ACCIDENT

Aircraft Type and Registration:	Piper PA-22-150, G-ARDS	
No & Type of Engines:	1 Lycoming O-320-A2B piston engine	
Year of Manufacture:	1959 (Serial no: 22-7154)	
Date & Time (UTC):	11 August 2021 at 1012 hrs	
Location:	Beverley Airfield, Yorkshire	
Type of Flight:	Private	
Persons on Board:	Crew - 1	Passengers - None
Injuries:	Crew - 1 (Minor)	Passengers - N/A
Nature of Damage:	Damaged beyond economical repair	
Commander's Licence:	Private Pilot's Licence	
Commander's Age:	66 years	
Commander's Flying Experience:	119 hours (of which 27 were on type) Last 90 days - 16 hours Last 28 days - 11 hours	
Information Source:	Aircraft Accident Report Form submitted by the pilot	

Synopsis

During the flare in a crosswind landing the aircraft's right wing lifted, causing it to slew off the runway and came to rest in a nearby field. The pilot suggested that the turbulence effects from a windfarm to the south of the airfield may have been a contributory factor in the loss of control.

History of the flight

The pilot had flown from his home airfield of Sherburn in Elmet to Beverley Airfield. The weather conditions were good. Runway 12 was active, with a left-hand circuit and a crosswind from 180° at 10 kt.

The pilot conducted an overhead join and flew a normal circuit. He reported that final approach was stable and aligned with the runway's extended centreline. As the aircraft passed through 150 ft agl the pilot felt "strong" turbulence and had to correct quickly to keep the wings level. He continued the approach, using the "wing-low" method[1] for the crosswind landing. The pilot reported that after the turbulence at 150 ft the approach was stable, until he flared for touchdown. He recalled that at this point he experienced a sudden "violent" gust which lifted the right wing. He attempted to correct with right aileron, and applied power to go around. This was unsuccessful and the aircraft continued to move to the left.

Footnote

[1] Using the rudder to align with the runway and aileron to roll into the crosswind to correct for the drift.

It missed a ditch to the north of the runway but struck the ground in a field beyond, causing substantial damage to the aircraft (Figure 1).

Figure 1
G-ARDS after the accident

In reviewing the accident, the pilot reported that he believed that both the turbulence during final approach and the loss of control during the flare may have been associated with wake turbulence downstream of a wind turbine installation to the south of the airfield. The pilot also commented that as the aircraft still had its rudder/aileron interlink installed[2], the coordination of the rudder with aileron inputs whilst responding to a gust, may have affected the aircraft's response.

Airfield information

Beverley is an unlicenced airfield located 4 nautical miles north-northeast of Beverley with a 710 m grass runway with 12/30 orientation. The aeronautical plate for the airfield identifies that there is a wind turbine installation 1 nm south of the airfield.

The installation comprises twelve 82 m diameter wind turbines, the most northerly is approximately 1.4 km south of Runway 12 threshold and 1.2 km south southwest of Runway 30 threshold (Figure 2).

Footnote

[2] The PA-22 was originally configured with a rudder/aileron interlink that coordinates the movement of the rudder and ailerons to simplify flying the aircraft. This is a sprung interlink that can be overridden. Many PA-22 aircraft have subsequently removed the interlink, however the interlink was still fitted to G-ARDS.

