ACCIDENT

Aircraft Type and Registration:	Airbus Helicopters AS355F1 Ecureuil II, G-OHCP
No & Type of Engines:	2 Allison 250-C20F turboshaft engines
Year of Manufacture:	1982 (Serial no: 5249)
Date & Time (UTC):	29 March 2017 at 1155 hrs
Location:	Summit of Rhinog Fawr, Snowdonia
Type of Flight:	Private
Persons on Board:	Crew - 1 Passengers - 4
Injuries:	Crew - 1 (Fatal) Passengers - 4 (Fatal)
Nature of Damage:	Aircraft destroyed
Commander's Licence:	Private Pilot's Licence
Commander's Age:	56 years
Commander's Flying Experience:	3,650[1] hours (of which 102 were on type) Last 90 days - 9.0 hours Last 28 days - 1.5 hours
Information Source:	AAIB Field Investigation

Synopsis

The helicopter was flying on a Visual Flight Rules (VFR) flight plan from its operating base near Cranfield Airport on a direct track to a private site near Dublin. The weather on departure was suitable for VFR flight but, as forecast, deteriorated markedly in the area of Snowdonia with low cloud and rain. The helicopter flew over a witness 4.3 nm southeast of the accident site before disappearing into the cloud. Shortly afterwards it struck the east side of Rhinog Fawr Mountain, fatally injuring the five occupants.

History of the flight

The pilot and four family members had planned to fly from the helicopter's operating base adjacent to Junction 13 of the M1 motorway, to a private site close to Dublin Airport before returning later that evening. The pilot had used two commercially available flight planning applications on his iPad, both for flight planning and during parts of the flight but it is not known what information he used.

The maintenance organisation was contacted by the pilot on the evening before the flight and requested that the helicopter be ready for departure at 1000 hrs with full fuel. The

Footnote

[1] The pilot's log book available to the investigation covered only the early part of his flying career and was incomplete. The total hours were identified from his aircrew medical renewal form and the total on type and last 90/28 days from the available technical log sheets.

next morning, the engineer moved the helicopter from the hangar to a parking spot and then refuelled the helicopter to tanks full. One family member arrived shortly afterwards, followed by two other passengers, and all three occupied the rear seats. The engineer had moved off to refuel another helicopter and did not see which seat each passenger occupied. Another passenger arrived and sat in the front left seat and the pilot occupied the front right seat. The engineer did not see the pilot arrive but noticed that the passengers had no luggage other than carrier bags. The helicopter was heard to start up and departed at about 1045 hrs.

The GPS derived ground track and vertical profile of the flight are shown in Figure 1 and Figure 2.

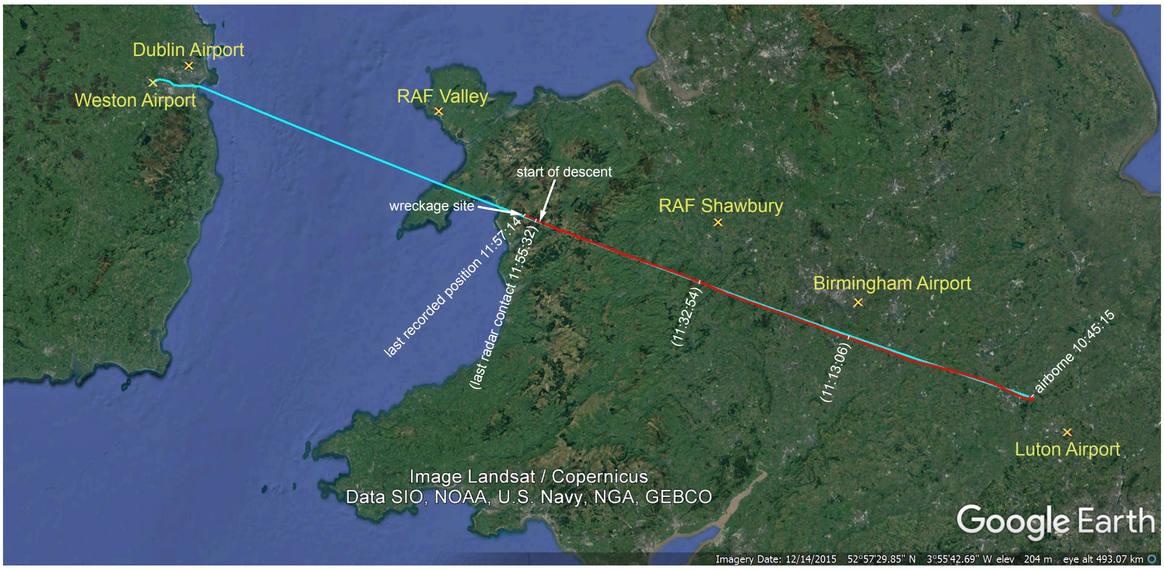


Figure 1

Planned route (blue) and actual track (red)

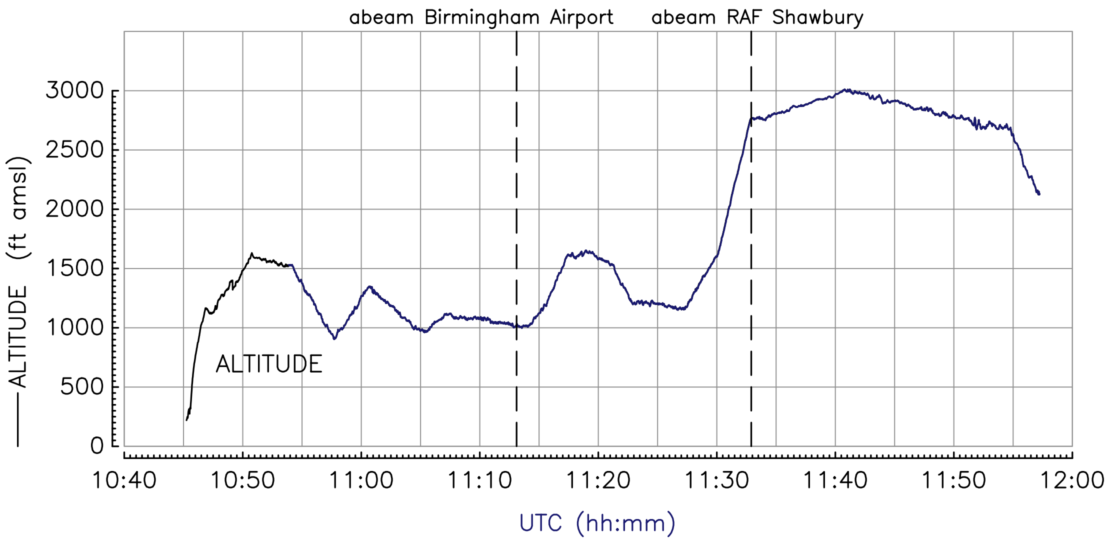


Figure 2

GPS derived vertical profile of the accident flight

The helicopter was flown along the direct track from the departure point towards the destination achieving a maximum altitude of 3,000 ft at about 1142 hrs. The heights flown appeared to approximate to remaining below the main cloud base in order to maintain Visual Meteorological Conditions (VMC).

A full description of the weather is included in the Meteorology section of the report, but in order to consider the weather encountered during the transit, the METAR cloud base for the airfields shown at the nearest time were:

- Luton Airport at 1050 hrs, cloud overcast at 1,200 ft,
- Birmingham Airport at 1120 hrs, cloud broken at 1,500 ft,
- Shawbury at 1120 hrs, cloud scattered at 1,400, broken at 3,000 ft,
- Valley at 1150 hrs, cloud broken at 600 ft.

At what he estimated was between 1130 and 1150 hrs, a witness was located in Coed Brenin Forest, 4.3 nm southeast of the accident site. He saw a helicopter pass overhead and watched it for some 5 - 10 seconds before it went into the cloud cover. He reported the elevation of his position as 120 m (400 ft) at which time the helicopter was at 2,500 ft. A replay of the NATS radar tape for the appropriate time, showed only G-OHCP in the area and flying on its track with no other aircraft in the vicinity.

The helicopter had been in a gentle descent from its maximum height to 2,500 ft before descending to 2,060 ft when it struck the east side of Rhinog Fawr Mountain, at about 1157 hrs. At the moment of impact, the auto pilot was engaged with the heading (HDG), turn coordinator (T/C) and vertical speed (V/S) modes active. This was consistent with a pilot-managed, autopilot-flown descent.

Accident site

The accident site was located on the south-east face of Rhinog Fawr in southern Snowdonia, at an elevation of 2,060 ft amsl, approximately 300 ft below the summit shown in Figure 3. The helicopter had struck a rock outcrop (Figure 4), completely destroying the cabin section and depositing wreckage along a trail 150 m in length, oriented on a heading of 280°M. The helicopter's main rotor, gearbox and engines had separated from the fuselage and continued over the rock outcrop, coming to rest 140 m from the initial impact. The degree of disintegration of the cabin indicated that the helicopter had been flying at cruising speed immediately prior to impact. Witness marks made by the cabin, right skid and right horizontal stabiliser on the rock outcrop showed that the helicopter was in an approximately level pitch and roll attitude at impact.

All major parts of the helicopter were identified at the accident site. A number of wreckage parts were burned and a small part of the impact area also exhibited evidence of burning, indicating that an intense, short-duration fuel fire had occurred after impact. There was a strong smell of unburned aviation fuel at the base of the rock outcrop, immediately below the impact area.

