AIRCRAFT ACCIDENT REPORT 5/82

Accidents Investigation Branch

Department of Trade

Report on the collision between Piper PA28 (Cherokee) G-AVBJ and G-AXZC near Hamble Aerodrome, Hants on 30 April 1981

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No	*Short Title*	*Date of Publication*
11/81	Piper PA 38–112 Tomahawk G–BGGH Wood Farm, Kiddington, Oxfordshire May 1980	February 1982
1/82	Pilatus PC–6/B2–H2 Turbo Porter G–BHCR Peterborough (Sibson) Aerodrome February 1981	April 1982
2/82	McDonnell Douglas DC10–30 N 83 NA London Heathrow Airport September 1980	September 1982
3/82	Maule M–5–235C G–LOVE Cranfield Aerodrome Beds September 1981	September 1982
4/82	Cessna Citation 500 G–BPCP St Peters Jersey Channel Islands October 1980	
5/82	Piper PA28 (Cherokee) G–AVBJ and G–AXZC Hamble Aerodrome Hants April 1981	

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Department of Trade
Accidents Investigation Branch
Bramshot
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6 September 1982

The Rt Honourable Lord Cockfield
Secretary of State for Trade

Sir,

I have the honour to submit the report by Mr L S H Shaddick, an Inspector of Accidents, on the circumstances of the accident to Piper PA28 (Cherokee) G–AVBJ and G–AXZC which occurred near Hamble Aerodrome, 30 April 1981.

I have the honour to be
Sir
Your obedient Servant

G C WILKINSON
Chief Inspector of Accidents

Accidents Investigation Branch

Aircraft Accident Report No 5/82
(EW/C746)

Operator (both aircraft):		College of Air Training, Hamble
Aircraft:	*Type (both aircraft):*	Piper PA28 (Cherokee)
	Model:	Series 180
	Nationality:	British
	Registrations:	G–AVBJ and G–AXZC
Place of Accident:		0.5 nm south east of Hamble aerodrome Latitude: 50° 51'N Longitude: 001° 18'W
Date and Time:		30 April 1981 at 1409 hrs All times in this report are GMT.

Synopsis

The accident was notified to the Accidents Investigation Branch on the afternoon of the accident and an investigation was commenced the same day.

The two aircraft were engaged in circuit training exercises and were flown solo by student pilots. G–AVBJ (BJ) was established on the final approach path and was struck on its right hand side from behind and above by G–AXZC (ZC) which had just completed a right turn on to finals from the base leg. At the moment of impact ZC was in a shallow right bank and had a much greater rate of descent and a slight overtaking speed. Following the collision, both aircraft went into near vertical dives and fell into soft mud on the eastern bank of the River Hamble, killing the two occupants.

It is concluded that the collision was caused by the pilot of ZC turning on to finals without realising that BJ was already established on an approach to land ahead of him. Blind spots in cockpit visibility, aggravated by the operation of a right hand circuit, were major factors in the failure of each pilot to detect subsequently the approach of the other aircraft. The level of inexperience of both students was also contributory.

1. Factual Information

1.1 History of the flight

The two aircraft involved in the collision, G–AVBJ (BJ) and G–AXZC (ZC), were being flown solo by students who were members of the same instructional course and who were both in the very early stages of flying training following their first solo flights. The runway in use at Hamble was grass runway 32, with parallel landing and take-off runs separated by a sterile area. The landing area was further sub-divided into left and right landing paths and aircraft were expected to use the left landing path if the runway ahead was clear. The circuit direction was right-hand and a full air traffic control (ATC) service was in operation.

At 1257 hrs BJ taxied out for a series of circuits which were to include both full stop and touch and go landings. All approaches were to be normal powered approaches. At 1348 hrs ZC also commenced a circuit detail, its pilot having been briefed to perform two normal touch and go landings followed by a final landing. A third solo Cherokee, G–AYBK (BK), was also flying at the time and the three aircraft became involved in a continuous series of circuits. Appendix A shows the disposition of the aircraft in the circuit at various times, the times being expressed in minutes and seconds before the collision.

