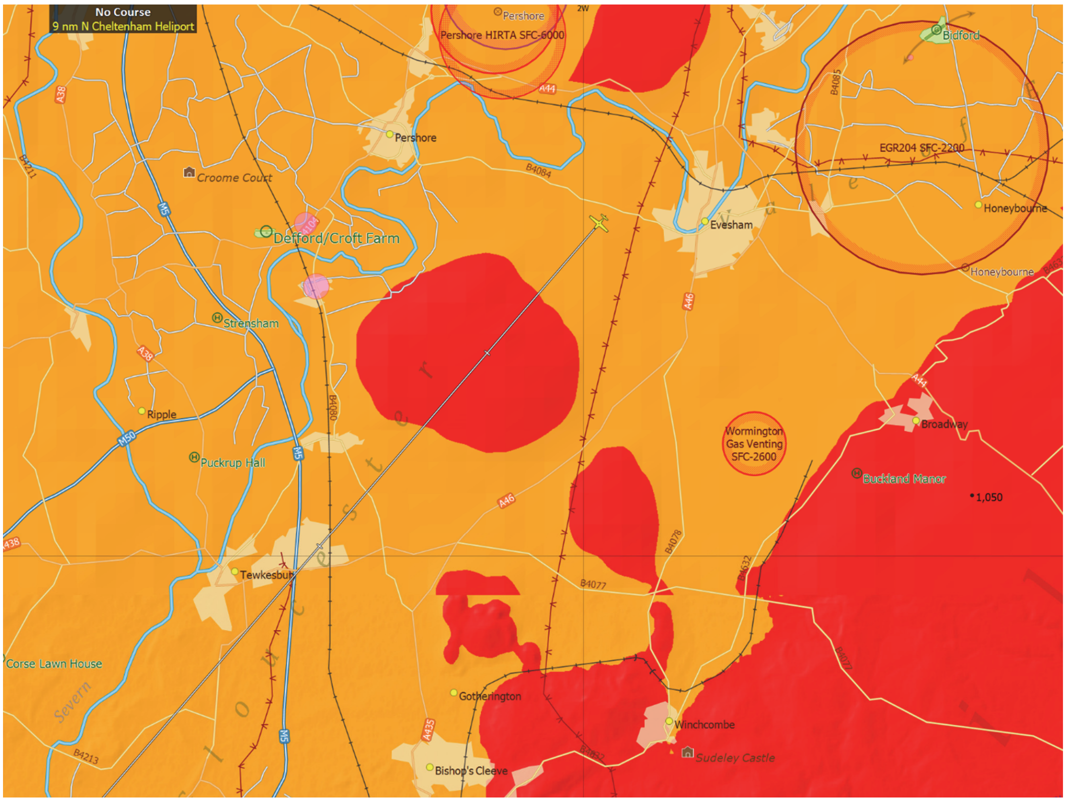


Figure 6

An example application showing the simulated track of G-WAVS towards Bredon Hill

The image shows the rising ground of Bredon Hill relative to the simulated aircraft flying at 900 ft amsl, and high ground to the right side of the Figure.

Civil Air Publication (CAP) 1535, '*The Skyway Code*', published by the CAA, states:

> *'Handheld and tablet based GPS systems have reduced the risk of CFIT*[2]*, particularly if lost. However, they should not be used to fly in poorer weather than you otherwise would.'*

The instructor was not known to use GPS navigation or flight planning software and did not carry a tablet or smart phone that could employ such systems. There is no requirement to do so.

Witnesses from the school stated that they had been taught that when lost they should circle a recognisable feature and then contact the Distress and Diversion cell at NATS Swanwick (D&D) on 121.5 MHz.

Footnote

[2] Controlled flight into terrain.

Personnel information

Instructor

The experienced instructor was also an examiner and was the only salaried member of the Instructional Staff at Coventry. He held a CPL(A) and Instrument Rating (Restricted) (IRR), and had approximately 5,700 hours flying experience[3].

Aircraft from the school were regularly flown to Gloucester and witnesses stated that the instructor had flown the route often.

Witnesses reported that the instructor appeared concerned about the conditions for the flight to Gloucester. He gave them the impression that he was unhappy with the plan but there is no evidence that he raised any such concerns with the higher management of the flying school.

Student

The student's records indicated that he had completed approximately 19 hours of flying training, including some navigation training prior to the accident sortie, and that he had an understanding of the procedures to follow when lost. He had not previously flown the route from Coventry to Gloucester.

Pathology

Post-mortem examinations of the pilots revealed no evidence of incapacitation before the accident. Both had sustained injuries that were not survivable.

Organisational information

The instructor involved had been with the school for several years and was the nominated Senior Instructor at its Coventry location. He was the only salaried member of the flying instructional staff at Coventry. The school did not appoint a duty pilot, separate from the flying programme, to supervise day to day flying activity and routine management of flying operations was conducted by the operations desk personnel, who were mostly inexperienced pilots on courses at the school.

The school did not have a formal process for monitoring or recording instructor performance.

The flying school regularly made use of training flights to transfer aircraft from Coventry to its engineering base at Gloucester.

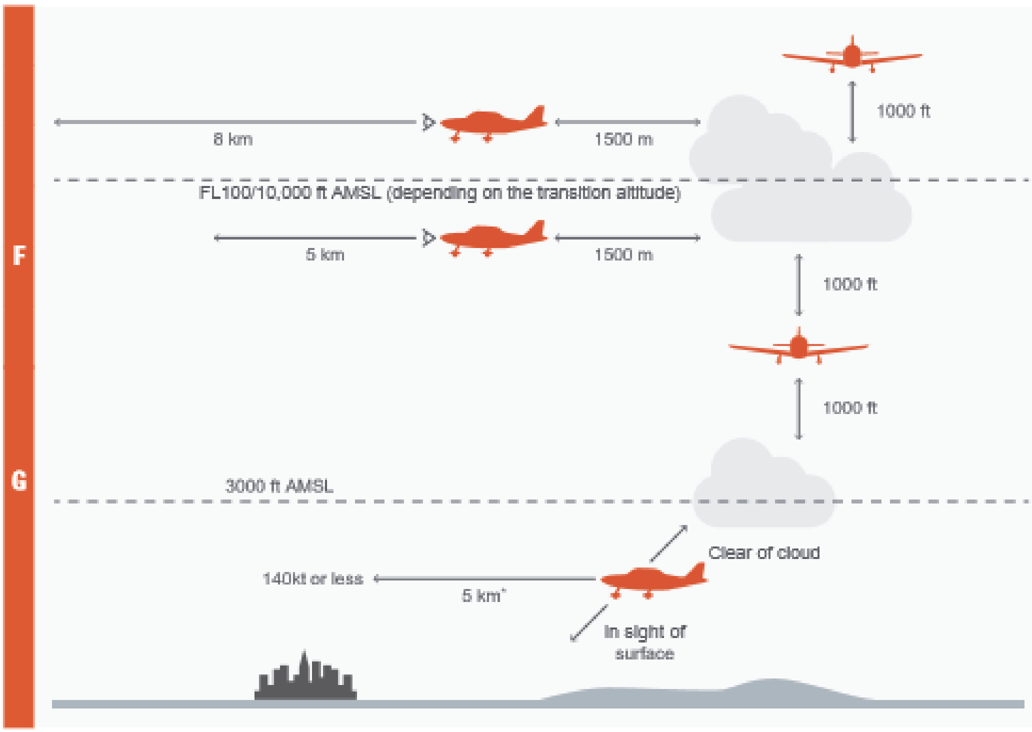
Flight in accordance with VFR

Regulations governing flight in accordance with VFR are contained in the Standard European Rules of the Air (SERA). The following extract from CAP 1535 provides a graphical representation (Figure 7).

Footnote

[3] It was not possible to determine the precise total because the last entry in his logbook was made in 2015.

Visual and instrument flight rules



Altitude band	Airspace class	Flight visibility	Distance from cloud
At and above 10,000 ft AMSL/FL100	A B C D E F G	8 km	1,500 m horizontally 1,000 ft vertically
Below 10,000 ft AMSL/FL100 and above 3,000 ft AMSL, or above 1,000 ft above terrain, whichever is the higher	A B C D E F G	5 km	1,500 m horizontally 1,000 ft vertically
At and below 3,000 ft AMSL, or 1,000 ft above terrain, whichever is the higher	A B C D** E	5 km	1,500 m horizontally 1,000 ft vertically
At and below 3,000 ft AMSL, or 1,000 ft above terrain, whichever is the higher	F G	5 km*	Clear of cloud and with the surface in sight

***5 km:** Where permitted by a Member State, this may be reduced to 1500 m if flying by day, in sight of the surface and at 140 kts IAS or less. In the UK, this is permitted in class G airspace.

Figure 7

Graphical representation of flight rules

For flight below 3,000 ft or less than 1,000 ft above terrain, whichever is higher, and at speeds below 140 kt, the SERA require a visibility of 5 km. However, Member States may reduce this visibility requirement to 1,500 m. The UK has done so. CAP 1535 states:

> *'For operations in class G airspace the legal VFR minima allow flight in potentially very poor conditions. Clear of cloud and visibility of 1500 m is all that is required if below 3000 ft AMSL and flying at less than 140 kts. In reality, the limiting factor is usually cloud rather than in-flight visibility - in*

conditions approaching 1500 m visibility, the cloud ceiling would likely mean flying dangerously low. The legal minima are not a good reference point for decision making because safe VFR flight normally ceases to be possible long before the visibility is that poor. They are limits not targets.'

The requirement to be in sight of the surface has been unintentionally omitted from this paragraph of the CAP 1535 but is reflected elsewhere in the document. The CAA stated that it intends to correct this omission in future publications.

CAP 1535 states that flight with a cloud ceiling of less than 1,500 ft agl or less warrants special attention to terrain and obstacles, and states:

'In practice, VFR flight when the surface visibility is being reported as less than 5 km is not recommended. You are unlikely to have a clear horizon to control the aircraft by and navigating visually will be difficult.'

The weather forecast for the accident flight indicated the probability of areas of low cloud and poor visibility.

The school's operations manual contained the following information relating to weather minima for takeoff:

'Single-engine aircraft may take-off only when:

VFR flights:

- *i. The cloud base is not less than 800 feet AGL and the RVR is not less than 1800 metres and / or:*
- *ii. The weather conditions at the departure airfield are not below those for a circling approach, and:*
- *iii. The cloud base en-route is not less than 1000 feet AGL and the visibility en route is not less than 1800 metres, and:*
- *iv. The weather conditions at the destination and alternate aerodromes are forecast to be greater than operating minima for a visual join, for not less than 60 minutes after the estimated time of arrival.'*

Regarding VFR Navigation it stated:

'VFR Navigation

Cloudbase /Flight Visibility

Dual Generally 1000ft, but not less than 800ft at any point en-route

Generally 5 km, but not less than 1800 m at any point enroute

For cross country flights the Operations Manual stated:

> *'For all cross-country flights adequate planning must be incorporated to enable a diversion to be made to an alternate airport which is open and has forecast weather to be above the minima for a period not less than 60 minutes before and after the expected arrival at that alternate.'*

Flight in low visibility

Safety Sense Leaflet 13 published by the CAA, and European General Aviation Safety Team Leaflet GA 1, both regarding collision avoidance, discuss effective visual scans and outline the limitations of human performance in this regard. Both state that it takes approximately 23 seconds to complete one effective scan of the aircraft instruments and the outside environment, and a further 10 seconds for the pilot to react effectively to an external threat; or 33 seconds in total. An aircraft with a ground speed of 140 kt will travel 1,500 m in approximately 20 seconds.

Flight planning and safety altitudes

The school's operations manual defined minimum safe altitude as being 1,000 ft above the highest obstacle within 5 nm of the intended track. For the planned route at Figure 1 this would have given a safe altitude of 2,400 ft. However, on the day of the accident an altitude of 2,400 ft would have required penetrating icing conditions for which the aircraft was not equipped.

