SERIOUS INCIDENT

Aircraft Type and Registration:	Piper PA-28-151 (Modified), G-BOTI	
No & Type of Engines:	1 Lycoming O-320-D3G piston engine	
Year of Manufacture:	1975 (Serial no: 28-7515251)	
Date & Time (UTC):	22 October 2022 at 1330 hrs	
Location:	9 nm final approach into Exeter Airport	
Type of Flight:	Private	
Persons on Board:	Crew - 1	Passengers - 1
Injuries:	Crew - None	Passengers - None
Nature of Damage:	None	
Commander's Licence:	Commercial Pilots Licence	
Commander's Age:	33 years	
Commander's Flying Experience:	331 hours (of which 40 were on type) Last 90 days - 21 hours Last 28 days - 16 hours	
Information Source:	AAIB Field Investigation	

Synopsis

The pilot started an early descent while attempting to fly an ILS approach to Runway 26 at Exeter Airport. He lost situation awareness with respect to his position relative to the runway and ILS descent point, possibly due to or exacerbated by a malfunction of the glideslope deviation indicator on the course deviation indicator (CDI). His awareness would probably have been rectified by referencing the DME to confirm his position relative to the descent point. The approach controller noticed the early descent three minutes after G-BOTI departed the cleared level and instructed the pilot to climb. The subsequent approach was flown using the localiser and without vertical guidance to a successful landing.

The CDI had been reported as unserviceable prior to scheduled maintenance, which had been completed on the day of the flight, although no fault was found.

History of the flight

G-BOTI, a PA-28-151, was leased by a flight school based at Exeter Airport. It had been flown to Biggin Hill seven days prior to the incident flight to undergo routine maintenance. The maintenance organisation at Biggin Hill was the registered owner of G-BOTI.

One of the defects which had been reported prior to the maintenance was the aircraft course deviation indicator (CDI)[1], which had been unserviceable for several months. The pilot was

Footnote

[1] Course deviation indicator – an aircraft instrument used to receive and display VOR, localiser, glide path or GPS information to the pilot.

not employed by the maintenance organisation but was flying to build his experience. He had ferried the aircraft from Exeter seven days earlier and he was aware of the reported defect with the CDI. When he arrived at Biggin Hill on the day of the incident flight there was maintenance work still being carried out on the aircraft, causing a delay to the planned departure. Once the work had finished, the pilot spoke to the engineer who had been working on G-BOTI and the engineer confirmed the CDI was serviceable.

The flight departed Biggin Hill at 1150 hrs. There was one passenger on board who also held a pilot's licence, although he was not qualified to fly under instrument flight rules (IFR). The pilot flew under IFR outside controlled airspace and navigated enroute between VORs (Figure 1), plotting his position at various points and comparing with navigation software he was using on a tablet device. He was satisfied that the VOR indications on the CDI were correct and the instrument was operating normally.