One of the main rotor blades was heavily impact-damaged, indicating that the main rotor had been rotating at impact. Both tail rotor blades were damaged, consistent with rotation under power at impact and rotational scoring marks on the tail rotor drive shaft were further evidence of tail rotor rotation at impact.

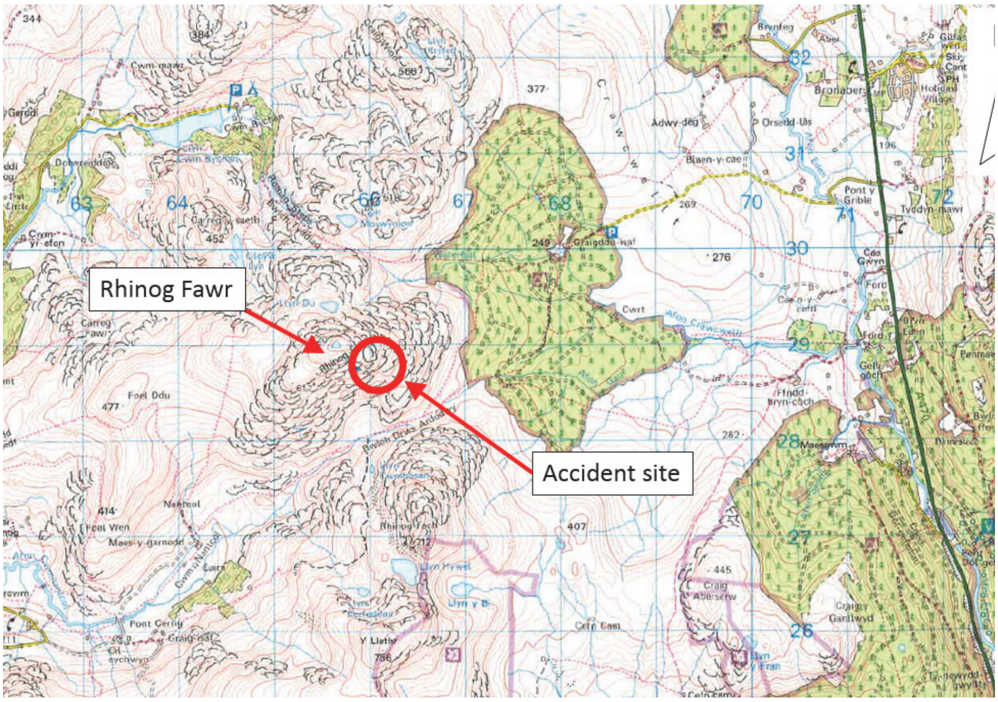


Figure 3
Location of the accident site

Figure 4
Section of the accident site wreckage trial

Aircraft description

G-OHCP was an AS355F1, a twin-engine light helicopter configured to carry a pilot and five passengers. The AS355F1 is powered by two Rolls-Royce (Allison) model 250-C20F gas turbine engines which drive a three-bladed main rotor system through the main gearbox (MGB). Each engine drive input in the MGB is fitted with a freewheel unit that is designed to allow normal operation in the event of an engine failure.

The AS355F1 is equipped with two independent hydraulic systems and is controlled by hydraulically-assisted flying controls. The pilot's control inputs are transmitted through a series of control rods, bell cranks and mixing units to three hydraulic actuators attached to the MGB and a single tail rotor actuator which change the pitch of the main and tail rotor blades respectively. The hydraulic system is powered by two pumps mounted on the MGB. In the event of a hydraulic system failure, the helicopter can continue to fly in response to the pilot's control inputs.

G-OHCP was fitted with analogue flight instruments and a panel-mounted Garmin GNS430 GPS display unit. In addition, the helicopter was fitted with an SFIM 85T31 three axis autopilot, capable of controlling the helicopter's desired flight path by inputs from electro-mechanical actuators mounted in series to each of the pitch, roll and yaw flight control linkages. The autopilot was controlled by an autopilot mode control panel, mounted on the centre instrument console.

Detailed examination

Flight instrumentation

All the helicopter's flight instruments had been severely damaged during the impact sequence. The pilot's artificial horizon and the standby artificial horizon were disassembled and examined in detail. Both units had suffered from significant internal damage. Circumferential scoring was identified on the gyroscope of the pilot's artificial horizon and rotational damage was observed on the cooling fins of the standby artificial horizon gyroscope wheel (Figure 5), indicating they were both operational at the time of impact.

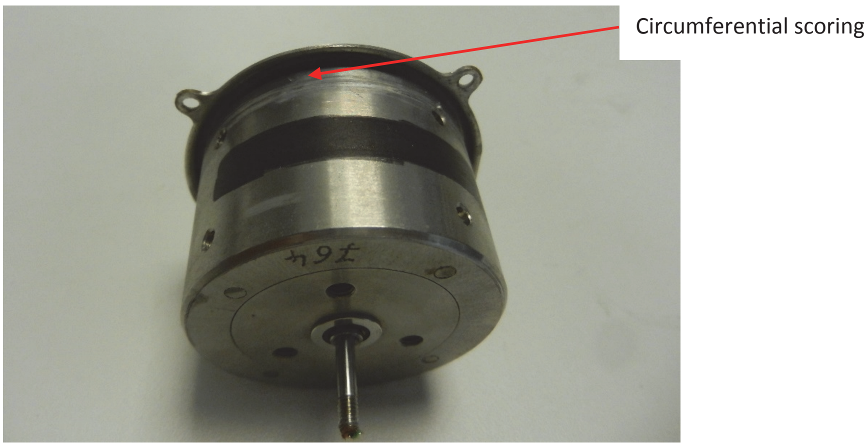


Figure 5

Pilot's artificial horizon gyroscope exhibiting circumferential scoring

GPS system

The Garmin GNS430 fitted to the helicopter was recovered and examined in detail. No information about the accident flight or any preceding flights were recovered from the unit. A modification is available for the GNS430 that introduces a terrain warning function. Examination of the internal components of the unit indicated that this modification had not been embodied and therefore, the unit would not have provided the pilot with any warning of the approaching high terrain.

Autopilot system

The autopilot mode control panel of the type fitted to G-OHCP features 16 push-button latching switches that illuminate when pressed; each button is illuminated by two incandescent filament light bulbs.

An additional autopilot monitoring panel is mounted centrally on the upper section of the pilot's instrument panel, with coloured captions further indicating whether the autopilot is engaged and which modes are selected. Each caption is illuminated by a single incandescent filament light bulb.

The autopilot mode control panel (Figure 6) was recovered from the wreckage trail. The control panel was substantially intact apart from the *'VOR', 'G/S', 'CPL'* and *'F/D'* buttons, which had separated during the accident and were not located.

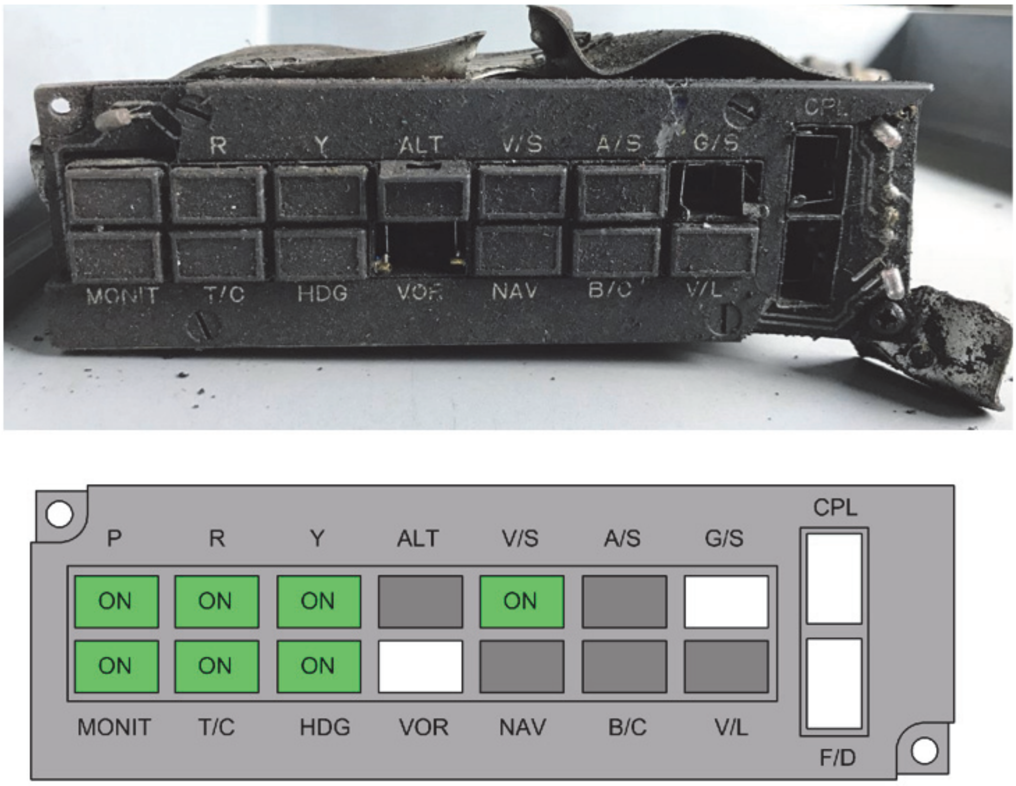
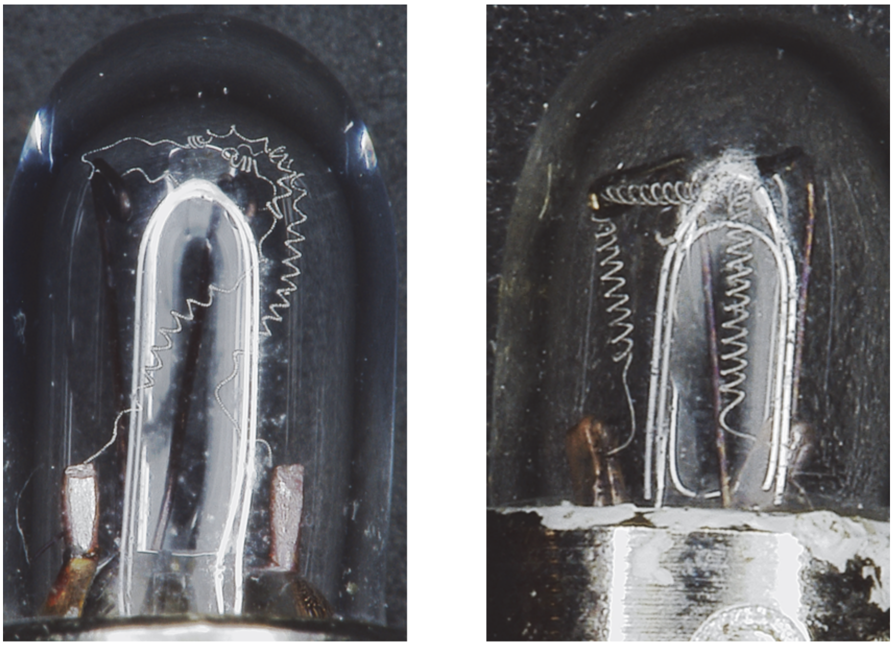