CAP 1535 states:

> *'Controlled flight into terrain and loss of control in IMC continue to be factors of many GA accidents. Attempting or continuing VFR flight in poor weather is a common cause of this.'*

It contains guidance on pre-flight planning as a means of mitigating the risks associated with such conditions.

Analysis

Engineering matters

A review of the maintenance documentation indicated the aircraft had been maintained to the required standard and the examination of the wreckage did not identify any anomalies or defects that could have contributed to the accident. Damage to the propeller indicated that the engine was producing power at the time of the accident.

Operational matters

It is likely that the aircraft encountered an area of low cloud and poor visibility during the flight to Gloucester. Such conditions were forecast, but the instructor decided to continue with the flight. The weather conditions forecast for the flight were better than those required for flight under VFR and by the school's operations manual. However, the poorer visibility likely to have been encountered around Bredon Hill would have been significantly more challenging and the pilots of the other aircraft stated that the summit of Bredon Hill (940 ft amsl) was in cloud.

Although the instructor's IRR permitted him to do so, climbing into cloud was not a safe option because the aircraft was not equipped for flight in the icing conditions forecast to be present. Therefore, the crew had either to try to find more favourable conditions or continue operating in poor visibility at low altitude.

These circumstances would have increased workload and stress, potentially reducing the crew's performance. An aircraft with a ground speed of 140 kt will travel 1,500 m in approximately 20 seconds therefore the timeframe available to the crew to react effectively would have been very short. Consequently, in the conditions prevailing near Bredon Hill, it is likely the crew would have had insufficient time to avoid any obstacles they encountered.

Bredon Hill is on a direct track between the manoeuvring position near Evesham and Gloucester NDB, and if the instructor was uncertain of his position he may have chosen to use the NDB to indicate the location of the airfield. It was not possible to determine if the ADF unit's antennae button had been depressed in the accident sequence but in this configuration it would not have indicated the NDB's location.

The last radio contact with the aircraft occurred during its manoeuvres near Evesham. The apparently routine nature of that contact does not indicate any urgency at that stage of the flight.

The occupants of G-WAVS were not using a flight planning or mapping application. Although such applications may not meet the requirements for certification as a terrain awareness warning system, they can offer valuable situational awareness to a pilot of surrounding higher ground when used appropriately.

Students at the school were taught that when lost they should circle a recognisable feature and then contact D&D on 121.5 MHz. While the circling manoeuvres near Evesham are consistent with this practice, there were no radio calls received by D&D from the aircraft and it was not possible to determine whether these manoeuvres were a result of the pilot being lost or for some other purpose.

NATS states on its website[4] that *'pilots are actively encouraged to request training fixes and practice pans'* from D&D. As well as providing valuable training for controllers and pilots, making such a "practice" call might enable pilots to request assistance without alarming passengers or other crewmembers who may overhear their transmissions.

Given the student's lack of experience it is unlikely he could have offered significant assistance to the instructor.

Footnote

4 https://nats.aero/blog/2014/08/distress-diversion/ [accessed October 2018].

The aircraft was approaching the end of its maintenance validity and the school decided to send the aircraft to its own facility at Gloucester where its regular maintenance was carried out. This organisation was also the aircraft's Continuing Airworthiness Management Organisation. An alternative maintenance facility was available at Coventry.

The instructor was described by the flying school as its Senior Instructor and it is likely he felt a duty towards the school and a wish to achieve the required tasking.

The minimum safe altitude for flight in instrument meteorological conditions was 2,400 ft, but the aircraft used for the flight was not equipped to fly in the icing conditions forecast to be present in cloud. The pilot was heard to express some concerns about the weather prior to the flight.

The routine management of flying operations was conducted by the operations desk personnel who mostly were inexperienced pilots on courses at the school. No person of adequate experience and authority was present to challenge the decision to conduct the flight in the conditions prevailing on the day of the accident.

The use of training flights for other purposes, such as positioning an aircraft for required maintenance, may provide useful experience for a student but has the potential to impose inappropriate pressures on the participants. The conduct of a training flight should not be influenced by unrelated operational necessities.

A more formal process of assessing performance and recording standardisation meetings may have assisted the organisation in sharing experience and good practice amongst its staff.

Conclusion

The aircraft struck trees near the summit of Bredon Hill following flight into conditions of deteriorating visibility. The aircraft was not equipped to operate in the icing conditions forecast in cloud and so could not climb to the minimum safe altitude.

In visibility close to the limits permitted under VFR there is very little time to avoid terrain and obstacles that may be encountered and, should conditions deteriorate, flight in these circumstances presents few options for a safe outcome.

CAP 1535, published by the CAA, advises pilots that flight in the minimum conditions of cloud and visibility permitted under VFR is not necessarily safe, and describes steps that can be taken when planning the flight to mitigating the risks of flight into terrain in poor weather.

ACCIDENT

Aircraft Type and Registration:	HK36 TC Super Dimona, G-FMKA
No & Type of Engines:	1 Rotax 912-A3 piston engine
Year of Manufacture:	2000 (Serial no: 36.672)
Date & Time (UTC):	13 July 2017 at 1830 hrs
Location:	Near Brimslade Farm, Wiltshire
Type of Flight:	Training
Persons on Board:	Crew - 2 Passengers - None
Injuries:	Crew - 2 (Fatal) Passengers - N/A
Nature of Damage:	Destroyed
Commander's Licence:	Airline Transport Pilot's Licence and EASA Private Pilot's Licence
Commander's Age:	57 years
Commander's Flying Experience:	18,200 hours Last 90 days - 266 hours Last 28 days - 40 hours
Information Source:	AAIB Field Investigation

Synopsis

The purpose of the flight was for the aircraft owner to undergo a biennial refresher training flight with an instructor to revalidate his class ratings. The aircraft was seen to be manoeuvring at low level shortly before it departed from controlled flight. It struck the ground in a near vertical attitude on farmland. Both pilots were fatally injured and the aircraft was destroyed. There was insufficient evidence available to determine conclusively the cause of the loss of control, but it was possibly as a result of a power-on stall.

History of the flight

The owner of G-FMKA was undertaking a biennial refresher training flight with an instructor for the purposes of revalidating his class ratings. On the day of the accident flight, the owner flew the aircraft solo from Nympsfield, where the aircraft was based, to Draycot, arriving around 1745 hrs.

The instructor had flown on three other instructional flights from Draycot earlier that day, after which he was asked to conduct this flight. The accident flight was the first time that the instructor had flown in a Super Dimona. Shortly before the flight, the instructor and owner were seen in discussion; however, the content of their discussion is unknown. The precise planned content of the flight could not be established, except that the intended length of flight was one hour.

A witness at Draycot observed what appeared to him to be normal control and engine run-up checks on the aircraft; this included operation of the airbrakes. The aircraft took off from Draycot at 1810 hrs and was seen to depart to the south, towards Marlborough. The airfield had a radio, but no RT calls were received from the aircraft and none were expected.

At approximately 1820 hrs, what is believed to be the accident aircraft was seen over Marlborough by a witness who held a PPL. He stated that he thought the aircraft was at around 1,000 ft agl and heading south. The engine could be heard running, the aircraft was in wings-level flight and all appeared normal. Shortly thereafter, the aircraft was seen manoeuvring in the vicinity of the accident site by several other eyewitnesses. All of the witnesses felt that their attention was drawn to the aircraft because it was much lower than expected. The witnesses, who were widely dispersed, also reported hearing engine noises. Some witnesses described the engine noise increasing in the latter stages of the flight.

There was a consistent view that the aircraft was in a left turn in the latter stages of flight. The closest witnesses to the accident site described the aircraft as being perhaps only 100 ft agl as it passed their house, approximately 400 metres from the accident site, and believed it was going to land.

Another witness described the aircraft as "spinning around one wing and looked very nose-down" before his view was obscured by trees. The accident site was surrounded by tall trees on three sides and none of the witnesses saw the aircraft hit the ground. The accident site was located approximately 7 miles from Draycot (Figure 1).

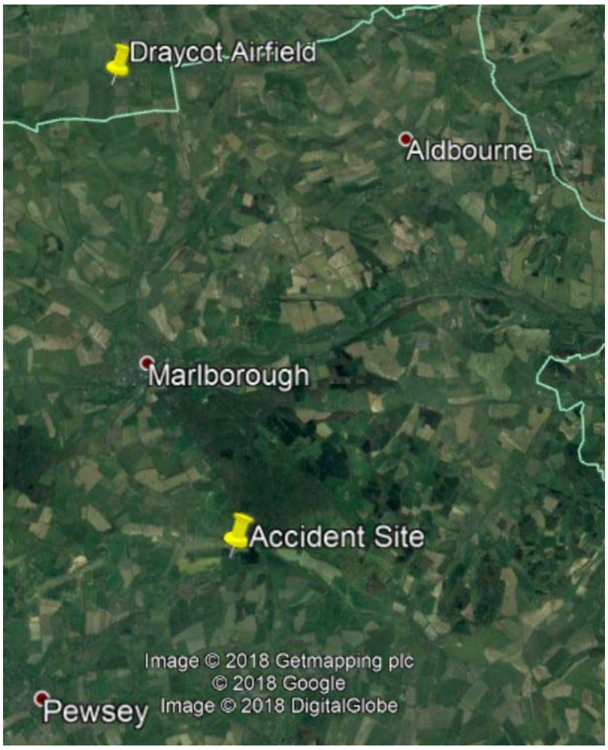


Figure 1
Accident geography

Witnesses described impact noises, followed by a small cloud of dust or smoke. Several witnesses made calls to the emergency services at approximately 1830 hrs. Witnesses who went to the accident site saw a small fire in the wreckage which then spread to the field's barley crop. Workers from the nearby farm used farm machinery to cut a firebreak to limit the spread of the fire. The two occupants had suffered fatal injuries.

Accident site

The accident site was in a gently sloping crop field near Brimslade Farm, to the south of Marlborough. This was one of several large fields in the area. The ground impact marks indicated that the aircraft had struck the ground in an extreme nose-down attitude whilst travelling at considerable speed vertically downwards. The impact speed was such that the engine section was buried back to the bulkhead.

An extensive post-crash fire had occurred, made more intense by combustion of the crop. Emergency service crews were still periodically damping down fire in the wreckage approximately 4 hours after the accident.

Site aerial imagery

An aerial survey of the accident site (Figure 2) was carried out using the AAIB's camera-equipped drone. This revealed impact markings created by the leading edges of the wings which formed symmetrical arcs centred at the point where the engine was buried. The pronounced curvature of the arcs indicated that the wings were experiencing considerable upwards bending at the point of impact. Measurements of the wing deflection were supplied to the aircraft manufacturer for analysis.

Aircraft performance

According to the analysis by the aircraft manufacturer, to produce the degree of upwards wing bending indicated by the ground impact marks, the aircraft would have to have been subjected to a positive acceleration approaching 9 g.

It was the aircraft manufacturer's opinion that such loads could not be achieved without an elevator control input.

Recorded information

A 'Flymap L' (GPS-based flight planning and navigation unit) was recovered from the accident site; however, it was damaged such that no data could be recovered from its internal memory.

The aircraft was not detected by radar, suggesting that it was flying at an altitude below the lower line-of-sight height limit for the radar heads closest to the route flown. For the radar heads of Clee Hill to the north and Bovingdon and Heathrow to the east, this means that the aircraft was probably no higher than 1,500 ft amsl (about 1,000 ft agl).