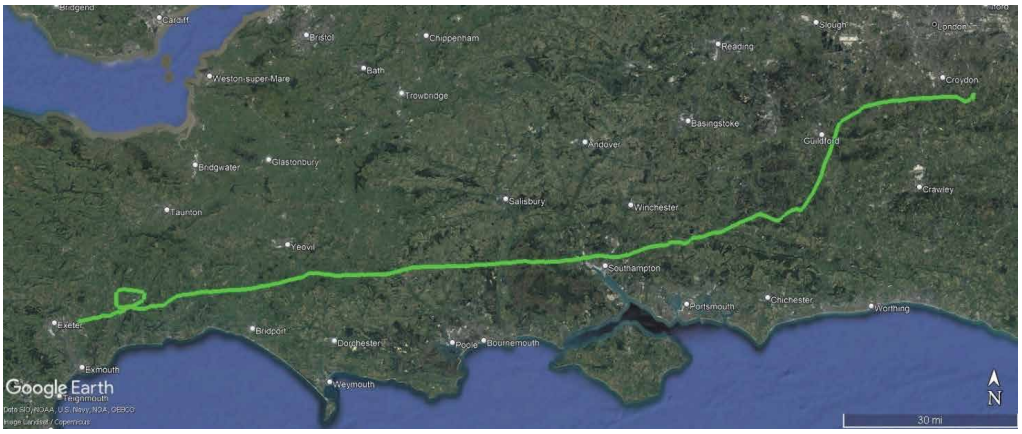

Figure 1
G-BOTI flight path

At 1311:37 hrs the pilot contacted Exeter Radar on 128.98 MHz and requested an ILS approach to Runway 26. The pilot stated that he had prepared for and briefed himself on the approach in advance, and although he had tuned the ILS frequency in the Garmin GNS430, he did not use the GPS function to navigate throughout the flight. At 1324 hrs the radar controller made a transmission; "YOU'RE CLOSING THE LOCALISER FROM THE RIGHT, WHEN ESTABLISHED DESCEND WITH THE GLIDEPATH".

The pilot recalled noticing the glideslope bar was centralised and he took this to indicate he was on the expected glidepath. He began his descent from the platform altitude of 2,600 ft but did not confirm his position with the DME. The aircraft was flying in IMC and the pilot was not visual with the ground. He did not recall seeing a red flag on the CDI, which would have indicated the instrument was unserviceable. When he initiated the descent, he was 12.5 nm from the threshold of Runway 26, which was approximately 5 nm before the expected descent point for the approach profile. The pilot continued his descent, with varying rates of descent that averaged approximately 600 ft/min, believing that the static glideslope deviation indicator on the CDI was confirming the aircraft's correct position on the glidepath.

G-BOTI descended to 1,155 ft amsl at 9.4 nm from the runway threshold when the radar controller queried his altitude. Three minutes after the pilot had begun descending, the controller then instructed him to climb. In response, the pilot initially arrested his descent and momentarily levelled the aircraft. The aircraft then descended to a minimum altitude of 1,150 ft before the pilot initiated a climb. The aircraft was 400 ft above terrain at its closest point, and the pilot did not have visual contact with the ground.

The pilot then flew a go-around during which he noticed that the glideslope deviation indicator on the CDI remained centralised, and he realised it was unserviceable. Following a discussion with ATC, he requested vectors for another ILS approach to Runway 26. On the subsequent approach, he used the localiser indicator and stored waypoints in the Garmin GNS430 to verify his position and descent point, and he flew to a successful landing.

Recorded data

The pilot provided the AAIB with a GNSS track log which was downloaded from a flight planning and navigation app. Radar and radio transmission recordings were also provided by Exeter Airport and NATS.

The aircraft took off from Biggin Hill at 1150 hrs and climbed to approximately 2,300 ft amsl, tracking towards Exeter. At 1318:11 hrs, while 23 nm from the threshold, the approach controller instructed G-BOTI to descend to 2,600 ft. After this transmission, the approach controller was changed. At 1325:01 hrs, when 12.5 nm from the runway threshold, a descent from 2,600 ft commenced. This initially levelled at 2,300 ft for 10 seconds before continuing (Figure 2).

At 1327:13 hrs, the aircraft was 9.4 nm from the runway threshold, descending at approximately 800 ft/min (Figure 3, Point A). The approach controller requested the pilot's altitude to which he replied 'ALTITUDE 1,100 DESCENDING'. At this time, the recorded radar altitude was 1,084 ft[2], the GNSS altitude was 1,155 ft and the terrain was estimated at 751 ft. After this query from the approach controller, the aircraft levelled at approximately 1,150 ft but descended to a minimum GNSS altitude of 1,096 ft. Terrain under the flight path undulated with the minimum clearance, based on GNSS altitude, estimated at 400 ft.

The approach controller asked whether G-BOTI was on the glidepath to which the pilot replied he was. At 1327:29 hrs (Figure 3, Point B), the approach controller stated 'GOLF TANGO INDIA YOU'RE WELL BELOW THE GLIDE PATH LEVEL, CLIMB UP TO ALTITUDE 2,600 FT'. The pilot acknowledged this and commenced a climb. During this, the aircraft's heading became more westerly and the approach controller asked if G-BOTI was established or whether a repositioning was required. The pilot responded with a repositioning request, which the controller facilitated, and the subsequent approach was successful.