Figure 6

Autopilot mode control panel recovered from the accident site (top), and assessment of the control panel buttons illuminated at impact by light bulb filament analysis (bottom)

The push-button switches were disassembled and their lightbulbs removed for visual examination by microscope. This examination showed that a number of bulbs' filaments were stretched, with the double-helix coils elongated, consistent with bulb illumination at impact. By contrast, the remaining bulbs examined did not exhibit any evidence of filament hot-stretching, indicating that those bulbs were unlit at impact (Figure 7).



V/S button (right bulb), lit at impact

ALT button (right bulb), unlit at impact

Figure 7

Example of *filament hot-stretching, left* and an unlit bulb, right, from the autopilot mode control panel buttons

The lightbulb filament analysis indicated that the autopilot was switched ON, and was engaged at impact. The pitch (*'P'* button), roll (*'R'*) and yaw (*'Y'*) channels were available and engaged, the pitch and roll monitor[2] (*'MONIT'*) was engaged and the turn coordination mode[3] (*'T/C'*) was ON. The analysis also showed that the heading hold (*'HDG'*) and vertical speed (*'V/S'*) modes were also engaged.

The autopilot logic dictates that for any vertical or lateral mode to be available, the coupler (*'CPL'*) button and/or the flight director[4] (*'F/D'*) push-button must be pressed. Due to

Footnote

2 The pitch and roll monitor is automatically engaged as soon as one (or both) of the pitch or roll channels is engaged. The MONIT push-button is therefore used to switch off the pitch and roll monitor, if the need arises. The monitor disengages automatically, and the button is then unlit, in case of the loss of a valid signal from the pilot's attitude directional indicator (ADI), such as would be caused by a failure of the ADI.

3 The turn coordination mode uses the yaw control actuator to minimise side-slipping during turning manoeuvres at airspeeds greater than 50 kt.

4 The flight director consists of pitch and roll command bars that are displayed on the pilot's ADI display, showing the pilot the attitude required to follow a certain flight trajectory.

the absence of both buttons it was not possible to determine which button, if either, was illuminated. However since the vertical speed and heading hold modes were engaged, one or both of these buttons were most probably lit at impact.

The pilot can select a target vertical speed using a bug on the vertical speed indicator (VSI), mounted in the instrument panel. Similarly the pilot can select the desired heading using a heading bug on the horizontal situation indicator (HSI). It was not possible to reliably determine the pre-impact positions of the vertical speed or heading bugs due to accident damage to the VSI and HSI.

The autopilot monitoring panel was recovered from the wreckage but its condition prevented a comprehensive examination. All light bulbs on the panel, apart from one, were broken and the filaments dispersed. The single intact light bulb was from the vertical speed (*'VS'*) caption; examination of this bulb filament by microscope showed that it had been illuminated at impact, confirming the analysis of the autopilot mode control panel.

Flying controls

All the damage observed in the mechanical elements of the flying controls was consistent with accident forces.

The main rotor and tail rotor hydraulic actuators were functionally tested with the assistance of their respective manufacturers. All four actuators functioned as expected in response to control inputs, and no significant anomalies were noted in their performance.

Main rotor gearbox and transmission

There was no evidence of a failure within the main gearbox. Both the left and right engine freewheel units operated correctly and the main rotor head turned when drive was applied to either of the engine input shafts.

Engines

Examination of the right engine confirmed that it had been subject to significant force during the impact sequence. The compressor and turbine sections of the engine had partially separated from the gearbox. The left engine, although damaged, had remained intact. Both engines were disassembled at an approved overhaul facility in the presence of the AAIB and representatives from the engine manufacturer.

Left engine

Tests of the Fuel Flow Governor (FFG) and the Fuel Control Unit (FCU) identified several minor defects; these would not have prevented the engine from operating normally.

The turbine casing had been distorted during the impact sequence, which prevented the power turbine from rotating freely. All the blades and nozzle guide vanes were present with no evidence of impact damage. The combustion chamber showed no evidence of abnormal operation and when tested, the fuel spray nozzle operated normally.

During the removal of the compressor from the gearbox, it was found that the retaining feature of the impeller drive coupling shaft had failed, allowing the shaft to be released. Examination of the remains of the shaft showed evidence of bearing impact marks on the shaft consistent with forces experienced during the impact sequence. Disassembly of the compressor and impeller module revealed that all the compressor vanes and stators were present. However there was clear evidence of rotational damage to the forward stages of the axial compressor (Figure 8), with associated loss of the compressor abraidable liner. There was also evidence of rotational contact between the impeller and the impeller shroud.

Figure 8
Left engine axial compressor and impeller assembly

Right engine

The right engine was severely damaged during the impact sequence. There was evidence that it hit the ground several times before coming to rest. Both the compressor and turbine modules had separated partially from the gearbox module. Impact damage prevented testing of the engine’s FFG and FCU.

The compressor case exhibited multiple penetrations (Figure 9) typical of significant axial compressor blade release.

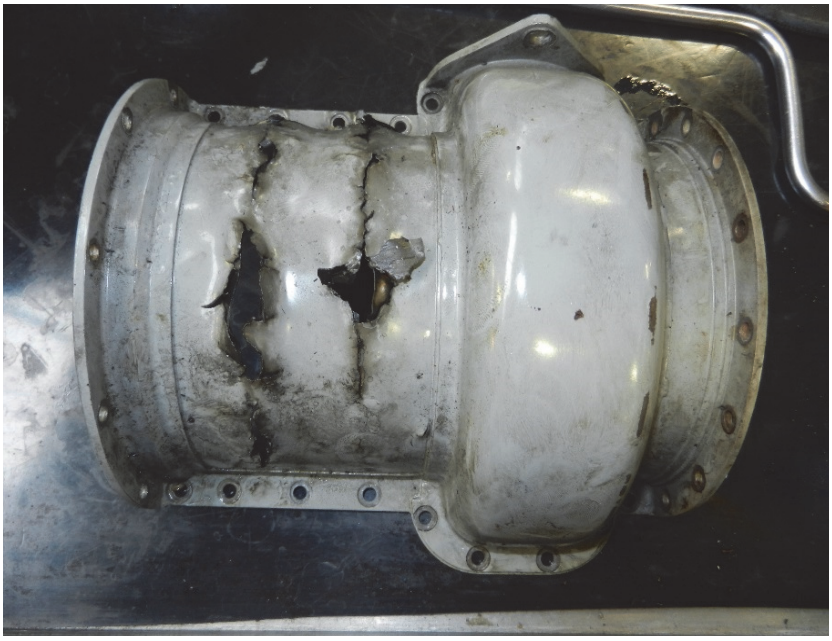


Figure 9

Right engine compressor case showing case penetration

Disassembly of the compressor assembly revealed significant damage to all the stator vanes in the first three stages of the axial compressor, and the remains of vegetation was observed on the fourth stage stator vanes (Figure 10).