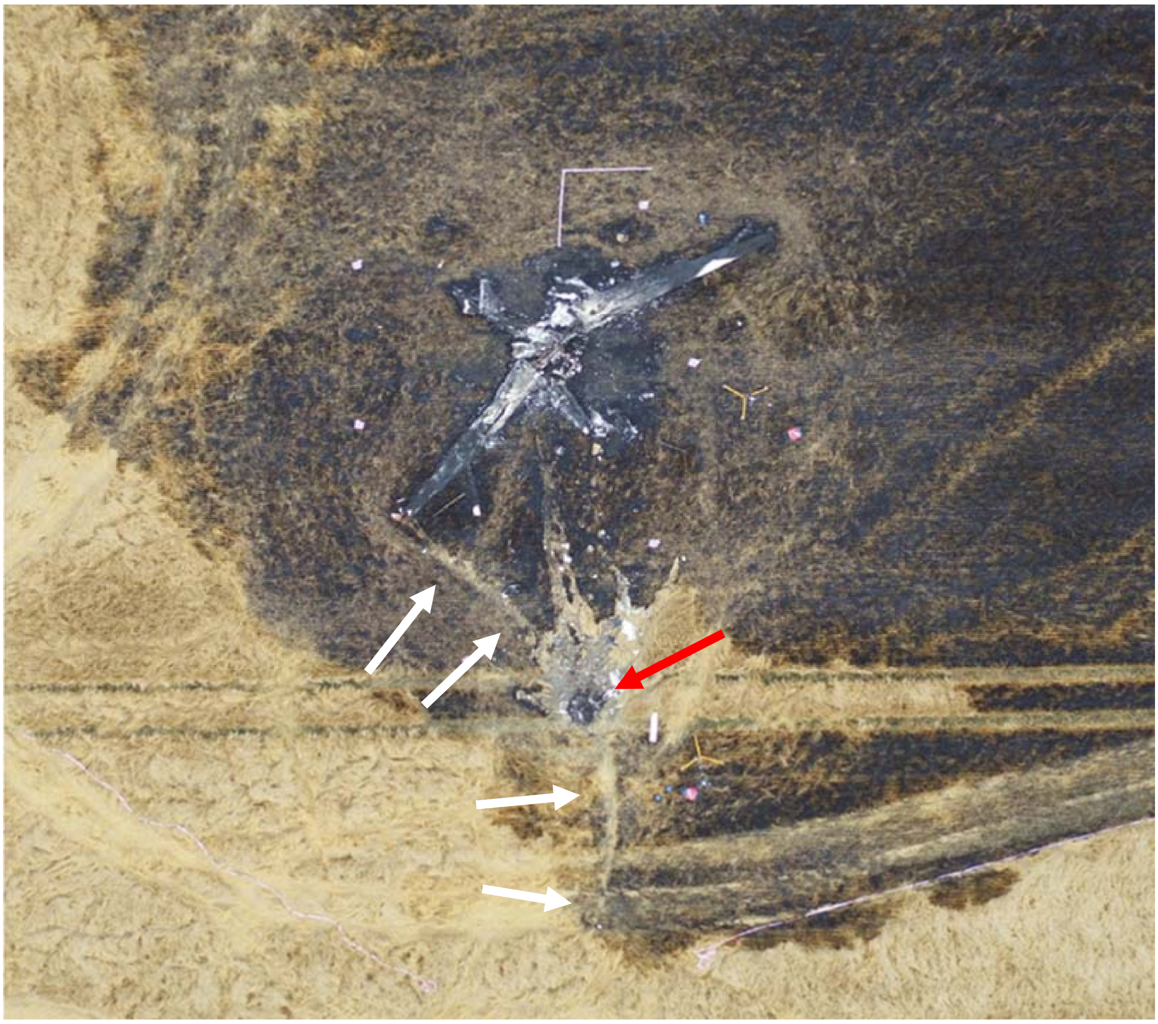


Figure 2

Aerial photo of accident site
(white arrows indicated curved impact marks from wing leading edges;
red arrow indicates engine impact location)

Aircraft information

The HK36 TC series Super Dimona (Figure 3) is certificated by the EASA as a touring motor glider (TMG). It is manufactured predominantly from glass reinforced plastic (GRP) and has conventional pitch, roll and yaw controls and upper wing surface airbrakes. The two-bladed propeller can be operated in a constant speed mode when the engine is supplying power, or may be feathered to minimise drag when the aircraft is gliding. The aircraft can be de-rigged for storage or ground transport.

The ailerons, elevator and airbrakes are operated by tubular steel push-pull rods, eye-end fittings, bellcranks and torque tubes. Most of the tubular push-pull rods are of a standard diameter and wall thickness, and most eye-ends are of a standard pattern. The rudder is cable operated.

A metal fuel tank is positioned behind the cabin area and a shelf is situated in the cabin behind the two pilot seats and above the tank.

Figure 3

HK36 TC Super Dimona (photo courtesy of Diamond Aircraft)

Super Dimona stall characteristics

Section 3.4 of the HK36 TC flight manual contains the following information regarding the aircraft's stall characteristics:

'3.4.1 BEHAVIOR WITH POWER OFF

Under all loading conditions, air brakes applied or retracted, wings level flight or banked flight, the HK 36 TC goes through a horizontal stall. The ailerons keep their effectiveness even with maximum elevator deflection.

A partial loss of positive control in the stick and pedals, buffeting, and pitch angle of 20° to 30° occur during this condition.

NOTE

During the horizontal stall, IAS rises to approximately 85 km/h (46 kts / 53 mph).

3.4.2 BEHAVIOR WITH POWER ON

See behavior with power off. Only at 50 % to 100 % power, wings level flight, and maximum rearward center of gravity, the airplane may perform a stall dive over the left or right wing after entering the horizontal stall if the control stick is pulled even further.

3.4.3 RECOVERY

The horizontal stall can be terminated immediately by relaxing the force on the elevator control.

NOTE

If the airplane performs a stall dive, immediately relax the force on the elevator control and pull out the airplane smoothly. If the stick is pulled further, the airplane may start to spin.

** Altitude loss resulting from stationary horizontal stall described above: approximately 10 - 20 m-(33 - 65 ft.).*

** Altitude loss resulting from stall dive over a wing: approximately 40 m (130 ft).'*

Aircraft maintenance and utilisation

At the time of the accident G-FMKA was in possession of an Airworthiness Review Certificate, (ARC), issued following an annual inspection. The ARC was dated 7 April 2017, valid until 27 June 2018. At the time of issue, the aircraft had carried out 1,015 hours total flying.

The annual inspection would have required de-rigging of the aircraft and removal of the seats to gain access to flying controls and various other components. It is known that the aircraft was normally hangered in a rigged state.

From the owner's flying logbook it was established that the aircraft had flown a further 10.6 hours since the ARC was issued.

Aircraft examination

Examination carried out both at the accident site and following recovery of the wreckage to the AAIB revealed that the fire had consumed most of the matrix material of the composite structure. Consequently, much of the remaining mass of glass-fibres previously forming the structure could not be identified as to their original location in the aircraft. In particular, a combination of impact forces and fragmentation together with fire had destroyed the fuselage between the engine bulkhead and the wing carry-through box. The metal fuel tank was totally disrupted.

Amongst items that were identifiable at the impact site were: both wingtips, the bulk of the tailplane and elevator, including both tailplane tips, the fin and rudder and the inboard section of the left aileron, incorporating the most inboard of the hinges. With the exception of the outboard length of the left aileron and a portion of the elevator, all control surfaces were accounted for at the accident site. The outboard section of the left aileron, beyond the operating bell crank, was not identified and an outboard section of the elevator appeared to have been destroyed by the fire. This had come to rest beneath the rear fuselage which sustained an intense fire for a lengthy period.

The severely burnt remains of the two wings were found in a relative position consistent with having been correctly attached at impact. Examination of the flying control tubes and bell cranks within the structure of each wing revealed no evidence of pre-impact failure. The extent of disruption of the fuselage, particularly in the area beneath the seats, made it impractical to carry out an effective examination of the control operating mechanism in that area. Numerous lengths of tubing terminated in fractures having the characteristics of compressive buckling preceding final overload failure (ie consistent with impact disruption.)

No specific evidence of pre-impact failure of the flying controls was found anywhere during the wreckage examination, although the extent of disruption of the midships section of the fuselage structure, the impact distortion of control tubes and the large numbers of fractures of those tubes and threaded portions of eye-ends in that section made it impossible to conclusively state that no pre-impact failure was present.

Examination of the propeller hub showed that the pitch change mechanism was seized in a position consistent with being in the normal powered flight range rather than in the feathered position appropriate to gliding flight. The seizure of the pitch change mechanism appeared to be the result of impact distortion of pitch change bearings or parts of that mechanism having occurred in the sequence during which the wooden blades had been sheared off at their root attachments. It was concluded that the seized position of the propeller hub components was at or very close to the flight pitch setting at impact.

During the examination the remains of a walking pole were found amongst the wreckage.

As the fuel quantity on board the aircraft was unknown, the aircraft's centre of gravity could not be determined.

Meteorology

Based on Met Office information, the weather was generally fine with an estimated wind of 250° at 15 kt. Weather radar imagery from around the time of the accident indicated that conditions were dry, with light to moderate showers to the east of the area.

Biennial refresher training

EASA Part-FCL paragraph FCL.740.A *Revalidation of class and type ratings — aeroplanes*, states that, for SEP[1] and TMG class ratings, the applicant shall:

> '(i) *within the 3 months preceding the expiry date of the rating, pass a proficiency check in the relevant class in accordance with Appendix 9 to this Part with an examiner;'*

Footnote

[1] Single-engine piston.

or based on previous experience by:

> ‘(ii) *within the 12 months preceding the expiry date of the rating, complete 12 hours of flight time in the relevant class, including:*
>
> — *6 hours as PIC,*
>
> — *12 take-offs and 12 landings, and*
>
> — *refresher training of at least 1 hour of total flight time with a flight instructor (FI) or a class rating instructor (CRI). Applicants shall be exempted from this refresher training if they have passed a class or type rating proficiency check, skill test or assessment of competence in any other class or type of aeroplane.’*

When applicants hold both a single-engine piston aeroplane-land class rating (denoted as SEP (land)) and a TMG rating, they may complete these requirements in *‘either class or a combination thereof, and achieve revalidation of both ratings.’*

Apart from being ‘*exempted from this refresher training if they have passed a class or type rating proficiency check, skill test or assessment of competence in any other class or type of aeroplane*’, the regulations do not provide any guidance material (GM) or acceptable means of compliance (AMC) to support these requirements and specifically what should be covered in the refresher training. The content and structure of the training flight (so the instructor is pilot in command) is, therefore, at the discretion of and agreed between the pilot and instructor, but typically includes exercises such as stall recovery and practice forced landings.

Personnel

Aircraft owner

The owner had commenced his flying on gliders in 1992. Over the next 7 years he accumulated nearly 300 hours gliding, in 350 flights. He then began training on SEP (land) aircraft. He gained his Private Pilot’s Licence in 1999 and flew various aircraft types. In May 2006 he underwent an SLMG[2] conversion and purchased G-FMKA. In June 2014, he passed his TMG licence skills test. From 2006, he appeared to have flown almost exclusively in G-FMKA.

At the time of the accident, his total powered flying experience amounted to just over 700 hours, together with a total of approximately 415 hours and over 400 flights on gliders. The owner had flown more than 12 hours in the preceding 12 months and so he only required a minimum of 1 hour of instructional flight to revalidate his licence.

Footnote

2 Self Launching Motor Glider.

Instructor

The instructor was a former military fast jet pilot and a current commercial airline pilot. His total flying experience amounted to approximately 18,200 hours. He had recently completed his training as a civilian Flight Instructor (FI) on SEP (land) aircraft which included a supervised period of 100 hrs of instructional flying. In the preceding 28 days he flew various SEP types, including his own Cirrus SR22. The instructor did not hold a TMG class rating.

Licensing requirements

Although they may appear outwardly similar in many ways, TMGs such as the Super Dimona have somewhat different flight characteristics from the more common SEP (land) class of aircraft. There are also operational differences; for example, TMGs are equipped with airbrakes or spoilers, whereas SEP aircraft are not. Licensing regulations require pilots who wish to fly TMGs to hold a TMG class rating, which requires specific training to be completed. To instruct on TMG aircraft, an instructor must hold a TMG class rating. It is a requirement of the EASA Part-FCL regulations that an instructor holds a class rating for the class of aircraft for which instruction is being given.