Footnote

[2] Radar altitude resolution is ± 50 ft.

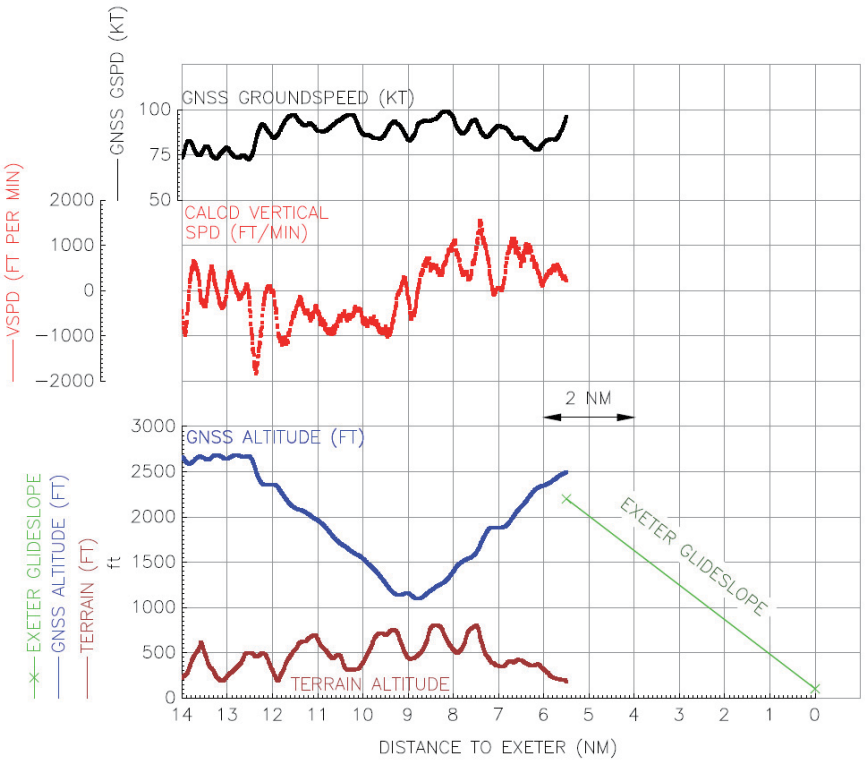

Figure 2

G-BOTI altitude and track distance from Exeter Airport.
Green line shows Exeter glideslope