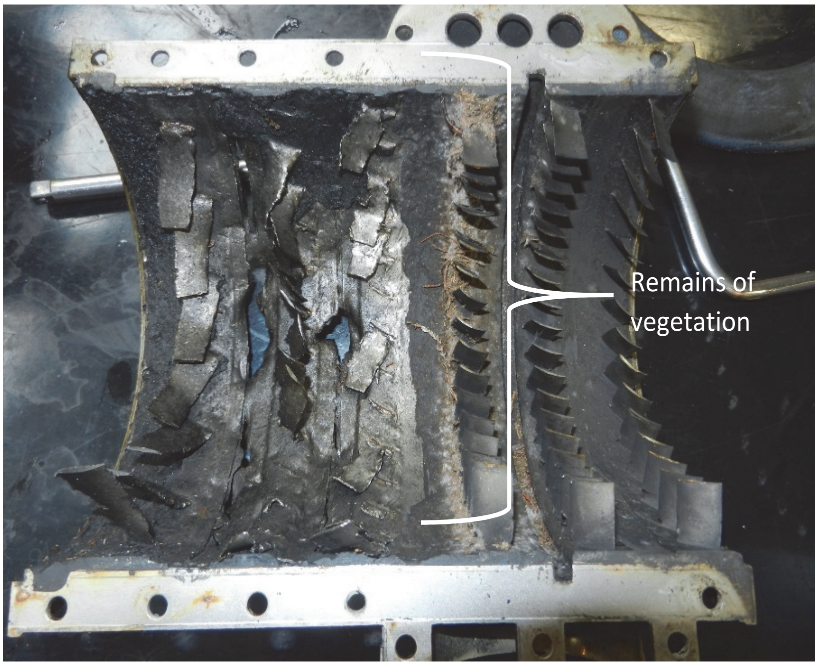


Figure 10

Damage to the right engine axial compressor stator vanes

The compressor spool was heavily damaged, all the first three stages of compressor blades had been released, and the blades on the fourth stage exhibited significant impact damage (Figure 11). The impeller and impeller shroud also showed signs of rubbing. Small particles of vegetation were also found within the impeller.

Disassembly of the turbine confirmed that all the blades and nozzle guide vanes were present with no evidence of impact damage. The combustion chamber showed no evidence of abnormal operation and when tested the fuel spray nozzle operated normally.

Figure 11

Right engine axial compressor

Recorded information

An iPad mini with the screen and matrix missing was recovered from the accident site and taken to the AAIB for the memory to be downloaded and analysed.

The logic board (containing the memory) and battery were still attached to the base of the iPad, which was slightly bent and dented (Figure 12). The logic board was removed from the iPad base and slaved into a similar iPad mini whose own logic board had been removed. The memory was downloaded using a commercially available data extraction and analysis software tool.

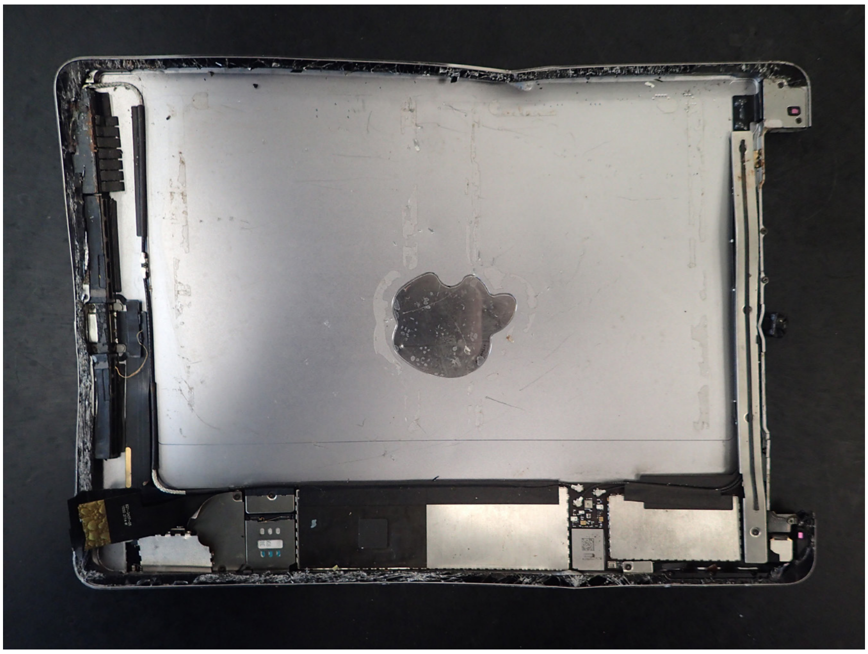


Figure 12

Base of iPad mini containing logic board (battery has been removed)

On initial power up, before the memory was downloaded, it was established that four apps were on or running in the background at the time of the accident, as well as the order in which they had last been selected. In order of recency these were: (1) RunwayHD; (2) SkyDemon; (3) Met Office website, and (4) a flight guide showing information for Tunisia (and therefore not related to the accident flight). Figure 13 to 15 show the stored screenshots for the relevant apps.

Both of the screenshots for RunwayHD (Figure 13) and SkyDemon (Figure 14) show the position of the helicopter as 8 nm east of Welshpool Airport (33 nm from the accident site, at 2,280 ft amsl with 112 kt groundspeed), implying that SkyDemon had been selected prior to this point (no information available as to how long for) and that RunwayHD was then selected and remained selected until the accident[5].

Footnote

5 Had another app been selected after this point then the RunwayHD screenshot would have shown the helicopter at a different location.

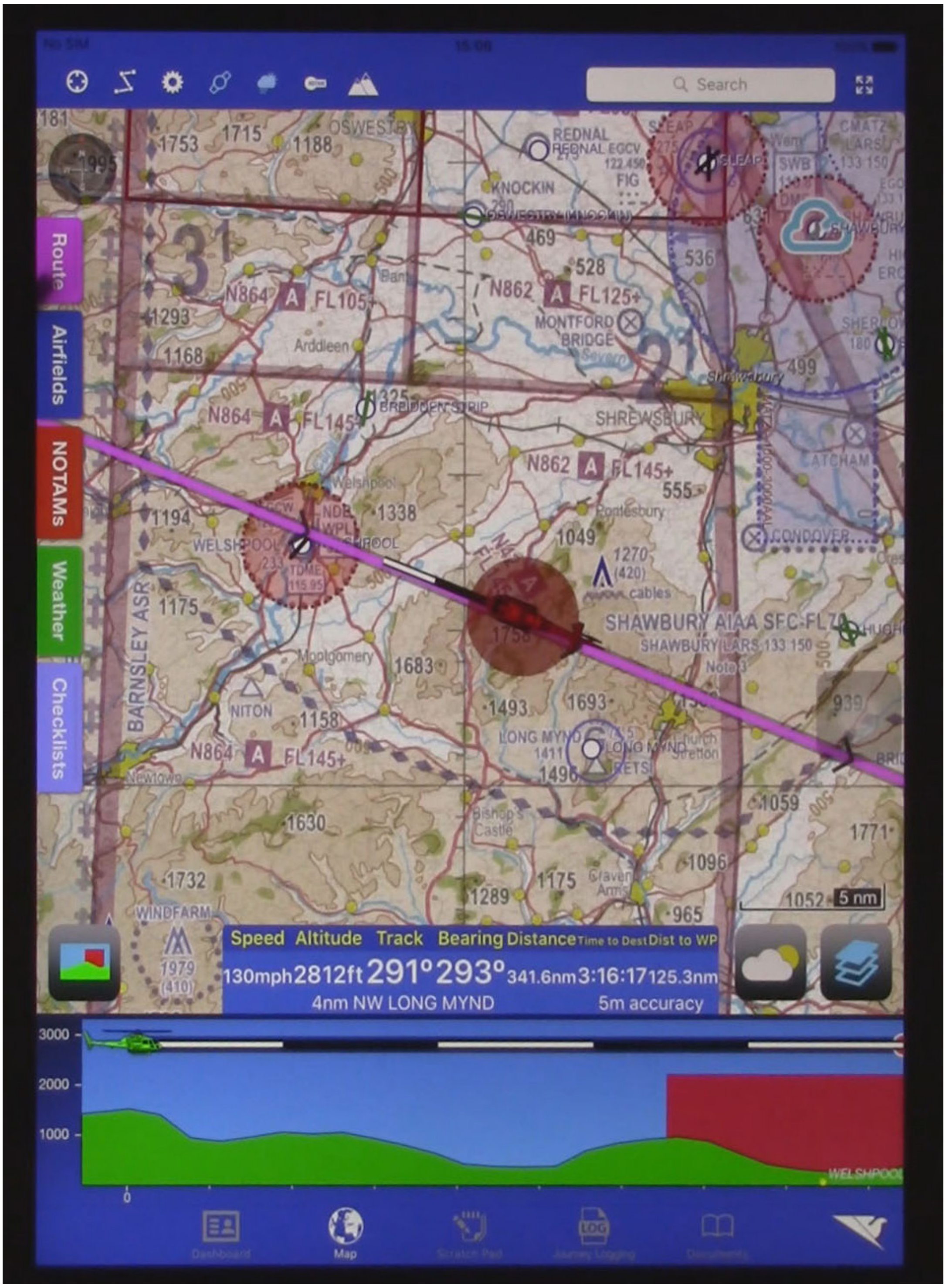


Figure 13

Stored screenshot of the selected app (Runway HD) running at the time of the accident