At –6.00 (Figure 1) BK had just completed an overshoot and was ahead of BJ as it took off again following a full-stop landing. ZC was on finals having been cleared for a touch and go. The pilot of ZC had in fact already made the two touch and go landings for which he was briefed, and this should have been an approach for his final landing.

A dual Baron, G–AWAJ (AJ) rejoined the circuit and crossed the upwind end of the runway at –5.00 (Figure 2). Its pilot could see BK downwind and had BJ on his left. BJ was completing its crosswind leg and was about to turn downwind. At this time ZC was in the course of its touch and go landing. One minute later, a dual Cherokee, G–AYAT (AT) also entered the circuit and crossed the upwind end of the runway (Figure 3). The commander of AJ had just had a conversation with the aerodrome controller regarding his aircraft's future programme and in the course of it AJ's downwind call had been omitted. There is no direct evidence regarding the position of ZC at this time but from calculations of when it completed its touch and go landing, it had probably reached 500 feet and was turning right on to the crosswind leg.

When AT turned on to the downwind leg its commander had a Cherokee (BJ) in sight ahead of him which was in an unusually wide downwind position and he could see another Cherokee and a Baron on finals (BK and AJ) (Figure 4). On the basis of timing, ZC was probably at the commencement of the downwind leg, fairly close behind AT. AT's commander now became aware of a potential conflict if the Cherokee ahead of him and to his left (BJ) should turn on to a right base leg from its wide position. The conflict became a reality when BJ started its turn and accordingly AT's pilot decided to discontinue the approach and overshoot on to the dead side of the runway in order to re-establish himself in the circuit. He therefore also turned right on to base leg inside BJ but maintained circuit height and informed ATC by radio telephony (RTF) of his intentions (time - 2.11). The disposition of the aircraft two minutes before the collision is shown in Figure 5; the position of ZC has again been estimated.

About this time BJ called 'finals for full stop' but the transmission was unintelligible to the aerodrome controller who interpreted the sound as two aircraft transmitting together. When the controller asked for the message to be repeated BJ did not reply but ZC reported that it was downwind. The evidence suggests that this was a late call. ZC was informed that it was number 3 to land. (The traffic ahead of it consisted of AJ and BJ since BK had just landed and AT had discontinued its approach). At this time the aerodrome controller became concerned with an impending conflict between aircraft on the runway (Figure 6). Cherokee BK had just landed, incorrectly in the circumstances, on the right hand landing run and the controller was alert to the possibility that, being flown by a solo student pilot, it might turn left across the path of the heavier and faster Baron (AJ) which was coming up on its left. Another aircraft was being held at the take-off point because on this runway when aircraft eventually turn left after landing to cross the take-off path, they are at first invisible to departing aircraft owing to the uphill slope at the beginning of the take-off run. The controller was busy issuing positive instructions to the aircraft concerned as he monitored the situation until at –0.40, with BK and AJ both safely taxying, he was satisfied that the potential conflict on the ground no longer existed.

Almost immediately, at –0.32, ZC called 'final for full stop landing left'. The controller asked the aircraft to confirm that it was on finals and this ZC did. Immediately, at –0.26, BJ reported 'final landing left for full stop' but again the message was unintelligible to the controller and appeared to be blocked by another transmission. At once the controller asked BJ to check its position and received another unintelligible reply, although on this occasion the words 'Bravo Juliet' were distinguished. This occurred only a few seconds before the two aircraft collided and no more RTF conversations with either aircraft were recorded.

A number of eyewitnesses saw the two aircraft in the moments preceding the collision as well as the accident itself. Their evidence, combined with that obtained from the engineering examination of the wreckage of both aircraft, shows that ZC struck BJ from above and behind on the latter's right hand side while they were heading towards the aerodrome. ZC was in a shallow right hand bank and had a much greater rate of descent and a slight overtaking speed. ZC's propeller pierced the right fuel tanks of BJ which almost immediately pitched nose up and banked towards ZC accompanied by an explosion and subsequent fire. ZC then banked steeply away from BJ and both aircraft fell in soft mud on the eastern side of the River Hamble, killing the two pilots. There was strong evidence from eyewitnesses that BJ was already established on its final approach, albeit apparently lower than normal, while ZC was on its base leg turning inside BJ above it and to its right. There were some reports that just before the impact ZC was slightly above, behind and to the right of BJ. Two observers considered that BJ rose slightly, without changing attitude, immediately before the collision. One eyewitness reported that the landing lights on both aircraft were illuminated. Theodolite measurements were taken, with the assistance of witnesses, which indicated that the collision occurred on the extended centre line of the runway, about 0.5 nautical miles (nm) from the aerodrome boundary and at a height of about 200 feet above mean sea level (120 feet above the aerodrome). The accident took place at 1409 hrs.