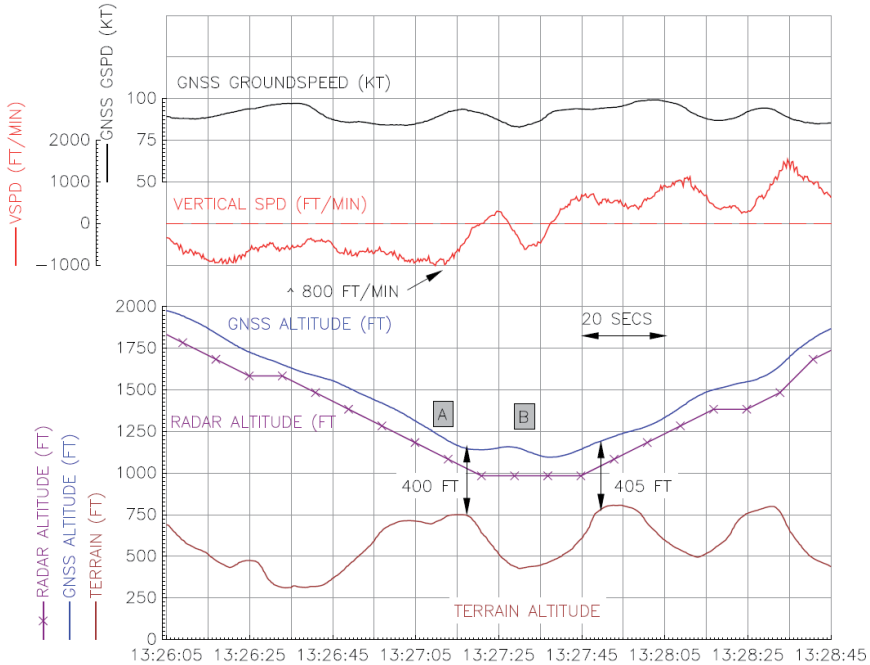

Figure 3

G-BOTI recorded data

Aerodrome information

General

Exeter Airport is an international airport with one runway, orientated 08/26. The landing distance available on Runway 26 is 2,036 m. The airport has regular commercial traffic and has various instrument approaches available for both runways.

Instrument Approach Chart

Aerodrome charts, including instrument approach charts, are published under Part 3 of the Aeronautical Information Publication (AIP)[3]. Aerodrome and approach charts can be produced by third parties and are based on the information published in the AIP. Both types of chart should contain the same information but may differ in presentation (Figures 4 and 5).

The ILS approach to Runway 26 at Exeter has a non-standard 3.5° glidepath[4] due to high terrain to the east of the airport. The published descent point from 2,200 ft is 5.5 nm from the runway threshold. From 2,600ft, which was the altitude from which G-BOTI was cleared to join the glidepath, the nominal descent point would have been at approximately 6.5 nm. This would not have been immediately apparent to the pilot when he received his clearance for the ILS approach.

Figure 5 shows the approach plate used by the pilot during the flight. For commencing a straight-in approach from the east, which was the clearance received by the pilot, the descent point is to be determined by DME. For aircraft without DME, there is a published procedural join to the ILS where timings can be used to join the ILS. There is a note which states that the glidepath signal is not to be used beyond 8 nm from the runway threshold[5] (highlighted in Figure 5).

Garmin GNS 430

The GNS 430 is a widely used integrated communication, navigation and GPS system with a colour moving map display. It is multi-functional and can be used to provide navigation information to a CDI, either from GPS or from a ground based navigational aid (VOR and ILS but not DME or NDB). Using deviation bars, the CDI can display horizontal and, depending on the navigation source selected, vertical guidance (Figure 6).

The frequency selections are made on the left of the unit. The communication section is at the top and the navigation section is at the bottom of the display. The active frequency, in white text, and standby frequency, in blue text, are displayed. The pale blue background highlights the frequency that can be altered using the selector knobs.

Footnote

[3] Aeronautical Information Publication's (AIP) contain regulations, procedures and other relevant information for aircraft operations.
[4] Standard ILS approaches have a 3° descent path.
[5] Standard glidepath coverage is to 10 nm.