The owner had conducted his previous biennial refresher training in 2015, in G-FMKA, at the same flying training school where the instructor had completed his FI training. This refresher training was conducted with the Chief Flying Instructor of the school, who did not hold a TMG class rating.

The similarity between the TMG and SEP classes of aircraft has led some to believe, incorrectly, that possession of a valid SEP (land) class rating also entitles them to fly TMG class aircraft. The AAIB raised the issue with the CAA, who agreed to publish safety information to flight instructors to clarify the requirements for instruction on TMG class aircraft.

Medical and pathological information

The post-mortem reports for the pilot and instructor cited the cause of death as multiple injuries. Within the limited examination possible, there was no natural disease identified to cause or contribute to death.

Survivability

The aircraft struck the ground at high speed in a steep nose-down attitude. The post-mortem examinations of the pilots indicated that the scale of injuries resulting from the impact were not survivable.

Analysis

Engineering aspects

The vertical nature of the flight path of the aircraft at impact, coupled with the elevator input required to create the 9 g impression in the ground, is consistent with the aircraft having been beyond the vertical shortly before ground contact.

All extremities of the aircraft were identified at the accident site, indicating that no in-flight structural failure had occurred. With the exception of the outboard length of the left aileron and a portion of the elevator, all control surfaces were identified at the accident site. Since the attached section of the left aileron incorporated only one short hinge, it would be logical to expect the whole of the aileron to have separated as two independent items if the surface had failed in flight, rather than only the outboard section separating leaving the inboard section as found in the wreckage attached by a single short hinge at its inboard end. Hence there is little doubt that both ailerons were attached and complete at the time of the impact.

The absence of the outboard section of the elevator in an identifiable state is explicable since that length appears to have come to rest beneath the rear fuselage which burned for a sustained period after the impact and required frequent damping down by fire and rescue services for at least four hours after the accident. The identified section of elevator ended in an extremely fire damaged termination. The complete rudder was also identified in the wreckage.

This evidence is therefore consistent with all the flying control surfaces being attached and complete when the aircraft struck the ground.

The impact damage and subsequent fire made it impractical to determine whether any pre-accident defect was present in the flying control system. The roll controls within each wing were free from such defects, but the same could not be conclusively stated about those sections within the fuselage. The extent of bending deflection of the wing structure, evident from the aerial survey, however, can only have been achieved by a functioning pitch control system with the control stick being moved forcefully backward. This is consistent with the pitch control being fully operable and one of the occupants operating the controls.

The most likely initial location for the walking pole found in the aircraft wreckage was on the shelf behind the two pilot seats. The confined space within the cockpit, particularly when carrying two occupants, would preclude the carriage of the pole elsewhere within the aircraft. It is difficult to envisage a plausible scenario whereby the pole could have interfered with the operation of the aircraft's controls.

Operational aspects

The planned content of the flight is unknown, except that its intended duration was one hour. As it was a refresher training flight as part of the pilot's revalidation of his SEP (land) and TMG class ratings, the content was at the discretion and agreement of both the pilot and instructor.

The aircraft was seen heading south from Draycot at about 1,000 ft agl. Shortly thereafter, it was manoeuvring and turning left near the accident site at a much lower altitude that had drawn witnesses' attention. For the aircraft to have been so low, either there was a problem, or a planned manoeuvre was being conducted. If there was a problem with the aircraft, no radio call was made to indicate as such. It is possible that a practice forced landing was being conducted and there were several suitable fields available in the vicinity.

The aircraft was observed in what is believed to be powered, controlled flight until the last few seconds. One witness described what could be construed as the aircraft entering a spin, just before he lost sight of it. It is improbable that the extreme aircraft attitude was a result of intentional pilot action, as such a manoeuvre at low height would carry a very high level of risk. Therefore, it is probable that the situation arose because of a departure from controlled flight. The power-off stall characteristics of the Super Dimona are benign; however, the power-on stall is different, and in certain circumstances the aircraft '*may perform a stall dive over the left or right wing*'. A power-on stall would appear to be the most likely explanation for the sudden loss of control and resultant unusual attitude.

The weather in the area of the accident flight was clear and dry with no low cloud and light winds. It is therefore unlikely that any meteorological event affected the flight.

According to the EASA Part-FCL regulations, the instructor was not qualified to be pilot in command or give instruction on TMG class aircraft such as the Super Dimona as he did not hold a TMG class rating.

Conclusion

The aircraft departed from controlled flight at low altitude, possibly from a power-on stall, for reasons which could not be determined conclusively. There was no evidence of a pre-existing problem with the flight controls, but the possibility could not be fully excluded. The ground impact marks suggested that an attempt to regain control of the aircraft was made, but there was insufficient height available in which to complete a recovery.

Safety action

The CAA has agreed to issue advice to remind flying instructors of the requirement to hold a valid TMG class rating if they intend to exercise their flight instructor privileges on this class of aircraft.

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:	Boeing 787-9, G-CKWC
No & Type of Engines:	2 Rolls-Royce Trent 1000-J3 Ten turbofan engines
Year of Manufacture:	2018 (Serial no: 38893)
Date & Time (UTC):	28 March 2018 at 2201 hrs
Location:	London Gatwick Airport
Type of Flight:	Commercial Air Transport (Passenger)
Persons on Board:	Crew - 10 Passengers - 260
Injuries:	Crew - None Passengers - None
Nature of Damage:	None
Commander's Licence:	Airline Transport Pilot's Licence
Commander's Age:	63
Commander's Flying Experience:	18,765 hours (of which 699 were on type) Last 90 days - 190 hours Last 28 days - 60 hours
Information Source:	Aircraft Accident Report Form submitted by the pilot

Synopsis

The aircraft began its takeoff roll from the displaced landing threshold of Runway 26R at Gatwick Airport, rather than at the beginning of the runway. This decreased the distance available for the takeoff by 417 m.

The beginning of the runway is marked by a white line, but the part of the runway before the landing threshold does not include white edge lights or centreline lights. This configuration complies with relevant specifications. The taxi route to the runway brought the aircraft up to the beginning of the runway on a taxiway that was on the same heading as the runway and no turn was required. This is unusual, as most runway entries will require a turn onto the runway centreline, but compliant. These factors, combined with the perceived lack of lighting on the pre-threshold part of the runway, meant the crew did not identify the beginning of the runway and instead taxied up to the lights of the landing threshold to begin their takeoff roll. Consequently, the aircraft took off with insufficient thrust to meet regulatory takeoff performance criteria for the actual length of runway available.

Following previous takeoff performance-related events with other aircraft operators, the airport operator undertook a review of operations using Runway 26R and introduced measures to reduce the likelihood of aircraft beginning their takeoff from the wrong point on the runway. Further measures were taken after this event.

History of the flight

G-CKWC was scheduled to depart Gatwick Airport (LGW) for Buenos Aires, Argentina at 2130 hrs. During the pre-flight briefing the crew had noted the presence of a NOTAM, which referred to the closure of the main runway at LGW and the use of the standby runway for takeoff and landings from 2145 hrs. The NOTAM stated that the last departure from the main runway would be five minutes before the closure. The crew noted that their departure was very close to that time and began planning for a takeoff from the standby runway. This meant a change of loading plan, including a reduction in planned cargo. A revised flight plan and loading plan were issued which would allow the flight to depart from the standby runway using full engine thrust.

At 2137 hrs, the aircraft pushed back from its stand at LGW. The aircraft taxied out for Runway 26R via Taxiways KA, K to hold at Holding Point P1. At 2156 hrs, the aircraft was given a conditional clearance to line up on Runway 26R after a landing A320. At 2158 hrs the aircraft crossed the holding point at P1 and taxied via P and AN to the runway. Whilst on Taxiway AN, before entering the runway, the crew received their takeoff clearance. Figure 1 shows the taxi routing taken by G-CKWC.

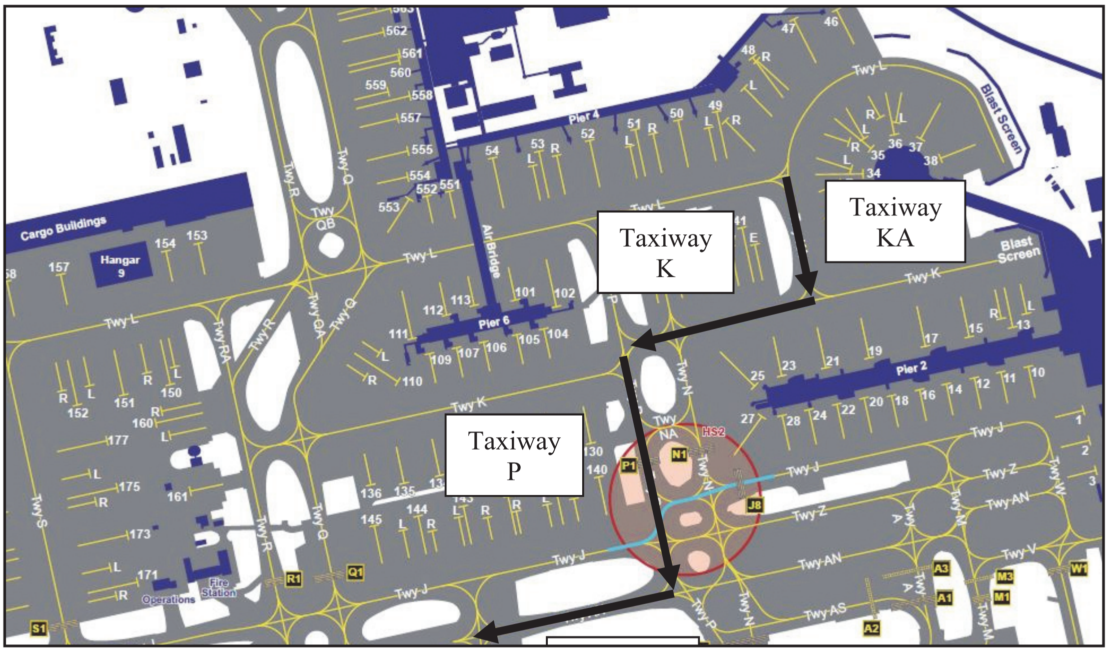


Figure 1

G-CKWC taxiway routing at LGW

The crew elected to perform a rolling takeoff. The tower controller noted that the aircraft did not appear to put on power or accelerate until at the Runway 26R landing threshold. The controller also saw that the aircraft did not appear to rotate until approximately abeam Taxiway FR as shown in Figure 2. The crew later recalled that there was not much runway remaining at lift-off.

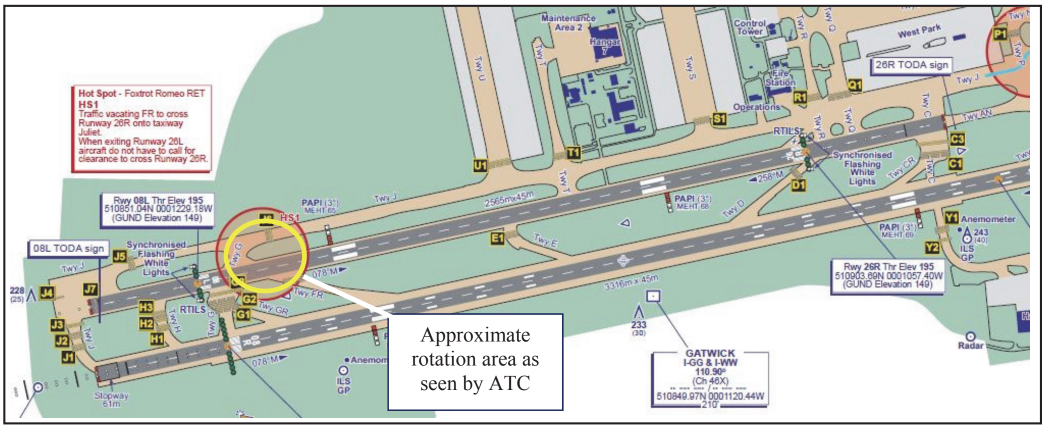


Figure 2

Full length of Runway 26R

Figure 3 shows where the aircraft takeoff performance was calculated from (TORA[1] 2,565 m) and where the takeoff actually commenced (TORA 2,140 m).