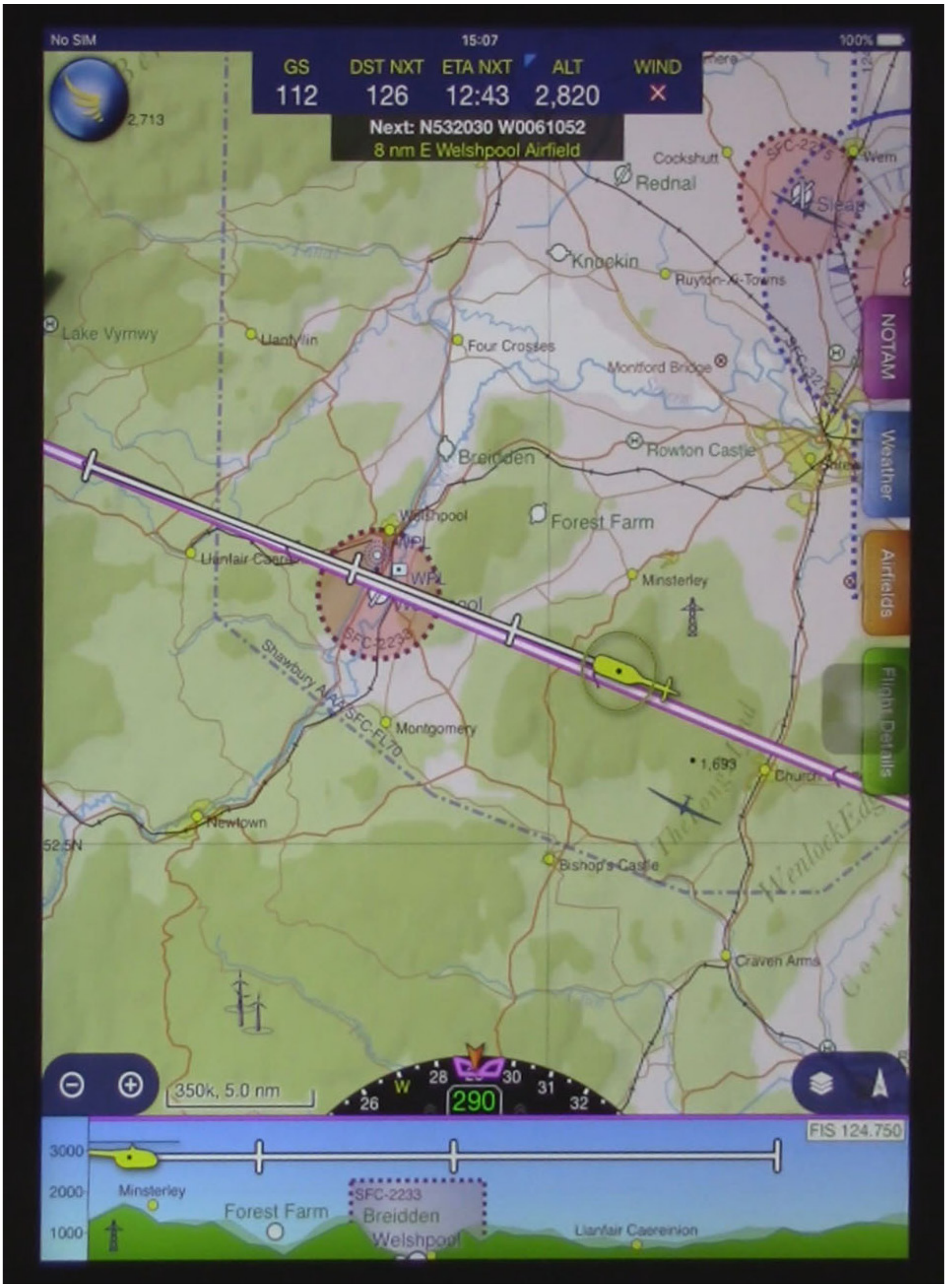


Figure 14

Stored screenshot of app (SkyDemon) running in the background
at the time of the accident

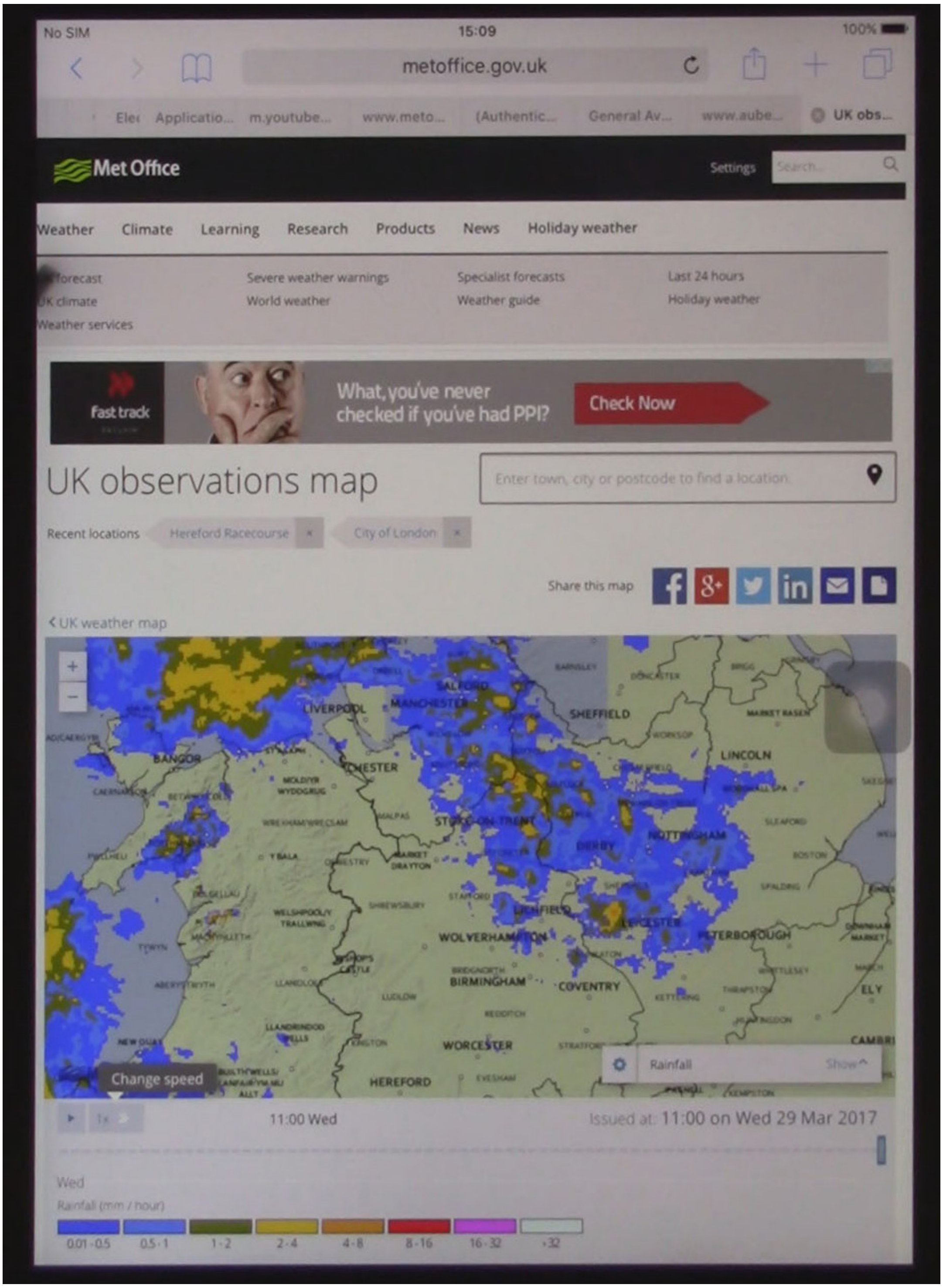


Figure 15

Stored screenshot of app running in the background at the time of the accident

Planned route and actual track

Recorded data from both RunwayHD and SkyDemon contained the planned route from Brook Farm, south of the Cranfield ATZ, direct to a point 216 nm further west, at the mouth of the River Liffey east of Dublin, continuing around Baldonnel aerodrome to Weston Airport. This track is shown as a pink line on the app screenshots[6] in Figure 13 and 14. The altitude for the route was 3,000 ft in RunwayHD and 4,000 ft in SkyDemon.

The planned route and actual track flown is illustrated in Figure 1, and the altitude and groundspeed profile for the flight in Figure 16 with other GPS derived and transponder information. The helicopter lifted around 1045 hrs; the last point, approximately 0.5 nm from the accident site, was recorded shortly after 1157 hrs. Figure 1 shows the helicopter flew close to the planned route, the maximum deviation being 0.7 nm in the early stages of the flight. The altitude profile in Figure 16 indicates that the first part of the route was flown between 1,000 and 1,500 ft amsl before climbing to 2,750 ft abeam RAF Shawbury at around 1133 hrs. Eight minutes later it climbed to a maximum of 3,000 ft before descending at approximately 25 ft/min to 2,700 ft. Shortly before 1155 hrs, the descent rate increased to 185 ft/min, after which radar contact was lost. The altitude of the last recorded point on the RunwayHD and SkyDemon apps was 2,125 ft. The calculated groundspeed for the flight varied between 100 and 120 kt.

Met Office webpage

A related web browsing history indicates that the Met Office UK observations rainfall map webpage was selected several times between 1008 hrs and 1133 hrs on the day of the accident, and for 10 minutes on the previous evening. The screenshot of the Met Office webpage (Figure 15), corresponding to the final selection of the website at 1133 hrs, shows the rainfall for Mid and North Wales issued at 1100 hrs, indicating a band of rain in the vicinity of the accident site.

Footnote

6 The stored RunwayHD route started at Weston Airport and ended at Brook Farm – the reverse of the actual flight – so the displayed route has arrows pointing back to Brook Farm.