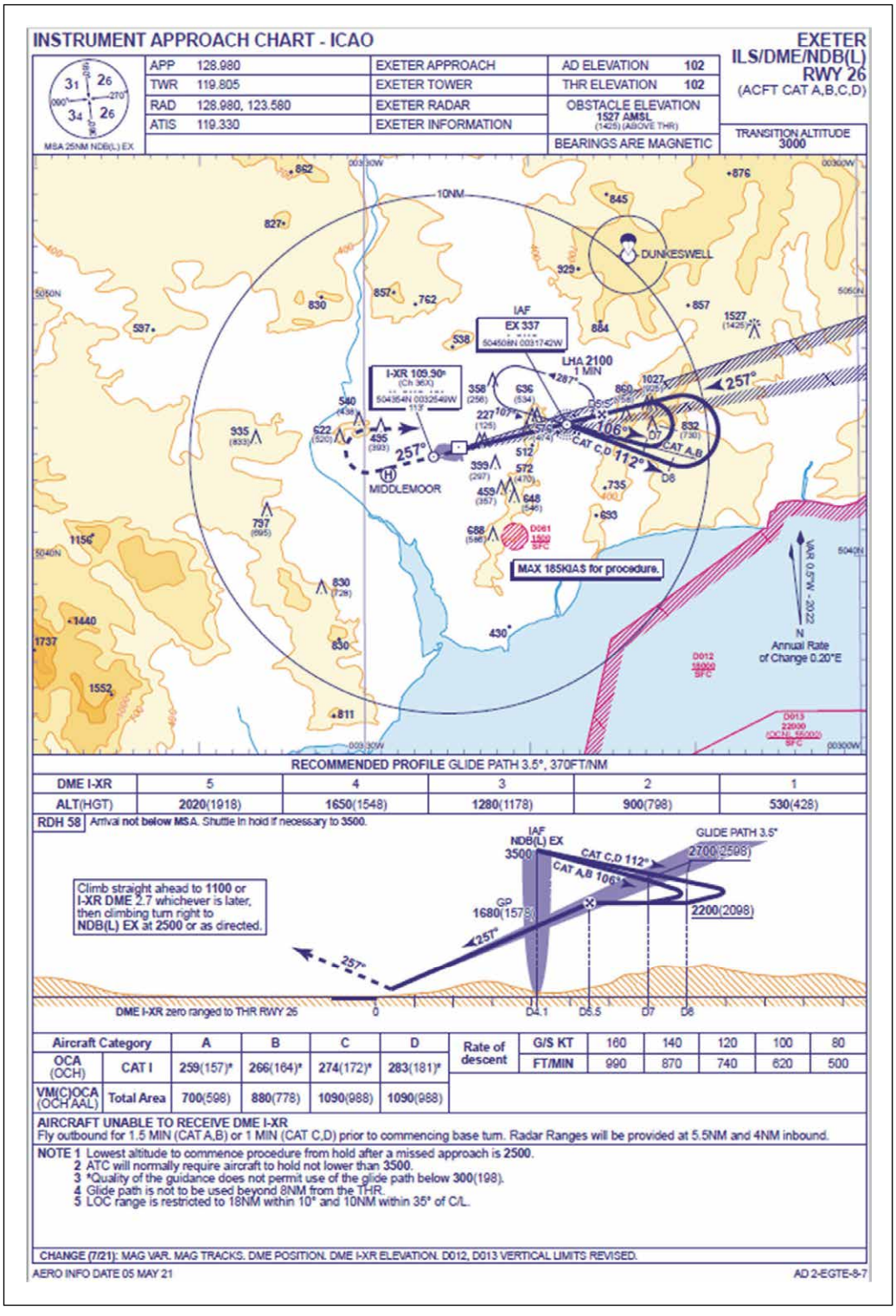

Figure 4

AIP ILS approach chart for Runway 26 at Exeter Airport

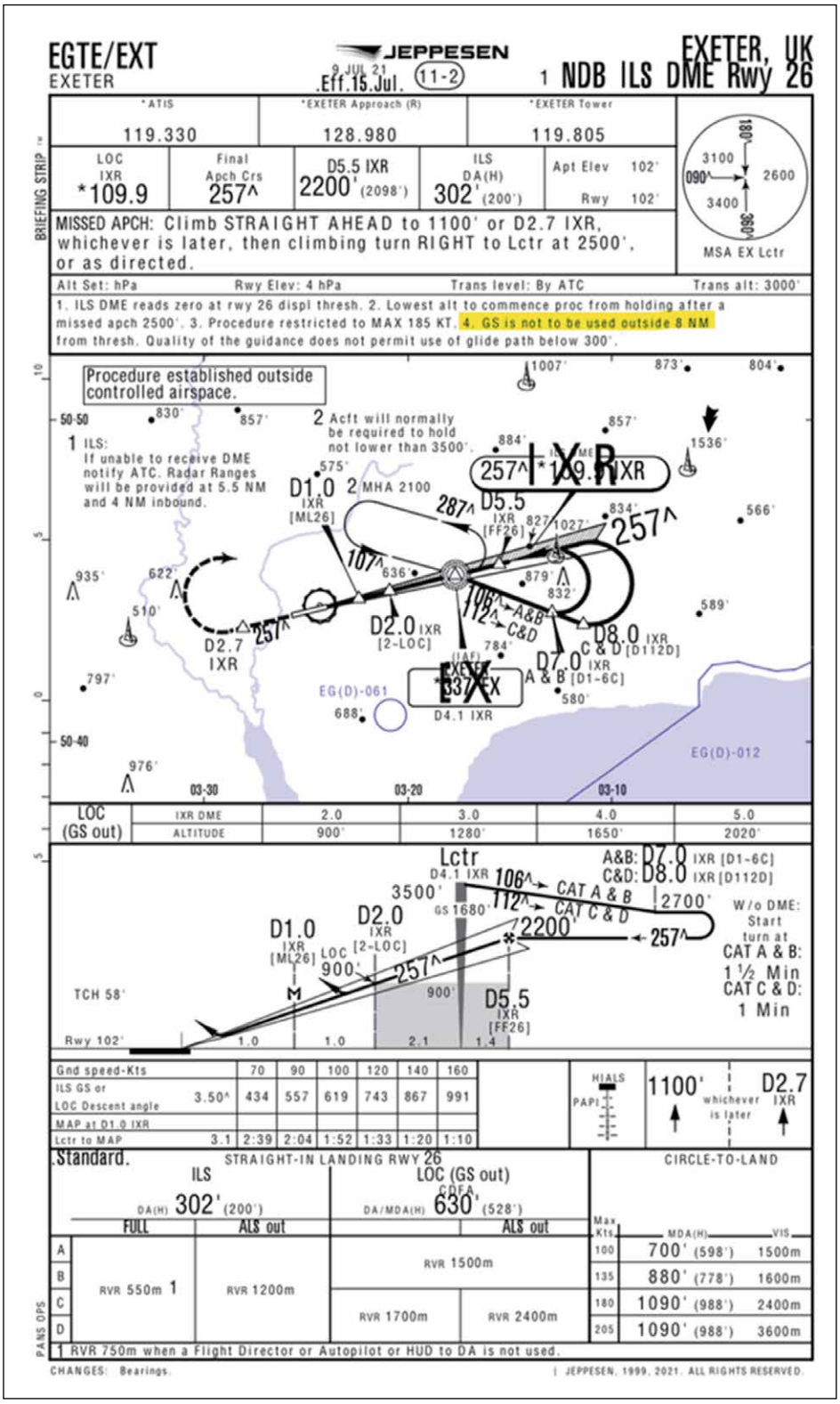

Figure 5

ILS approach chart used by the pilot of G-BOTI

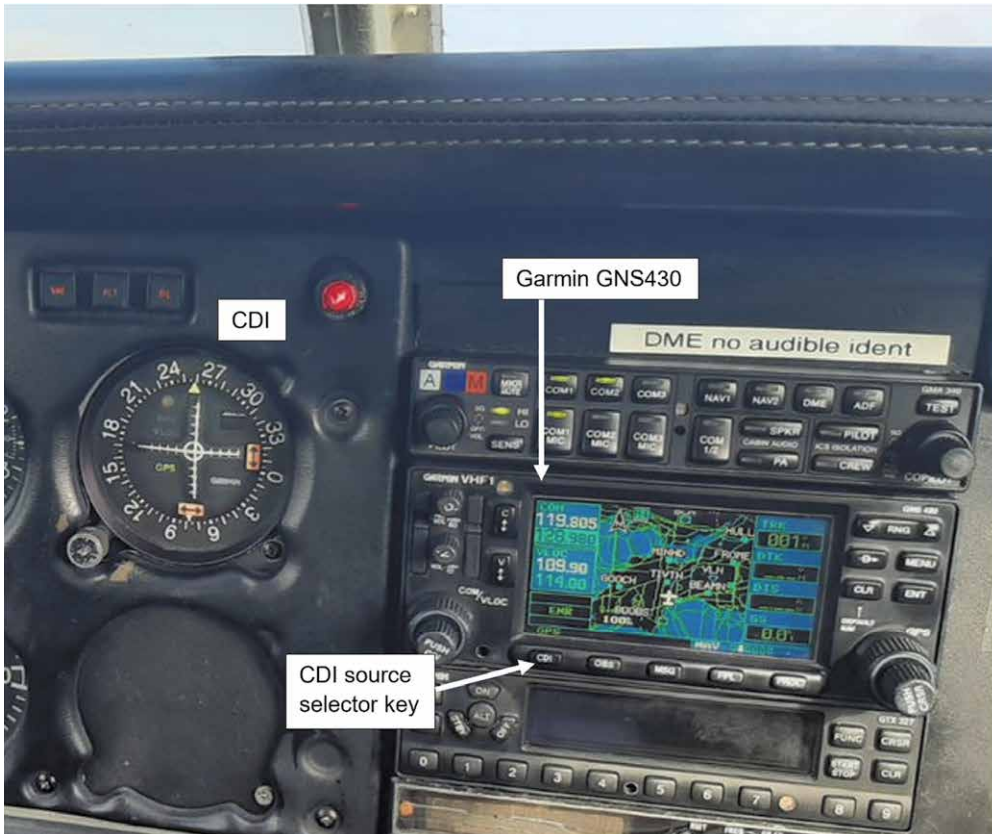

Figure 6
GNS 430 and CDI fitted to G-BOTI

If a VOR or ILS is selected and identified, the 'CDI' source selector key located at the bottom left of the GNS 430 display screen must be selected to 'LOC' to display the navigation information on the CDI. The selection will be displayed above the 'CDI' key and repeated as a caption on the CDI display.

To use GPS-derived navigational data, the 'CDI' source selector key must be selected to 'GPS'. Then the GPS-derived navigation data will be displayed on the CDI along with a 'GPS' caption. In Figure 6, as GPS is the selected navigation source, 'GPS' is displayed above the 'CDI' source selector key and as a caption on the CDI. The orange flags next to the vertical and horizontal guidance bars on the CDI show that there is no valid navigational data, and the centred deviation bars should not be used.

The GNS 430 has many functions (the pilot's guide and reference consists of 266 pages), but there is no requirement for pilots to receive training on such navigation equipment. The GNS 430 in G-BOTI was fitted with a terrain database that could have been used to enhance terrain awareness.