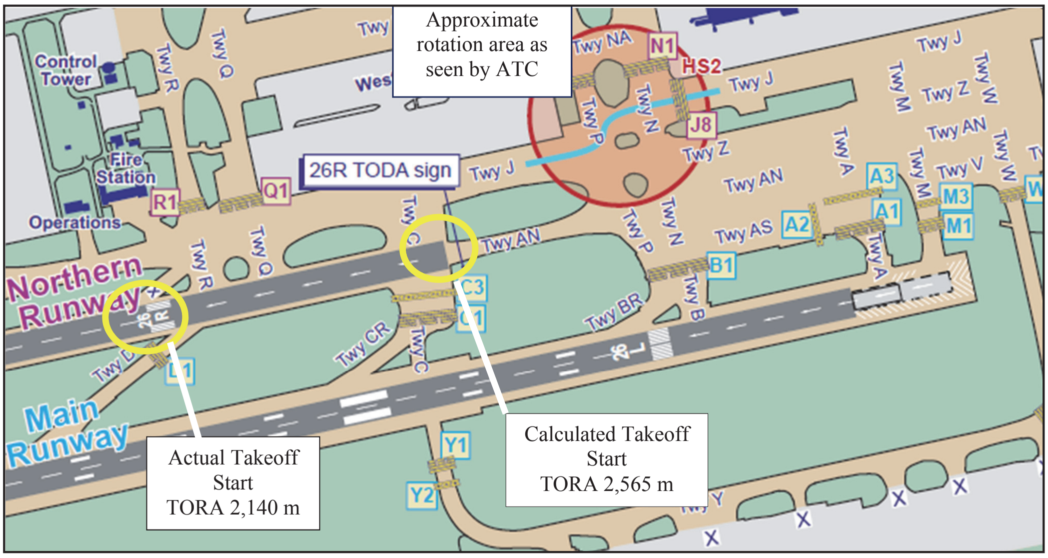


Figure 3

The calculated and actual takeoff start points

The tower controller filed a report, which was passed to the operator and subsequently upgraded to a Mandatory Occurrence Report (MOR)[2]. After an evaluation of the flight data and the performance calculations, the operator submitted an MOR to the CAA. The AAIB was informed of the event by the CAA.

Footnote

1 Takeoff run available (TORA) - the distance from the point on the surface of the aerodrome at which the aeroplane commences its takeoff run to the nearest point in the direction of takeoff at which the surface of the aerodrome is incapable of bearing the weight of the aeroplane under normal operating conditions.

2 Mandatory occurrence report (MOR): an occurrence means any safety-related event which endangers or which, if not corrected or addressed, could endanger an aircraft, its occupants or any other person. See *Reporting of occurrences* later in this report.

Airfield information

LGW is a single runway airport although it does have a standby runway which can be used when the main runway is unavailable. The standby runway is used as a taxiway when not in use as a runway. The main and standby runways cannot be used at the same time as there is insufficient distance between them. There is a changeover period of approximately 15 minutes between using one of the runways and the other. During this period neither runway is available.

The use of the standby runway (08L/26R) at Gatwick is not common and occurs most frequently at night when the airport movements (takeoffs and landings) are reduced and work can be undertaken on the main runway. In 2017, movements on the standby runway accounted for only 1.3% of the total movements at the airport.

The Runway 26R landing threshold is displaced by 417 m from the start of the TORA due to obstacle clearance requirements for the approach. Takeoffs should be commenced from the beginning of the runway which is indicated by a white line. The start of the runway also has large centreline arrows showing the presence of a displaced landing threshold. The runway markings are shown at Figure 4.

Figure 4

Image showing the runway markings © Google Earth

Runway 26R/08L has red edge lighting for the part of the runway before the displaced landing threshold and no centreline lights. This configuration is compliant with relevant regulations. The edge lights revert to white once past the displaced landing threshold. The area between the beginning of Runway 26R and the displaced threshold contains one bar and some centre lights of the approach lighting system. The displaced threshold has green threshold lights as well as a set of Runway Threshold Identification Lights (RTILS). RTILS consist of two synchronised white flashing lights, one at each end of the green threshold bar. The RTILS are angled for landing traffic and should not be visible to aircraft on the ground at the beginning of the runway. Figure 5 shows the markings and lighting on Runway 26R shown from before the beginning of the runway.

Figure 5

View of the markings and lighting Runway 26R
(Photo courtesy of Gatwick Airport Limited)

Figure 6 shows the same view in darkness.

Figure 6

Start of Runway 26R at night
(Photo courtesy of Gatwick Airport Limited)

The entry to Runway 26R for departing traffic is along Taxiway AN from the Holding Points at P1 and N1 (as shown in Figure 3). This means that the aircraft must taxi in a straight line along AN which is on the same heading as the runway itself. This is an unusual arrangement for runway entry although it is compliant with relevant regulations. Pilots would be more used to entering the runway from a holding point adjacent to the runway, often with a 90° turn onto the runway centreline. The AN taxiway is approximately 250 m long before the aircraft reaches the white line indicating the start of the runway. In Figures 5 and 6 the green taxiway lights of AN are visible reaching and crossing the white line indicating the start of the runway.

After previous reported issues over many years with crews mis-identifying the start of the runway for takeoff, in the early 1990s[3] LGW fitted a sign on the grass to the left of the beginning of the runway at the end of Taxiway AN to indicate the start of the TODA[4] and the distance available from that point. The sign is covered when Runway 26R is not in use to avoid any confusion for pilots using Runway 26L. The sign is illuminated at night. None of the crew of G-CKWC recalled seeing the TODA sign even though it was illuminated.

The UK Aeronautical Information Publication (AIP) contains details on airports including Gatwick. Information in the AIP is used by commercial chart suppliers to produce the charts used by pilots in flight operation. The AIP includes a significant section of textual data which may be repeated by the chart suppliers in the data given to pilots in their commercial charts. In section 2.20, entitled '*Local Traffic Regulations*', subsection '*Runway and approach lights*' the AIP states:

> *'Aircraft taking-off from Runway 26R **MUST NOT** commence their take-off run before reaching the **START OF TODA** information sign. This sign is located to the left of the runway, 417 m before the marked runway threshold.'*

There is no further information on the location from where aircraft should start their takeoff run.

Other reports

Information from Gatwick Airport indicated that there were at least four other incidents of aircraft not starting their takeoff roll at the beginning of the TORA on Runway 26R between September 2017 and the incident reported here. These incidents, which occurred to various operators other than the operator of G-CKWC, were recorded by the air traffic controllers at the airport.

Footnote

3 The investigation did not identify the exact date of installation.

4 Takeoff distance available (TODA) – the distance from the point on the surface of the aerodrome at which the aeroplane commences its takeoff run to the nearest obstacle in the direction of takeoff projecting above the surface of the aerodrome and capable of affecting the safety of the aeroplane, or TORA x 1.5, whichever is the less.

Crew report

The crew reported that the takeoff seemed normal although it did use the full runway distance. After departure both pilots commented that there was not much runway remaining at lift-off. Given the limiting length of the runway, the load had been reduced to allow takeoff, and therefore the crew were not surprised by the length of the runway used during the takeoff run and were unaware of any problem.

When asked specifically about what they saw at the beginning of Runway 26R the commander said that neither of the pilots could recall seeing anything that indicated they were in the wrong place nor did they see the TODA sign. The routing along Taxiway AN was dark and "the runway looked pitch black and the only thing we saw was the green lights". He agreed that the crew were aware of the displaced threshold on Runway 26R but did not see the markings indicating the beginning of the runway.

The commander was familiar with Gatwick although he had rarely operated from Runway 26R.

Aircraft performance

The operator conducted an investigation which included analysis using recorded flight data and the B787 performance program used by the operator. Use of the performance program showed that, for the weather conditions on the night of the incident and the calculated aircraft weight of 223,813 kg, an accelerate stop distance of 2,564 m was required which is equal to the ASDA[5] for the full length of Runway 26R.

From the position of the displaced landing threshold, the ASDA is 2,156 m. Had the aircraft suffered an engine failure just before V_1 and had the crew decided to stop, a runway overrun could have occurred. A calculation by the operator indicated that the aircraft was around 12,000 kg too heavy for the distance available. The airfield boundary fence is 2,250 m from the landing threshold of Runway 26R where the aircraft began its takeoff roll.

The operator also completed an analysis of the performance in the case of an engine failure at V_1, followed by a continued takeoff. This showed that the accelerate-go[6] distance was 2,354 m. From the displaced threshold of Runway 26R, the TODA is 2,295 m. The aircraft would have failed to meet the regulated takeoff performance criteria in both cases.

Assumptions are made in the calculation of regulated takeoff performance. Should actual circumstances be more favourable than the assumptions on any given takeoff, aircraft performance may be better than predicted. In this case, for example, allowance was made for a wet runway when it was damp, but no allowance was made for the fact that the runway

Footnote

5 Accelerate Stop Distance Available (ASDA) – the distance from the point on the surface of the aerodrome at which the aeroplane commences its takeoff run to the nearest point in the direction of takeoff at which the aeroplane cannot roll over the surface of the aerodrome and be brought to rest in an emergency without risk of accident.

6 Accelerate-go distance - the runway required to accelerate to V_1 with all engines operating at takeoff power, experience an engine failure at V_1, and continue the takeoff on the remaining engine. The runway required includes the distance required to climb to 35 ft by which time V_2 speed must be attained.

is grooved or that the aircraft used a rolling takeoff technique. Each of these factors was likely to have had a beneficial effect, compared to the regulatory calculation, had the engine suffered an engine failure near V_1.

Reporting of occurrences, accidents and serious incidents

Reporting of occurrences

Regulation (EU) 376/2014 is concerned with '*the reporting, analysis and follow-up of occurrences in civil aviation'.* Article 4, '*Mandatory Reporting',* details requirements for the mandatory reporting of occurrences.

This event was reported internally by air traffic control personnel at Gatwick and later to the CAA. The internal report was passed by the Air Navigation Service Provider (ANSP) at Gatwick to the airport and the aircraft operators. The aircraft operator began an investigation into the event. The investigation showed that that the aircraft had triggered a 'long lift-off' event in the company flight data monitoring program. Upon evaluation of flight data and the performance calculations, the operator upgraded the event to an MOR and submitted it to the CAA on 30 April 2018. The AAIB learned of the event on 14 May 2018 from the CAA.

Reporting of accidents and serious incidents

The reporting requirements for accidents and serious incidents flow from provisions within Annex 13 to The Convention on International Civil Aviation (Chicago Convention) and are brought into UK law through Regulation (EU) 996/2010 and The Civil Aviation (Investigation of Air Accidents and Incidents) Regulations 2018.

Annex 13, Attachment C defines a serious incident as:

> *'involving circumstances indicating that there was a high probability of an accident.'*

It gives a list of examples of serious incidents which includes:

> *'Gross failure to achieve predicted performance during take-off or initial climb.'*

These definitions are mirrored in EU 996/2010 and the UK Regulations 2018.

The relationship between EU 376/2014 and EU 996/2010 is shown by Recital (3) to EU 376/2014, which states:

> *'This regulation should not interfere with … accident and incident investigations managed by national safety investigation authorities.'*

And:

> *'In the event of an accident or a serious incident, notification of the occurrence is also subject to EU 996/2010.'*

EU 996/2010, Article 9, *Obligation to notify accidents and serious incidents* states:

> *'Any person involved who has knowledge of the occurrence of an accident or serious incident shall notify without delay the competent safety investigation authority of the State of Occurrence thereof.'*

This event involved a gross failure of the aircraft to achieve its predicted takeoff performance and would therefore have been reportable under the provisions of EU 996/2010 had it been recognised as a serious incident at the time.

