ACCIDENT

Aircraft Type and Registration:	1) Taylorcraft BC12D, Twosome, G-BVXS 2) Pitts S-2C, Pitts Special, G-IICI
No & Type of Engines:	1) 1 Continental Motors Corp A65-8 piston engine 2) 1 Lycoming AEIO-540-D4A5 piston engine
Year of Manufacture:	1) 1946 (Serial no: 9284) 2) 1998 (Serial no: 6017)
Date & Time (UTC):	18 December 2011 at 1400 hrs
Location:	Leicester Airport
Type of Flight:	1) Private 2) Private
Persons on Board:	1) Crew - 1 Passengers - None 2) Crew - 1 Passengers - 1
Injuries:	1) Crew - 1 (Fatal) Passengers - N/A 2) Crew - None Passengers - None
Nature of Damage:	1) Destroyed 2) Damaged beyond economic repair
Commander's Licence:	1) Private Pilot's Licence 2) National Private Pilot's Licence
Commander's Age:	1) 55 years 2) 48 years
Commander's Flying Experience:	1) 640 hours (of which in excess of 150[1] were on type) Last 90 days - 15 hours Last 28 days - 1 hours 2) 948 hours (of which 150 were on type) Last 90 days - 21 hours Last 28 days - 4 hours
Information Source:	AAIB Field Investigation

Synopsis

The mid-air collision occurred when both aircraft were on the crosswind leg of the visual circuit for Runway 33 at Leicester Airport, soon after G-BVXS had taken off and as G-IICI had joined the circuit from the northeast. G-BVXS became uncontrollable after the collision and the pilot was fatally injured when the aircraft struck the ground. The two occupants of G-IICI were uninjured after making a forced landing.

Footnote

[1] Only the pilot's current logbook was recovered after the accident. 150 hours on type had been recorded in this logbook, but it was known that the pilot had completed the majority of his flying on type.

History of the flights

The pilot of G-IICI stated that he was returning to Leicester Airport from Langar Airfield, 18 nm north-north-east of Leicester Airport. He occupied the rear seat and a passenger, who was a microlight pilot, occupied the front seat. Enroute they both practised some aerobatics overhead Melton Mowbray Airfield, 9 nm north-east of Leicester Airport. Prior to commencing the aerobatics, the pilot tuned the radio to the Leicester frequency and turned down the volume to a level at which he could perceive transmissions[2], but not hear speech. He did this to improve communication between himself and the passenger whilst maintaining an awareness of radio activity. Having completed the aerobatics they headed south. The pilot stated that he probably then turned up the volume on the radio, to listen to Leicester Radio, when he was at about 6 nm from Leicester. He subsequently flew some rolling aerobatic manoeuvres. During this time the pilot of G-BVXS had made the radio calls for start-up, taxi and takeoff, and began the takeoff roll from Runway 33 at Leicester Airport, with the intention of completing about two visual circuits.

Upon completion of the aerobatics the pilot of G-IICI said to the passenger "we are getting close to Leicester, I'll take it from here". A few seconds later, when the aircraft was just north of Houghton-on-the-Hill, about 2 nm north-east of Leicester Airport, the pilot stated that he transmitted "Leicester radio, golf india india charlie india inbound".

An observer in the tower, who was also a pilot, not only heard the Air to Ground Operator (A/G) reply with the runway in use as "three three left hand" and the QFE "nine nine eight millibars", but also heard the pilot of G-IICI acknowledge. The pilot stated that he had responded with "three three left, nine nine eight, charlie india has about three miles to run from the north and will join deadside at a thousand feet". He then looked at the altimeter to check that the correct QFE was set. At this point, G-BVXS had just started its takeoff roll.

The pilot of G-IICI positioned the aircraft to the north of the airfield to join the crosswind leg for Runway 33. He then believes he transmitted "golf charlie india deadside at one thousand feet". At this time the pilot estimated that the aircraft's heading was about 240°, at 1,000 ft aal with an IAS of 110 mph. The sun was low and about 45° to the aircraft's left. The pilot stated that no circuit traffic had been notified to him nor had he heard or seen any other traffic, with the exception of a helicopter using Runway 24. G-BVXS was still climbing on the crosswind leg. This resulted in it being in front of and below G-IICI.

The pilot of G-IICI reported that he then initiated a left turn onto the downwind leg for Runway 33 and noted that the sun was particularly bright. The aircraft was at 1,000 ft aal, 110 mph, flying almost directly into the sun, with about 30° of bank, when the pilot heard a loud bang, the aircraft "shuddered", and the propeller stopped. His initial thought was that the engine had "exploded"; however, on asking his passenger "what was that?", the passenger replied, "aircraft". The pilot attempted to maintain airspeed and transmitted "MAYDAY MAYDAY MAYDAY golf charlie india mid-air collision," and he looked for a suitable landing area.