1.2 Injuries to persons

1.2.1 *G–AVBJ*

Injuries	*Crew*	*Passengers*	*Others*
Fatal	1	–	–
Serious	–	–	–
Minor/none	–	–	–

1.2.2 *G–AXZC*

Injuries	*Crew*	*Passengers*	*Others*
Fatal	1	–	–
Serious	–	–	–
Minor/none	–	–	–

1.3 Damage to aircraft

Both aircraft were destroyed.

1.4 Other damage

Nil.

1.5 Personnel information

The pilots of both aircraft were Libyan nationals undergoing a flying training course at the College of Air Trading, Hamble.

1.5.1 *G–AVBJ*

Commander: Male, aged 20

Licence: Student pilot. Class 1 medical certificate issued 25 September 1980

Flying experience: 17 hours 25 minutes, of which 4 hours 35 minutes were solo, all on type.

The commander had made his first solo flight on 22 April 1981 after 11 hours 10 minutes instruction, and between then and the day of the accident he flew a further 1 hour 25 minutes dual and 2 hours 10 minutes solo, all in the circuit. On the morning of the accident he received another dual check of 25 minutes, using grass runway 32 at Hamble, and then flew solo in the circuit for one hour. He was considered by his instructor to be of above average ability.

1.5.2 *G–AXZC*

Commander:	Male, aged 21
Licence:	Student pilot. Class 1 medical certificate issued 8 October 1980
Flying experience:	15 hours 25 minutes, of which 1 hour 20 minutes were solo, all on type.

The commander had made his first solo flight on 29 April 1981, the day before the accident, after a total of 11 hours 45 minutes of instruction. After a dual check he made a second solo flight later the same day. On the morning of the accident he received another 50 minutes dual, with a view to further solo, but he did not satisfy the instructor that his approaches were consistent enough in their latter stages. In the afternoon, still using runway 32, he was given another hour's instruction, and his instructor then considered that a safe standard had been reached. The student assured his instructor that he felt ready to go solo, and was briefed to carry out two normal approaches and touch and go landings, to be followed by a final landing. Generally, this student was considered by his flying instructor to be of average ability.

1.5.3 *Aerodrome controller*

Holder of a current CAA Air Traffic Controller's Licence validated for operations at Hamble.

1.5.4 *Rest and duty periods*

Both pilots had ceased work the previous evening at 1530 hrs and reported for duty on the day of the accident at 0730 hrs. After their morning's flying they had normal lunch breaks before resuming training. The aerodrome controller began his watch at 1200 hrs.

1.6 **Aircraft History**

1.6.1 *G–AVBJ*

(a)

Aircraft type:	Piper PA28–180
Date of manufacture:	1967
Engine type:	Lycoming 0–360–AH
Certificate of Airworthiness:	Transport category valid from 22 September 1978
Certificate of Maintenance:	Valid from 15 April 1981
Total airframe hours:	6374:10
Hours since last check:	23:25

(b) Weight and centre of gravity (CG)

Maximum weight authorised:	2400 lbs
Accident weight (estimated):	1854 lbs
CG limits at estimated weight:	84.00 in to 95.9 in aft of datum
Accident CG (estimated):	86.67 in aft of datum.

1.6.2 *G–AXZC*

(a) Aircraft type: Piper PA28–180

Date of manufacture:	1970
Engine type:	Lycoming 0–360–AH
Certificate of airworthiness:	Transport category valid from 4 October 1979
Certificate of Maintenance:	Valid from 2 April 1981
Total airframe hours:	3,808:47
Hours since last check:	24:32

(b) Weight and centre of gravity (CG)

Maximum weight authorised:	2400 lbs
Accident weight (estimated):	1875 lbs
CG limits at estimated weight:	84.00 in to 95.9 in aft of datum
Accident CG (estimated):	87.16 in aft of datum

1.6.3 *Fuel type – Avgas 100 LL*

1.7 Meteorological information

There was little change in the weather throughout the day. Immediately after the accident the following observation was made at Hamble.