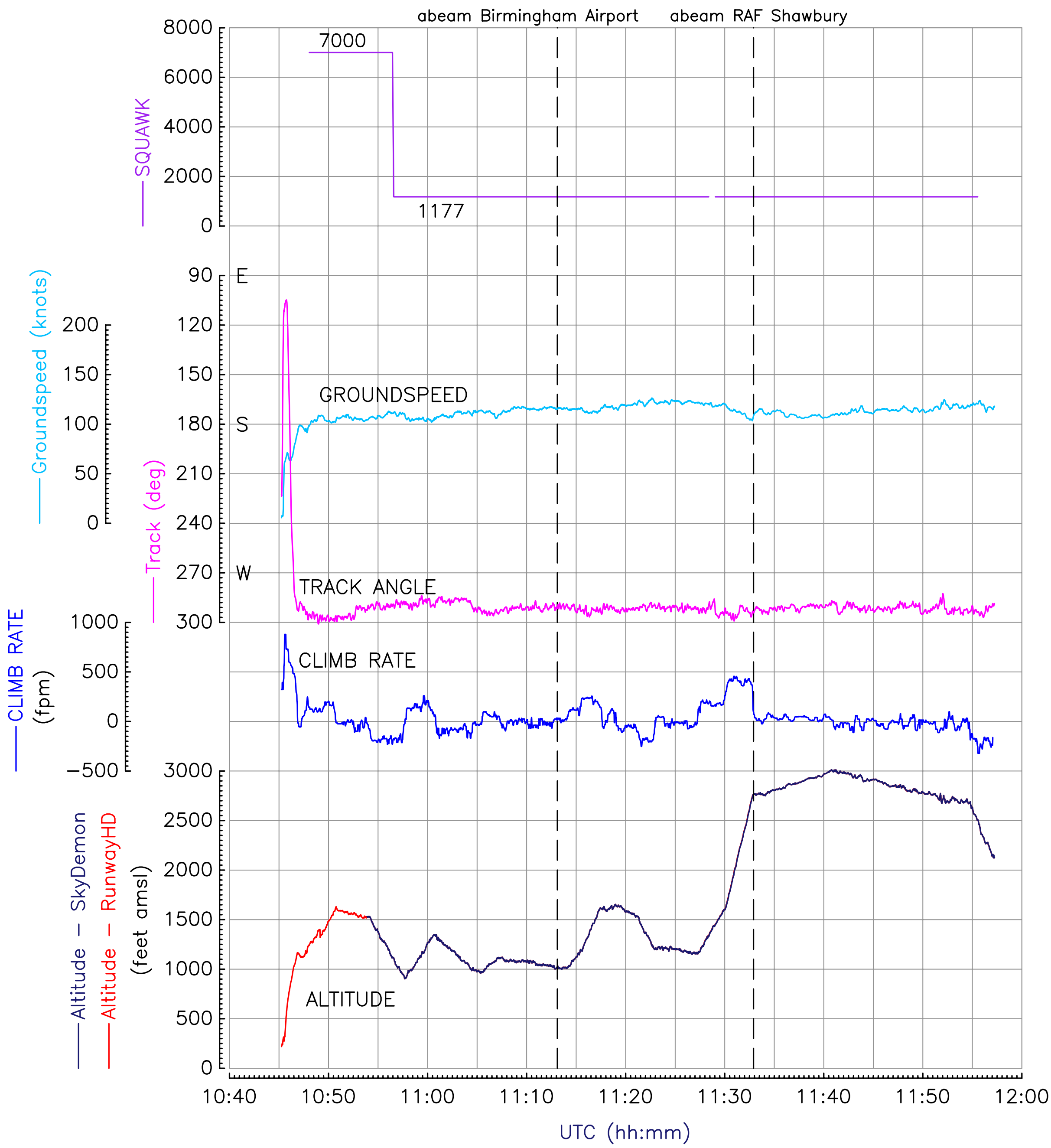


Figure 16

Recorded data from RunwayHD and SkyDemon with radar Mode A squawk

Weight and balance

The All Up Weight (AUW) of the helicopter at takeoff was approximately 2,555 kg, assuming full fuel and estimated weights for the passengers and the small amount of luggage. The Maximum Permitted All Up Weight (MPAUW) was 2,400 kg. Consequently the helicopter was approximately 155 kg over MPAUW on departure, though some fuel would have been consumed during start and prior to takeoff. With an approximate fuel consumption of 180 kg per hour, the AUW at the time of the accident would have been 2,375 kg.

The Centre of Gravity (CG) envelope at MPAUW was 3.25 to 3.475m aft of the CG datum at 2,400 kg. The CG of the helicopter at departure was approximately 3.31 m and at the time of the accident was approximately 3.3 m. At the time of the accident, the helicopter weight and CG were within the promulgated permitted weight and CG operating envelope.

Meteorology

The Met Office provided an aftercast for the flight.

General situation

The meteorological synoptic chart showed a series of fronts approaching the south and west of the UK, and a moderate to strong gradient wind from the southwest. On the 0600 hrs analysis a warm front was positioned through Cardigan Bay and ran across the north midlands and then down through Norwich. At 1200 hrs a wave had developed along the front and had pushed north. A cold front was positioned north-south through Bangor, North Wales, to Swansea. A warm sector covered the area of Wales east of that front and England, and another cold front was positioned north-south through Ireland.

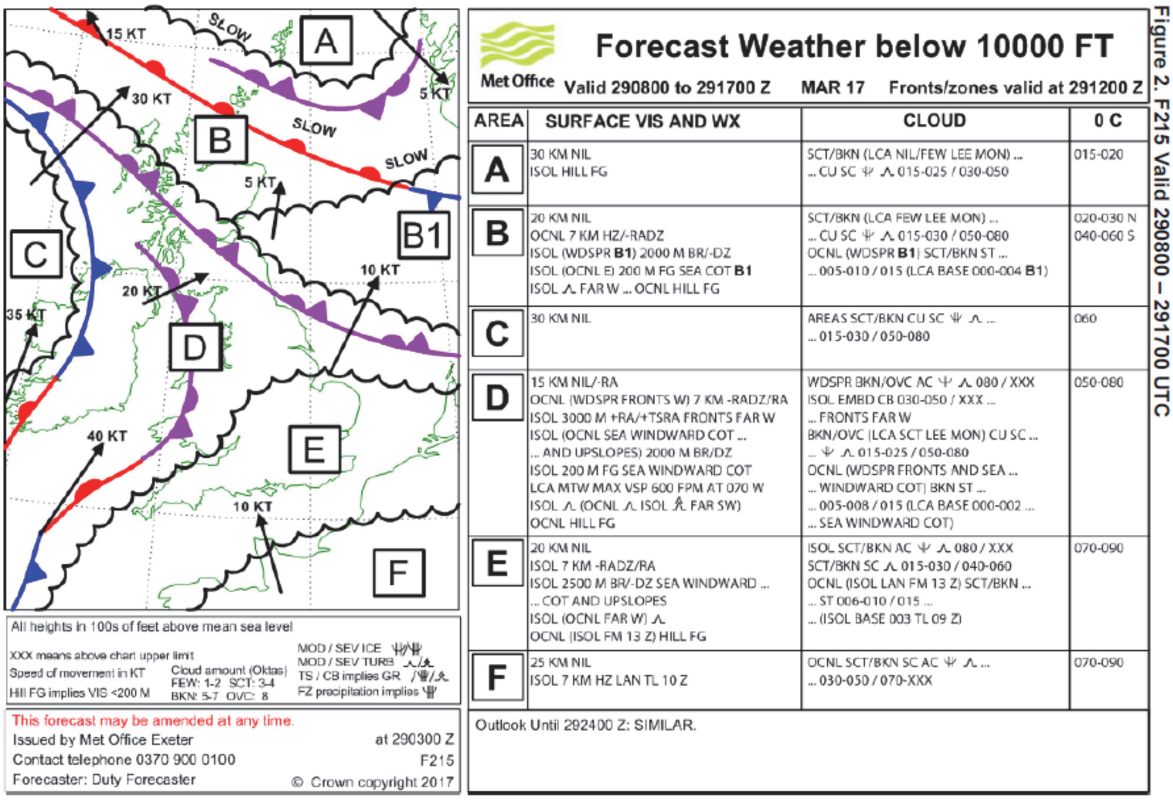
Chart F215

Met office Chart F215, depicts the forecast weather below 10,000 ft. The relevant chart covering the time of the accident is at Figure 17.

The route of the flight would have passed from Zone E into Zone D in the Kidderminster area. Zone E had the lowest cloud base, scattered or broken stratus with a base between 600 and 1,000 ft amsl with tops to 1,500 ft merging with the main cloud base which was scattered to broken at 1,500-3,000 ft amsl. Visibility and weather in Zone E were noted as prevailing 20 km with no weather, and isolated areas of 7km visibility associated with light rain and drizzle or light rain.

Zone D was the area encompassing the frontal zones. The fronts on the chart are drawn as occlusions however they are in very similar positions to those on the 1200 hrs UTC analysis chart. Cloud bases were occasionally broken ST 500-800 ft amsl with tops up to 1,500 ft. This stratus was widespread along the fronts and on windward coasts where it was locally deteriorating to the surface to 200 ft. Above this was a layer of broken to overcast Cumulus and Stratocumulus with bases from 1,500 to 2,500 ft; this cloud was expected to have moderate icing and turbulence. Locally in the lee of the mountains (that part of the flight over the Welsh border areas) there may have been breaks as the cloud cover reduced to scattered. Visibility and weather in Zone D was also worse than in Zone E. Prevailing visibility was 15 km in nil weather, occasionally (widespread along the fronts) deteriorating to 7 km in light rain and drizzle or moderate rain. Isolated further deteriorations to 2,000 metres in mist and moderate drizzle, this increased to occasional for sea areas, windward coasts and upslopes. In sea areas and windward coasts fog bringing visibility to 200 metres was expected and occasional fog inland.