Witnesses observed G-BVXS in a near vertical dive from which it did not recover. It struck the ground in

Footnote

[2] The aircraft was in Class G airspace at this time and therefore there was no requirement for radio communications.

a field next to some houses on the road on the southern boundary of the airport. The pilot was fatally injured.

After the collision, G-IICI had debris of G-BVXS trailing from its propeller. It touched down on a disused aircraft dispersal area in a field adjacent to the airport boundary road and headed towards a hedgerow. In an attempt to increase the available landing distance the pilot applied right rudder; however, this had limited effect. The aircraft struck the hedgerow left wing first and came to rest on its left side in the middle of the road. Having secured the aircraft's engine and electrics, the pilot and passenger exited the aircraft unaided and uninjured.

G-IICI pilot's additional comments

The pilot of G-IICI stated that owing to the poor visibility from the Pitts Special he had been taught to perform a visual "sweep" of the airspace ahead by gently weaving the aeroplane from side to side, and to deliberately fly with a small amount of bank, or out-of-balance yaw, to improve his lookout. When joining the visual circuit he noted that flying at a speed of around 110 mph allowed him to keep the nose low, to improve forward visibility.

The pilot of G-IICI noted that his joining transmission to Leicester Information was made later than usual because of a combination of the tailwind, his higher airspeed in the descent and cloud avoidance which had altered his usual route and expedited his flight. As a result he was aware of the importance of maintaining a good lookout.

He also commented that he was aware that an overhead join was preferred at Leicester, but because of the observed cloud base to the north of the airport, he decided to carry out a crosswind join.

He was aware that he needed to pay special attention and to look out to the left and right at 1,000 ft during the turn from the crosswind leg onto the downwind leg because of the sun. He believed that this was the most likely location for other traffic since he had already looked down at the runways and had not seen any traffic.

The pilot of G-IICI did not report any technical problems with the aircraft prior to the collision.

Air to Ground operator's (A/G) comments

The A/G operator, who co-owned G-BVXS with the accident pilot, had flown a local flight in G-BVXS with the accident pilot prior to commencing his duty. He stated that the pilot of G-BVXS made all the appropriate transmissions during start-up, taxiing and takeoff. The observer in the tower had stated that a joining transmission from G-IICI had been made and that the A/G operator had acknowledged, but the A/G operator had no recollection of these transmissions.

The A/G operator did not report any technical problems with G-BVXS on its previous flight.

G-IICI wreckage site

The wreckage of G-IICI was located on a road that borders the southern boundary of Leicester Airport. It was largely intact and was lying on the left side of its fuselage. Both left mainplanes were severely damaged. The cockpit area was intact and the occupants were able to vacate the aircraft using the hinged canopy.

In the field next to the road were several sets of ground marks covering a distance of 150 m, consistent with all three wheels touching the ground during the forced landing. These marks stopped at the electric fence and dense hedgerow that marked the boundary between the

field and the road. A tree stump and a fence post in the hedge were no longer in the ground and were close to the location of the aircraft. Attached to the propeller of the G-IICI was the wreckage of the empennage and some of the rear fuselage of the G-BVXS (see Figure 1).

G-BVXS wreckage site

With the exception of the rear fuselage and the empennage, the majority of the G-BVXS wreckage was located in an uncultivated area in the corner of a field. The wings, whilst significantly damaged and crumpled, were still attached to the forward fuselage. The fuselage appeared to have struck the ground at more than 90° nosedown. Most of the engine was below ground level, and there was a distinct, full-span ground impact mark underneath the wings. There was slightly more damage to the right wing than the left.

Approximately 12 other pieces of wreckage from G-BVXS were located away from the main wreckage sites. The most significant of these were the right mainwheel and the tailwheel of G-BVXS which were 75 m and 200 m respectively due south of the main G-BVXS wreckage.

Aircraft information

The Taylorcraft is a two-seat high-wing monoplane with a tailwheel configuration. It was built in 1946 and was fitted with a 65 hp continental engine. Both the airframe and the engine had had an annual check in April 2011 when the Permit to Fly for the aircraft was renewed.

The typical rate of climb for a Taylorcraft BC12D, Twosome, is around 600 ft/min, and the typical straight-and-level airspeed in the circuit is around 70 kt (about 80 mph).

Figure 1

Location of G-IICI - note some wreckage from G-BVXS (silver and red) attached to the propeller of G-IICI

The Pitts Special is a two-seat biplane with a tailwheel configuration. It was built in 1998 and was fitted with a 260 hp Lycoming engine. Both the airframe and engine had been the subject to a 50-hr check in September 2011. The aircraft had a valid Airworthiness Review Certificate.