Surface wind:	330°/10–15 knots
Visibility:	10 to 15 kilometres
Cloud:	4/8 stratocumulus, base 2,500 feet (estimated)
QNH:	1014 millibars
QFE:	1011 millibars

The accident happened in daylight.

1.8 Aids to navigation

Not relevant.

1.9 Communications

Both aircraft were communicating with Hamble Aerodrome Control on 120.65 MHz and all messages on this frequency were transcribed from the RTF tapes. In the six minutes preceeding the collision all aircraft in the circuit made routine circuit position reports with the exception of the Baron AJ which was involved in a conversation with the controller and omitted its downwind call. The RTF tapes revealed that during this period there was a steady but not continuous flow of ATC communications but at no time was the frequency so crowded as to prevent the normal exchange of messages.

It has been calculated that ZC was late in making its downwind call but in other respects communications with this aircraft were satisfactory. For most of its flight BJ was also able to maintain satisfactory communications. However, approximately 12 minutes before the accident, the pilot made two transmissions which were heavily distorted and which gave the aerodrome controller the impression that two aircraft were transmitting together. When asked to repeat the message BJ did not reply. The next series of transmissions from the aircraft were satisfactory until −1.49 when BJ again made a heavily distorted transmission at the time unintelligible to the controller but later identified during analysis as a finals call. The controller once more interpreted this as two aircraft transmitting together but when he asked for clarification the pilot did not repeat his message, and instead ZC immediately reported that it was downwind. The next series of distorted messages started at −0.26 when the controller heard similar characteristics in a transmission and placed the same interpretation on them. The RTF recording shows that this message was from BJ reporting 'final landing left for full stop'. Finally, almost immediately before the collision, BJ made another unintelligible transmission.

Since the radio equipment of BJ did not survive the impact, it was not possible to make a detailed investigation of possible causes for the poor quality of the transmissions. However, laboratory analysis of the RTF tapes showed that nearly all the transmissions which the controller interpreted as two aircraft transmitting together were in fact heavily distorted transmissions made solely by BJ. The exception was the very last transmission from BJ which was blocked by some form of unidentifiable outside interference, and which prevented any interpretation of the final message even in the laboratory. The available evidence was insufficient to allow any conclusions to be drawn regarding the distortions in BJ's messages or the outside interference. The effect of these occurrences on ATC is discussed in Section 2.

1.10 Aerodrome and ground facilities

Hamble is a grass aerodrome, with its longest axis on runway 18/36, providing a take-off distance of 870 metres. Throughout the day of the accident grass runway 32 was in use, with a take-off distance of 725 metres and a landing distance of 687 metres. At the time of the accident all runways had separate take-off and landing paths. Take-offs were made to the left of a line of markers; to the right of this line was a sterile area, bounded on its right side by another line of markers. Landings, including touch and go landings, were made to the right of this second series of markers. There were two landing paths which were separated by an abbreviated line of markers. When the circuit was busy, therefore, aircraft could land alternatively left and right using the left landing run by choice whenever traffic permitted. On the runway 32, after-landing aircraft would need to obtain ATC permission to cross the sterile area and the take-off run in order to taxi back to either the take-off point or the apron. These arrangements are shown in Appendix B.

The purpose of the dual landing runs was to accommodate a greater number of aircraft in the circuit than would otherwise be possible. Since the accident a single landing run only has been in use on all runways, with a parallel take-off runway separated from it by a sterile area.

The control tower is situated on the south side of the aerodrome and there are good views from the visual control room around the circuit for runway 32. The approach controller and the aerodrome controller shared the console, which faced in a northerly direction. The approach controller was positioned on the left, the aerodrome controller on the right, with an ATC assistant between them. The aerodrome controller had a circuit diagram in front of him containing small plates bearing the callsigns of aircraft in the circuit, which he moved round the diagram in response to the various RTF calls. Full RTF was employed in the circuit with the standard reporting points, and when making their downwind and finals position reports pilots also expressed their landing intentions. In their radio call on finals they were required to nominate their landing path (left or right) and to state whether they were landing or performing a touch and go. All aircraft flying in the circuit were required to have their taxi lights illuminated.