Another effect of note on this chart was the mountain wave activity expected in the west of Zone D. It was expected to bring maximum vertical wind speeds of 600 feet per minute at 7,000 ft.



AREA	SURFACE VIS AND WX	CLOUD	0 C
A	30 KM NIL ISOL HILL FG	SCT/BKN (LCA NIL/FEW LEE MON) ... ... CU SC 015-025 / 030-050	015-020
B	20 KM NIL OCNL 7 KM HZ/-RADZ ISOL (WDSPR **B1**) 2000 M BR/-DZ ISOL (OCNL E) 200 M FG SEA COT **B1** ISOL FAR W ... OCNL HILL FG	SCT/BKN (LCA FEW LEE MON) ... ... CU SC 015-030 / 050-080 OCNL (WDSPR **B1**) SCT/BKN ST ... ... 005-010 / 015 (LCA BASE 000-004 **B1**)	020-030 N 040-060 S
C	30 KM NIL	AREAS SCT/BKN CU SC ... ... 015-030 / 050-080	060
D	15 KM NIL/-RA OCNL (WDSPR FRONTS W) 7 KM -RADZ/RA ISOL 3000 M +RA/+TSRA FRONTS FAR W ISOL (OCNL SEA WINDWARD COT ... ... AND UPSLOPES) 2000 M BR/DZ ISOL 200 M FG SEA WINDWARD COT LCA MTW MAX VSP 600 FPM AT 070 W ISOL (OCNL ISOL FAR SW) OCNL HILL FG	WDSPR BKN/OVC AC 080 / XXX ISOL EMBD CB 030-050 / XXX ... ... FRONTS FAR W BKN/OVC (LCA SCT LEE MON) CU SC ... ... 015-025 / 050-080 OCNL (WDSPR FRONTS AND SEA ... ... WINDWARD COT) BKN ST ... ... 005-008 / 015 (LCA BASE 000-002 ... ... SEA WINDWARD COT)	050-080
E	20 KM NIL ISOL 7 KM -RADZ/RA ISOL 2500 M BR/-DZ SEA WINDWARD ... ... COT AND UPSLOPES ISOL (OCNL FAR W) OCNL (ISOL FM 13 Z) HILL FG	ISOL SCT/BKN AC 080 / XXX SCT/BKN SC 015-030 / 040-060 OCNL (ISOL LAN FM 13 Z) SCT/BKN ... ... ST 006-010 / 015 ... ... (ISOL BASE 003 TL 09 Z)	070-090
F	25 KM NIL ISOL 7 KM HZ LAN TL 10 Z	OCNL SCT/BKN SC AC ... ... 030-050 / 070-XXX	070-090

Outlook Until 292400 Z: SIMILAR.

Figure 17

Met Office Chart 215 for the period including the accident flight

TAFs and METARs[7]

Luton (EGGW)

TAF EGGW 290502Z 2906/3006 21011KT 9999 BKN010 TEMPO 2906/2913 8000-SHRA TEMPO 2906/2910 BKN009 BECMG 2907/2910 FEW015 SCT025 TEMPO 2910/2913 BKN014 PROB30 TEMPO 3004/3006 9000 –SHRA=

METAR EGGW 291050Z AUTO 21011KT 9999 OVC012 13/10 Q1022=

METAR EGGW 291120Z AUTO 20110KT 170V240 9999 OVC011 13/11 Q1022=

Birmingham (EGBB)

TAF EGBB 290501Z 2906/3006 20009KT 9999 FEW010 SCT025 TEMPO 2906/2910 9000 –RA BKN010 PROB40 TEMPO2906/2910 4000 RADZ BKN006 PROB30 TEMPO 2910/3006 9000 –RA BKN013=

TAF EGBB 291058Z 2912/3012 20009KT 9999 FEW010 SCT025 TEMPO 2912/2921 9000 –RA BKN013 BECMG 2921/2924 BKN010 PROB30 TEMPO 3000/3008 8000 –RA BKN008 BECMG 3009/3012 SCT015=

METAR EGBB 291120Z 19008KT 9999 BKN015 13/11 Q1020=

METAR EGBB 291050Z19008KT 9999 BKN012 13/11 Q1020=

METAR EGBB 291020Z 19009KT 9999 BKN012 13/11 Q1019=

METAR EGBB 290950Z 20009KT 170V230 9999 BKN011 13/11 Q1019=

Shawbury (EGOS)

TAF EGOS 290755Z 2909/2918 21010KT 9999 FEW020 SCT035 BECMG 2909/2911 21012G20KT TEMPO 2909/2918 BKN020 PROB30 TEMPO 2909/2918 7000 –RADZ SCT012=

TAF EGOS 291039Z 2912/2918 19012G22KT 9999 FEW020 SCT035 TEMPO

2912/2918 BKN020 PROB30 TEMPO 2912/2918 7000 –RADZ SCT012=
METAR EGOS 290950Z 21017KT 9999 FEW012 SCT018 BKN120 13/10 Q1018 WHT NOSIG=

METAR EGOS 2911050Z 19018KT 9999 FEW014 SCT018 BKN100 13/10 Q1018 WHT NOSIG=

SPECI EGOS 291120Z 16012KT 9999 SCT014 BKN030 BKN120 13/11 Q1018 GRN TEMPO 18012G22KT SCT015 WHT=

METAR EGOS 291150Z 17014KT 9999 SCT014 BKN030 BKN120 13/10 Q1018 GRN TEMPO SCT015 WHT=

Footnote

[7] A summary of meteorological information appears at the end of this section. Resources for decoding TAFs and METARs are available on the Met Office web site: https://www.metoffice.gov.uk/aviation/ga

Valley (EGOV)

TAF EGOV 290747Z 2909/2918 18020KT 8000 BR OVC006 BECMG 2909/2911 OVC007 TEMPO 2909/2918 3000 RADZ BKN003=

TAF EGOV 291034Z 2912/2919 17025KT 8000 BR OVC007 TEMPO 2912/2919 3000 RADZ BKN004=

SPECI EGOV 290921Z 17019KT 7000 RA OVC006 11/10 Q1015 BLACKYLO1 TEMPO 3000 RADZ BKN003 YLO2=

METAR COR EGOV 290950Z 16019KT 8000 BR OVC007 11/10 Q1015 BLACKGRN TEMPO 3000 RADZ BKN003 YLO2=

SPECI EGOV 291038Z 16020KT 3000 –DZ OVC004 11/10 Q1015 BLACKYLO2 BECMG 8000 BKN007 GRN=

METAR EGOV 291050Z 15019KT 8000 6000N –RA FEW004 OVC006 11/10 Q1015=

METAR EGOV 291052Z 15019KT 8000 6000N –RA FEW004 BKN006 11/10 Q1015 BLACKYLO1 BECMG BKN007 GRN=

SPECI EGOV 291107Z 16018KT 9999 –RA FEW004 BKN013 11/11 Q1014 BLACKGRN TEMPO 3000 DZ BKN004 YLO2=

METAR EGOV 291150Z 16017KT 9999 BKN006 11/10 Q1015 BLACKYLO1 TEMPO 4000 –RADZ BKN004 YLO2=

Dublin (EIDW)

TAF EIDW 290500Z 2906/3006 15007KT 9999 SCT010 BKN022 TEMPO 2906/2910 5000 –RADZ BKN012 BECMG 2907/2909 18010KT BECMG 2909/2912 19015KT TEMPO 2911/2915 19016G26KT TEMPO 2920/3001 5000 –RA BKN012 BECMG 3000/3003 22010KT BECMG 3003/3006 17007KT TEMPO 3004/3006 5000 –RA BKN012=

METAR EIDW 290930Z 10010KT 9000 FEW004 BKN021 BKN200 13/10 Q1012 NOSIG=

METAR EIDW 291000Z 15004KT 110V200 9000 FEW004 BKN020 BKN050 13/10 Q1012 NOSIG=

METAR EIDW 291030Z 12011KT 9000 FEW004 BKN020 BKN050 14/10 Q1012 NOSIG=

METAR EIDW 291100Z 12009KT 100V160 9000 FEW004 BKN020 BKN050 14/10 Q1012 NOSIG=

METAR EIDW 291130Z 21013KT 9999 FEW004 BKN022 BKN050 14/10 Q1012 NOSIG=

METAR EIDW 291200Z 19012KT 150V210 9999 FEW004 SCT022 BKN050 15/11 Q1012 NOSIG=

METAR EIDW 291230Z 21012KT 9999 FEW004 BKN022 BKN050 15/10 Q1012 NOSIG=

METAR EIDW 291300Z 21010KT 9999 FEW005 BKN024 BKN250 15/10 Q1012 NOSIG=

Summary of meteorological information

A flight departing Brook Farm at about 1056 hrs and flying a direct track to the destination would have experienced a light south-westerly wind and cloud bases 1,000 ft amsl as far as Snowdonia. Underneath this cloud, visibility would have been around 20 km, probably with no rain or drizzle. Before entering Snowdonia it is likely there were isolated patches of hill fog on upslopes but the main cloud base would have been clear of the tops of the terrain. As the flight progressed north-west the front would have moved east and conditions would have deteriorated. The western parts of Snowdonia and the Welsh coastal areas would have had extensive hill fog, cloud bases being between 200 and 400 ft amsl. As well as the poor cloud bases and visibility, moderate turbulence may have been experienced due to convection embedded along the frontal zone. Once over the Irish Sea and further away from the cold front the turbulence would have eased although cloud bases and visibility would have remained poor, between 200 and 400 ft and 2,000 to 5,000 metres respectively. On crossing the Irish coast en route to the destination, shelter from the Wicklow Mountains would have led to a significant improvement in conditions.