Engineering investigation

The controls on both aircraft were checked and nothing significant was found that might have contributed to the accident.

The wreckage from both aircraft was inspected and compared. There were some black witness marks halfway along one propeller blade of G-IICI; these matched a distinctive gouge in the tailwheel (which was made of solid black plastic) of G-BVXS that had become detached. There was a large dent in the inboard section of the upper right main-plane of G-IICI that was consistent with it having struck the right mainwheel of G-BVXS and causing the wheel to detach from the gear leg during the collision.

Weather information

An aftercast was provided by the Met Office. In summary, it stated that at Leicester Airport, at 1400 hrs, the visibility was 40 to 45 km with no cloud, the temperature was +4°C and the dew point was between 0°C and -2°C. The surface wind was from approximately 300° at 10 kt. At 2,000 ft the wind was estimated to be from 340° at 22 kt. Satellite imagery taken over the area at the time of the accident showed mainly clear skies, with some scattered cloud. A review of video evidence confirmed that there was scattered cloud at the time.

At 1400 hrs the sun's bearing was 207°T and its elevation was 10° above the horizon.

Recorded data

Radar data for G-IICI and GPS data for G-BVXS was recovered that allowed the position of each aircraft leading up to the collision to be determined. Additionally, video and audio recordings from a digital video camera mounted on the helmet of G-IICI's pilot were analysed.

Radar and GPS

Radar coverage from the Clee Hill radar head in Shropshire tracked G-IICI for the majority of its flight until two seconds before initial touchdown. This coverage was a combination of both Primary (PSR) and Secondary (SSR) Surveillance Radar. PSR coverage within the vicinity of the airfield was intermittent, such that the last 30 seconds of the flight was only detected by the SSR. For these SSR recordings, the transponder fitted to G-IICI was only responding with Mode A messages so no altitude information was available. The collision occurred out of coverage of the PSR. G-BVXS was not fitted with a transponder and therefore was not detected by the radar.

A Garmin GPSMAP 496 was recovered from the wreckage of G-BVXS. The GPS unit had sustained damage during the ground impact but data was recovered from its internal memory that included a log of the accident flight. The last recorded point positioned G-BVXS on the crosswind leg of the left-hand circuit to Runway 33,973 ft aal[3] and about two seconds after the collision. The GPS altitude data together with a calculated climb rate (averaged over consecutive points[4]) is illustrated at Figure 2 and shows that G-BVXS was climbing at about 500 ft/min during the climb onto the crosswind leg. The calculated groundspeed, again between consecutive points, showed that G-BVXS's average speed over the last 10 seconds of the recorded log was 45 kt. Similarly, the groundspeed of G-IICI during this same period leading up to the collision was about 90 kt.

The complete GPS track of G-BVXS and the radar track of G-IICI from time 1358:22 hrs (coincident with G-BVXS beginning its takeoff rollout) are illustrated at Figure 3, together with the collision point and wreckage

Footnote

[3] The actual recorded GPS altitude has been converted to height above airfield level such that the takeoff ground roll occurs at zero feet.

[4] Note that the period between the last two pairs of recorded points was 15 and 10 seconds respectively.