During the power up sequence of the unit, a self-test page is displayed to confirm the CDI is displaying correctly. The test settings drive a half scale deflection of the glideslope deviation bar and remove its associated warning flag from view. To move on from this page the pilot must press the 'ENT' key.

Maintenance

The aircraft was returning from Biggin Hill where a 100-hour maintenance inspection had been carried out. In addition to the routine tasks, an avionics engineer worked a reported defect with Nav 1, the GNS 430; '*Nav 1 INOP (identifying but not displaying VOR or glideslope)*'.

Using an IFR4000 test set, the engineer checked the operation of Nav 1. The VOR indication was recalibrated because it was found to be 5° out of alignment, but the glideslope was found to be working correctly even at low signal strengths. The defect was cleared and a further report on its operation during the next flight, the incident flight, was requested.

Immediately after the incident flight, the operator restricted the aircraft to VFR flights. However, subsequently, an instructor from the operator found that the GNS 430 and its CDI were operating normally.

Meteorology

The weather conditions at Exeter Airport at the time of the serious incident was scattered cloud at 800 ft agl, a cloud base at 2,500 ft agl and good visibility. The wind was from 170° at 11 kt and the temperature was 16°C.

Personnel

The pilot held a valid CPL and his medical was in date. He had held a PPL since 2016 and completed his CPL and instrument rating skills test in 2021.

Air Traffic Control

General

The radar controller, who had recently taken over the frequency when G-BOTI was already at 2,600 ft on a closing heading for the localiser, described the traffic level as light, with G-BOTI and one other aircraft on frequency. After issuing a clearance for G-BOTI to descend with the glidepath once established on the localiser, the controller's attention turned to the other aircraft, which was behind G-BOTI in the traffic sequence. The controller stated it is normal for aircraft to join the glidepath at 2,600 ft, and the published platform altitude of 2,200 ft would only be used for aircraft joining within 8 nm. When the controller's attention returned to G-BOTI three minutes later, it was well below the glidepath and an immediate intervention was required to instruct the pilot to initiate a climb.