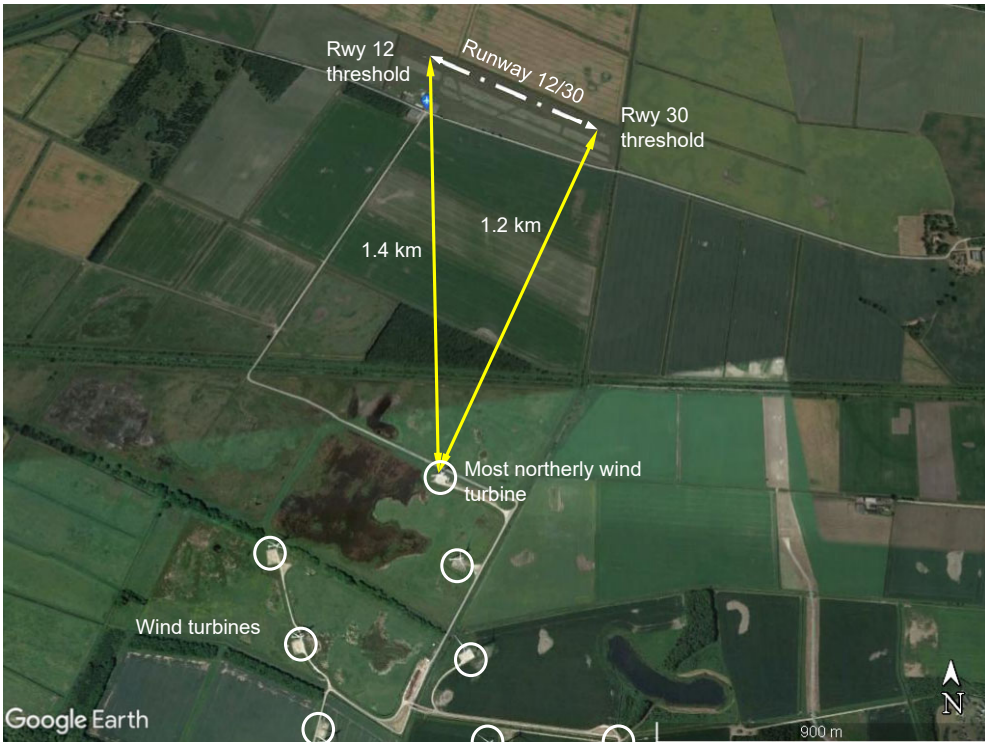

Figure 2

Location of most northerly wind turbine at Hall Farm in relation to the runway at Beverley Airfield

The AAIB contacted the airfield management enquiring whether there had been any reports of aircraft experiencing turbulence on approach and landing when with a southerly wind direction. They were not aware of any occurrences but did suggest that there can be some shadowing from the trees to the west of the clubhouse.

CAP 764 - CAA Policy and Guidelines on Wind Turbines

CAP 764, the CAA Policy and Guidelines on Wind Turbines, issue 6, February 2016[3] identifies the risk wind turbines pose to aviation. Paragraphs 2.51 to 2.61 discuss turbulence caused by the wake of the turbine. They describe that the wake turbulence, which is similar, but not identical to, that produced by aircraft, extends downwind behind the wind turbine blades and tower. The turbulence experienced in the 'near field' (within one rotor diameter) is well understood and can be related to the efficiency and power extraction from the airflow through the turbine. The 'far field' effect is less well understood, with the dissipation of the turbulence, and therefore its reduction of intensity, being dependent on the convection, turbulence diffusion, the topography (such as obstacles and terrain downwind the turbine) and the atmospheric conditions.

Published research referred to in the CAP identifies that turbulence effects could still be noticeable up to 16 rotor diameters downstream of a wind turbine. However, research

Footnote

[3] http://publicapps.caa.co.uk/docs/33/Cap764.pdf [accessed 18 Janaury 2022.]

published by Liverpool University[4], in conjunction with the CAA, suggests that the turbulence should become dissipated below noticeable levels within five rotor diameters of the turbine. This was based on computational fluid dynamics and 'light detection and ranging' (LIDAR) measurements of the 'velocity deficit'[5] in the wake of a 30 m diameter wind turbine.

A more recent publication by the Netherlands Aerospace Centre[6], identified that for helicopter operations wind turbine wake turbulence had diminished sufficiently for safe operation by six rotor diameters downwind of the rotor. This analysis was based on a *'relatively simple analytical wake model'* of a single 8 MW wind turbine with a 164 m rotor diameter. The report also suggests a safe distance from a windfarm (of multiple wind turbines) would be eight rotor diameters. A maximum 'wind velocity deficit' of 6 kt was used in this analysis, based on helicopter susceptibility to such turbulence.

The windfarm installation to the south of Beverley Airfield is 1.4 km from the Runway 12 threshold, which is just over 17 times the wind turbine diameter. The threshold of Runway 30 is within 15 times the wind turbine diameter.

The CAP states that there *'are currently no Mandatory Occurrence Reports (MOR) or aircraft accident reports related to wind turbines in the UK'*. It goes on to state *'Pilots of any air vehicle who firmly believe that they have encountered significant turbulence, which they believe to have been caused by a wind turbine, should consider the need to report this through the existing MOR scheme.'*

AAIB Comment

The available literature would suggest that the possibility of encountering wake turbulence from the windfarm at this airfield is remote. However, it cannot be entirely ruled out. The accident aircraft flew an approach that crossed downwind of the wind turbines but the distance from the closest turbine to the location that the aircraft encountered the upset was further than 16 rotor diameters identified in CAP 764 as the furthest distance that turbulence would be encountered. It was also well outside that of the most recent estimates of eight rotor diameters downwind of windfarms.

The analysis that has been conducted has been based on limits for commercial fixed-wing and rotary-wing aircraft and may not take into account the effects on general aviation operations. It is therefore incumbent on the General Aviation community to provide feedback to the CAA, via an MOR, if they suspect they have been affected by wind turbine wake turbulence. This will allow a more representative understanding of the issue and ensure the guidance for operating close to a wind farm is based on theoretical and practical knowledge.

Footnote

4 Aircraft Encounter with Wakes - Flight Science and Technology - University of Liverpool
5 Velocity deficit is variation in average wind speed in the flow downwind of a turbine.
6 https://reports.nlr.nl/bitstream/handle/10921/1496/TP-2019-083.pdf?sequence=1&isAllowed=y [accessed January 2022.]