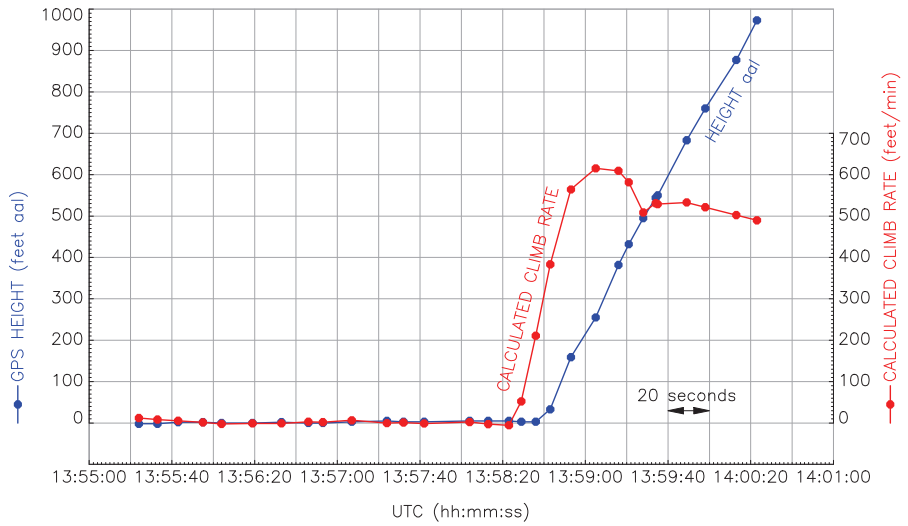

Figure 2

GPS derived height above airfield level for G-BVXS

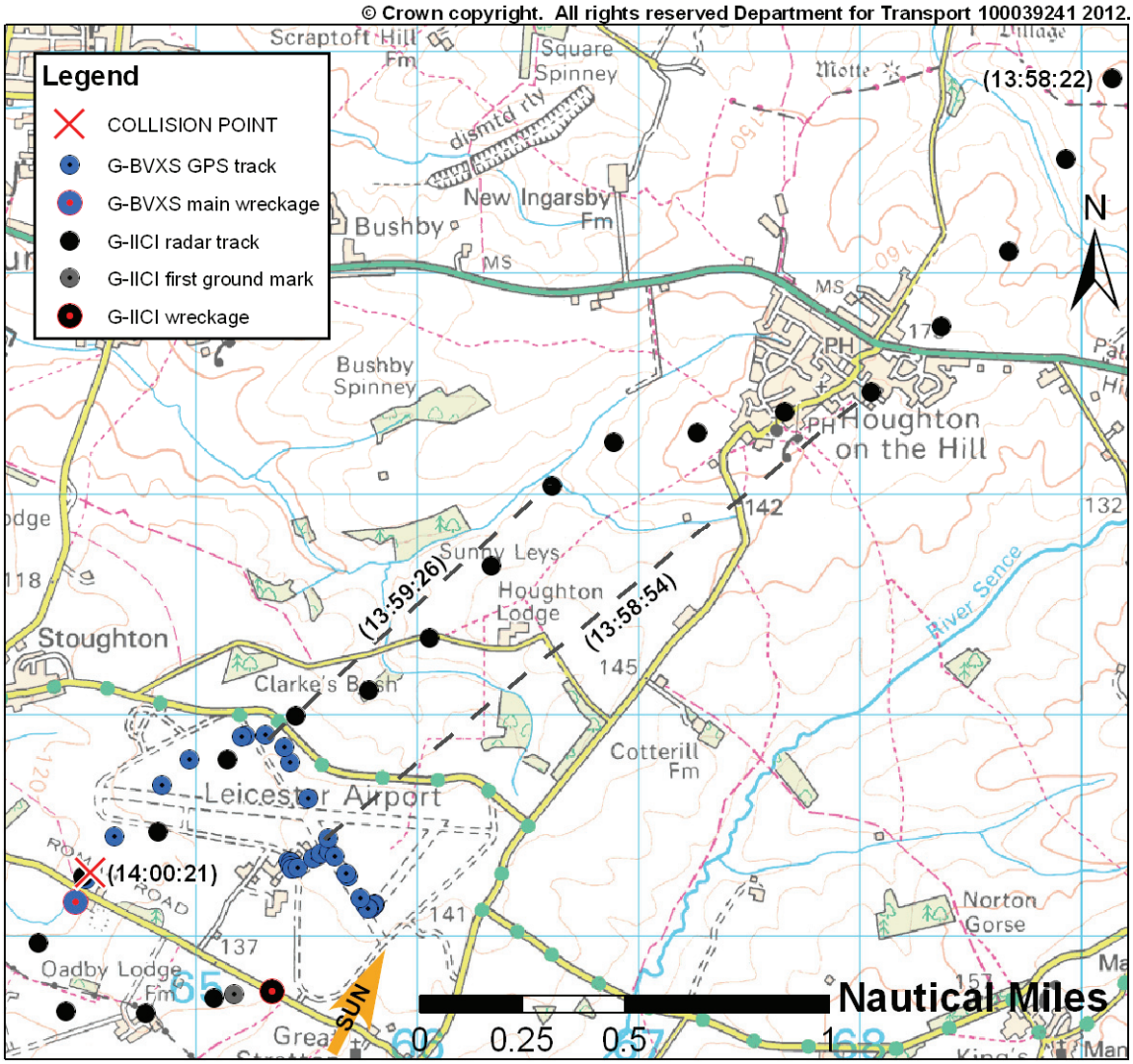

Figure 3

G-BVXS and G-IICI ground tracks from GPS and radar

locations of both aircraft. Also indicated are the relative positions of both aircraft to each other at a number of points leading up to the collision. They show that G-BVXS was either directly ahead, but under the nose (and in the general direction of the sun – also indicated), of G-IICI, or on a constant bearing from the time G-IICI turned onto the crosswind leg, until the collision.