Civil Aviation Publication (CAP) 493, *The Manual of Air Traffic Services (MATS) Part 1,* contains in Section 6, Chapter 3 information on how ANSPs should meet their obligations to report accidents and serious incidents. At the time of this incident to G-CKWC, following an accident or serious incident at an aerodrome, the senior controller was required to telephone the Area Control Centre (ACC) Watch Manager and, subsequently, submit an MOR. On receiving a report of an accident or serious incident, the Operational Supervisor at an ACC was required to telephone the AAIB. As a result of an AAIB Special Bulletin into another serious incident[7] in 2017, a Supplementary Instruction to MATS Part 1 was issued by the CAA on 15 June 2018, which implemented changes to the initial reporting action procedures for air traffic control units. With effect from 14 August 2018, the senior controller at an aerodrome is also required to telephone the AAIB to report a serious incident. In circumstances where there is doubt about whether or not an occurrence should be classified as a serious incident, and therefore reported under the provisions of EU 996/2010, the AAIB recommends that it is reported. Further information is available at: https://www.gov.uk/guidance/report-an-aircraft-accident-or-serious-incident.

Following this serious incident, the ANSP at Gatwick committed to raising awareness with their staff about their obligations to report serious incidents to the AAIB. The ANSP commented that these measures, along with the fact that the amended MATS Part 1 includes examples of serious incidents, would help ATCOs observing occurrences to assess whether they should be reported under the provisions of EU 996/2010.

Other information

The airport operator set up a working group to look at issues associated with Runway 26R after a number of incidents in 2017. The working group involves airlines, ATC as well as airside management from the airport. The remit covers lighting, markings, procedures and publications.

Following this serious incident, the airport operator and ANSP introduced further measures to reduce the likelihood that aircraft would begin their takeoff from the incorrect point on Runway 26R. These measures, which are described in detail later in the report, included a Safety Notice (Figure 7) and revised runway markings between the beginning of the TORA and the displaced threshold (Figure 8).

Footnote

[7] AAIB Special Bulletin S2/2017 C-FWGH.


YOUR LONDON AIRPORT Gatwick

AIR NAVIGATION SOLUTIONS

SAFETY NOTICE

Runway 26R Take Off Operations

26R Departures

Recent safety reports have highlighted that crews maybe misidentifying the correct location to commence take off roll at the start of 26R and have taxied forward to the landing threshold lighting before commencing take off roll. This is the 2nd safety notice that has been produced to increase crew awareness of where the beginning of the take-off distance available (TODA) commences for departing aircraft during 26R operations at London Gatwick Airport.

Figure 7

Safety Notice issued by Gatwick and the ANSP

At the end of July 2018, Gatwick Airport also published the Gatwick Operators Briefing Pack, designed to provide a briefing to operators on air traffic control operations at Gatwick. The pack includes information on operations on the secondary runway. It was distributed to operators at Gatwick and would be sent to any new operators at the airport.

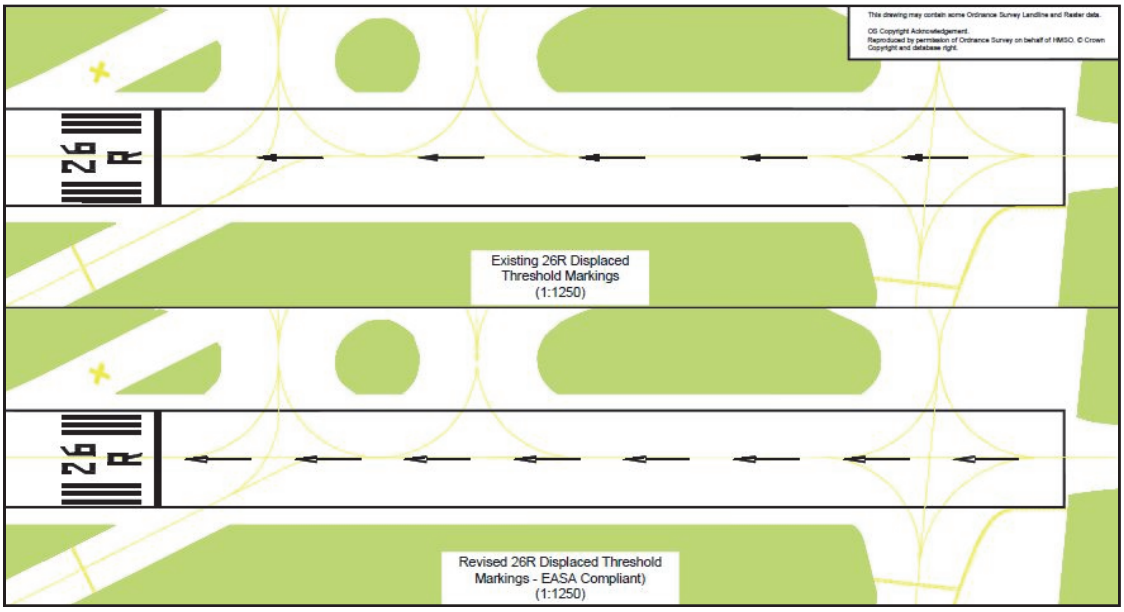


Figure 8

Revised markings Runway 26R

Analysis

The crew operating G-CKWC were familiar with Gatwick Airport but had operated from Runway 26R infrequently. They did not identify the beginning of the runway and taxied forward to the landing threshold before beginning their takeoff roll. This decreased the takeoff distance available and meant that the aircraft did not meet regulated takeoff performance requirements for its actual takeoff weight.

The distance available for the takeoff would have been insufficient (based on regulations) had an aircraft engine failed before V_1 and had the crew decided to stop. The actual accelerate stop distance required was 2,564 m, whereas the airfield boundary is approximately 2,250 m from the point at which G-CWKC began its takeoff roll. Runway overrun is a type of runway excursion, which is one of the CAA's 'Significant Seven' risks to commercial air transport.

The distance available for takeoff was also insufficient to meet regulatory requirements for obstacle clearance should the aircraft have continued the takeoff after an engine failure at V_1.

This was not the first time that an aircraft had begun its takeoff roll from the landing threshold. Gatwick reports indicated there had been at least four incidents, involving multiple operators, between September 2017 and this incident involving G-CKWC. Failure of crews to identify the start of Runway 26R, especially at night, presents Gatwick with a potentially significant hazard to operations. The airport, aware of the risk, put in place several actions to improve the awareness of crews about the location of the beginning of the runway. They also committed to repainting the markings before the landing threshold.

Conclusion

The aircraft began its takeoff roll from the displaced threshold of Runway 26R rather than the beginning of the runway. The crew did not identify the beginning of the runway and instead taxied the aircraft forward to the landing threshold. A combination of an unusual straight-line runway entry, a perceived lack of lighting in the pre-threshold area and the bright threshold lights ahead contributed to the crew not identifying the beginning of the runway.

From the point at which the aircraft began its takeoff roll, its performance did not meet regulatory requirements for both stopping and continuing should an engine have failed close to V_1. The risks in both cases were significant to the aircraft and its occupants.

Safety Action

Following this serious incident, the following safety action was taken by the airport operator and/or ANSP:

- An amendment was made to the NOTAM used to promulgate the closure of the main runway and the use of Runway 08L/26R. The amended NOTAM included wording describing the position from where the takeoff roll should commence.

- A Safety Notice was published on 13 April 2018 to provide further information for pilots on the location on Runway 26R from where they can commence their takeoff. This Safety Notice was subsequently amended and reissued to include a photograph with the airfield lighting illuminated. This amended notice is shown at Figure 7.

- A review was undertaken of the markings on the standby runway before the displaced landing threshold on both 08L and 26R which revealed that they were not EASA compliant. The airport planned remedial work for September 2018 which would increase the number of arrows painted on the centreline before the displaced threshold as shown at Figure 8.

- The airport operator agreed to investigate other paint schemes that may increase awareness of the location of the beginning of the runway. These might include an increase in the thickness of the white line which indicates the start of the runway so that it is easier to see at night, and some yellow taxiway edge markings to make the junction between AN and the start of the runway more obvious.

- The airport operator would investigate whether it would be possible to use an alternative holding point when Runway 26R is in use to allow for a more familiar 90° turn to line up onto the runway. This option would present significant challenges for the airport in terms of taxiway lighting and taxi routings which may need significant work in the longer term.

- The airport operator would review the wording of the AIP to see if more information could be included on the location of the beginning of the runway, how pilots might identify where they should begin their takeoff roll, and whether information from the Safety Notice could be included.

- The ANSP decided to raise awareness with staff about their obligation to report serious incidents to the AAIB.

ACCIDENT

Aircraft Type and Registration:	Boeing Stearman, N43YP
No & Type of Engines:	1 P&W R1340 series piston engine
Year of Manufacture:	1942 (Serial no: 75-6018)
Date & Time (UTC):	26 May 2018 at 1245 hrs
Location:	Turweston Aerodrome, Buckinghamshire
Type of Flight:	Private
Persons on Board:	Crew - 1 Passengers - None
Injuries:	Crew - None Passengers - N/A
Nature of Damage:	Extensive
Commander's Licence:	Private Pilot's Licence
Commander's Age:	65 years
Commander's Flying Experience:	1,255 hours (of which 143 were on type) Last 90 days - 8 hours Last 28 days - 8 hours
Information Source:	Aircraft Accident Report Form submitted by the pilot

Synopsis

The aircraft suffered a total loss of engine power during the initial climb. The aircraft was extensively damaged during the subsequent forced landing, but the pilot was uninjured.

History of the flight

The pilot reported that, prior to departure, he operated the engine at full throttle and achieved an engine speed of 1,900 rpm with almost imperceptible 'mag-drop'. On applying full carburettor heat there was a 50 rpm engine speed reduction.

Shortly after takeoff, at approximately 100 ft, there was a sudden and complete loss of power. The pilot briefly considered landing ahead in a crop field but judged that this would almost certainly cause the aircraft to overturn. The position of the fuel tank within the centre section of the upper wing influenced his thinking. He therefore attempted to turn back and land in the downwind direction, albeit with limited confidence in a successful outcome. The aircraft struck the ground in a left wing-low attitude with a significant sink rate and was substantially damaged.

During a subsequent visit to the site, the pilot examined the crop field beyond the airfield boundary. He noted that it contained a tall bean crop and he felt that this confirmed his decision that a forced landing ahead would have been more hazardous.

Aircraft examination

Although the aircraft was extensively damaged, a decision was made to repair it. The engine will be sent to an overhaul facility for strip examination, shock-load inspection and replacement of any damaged components. The fuel system will also be examined closely. This work was yet to be completed at the time of publication of this bulletin.

Survivability

The pilot, who was uninjured, was secured by a full harness and the aircraft remained upright through the impact sequence.

Meteorology

The reported conditions on the day included a temperature of 19°C and a dewpoint of 15°C.

Examination of various published charts of carburettor icing probability show that the combination of temperature and humidity reported in this accident is not in the region in which serious icing can be expected at cruise power. It is thus reasonable to conclude that icing at climb power is unlikely to have occurred.

Conclusion

No obvious cause for the power loss has been found thus far; however, the repair of the aircraft and engine may provide evidence to explain the event.