Manual of Air Traffic Services (MATS) Part 2

MATS Part 2 details the instructions and procedures specific to an Air Traffic Service Unit and is applicable in conjunction with MATS Part 1[6]. MATS Part 2 for Exeter Airport

Footnote

[6] Manual of Air Traffic Services (MATS) Part 1 - Civil Aviation Publication (CAP) 493.

contains the following guidance for controllers when vectoring aircraft for an ILS approach to Runway 26:

> '*Due to the steep angle glidepath aircraft should not be vectored to intercept the ILS localiser at a range exceeding 18 nm. The ILS glidepath provides coverage to a distance of 8 nm from the threshold. If an aircraft establishes beyond 10 nm from touchdown the pilot should be instructed "After 8 DME descend on the glidepath*.'

This phraseology was not used by the controller when clearing G-BOTI for the ILS approach, though G-BOTI established on the localiser outside 10 nm. The controller used the correct phraseology when clearing the subsequent aircraft in the sequence for an ILS approach two minutes later.

Other information

Situation awareness

Pilot situation awareness is understanding the aircraft's position in space, being aware of the potential factors which can impact the flight and being able to predict the future effects of those factors. It is important for pilots to maintain good situation awareness for effective performance. When a pilot does not have an accurate understanding of the aircraft state or position, the fidelity of those predictions is compromised.

Analysis

The pilot of G-BOTI did not have an accurate understanding of the aircraft's position relative to the runway, which compromised his situation awareness, particularly in relation to the high terrain and the runway threshold, to the degree that he began his descent 5 nm earlier than the charts allowed. This may have been as a result of his relatively low experience flying ILS approaches, compounded by the clearance received by ATC to intercept the ILS at a height which was not on the approach chart. The pilot believed that the CDI glideslope deviation bar was telling him he was at his descent point because he did not see an orange failure flag, which would have indicated the CDI was not serviceable and might have alerted him to his incorrect mental model of his position relative to the runway.

When an aircraft approaches a descent point from an altitude below the glideslope, the glideslope deviation indicator will show deviation reducing until it becomes zero at the descent point. A static indicator showing no deviation may be a compelling reason to believe that the aircraft is on the glideslope or, in this case, that it has reached the descent point. The pilot did not recall a visible flag on the instrument which meant the CDI display would have been consistent with what he expected to see at that point. However, a check of the DME is an important, independent way to confirm that the aircraft is, in fact, where the pilot thinks it is. A DME check by the pilot of G-BOTI would have revealed that he was further from the airport than he thought and outside the 8 nm within which the glidepath signal was reliable. In addition, a check of the DME as the aircraft descended through 2,200 ft amsl would also have highlighted the fact that the aircraft was below the descent profile.

The CDI had been reported unserviceable prior to the maintenance activity, but it was tested immediately prior to the incident flight and no fault was found. It was reported unserviceable again after the incident flight and it is possible there was an unidentified, intermittent defect with the instrument.

The Exeter controller intervened to stop the aircraft's descent toward terrain, possibly preventing a CFIT event. The clearance given to the pilot of G-BOTI for the ILS approach did not comply with unit procedures to use the phraseology '*after 8 DME descend on the glidepath*', which may have prompted the pilot to confirm his DME before initiating a descent. The aircraft was below the minimum safe altitude for three minutes before the controller queried the pilot.

Conclusion

The pilot started an early descent while attempting to fly an ILS approach to Runway 26 at Exeter Airport, due to degraded situation awareness. This was possibly exacerbated by a malfunction of the glideslope deviation indicator on the CDI.

The approach controller did not use the correct phraseology, which would have made the approach clearance conditional on the pilot confirming his distance from the runway threshold using DME. The pilot would in any case have improved his situation awareness – and probably prevented this serious incident – by checking the DME range at the descent point and when descending through 2,200 ft. A DME check is an important part of procedures such as this because it provides an independent means of confirming that it is safe to descend.

Although the CDI was reported unserviceable before the scheduled maintenance, no fault was found during testing. It is possible that there was an unidentified, intermittent defect with the instrument.

Published: 6 July 2023.