Video evidence

The pilot of G-IICI was wearing a headset and canvas aerobatic pilot helmet with a *Mini DV* digital video camera mounted on the top left (thus filming slightly higher than the pilot's line of sight). The camera was recording at 25 frames per second, with 720 x 480p resolution and a field of view of about 140°.

A general observation from the video was that the pilot of G-IICI was moving his head left to right, consistent with his statement that he was keeping a good lookout as he joined the circuit.

The audio recording from the camera was taken from its own microphone such that any radio transmissions or conversations between the pilot and passenger were generally masked by the sound of the engine. However, at time 1356:38 hrs, with the aircraft passing the village of Twyford 6 nm to the north east of the airfield, unintelligible speech could be heard immediately after the pilot momentarily looked down inside the cockpit. He subsequently flew some seven rolling aerobatic manoeuvres; the last manoeuvre was completed at 1358:34 hrs when the aircraft was about 2.3 nm from Leicester Airport. The pilot momentarily looked down again at 1358:49 hrs with the aircraft at Houghton-on-the-Hill (just under 2 nm from the airfield). This is consistent with the pilot's statement that he checked the QFE after making his joining transmission. An image from the video recording at this time is given at Figure 4 which also shows the altimeter indicating 1,200 ft aal.

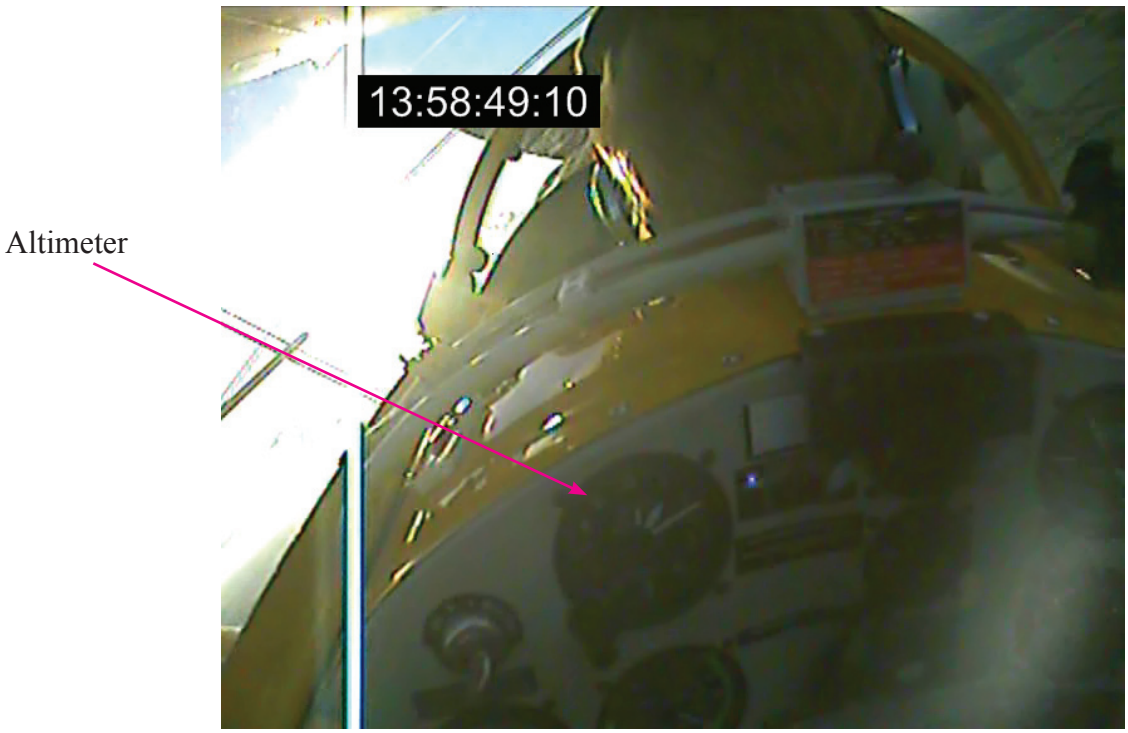

Figure 4

Head-down view from helmet-mounted camera video recording as the aircraft reaches Houghton-on-the-Hill with the altimeter visible and indicating 1,200 ft

Figure 5

View from helmet-mounted camera with the airfield just in view

Figure 5 is an image from the video recording with the airfield just visible at the bottom and left of centre, with the sun clearly in the view. G-BVXS would have been out of view, masked by the nose of G-IICI. This image also shows that, given the lack of contrast between G-BVXS and the surrounding countryside and the position of the sun[5], the aircraft would have been difficult to detect visually[6].