ACCIDENT

Aircraft Type and Registration:	Christen Eagle II, G-KLAW
No & Type of Engines:	1 Lycoming AEIO-360-A1D piston engine
Year of Manufacture:	2010 (Serial no: 003-1)
Date & Time (UTC):	21 November 2017 at 1100 hrs
Location:	RNAS Yeovilton
Type of Flight:	Private
Persons on Board:	Crew - 1 Passengers - 1
Injuries:	Crew - None Passengers - None
Nature of Damage:	Main landing gear, tail wheel and fabric on lower left wing damaged
Commander's Licence:	Airline Transport Pilot's Licence
Commander's Age:	56 years
Commander's Flying Experience:	21,000 hours (of which 150 were on type) Last 90 days - 50 hours Last 28 days - 25 hours
Information Source:	Aircraft Accident Report Form submitted by the pilot

On landing, the aircraft was initially controlled using the rudder but, as the aircraft decelerated through 40 kt, the pilot attempted to apply differential braking to keep the aircraft straight. It became apparent that the left brake pedal went straight to the floor with little or no braking available on that side. This, combined with a crosswind from the right, meant the pilot was unable to maintain runway heading and the aircraft rotated right through 200° before coming to a stop. The aircraft suffered very little damage, but the main landing gear and tailwheel were replaced as a precaution and some fabric repair was required for the lower left wing.

The brake was subject to a strip-down inspection following the incident. It was noticed that one of the brake callipers had been leaking for some time, which could have contributed to uneven braking forces on the main gear.

ACCIDENT

Aircraft Type and Registration:	DA 40 D Diamond Star, G-CCFS
No & Type of Engines:	1 Thielert TAE 125-02-114 piston engine
Year of Manufacture:	2003 (Serial no: D4.034)
Date & Time (UTC):	18 August 2018 at 1330 hrs
Location:	Full Sutton Airfield, Yorkshire
Type of Flight:	Training
Persons on Board:	Crew - 1 Passengers - None
Injuries:	Crew - None Passengers - N/A
Nature of Damage:	Pitot tube on left wing, propeller, tailskid, and nosewheel spat damaged
Commander's Licence:	Student pilot
Commander's Age:	49 years
Commander's Flying Experience:	37 hours (of which 37 were on type) Last 90 days - 34 hours Last 28 days - 16 hours
Information Source:	Aircraft Accident Report Form submitted by the pilot

The student pilot reported that during a circuit training detail the aircraft suffered a hard landing, causing it to veer to the left of the runway.

The instructor commented that the student flared too high and then allowed the aircraft to descend too rapidly, causing the hard landing. The student felt that the accident would have been avoided had he decided to abandon the landing and go around.

The instructor considered that the student, who had accrued 35 hours dual instruction, was competent to carry out solo circuits and landings. He had successfully completed five previous solo landings in between ongoing flying instruction sessions.

ACCIDENT

Aircraft Type and Registration:	Denney Kitfox MK4 (Modified), G-CJLM
No & Type of Engines:	1 Rotax 912UL piston engine
Year of Manufacture:	2017 (Serial no: PFA 172-12080)
Date & Time (UTC):	7 July 2018 at 1100 hrs
Location:	Stoke Golding Airfield, near Nuneaton, Warwickshire
Type of Flight:	Private
Persons on Board:	Crew - 1 Passengers - 1
Injuries:	Crew - None Passengers - None
Nature of Damage:	Damage to left landing gear, wing, propeller, engine cowls and exhaust
Commander's Licence:	Private Pilot's Licence
Commander's Age:	59 years
Commander's Flying Experience:	215 hours (of which 7 were on type) Last 90 days - 6 hours Last 28 days - 3 hours
Information Source:	Aircraft Accident Report Form submitted by the pilot

The pilot, who had 7 hours on type, was intending to conduct a single circuit of the airfield following takeoff from Runway 26. The wind was varying between 260° and 290° at less than 10 kt, based on the pilot's assessment of the windsock. The takeoff roll started normally and the aircraft's tail lifted off without issue. After travelling approximately 190 m, the pilot reported that the aircraft suddenly veered to the right, and he was unable to apply a correcting rudder input quickly enough to prevent the aircraft from leaving the runway. The left landing gear leg collapsed under the loads imparted by the turn and the resulting contact with the ground caused damage to the left wing, the propeller, the engine and its cowls.

ACCIDENT

Aircraft Type and Registration:	Just SuperSTOL, G-HONO
No & Type of Engines:	1 Rotax 912IS piston engine
Year of Manufacture:	2017 (Serial no: LAA 397-15378)
Date & Time (UTC):	14 July 2018 at 1903 hrs
Location:	Farmstrip near Market Drayton, Shropshire
Type of Flight:	Private
Persons on Board:	Crew - 1 Passengers - 1
Injuries:	Crew - None Passengers - N/A
Nature of Damage:	Left wing damaged
Commander's Licence:	Commercial Pilot's Licence
Commander's Age:	55 years
Commander's Flying Experience:	1,103 hours (of which 12 were on type) Last 90 days - 52 hours Last 28 days - 26 hours
Information Source:	Aircraft Accident Report Form submitted by the pilot

The pilot reported that he was returning to the farm strip, orientated north-west/south-east, after a local flight. The windsock indicated a wind from the west, predominantly across the strip, so he elected to land in a south-easterly direction providing a more open approach.

He planned to touchdown at a low point in the middle of the strip but landed before it on a slight downhill section. The aircraft then started to track left towards the edge of the strip, so he applied right rudder to correct this, initially with little effect. As the aircraft approached the end of the strip, while still travelling fast, he increased the rudder input. The aircraft then ground looped during which the right main gear lifted and the left wing contacted the ground.

The pilot believed he flew the approach faster than normal and the right brake was applied when the rudder was deflected. Also, having landed on the downhill section he considered he should have flown a go-around.

After downloading his GPS flight log, he discovered the aircraft had landed with a 5 kt tailwind. He added that had he monitored the wind on the GPS during the approach he may have noticed this. He also felt rushed before the flight.

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INCIDENT

Aircraft Type and Registration:	Piper PA-32R-301 Saratoga SP, G-ELLA
No & Type of Engines:	1 Lycoming IO-540-K1G5 piston engine
Year of Manufacture:	1996 (Serial no: 3246050)
Date & Time (UTC):	10 January 2018 at 1330 hrs
Location:	In flight, near the Compton VOR
Type of Flight:	Training
Persons on Board:	Crew - 2 Passengers - None
Injuries:	Crew - None Passengers - N/A
Nature of Damage:	Damage to the forward baggage bay door
Commander's Licence:	Private Pilot's Licence
Commander's Age:	68 years
Commander's Flying Experience:	11,600 hours (of which over 200 were on type) Last 90 days - 80 hours Last 28 days - 17 hours
Information Source:	Aircraft Accident Report Form submitted by the pilot and additional enquiries made by the AAIB

Prior to undertaking a training flight with an instructor, the owner completed a pre-flight inspection. As part of this, he took off the aircraft's cover and stored it in the forward baggage bay but, during the flight after practising a stall, the baggage bay door opened unexpectedly. The cover was sucked out of the baggage bay and struck the wing before detaching from the airframe. The baggage bay door remained open in the slipstream, with no control difficulties experienced by the crew, as they returned to White Waltham airfield where the aircraft landed safely.

The instructor believes that the baggage bay door was not properly secured during the pre-flight inspection. Other than to the baggage bay door, no other damage was noted, and the aircraft was returned to service once it had been repaired.

ACCIDENT

Aircraft Type and Registration:	Piper PA-38-112 Tomahawk, G-OEDB	
No & Type of Engines:	1 Lycoming O-235-L2C piston engine	
Year of Manufacture:	1978 (Serial no: 38-79A0167)	
Date & Time (UTC):	28 June 2018 at 0950 hrs	
Location:	On approach to Tatenhill Airfield, Staffordshire	
Type of Flight:	Training	
Persons on Board:	Crew - 1	Passengers - None
Injuries:	Crew - None	Passengers - N/A
Nature of Damage:	Propeller, engine and nose landing gear damaged	
Commander's Licence:	Student pilot	
Commander's Age:	56 years	
Commander's Flying Experience:	90 hours (of which 90 were on type) Last 90 days - 4 hours Last 28 days - 1 hour	
Information Source:	Aircraft Accident Report Form submitted by the pilot	

The student pilot was briefed by an instructor to carry out a cross-country flight from Hawarden Airport to Tatenhill and then Shobdon Aerodromes before returning to Hawarden. The flight to Tatenhill was uneventful and the aircraft was positioned for Runway 08. The weather was good with no wind and an OAT of 32ºC. On the final approach, the aircraft was at 70 KIAS, with a steady rate of descent and configured with two stages of flap. At about 50 ft agl, power was reduced to idle and the flare commenced but the aircraft sank and bounced off the runway, ballooned and bounced a second time. The pilot increased power to go around but the aircraft seemed unresponsive, so power was cut again. The pilot attempted to keep the aircraft straight whilst reducing speed, but it veered to the left and departed the runway onto the grass.

The pilot switched off the fuel and electrics and exited the aircraft unassisted, although the airfield RFFS had attended. The pilot considered that the lack of wind, high OAT and weight of the aircraft contributed to the incident, and the aircraft was unresponsive and without enough power to go around.

ACCIDENT

Aircraft Type and Registration:	Steen Skybolt, G-SKIE	
No & Type of Engines:	1 Lycoming IO-360-A1A piston engine	
Year of Manufacture:	1989 (Serial no: AACA/357)	
Date & Time (UTC):	24 June 2018 at 1745 hrs	
Location:	Kenyon Hall Farm strip, Croft, near Warrington, Cheshire	
Type of Flight:	Private	
Persons on Board:	Crew - 1	Passengers - None
Injuries:	Crew - None	Passengers - None
Nature of Damage:	Damaged beyond economical repair	
Commander's Licence:	National Private Pilot's Licence	
Commander's Age:	73 years	
Commander's Flying Experience:	550 hours (of which 19 were on type) Last 90 days - 5 hours Last 28 days - 3 hours	
Information Source:	Aircraft Accident Report Form submitted by the pilot	

The pilot stated that he was taking off from Kenyon Hall Farm strip which is orientated north-east/south-west. The wind was from 340° at 2 kt, so he chose to take off in a north-easterly direction, which has some trees down its left edge.

He took off from a three-point attitude, which he considered normal for this aircraft, and soon after becoming airborne he saw the top of a tree ahead. Being too late to avoid it, the aircraft "sliced the top of the tree off and crashed into another tree", before coming to rest on its left side in some lower branches. The pilot was uninjured but was trapped inside as he was unable to open the canopy. The local RFFS arrived about 50 mins later and released the pilot.

The pilot commented that he had commenced the takeoff roll about 15° left of the strip's track and flown towards the first tree. He believes this was caused by a failure to apply sufficient right rudder to counter the engine torque and not maintaining sight of the right edge of the runway, which borders a field of crops, in his peripheral vision.

Figure 1
G-SKIE after the accident

ACCIDENT

Aircraft Type and Registration:	Ikarus C42 FB80 Ikarus, G-ULSY	
No & Type of Engines:	1 Rotax 912-UL piston engine	
Year of Manufacture:	2004 (Serial no: 0405-6603)	
Date & Time (UTC):	13 July 2018 at 1230 hrs	
Location:	Sandown Airfield, Isle of Wight	
Type of Flight:	Private	
Persons on Board:	Crew - 1	Passengers - 1
Injuries:	Crew - None	Passengers - None
Nature of Damage:	Left landing gear collapsed	
Commander's Licence:	National Private Pilot's Licence	
Commander's Age:	51 years	
Commander's Flying Experience:	183 hours (of which 101 were on type) Last 90 days - 50 hours Last 28 days - 24 hours	
Information Source:	Aircraft Accident Report Form submitted by the pilot and further enquiries by the AAIB	

Shortly after touchdown, G-ULSY's left landing gear assembly failed, allowing the mainwheel to pivot rearwards and inwards towards the fuselage. The aircraft veered left uncontrollably, departed the prepared surface and came to rest in long grass adjacent to the runway (Figure 1). Neither occupant was injured and they vacated the aircraft unaided.

Figure 1

G-ULSY's left landing gear assembly after the accident

Investigation revealed that the rod end bolt connecting the drag link to the undercarriage assembly had sheared forward of the rose joint lock nut (Figures 2 and 3).