Personnel

The pilot was an experienced private helicopter pilot and had renewed his Licence Proficiency Check (LPC) on 17 August 2016. He held a PPL(H) with an AS355 type rating, a night rating and a current class two medical certificate. He did not hold any instrument flying qualification. As part of the renewal process, the pilot was required to demonstrate level turns to the left and right on instruments, and maintaining altitude, whilst wearing 'Foggles'[8]. This was intended to demonstrate that, should an inadvertent entry be made into cloud, the pilot would be able to reverse the aircraft's track and return to an area clear of the cloud.

Medical and pathological information

A post-mortem examination of the pilot included toxicological analysis involving tests for alcohol and other substances. A small amount of alcohol was detected that may have been produced post-mortem. Other substances were detected but their effect if any on the performance of the pilot could not be determined due to the severe trauma he sustained.

Footnote

[8] Foggles are spectacles worn by the pilot under test which permit visibility of the flight instruments but obscure the external references in order that the pilot flies by sole reference to his flight instruments.

Flight in Class G airspace

The helicopter was being operated in Class G airspace and was required to be flown under the VFR in VMC. According to Section 5 of the Standardised European Rules of the Air, as set out in the following excerpt from the UK Integrated Aeronautical Information Package, the helicopter was required to be clear of cloud and in sight of the surface, with a minimum inflight visibility of 1,500 m.

VFR flights shall be conducted so that the aircraft is flown in conditions of visibility and distance from clouds equal to or greater than those specified in Table 1.

Table 1

(See Paragraph 1.1)

Altitude Band (Note 1)	**Airspace Class**	**Flight Visibility**	**Distance from Cloud**
At and above 3050 m (10000 ft) amsl	A B C D E F G (Note 2)	8 km	1500 m horizontally 300 m (1000 ft) vertically
Below 3050 m (10000 ft) amsl and above 900 m (3000 ft) amsl, or above 300 m (1000 ft) above terrain, whichever is the higher.	A B C D E F G (Note 2)	5 km	1500 m horizontally 300 m (1000 ft) vertically
At and below 900 m (3000 ft) amsl, or 300 m (1000 ft) above terrain, whichever is the higher	A B C D E (Note 2)	5 km	1500 m horizontally 300 m (1000 ft) vertically
	F G	5 km (Note 3)	Clear of cloud and with the surface in sight

Note 1: Or *if, any aircraft which is not a helicopter, at 3000 ft amsl or below and flying by day only at 140 KIAS or less:*

Clear of Cloud and with the surface in sight in a Flight Visibility of at least 5 km.

Note 2: Or *if a Helicopter and flying by day at 3000 ft amsl or below:*

Clear of Cloud and with the surface in sight in a Flight Visibility of at least 1500 m.

Note 3: *Flight visibilities reduced to not less than 1500 m are permitted for flights operating:*

(a) at speeds of 140 KIAS or less to give adequate opportunity to observe other traffic or any obstacles in time to avoid collision; or

(b) in circumstances in which the probability of encounters with other traffic would normally be low, e.g. in areas of low volume traffic and for aerial work at low levels.

Maximum Elevation Figures (MEF)

Figure 18 shows part of an aeronautical chart including the area in which the accident occurred. MEF are located in quadrangles bounded by graticule lines for every half degree of latitude and longitude. MEFs are represented in thousands and hundreds of feet above mean sea level. Each MEF is based on information available concerning the highest known feature in each quadrangle, including terrain and obstacles and allowing for unknown features. A note printed on the complete chart states that this is not a safety altitude. The MEF provides an instant figure on which to base the Minimum Safe Altitude (MSA) for a given area. MSA is based on the MEF plus 1,000 feet, below 5,000 feet. Thus, the MSA in the quadrangle containing the accident mountain would have been MEF 3,300 ft plus 1,000 ft terrain clearance giving an MSA of 4,300 ft. MSA is applied on IFR flights but is not required for VFR flights.

Figure 18

1:500,000 Chart with Maximum Elevation Figures shown

Other information

Use of a tablet device to provide information in flight

The pilot had an iPad fixed on the centre of the instrument panel with a dedicated power supply and equipped with a Runway HD and SkyDemon flight planning tool. The engineer who refuelled the helicopter noticed that it was fitted before the accident flight with the power ON and displaying an aviation chart with a track.

The Runway HD app automatically updates weather and NOTAMS every six hours, and the pilot's subscription provided for 1:500,000 and 1:250,000 aviation charts, and 1:50,000 Ordinance Survey (OS) maps. Spot heights are shown in feet on the aviation charts and metres on the OS maps. The system has airspace alerts but no terrain alerts, however a terrain overlay feature can be selected which colour codes the terrain getting redder the higher it goes. A vertical terrain profile is available which shows the ground five minutes ahead on the helicopter's track. It is not known if these facilities were selected and in use.

Decision making

On 15 January 2017 a Piper PA-30 Twin Comanche, G-ATMT collided with terrain in Instrument Meteorological Conditions (IMC), fatally injuring the sole occupant. The AAIB report of its investigation into this accident[9] considered decision making by pilots faced with a transition from VMC to IMC, and concluded:

> *'a. When under stress, people tend to place a greater emphasis on positive outcomes when making decisions.*
>
> *b. When conditions deteriorate gradually, cues suggesting that a course of action be abandoned often fail to change that course.*
>
> *This indicates that, if intending to remain in VMC, it is better to anticipate the need to avoid the boundary between VMC and IMC than to fly towards it and, perhaps inadvertently, across it.'*

Analysis

Engineering

The investigation did not identify any defect that would have prevented the helicopter from responding normally to the pilot's control inputs.

The helicopter's records showed that the helicopter had been maintained in accordance with its approved maintenance program and that it was compliant with all the mandatory requirements in force at the time of the accident.

The evidence found at the accident site showed that the helicopter struck a rock outcrop in a relatively level pitch attitude at high speed. There was no evidence of a failure of the main rotor drive system and the damage to the main rotor blades and the evidence of rotational scoring to the tail rotor drive shaft indicated that the rotor system was operating under power at impact.

Examination of the flight instrumentation showed that both the pilot's and the standby artificial horizon were operating at impact. The evidence provided by the autopilot mode control panel indicated that the autopilot had been engaged and the modes selected were those associated with normal, descending flight. The GARMIN GNS430 fitted had not been equipped with the modification that would have provided a terrain warning function.

There was no evidence to indicate the presence of a restriction or a pre-existing defect in the flying control circuits, and the main and tail rotor hydraulic actuators operated normally when tested.

Footnote

9 Published in AAIB Bulletin 10/2017.

The damage observed to both the left and the right engines was consistent with both engines operating normally immediately prior to the impact. There was no evidence of a pre-existing defect in either engine which would have prevented them responding normally to control inputs.

Operations

The pilot was licensed to fly the helicopter in VMC by day or night and held a valid Class 2 medical certificate. He did not hold any instrument flying qualification and none was required for flight in VMC.

The weather was a significant factor in the accident and from the iPad download, weather information was available to the pilot prior to and during the flight. The pilot would have been flying towards the deteriorating weather in the area of the West Coast of Wales and the Mountains. If unable to maintain VMC the pilot had the option to turn back, divert or land. If he continued, the poor visibility and low cloud forecast for and reported at Valley, combined with low cloud in the Dublin area, would have meant a low level crossing of the Irish Sea in marginal weather conditions.

The helicopter was seen to enter cloud when at an altitude of approximately 2,500 feet heading towards the high ground at Rhinog Fawr, which has a summit of 2,360 ft. The helicopter, which was descending, continued on its track, increasing its rate of descent at about the time it entered the cloud. Having entered cloud, there appears to have been no attempt to turn back.

The pilot had recently demonstrated his ability to perform a 180° turn on instruments during his LPC. It is possible that his last visual observation of the surface was at about 2,000 ft agl, whilst over low ground. It is therefore possible that having entered the cloud, his mental picture was that he had adequate height to descend and regain VMC. However, if he did check the terrain ahead from his chart or iPad he may have then been aware of the rising ground. Given that the cloud would have meant the pilot was now flying in IMC and as the helicopter's GNS430 was not fitted with the terrain warning modification, there was no other means of warning the pilot of the rising ground.

The helicopter was being flown using the autopilot system with the HDG and V/S modes engaged. On entering IMC, it would have been possible to maintain the current height by selecting the ALT mode of the autopilot or setting the VSI command bug to zero. Selecting the heading bug to the reciprocal heading would have initiated a left or right 180º turn which, if completed before impact, should have allowed the pilot to regain VMC and surface contact.

There was no apparent attempt to avoid the high ground, resulting in impact with the mountain at approximately cruise speed whilst in IMC.

Conclusion

The accident occurred after the helicopter entered cloud while descending. The pilot did not carry out a 180° turn away from the rising ground and probably did not regain VMC before impact with the side of the mountain.

CAA Safety Sense Leaflet 1e – *Good Airmanship*, Leaflet 5e – *VFR Navigation*, and Leaflet 23 – *Pilots – It's Your Decision*, provide guidance for pilots operating VFR in the lower levels of Class G airspace and in poor weather.

The CAA has published CAP 1535 – *The Skyway Code*, intended to provide General Aviation pilots involved in non-commercial and flight training operations with practical guidance on the operational, safety and regulatory issues relevant to their flying, such as flight planning, meteorology and decision making.