The first recorded view with G-BVXS in the image occurred just before 1400:19 hrs, as the pilot moved his head from left to right (Figure 6). The collision occurred two seconds later during which time the pilot continued this look out scan to the right and then scanned back to the left and right again. The nose of G-IICI was not always in the camera's field of view during the head turns so only glimpses of G-BVXS were seen in the subsequent video images.

Medical examination

A post-mortem examination of the pilot of G-BVXS was carried out by a consultant aviation pathologist. He concluded that the pilot died as a result of multiple injuries consistent with having been caused when his aircraft struck the ground. Additionally, there were no medical or toxicology factors that may have contributed the accident.

Footnote

[5] The sun's appearance as seen on the video is not necessarily representative of how it would be perceived by the pilot.

[6] Limitations of the See-and-Avoid Principle; ATSB Research Report, April 1991, http://www.atsb.gov.au/publications/1991/limit_see_avoid.aspx states "*...particularly poor contrast between an aircraft and its background can be expected when:...• A dark aircraft appears against a dark background*". The report also discusses the effect of glare and its "*reduction in visual effectiveness*".

Figure 6

First recorded image with G-BVXS in view (a small portion of the left wing and strut is visible at the junction of G-IICI's propeller blade and upper nose cowling)

Airfield information

Leicester Airport is 469 ft amsl and has three runways orientated 15/33, 04/22 and 10/28. It has a 2 nm diameter Aerodrome Traffic Zone (ATZ) centred on the mid-point of Runway 10/28 from the surface to 2,000 ft aal.

An air/ground communications service (AGCS), callsign 'Leicester Radio' was provided by an A/G. The introduction to CAP 452, *Aeronautical Radio Station Operator's Guide* states the following:

> *'1.1 Air Ground Communications Service (AGCS) is a service provided to pilots at specific UK at aerodromes. However, it is not viewed by the UK as an Air Traffic Service because it does not include an alerting service as part of its content.*
>
> *1.2 AGCS radio station operators provide traffic and weather information to pilots operating on and in the vicinity of the aerodrome. Such traffic information is based primarily on reports made by other pilots. Information provided by an AGCS radio station operator may be used to assist a pilot in making a decision; however, the safe conduct of the flight remains the pilot's responsibility.'*

The section on Leicester Airport in the *UK Aeronautical Information Publication* states the following:

'FLIGHT PROCEDURES

1. Circuits

a. All fixed-wing circuits are to the left.

b. The standard overhead join is preferred for fixed wing.

c. Fixed wing circuits will be at 1000 ft QFE.'

Commercially available flight guides also state '*the standard overhead join is preferred'*.

Leicestershire Aero Club Pilots' Order Book

Leicester Airport was operated by Leicestershire Aero Club. All members of Leicestershire Aero Club are to indicate they know and understand the contents of the orders book by signing prior to first flying at Leicestershire Aero Club, annually or after the issue of amendments.

'ORDER No: 2.4 - Turns after take-off

Provided the ANO and Rules of the Air are complied with at ALL times:

2.4.1 Pilots shall not make turns immediately after take-off below 1000 feet above ground level when departing from Runway 28, or 500 feet from any other Runway.

ORDER No: 5.3 - Signals square and signal instructions from ATC

Order 5.3.3: An Air/Ground Service only provides basic information and may not give instructions. Pilots shall notify the A/G station of their intentions at all stages of the taxi, take-off and whilst in the circuit or ATZ. Pilots are responsible for deciding the course of action in all circumstances.

ORDER No: 5.4 - Circuit procedures

5.4.1. Normal circuit height is 1000 feet agl (QFE) and the circuit direction is left hand.

5.4.2 When using Runway 28, all aircraft are to climb straight-ahead maintaining runway centre line to 1000 feet A.G.L before turning.

*5.4.4 Pilots shall report **DOWNWIND** with their intention (Land, Go-around or Touch and Go) and any non-standard powered approach information (eg: Glide-Approach, Flapless etc.).*

5.4.9 VFR Circuit Rejoin

A VERY GOOD LOOKOUT MUST BE KEPT WHEN REJOINING

5.4.10. Rejoins are variable. Either:

a) Overhead at a height of typically 2000 feet agl, but not below 1500 feet agl commencing descent on the DEADSIDE once passed the centreline of the active runway in an arc so as to cross the upwind end and 1000 feet agl (to join the conventional crosswind leg). An appropriate R/T call must be made prior to commencing the descent. Descending aircraft must give way to traffic already established in the circuit.

b) Rejoin directly onto a conventional circuit leg (crosswind, downwind, base) at the circuit height of 1000 feet agl. Joining traffic must make their intentions know by R/T prior to entering the ATZ and give way to established circuit traffic.