Figure 2

Diagram showing drag link and rose joint locations

Figure 3

Rose joint/rod end bolt fracture face

The pilot reported that the touchdown was not unduly heavy and that he had not started braking at the time of failure. It was not possible to determine what caused the bolt to shear.

While other aircraft types, such as the Pietenpol Air Camper, have experienced issues with undercarriage rod end bearing failures, this was the first such Ikarus C42 incident notified to the aircraft type's CAMO[1]. The CAMO would continue to monitor component failure trends and would take action should rod end reliability become a cause for concern.

Footnote

1 Continued Airworthiness Management Organisation.

ACCIDENT

Aircraft Type and Registration:	Jabiru UL-450, G-CEOM
No & Type of Engines:	1 Jabiru 2200A piston engine
Year of Manufacture:	2007 (Serial no: PFA 274A-14455)
Date & Time (UTC):	29 September 2018 at 1200 hrs
Location:	Cromer Airfield, Norfolk
Type of Flight:	Private
Persons on Board:	Crew - 1 Passengers - 1
Injuries:	Crew - None Passengers - None
Nature of Damage:	Damage to nose and right landing gear, wing and propeller
Commander's Licence:	Private Pilot's Licence
Commander's Age:	69 years
Commander's Flying Experience:	1,114 hours (of which 354 were on type) Last 90 days - 4 hours Last 28 days - 1 hour
Information Source:	Aircraft Accident Report Form submitted by the pilot

Synopsis

The aircraft veered to the left immediately after landing at Cromer Airfield, Norfolk. The main wheel tyre pressures had been checked prior to the flight but, following the accident, the left tyre was found to have deflated. The pilot considered that its valve had not fully sealed and the air had leaked out during the flight.

History of the flight

The pilot and a passenger were flying from Darley Moor Airfield to Cromer Airfield. During the pre-flight inspection the pilot noticed that both main tyres appeared slightly underinflated and having checked their pressures, which were 20 psi, increased them to 25 psi. The takeoff and flight to Cromer, located 111 nm east of Darley, were uneventful. The aircraft was established on the approach to grass Runway 22 at 55 kt with full flap. The wind was from 245° at 5 kt. As the aircraft touched down, the aircraft immediately turned to the left and started to skid sideways, which subsequently caused the nose and right landing gear legs to collapse. The aircraft came to a stop at the side of the runway (Figure 1). The pilot and passenger were not injured.

The pilot reported that the left tyre was found to be deflated and there were grooves in the runway caused by the left wheel and brake assembly. He considered that, following inflation of the tyres at Darley Moor, the left wheel tyre valve had not fully sealed, allowing air to slowly leak from the tyre.

Figure 1
G-CEOM gear collapse

ACCIDENT

Aircraft Type and Registration:	Pegasus Quantum 15-912, G-KAZI
No & Type of Engines:	1 Rotax 912-UL piston engine
Year of Manufacture:	2005 (Serial no: 8120)
Date & Time (UTC):	12 July 2018 at 1910 hrs
Location:	Headon Airfield, Nottinghamshire
Type of Flight:	Training
Persons on Board:	Crew - 1 Passengers - 1
Injuries:	Crew - 1 (Minor) Passengers - 1 (Minor)
Nature of Damage:	Damaged beyond economical repair
Commander's Licence:	Private Pilot's Licence
Commander's Age:	66 years
Commander's Flying Experience:	3,897 hours (of which 3,122 were on type) Last 90 days - 77 hours Last 28 days - 21 hours
Information Source:	Aircraft Accident Report Form submitted by the pilot

The student had already completed two landings on Runway 05 with the instructor following through on the control bar. For the third landing, to show the student that he had full control, the instructor removed his hands from the control bar. An idle approach was flown, with the student increasing power during short final to maintain the approach speed and angle. He began to round out on crossing the threshold. Shortly thereafter, the aircraft touched down heavily, bounced and veered off the centreline. The instructor took control and advanced the hand throttle but was unable to regain full control before the aircraft struck a hedge parallel to and right of the runway. It span horizontally through 180° before coming to rest in the hedge (Figure 1).

The instructor reported that he had instructed the student to round out more, but he believed that the student had made an opposite control input, steepening the approach. The student did not recall this.

The instructor commented that he should not have too much confidence in a student's ability until they have more experience, and he should maintain vigilance during critical stages of training flights and be ready to take immediate control, if required.

Figure 1
G-KAZI in situ after accident

ACCIDENT

Aircraft Type and Registration:	Pegasus Quantum 15 (Modified), G-BZBR
No & Type of Engines:	1 Rotax 503-2V piston engine
Year of Manufacture:	2000 (Serial no: 7631)
Date & Time (UTC):	7 August 2018 at 1736 hrs
Location:	Charity Farm, Warwickshire
Type of Flight:	Private
Persons on Board:	Crew - 1 Passengers - None
Injuries:	Crew - 1 (Serious) Passengers - N/A
Nature of Damage:	Extensive damage to trike and wing
Commander's Licence:	National Private Pilot's Licence
Commander's Age:	69 years
Commander's Flying Experience:	32 hours (of which 32 were on type) Last 90 days - 0 hours Last 28 days - 0 hours
Information Source:	Aircraft Accident Report Form submitted by the pilot

After taking off from the unlicensed airstrip, the pilot encountered turbulence, so he decided to complete a circuit and land, rather than continue with the flight. He flew a long and low approach and collided with a wire mesh fence at the landing strip boundary. The pilot suffered serious injuries and the aircraft was extensively damaged.

The pilot considered that his approach may have been affected by the adverse wind conditions.

ACCIDENT

Aircraft Type and Registration:	Spacek SD-1 Minisport, G-MZSP
No & Type of Engines:	1 piston engine
Year of Manufacture:	2014 (Serial no: 111)
Date & Time (UTC):	9 July 2018 at 1005 hrs
Location:	Popham Airfield, Hampshire
Type of Flight:	Private
Persons on Board:	Crew - 1 Passengers - None
Injuries:	Crew - None Passengers - N/A
Nature of Damage:	Nose gear and one propeller blade damaged
Commander's Licence:	National Private Pilot's Licence
Commander's Age:	75 years
Commander's Flying Experience:	750 hours (of which 3 were on type) Last 90 days - 10 hours Last 28 days - 3 hours
Information Source:	Aircraft Accident Report Form submitted by the pilot

The pilot stated that he was taking off from Runway 26, a grass runway, at Popham Airfield, for a local flight. About 50 m into the ground roll the nosewheel lifted before the rotation speed of 45 kt had been achieved. The pilot eased the stick forward to lower the nose and the nose gear touched down firmly. It subsequently collapsed resulting in the propeller striking the ground and the engine stopping with the aircraft coming to a stop on the runway. The pilot was uninjured and removed the aircraft from the runway with assistance.

The pilot believed that due to his lack of experience on type he may have pushed the control column forward too much and too quickly. He also believed that an uneven part of the grass runway may have contributed to the nose gear failure.

ACCIDENT

Aircraft Type and Registration:	Team Minimax 91, G-MYBM
No & Type of Engines:	1 Hummel 1/2 VW 45 HP piston engine
Year of Manufacture:	1992 (Serial no: PFA 186-12212)
Date & Time (UTC):	3 August 2018 at 1433 hrs
Location:	Manchester Barton Airport
Type of Flight:	Private
Persons on Board:	Crew - 1 Passengers - None
Injuries:	Crew - None Passengers - N/A
Nature of Damage:	Top longerons cracked
Commander's Licence:	Private Pilot's Licence
Commander's Age:	71 years
Commander's Flying Experience:	430 hours (of which 0 were on type) Last 90 days - 0 hours Last 28 days - 0 hours
Information Source:	Aircraft Accident Report Form submitted by the pilot

Synopsis

When the pilot set idle power during the flare, the aircraft descended more quickly than he expected and landed heavily, damaging the top longerons. This was the pilot's first flight in this aircraft.

History of the flight

Whilst landing on Runway 26L, the pilot selected idle power during the flare and the aircraft landed heavily. Subsequent inspection revealed the top longerons were cracked. The pilot commented that he was surprised at how quickly the aircraft descended when the power was removed. Before the flight, the pilot had studied the pilots' notes for the aircraft but did not recall this characteristic being mentioned.

Pilot's recent experience

The was the pilot's first flight since completing tailwheel aircraft differences training in April 2018. It was also his first flight in this type of aircraft. His previous flying experience had been in mainly in Slingsby T67 and Piper PA-28 aircraft.

AAIB comment

Small, light aircraft can have different handling characteristics to traditional and generally larger, factory-built general aviation aircraft. Particularly relevant in this case are the higher drag and lower inertia, which led to the high descent rate when the power was removed.

The LAA has identified that the transition on to a new type carries a higher risk of an accident than initial test flying. To help mitigate this risk it has published useful information in two articles in its monthly members magazine '*Light Aviation*'. The first article appeared in the September 2018 issue. In addition to offering advice and guidance on the topic in these articles, it recommends the LAA Pilot Coaching Scheme which can assist members converting to a new type. Details of the scheme can be found on the LAA website[1].

Footnote

1 http://www.lightaircraftassociation.co.uk/PCS/pcs.html [accessed October 2018].

Miscellaneous

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

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

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

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

Published February 2014.

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

Published June 2014.

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

Published September 2014.

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

Published July 2015.

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

Published August 2015.

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

Published October 2015.

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.

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

http://www.aaib.gov.uk

GLOSSARY OF ABBREVIATIONS

aal	above airfield level
ACAS	Airborne Collision Avoidance System
ACARS	Automatic Communications And Reporting System
ADF	Automatic Direction Finding equipment
AFIS(O)	Aerodrome Flight Information Service (Officer)
agl	above ground level
AIC	Aeronautical Information Circular
amsl	above mean sea level
AOM	Aerodrome Operating Minima
APU	Auxiliary Power Unit
ASI	airspeed indicator
ATC(C)(O)	Air Traffic Control (Centre)(Officer)
ATIS	Automatic Terminal Information Service
ATPL	Airline Transport Pilot's Licence
BMAA	British Microlight Aircraft Association
BGA	British Gliding Association
BBAC	British Balloon and Airship Club
BHPA	British Hang Gliding & Paragliding Association
CAA	Civil Aviation Authority
CAVOK	Ceiling And Visibility OK (for VFR flight)
CAS	calibrated airspeed
cc	cubic centimetres
CG	Centre of Gravity
cm	centimetre(s)
CPL	Commercial Pilot's Licence
°C,F,M,T	Celsius, Fahrenheit, magnetic, true
CVR	Cockpit Voice Recorder
DME	Distance Measuring Equipment
EAS	equivalent airspeed
EASA	European Aviation Safety Agency
ECAM	Electronic Centralised Aircraft Monitoring
EGPWS	Enhanced GPWS
EGT	Exhaust Gas Temperature
EICAS	Engine Indication and Crew Alerting System
EPR	Engine Pressure Ratio
ETA	Estimated Time of Arrival
ETD	Estimated Time of Departure
FAA	Federal Aviation Administration (USA)
FDR	Flight Data Recorder
FIR	Flight Information Region
FL	Flight Level
ft	feet
ft/min	feet per minute
g	acceleration due to Earth's gravity
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)
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
TGT	Turbine Gas Temperature
TODA	Takeoff Distance Available
UAS	Unmanned Aircraft System
UHF	Ultra High Frequency
USG	US gallons
UTC	Co-ordinated Universal Time (GMT)
V	Volt(s)
V_1	Takeoff decision speed
V_2	Takeoff safety speed
V_R	Rotation speed
V_{REF}	Reference airspeed (approach)
V_{NE}	Never Exceed airspeed
VASI	Visual Approach Slope Indicator
VFR	Visual Flight Rules
VHF	Very High Frequency
VMC	Visual Meteorological Conditions
VOR	VHF Omnidirectional radio Range

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