ORDER No: 5.6 - Lookout near and within the circuit

5.6.1 Qualified pilots and solo students are responsible for maintaining a vigilant lookout and adequate separation within the ATZ.

5.6.2 Pilots are to report entering the ATZ, joining with position, Downwind and Final.

ORDER No: 5.8 - Use of RTF

5.8.4 The following positional calls will be made to Leicester Radio (whether manned or otherwise):

***Downwind** - when abeam the upwind end of the active runway.*

***Final/full stop** - when the turn from base leg onto final approach is complete.*

***Final/touch & go** - when the turn from base leg onto final approach is complete.'*

At the time of the accident it did not state an overhead join was preferred. The operator of Leicester Airport stated that an amendment has been issued to include that overhead joins are preferred to align with the advice given in the AIP.

CAA Safety Sense Leaflets

CAA Safety Sense Leaflet 6, *Aerodrome Sense,* states the following:

'3 Arrival

i) Keep a good lookout, using others' radio calls to help identify all traffic joining or already in the pattern. Give way to aircraft already in the pattern.

4 CIRCUIT PATTERN

a) Follow the pattern illustrated [standard overhead join], unless a different procedure is published. Watch out for others who may follow the 'wrong' pattern.'

It also includes a diagram of an overhead join (Figure 7).

CAA Safety Sense Leaflet 13, *Collision Avoidance*, contains advice for avoiding mid-air collisions and in its summary contains the following points amongst others:

'• Plan your flight so you are looking ahead for expected features.

- *Plan to avoid busy areas if possible.*
- *Beware of blind spots, move your head or manoeuvre the aircraft.*
- *Spend the minimum time with your head down checking the charts (or GPS), changing radio frequencies etc.*
- *Aircraft below you may blend into the background of buildings etc.*

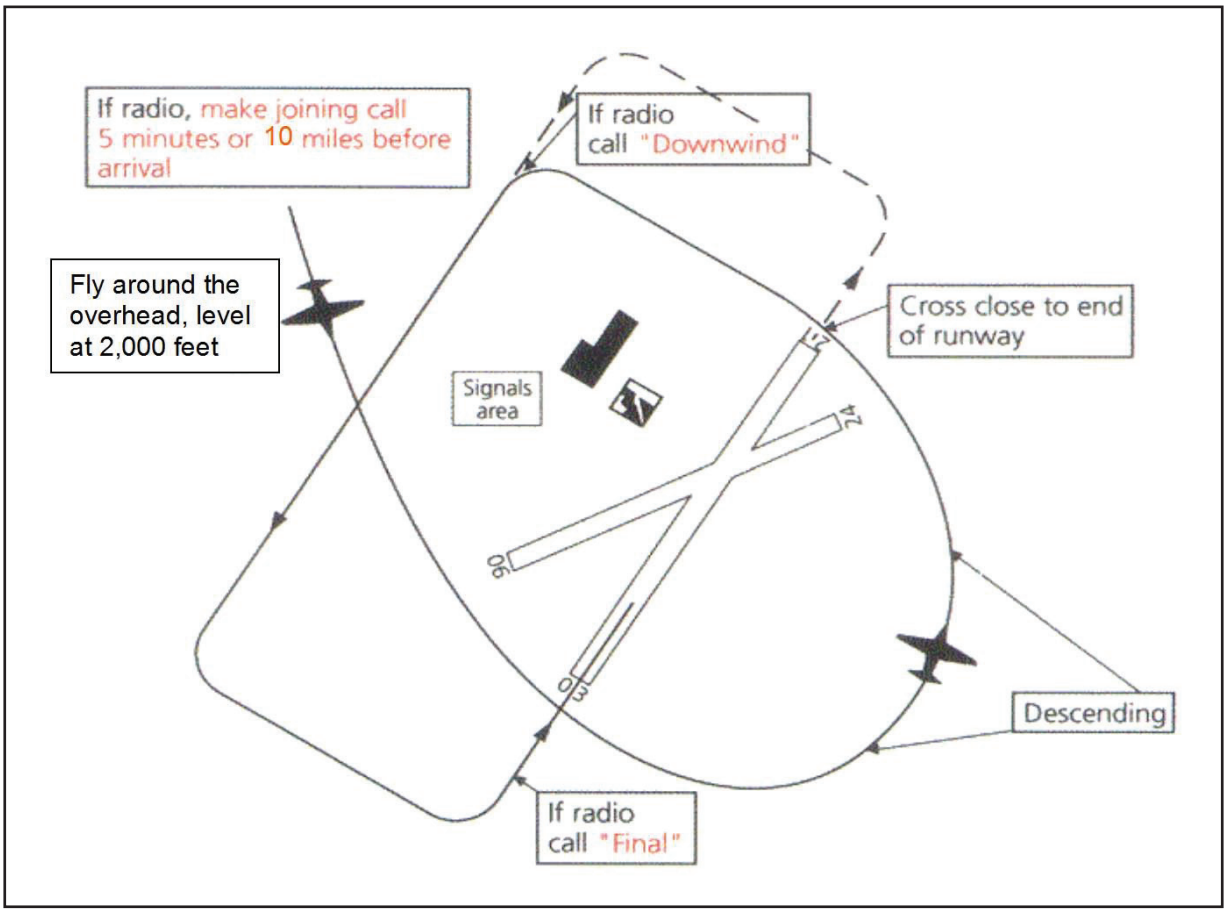

Figure 7

Diagram of the overhead join from CAA Safety Sense Leaflet 6

- *Use LARS and other radio information to form a mental picture of what is going on. Don't rely solely on it – someone could be NON-RADIO.*
- *Encourage your passengers to assist in the look-out.'*

ATC procedures

An ATZ has the characteristics of the airspace in which it is located. The Leicester ATZ is located within an area of Class G 'uncontrolled' airspace. As such, ATC are not required to provide 'separation' between VFR traffic.

Civil Aviation Publication (CAP) 393, *Air Navigation: The Order and the Regulations, Section 2, The Rules of the Air Regulations 2007* states in *Section 4, General Flight Rules*:

'Avoiding aerial collisions

'8 (1) Notwithstanding that a flight is being made with air traffic control clearance it shall remain the duty of the commander of an aircraft to take all possible measures to ensure that his aircraft does not collide with any other aircraft.'

Analysis

The GPS data from G-BVXS and the images of the aircraft captured on the helmet-mounted camera indicated that the aircraft's engine and controls were performing normally at the time of the collision. The pilot of the G-IICI did not report any technical problem with his aircraft, and nothing significant was found during the inspection of the controls for both aircraft. It is therefore very unlikely that there was a technical problem that caused or contributed to the accident.

The video images from the helmet-mounted camera showed that G-BVXS was approximately wings level (wings parallel with the horizon) when the collision occured. G-IICI was banked at approximately 30° to the left, almost on the same heading as G-BVXS, with the spinner of G-IICI approximately half a metre below and to the right of the tail wheel of G-BVXS. The witness mark located halfway along one of the propeller blades of G-IICI (which appeared to match the damaged tail wheel of G-BVXS) and the fact that the right main wheel of G-BVXS became detached but the left wheel remained attached, are all consistent with analysis of the flight paths using the video images.

The pilot of G-IICI turned down the volume on the aircraft's radio prior to commencing aerobatics. He then turned it up again about 6 nm from Leicester and flew some rolling aerobatic manoeuvres prior to making his joining call at about 2 nm from Leicester Airport. During this time the pilot of G-BVXS started up, taxied out and took off making all appropriate calls as he did so.

In appropriate conditions, a standard overhead join offers the opportunity for a pilot to gain improved situational awareness of other circuit traffic. The pilot of G-IICI had not carried out a standard overhead join due to his assessment of the cloud base to the north of the airfield. In addition, situational awareness may have been improved by keeping the radio's volume to a level at which radio calls from other aircraft in the circuit can be heard and making joining radio transmissions 5 mins or 10 nm from the airport, as recommended in Safety Sense Leaflet 6.

The GPS and radar data confirmed the two aircraft were on a converging course. The video evidence shows that G-BVXS was climbing but obscured from the view of the pilot of G-IICI by the nose of his aircraft.

The lack of contrast between G-BVXS and the surrounding countryside, compounded by the position of the sun, would have made it difficult for the pilot of G-IICI to detect the other aircraft visually.

It is not known if the pilot of G-BVXS heard the transmissions from the pilot of G-IICI or the responses from the A/G operator. As G-BVXS was turning onto the crosswind leg after takeoff, G-IICI would have been above and to the right of G-BVXS and about 1 nm away. However, after completing the turn onto the crosswind leg, G-IICI would have been behind and above G-BVXS, and therefore would not have been visible to the pilot of the G-BVXS.

Conclusion

The mid-air collision occurred when both aircraft were on the crosswind leg of the visual circuit, soon after G-BVXS had taken off and as G-IICI had joined the circuit from the northeast. The two aircraft collided because their respective pilots either did not see the other aircraft, or did not see it in time to take effective avoiding action. Contributory factors were a combination of poor forward visibility from G-IICI, the lack of contrast between G-BVXS and the surrounding countryside, the position of the sun and the relative positions of G-IICI and G-BVXS.