1.11 Flight recorders

None were required and none were fitted.

1.12 Wreckage and impact information

1.12.1 On site examination

Both aircraft impacted the mud flats at the eastern edge of the River Hamble approximately half a mile upstream from the harbour master's office at Warsash.

The wreckage of BJ was lying in a drainage channel approximately 200 feet to the south of the wreckage of ZC. The aircraft was in a steep nose down attitude with the whole of the forward fuselage embedded in the mud. An intense post-impact fire had consumed the upper portion of the cabin and the whole of the rear fuselage. Parts of the tailplanes and most of the fin survived the fire and were lying just behind the left wing, which was still attached to the centre section, but was also extensively fire damaged. The bulk of the left wing was lying on the bank of the drainage channel.

The right inner wing was relatively undamaged by the impact and was only scorched in the post-impact fire. The right outer wing, from the junction of the flap and aileron outboard, was detached and was found as a single item lying on the edge of the drainage channel some 55 feet to the west of the main wreckage. This portion of wing was lightly damaged by ground fire. There were indications that this fire was centred in the cavity formed by the wing tip rib and fairing.

Considerable damage resulting from propellor strikes was evident in the fracture region of the right wing, both on the inboard wing on the main wreckage and also on the separated outer wing. This damage comprised deep spanwise cuts beginning approximately 2 feet forward from the aileron trailing edge and progressing forwards across the wing. The initial cuts penetrated the upper skin and wing ribs only, but successive cuts penetrated more deeply into the wing structure. The third and subsequent cuts penetrated both top and bottom wing skins and scored the main spar.

At the same spanwise position the wing structure aft of the main spar was heavily damaged as a result of a heavy blow to the trailing edge of the wing. Separation of the right outer wing had resulted in tearing of the wing skin forward of the main spar, which also split open the integral fuel tank located in the wing leading edge just inboard of the fracture line. Strips of wing skin from the area of the propeller strike were found, together with fragments of glass from the anti-collision beacon, on garden land some 300 yards to the south east of the main wreckage.

It was evident from the nature of the damage, and from the post-impact position of the separated wing section and the strips of wing skin, that the wing had been severed in the air as a result of the collision.

The fin displayed evidence of collision damage. The leading edge was flattened back against the spar at a point approximately $\frac{1}{3}$ up the fin. The damage was evidently produced by a glancing contact with a flat surface. The top of the fin was also locally damaged in a way which was not compatible with ground impact; the glass fibre fairing was broken off and the rotating beacon was missing. The VHF aerial mounted on the top of the fin was also broken away leaving only part of the aerial mounting block still attached to the end rib.

The impact damage sustained by BJ was, in general terms, similar to that described for XC but the orientation of the wing leading edge in this case was indicative of a pitch attitude at impact in the order of 70° nose down with the wings approximately level. There was no evidence of yawing momentum.

G–AXZC

ZC was lying with the nose section embedded in the mud in a steep nose down attitude. The rear fuselage had broken adjacent to the wing trailing edge and had folded downwards, coming to rest with the tip of the fin resting on the mud. Several fragments of glass fibre engine cowling and propeller spinner were found in a fan shaped area extending approximately 70 feet to the north east of the main wreckage. With the exception of these items and some small pieces of secondary structure lying on the ground at the point of impact, the wreckage of ZC was complete.

The ground impact broke up completely the forward section of the cabin and fractured the main spar of the left wing at its attachment to the fuselage.

Both wings were crushed rearwards from the leading edge and the fuel tanks were ruptured, but there was no fire. The rear fuselage, tailplanes, fin and rudder were undamaged.

The distribution and orientation of the damage sustained by ZC indicated that it had struck the ground semi-inverted, with the nose approximately 30° beyond the vertical and with the right wing slightly low. There was no evidence of yawing momentum at impact and the horizontal velocity was negligible.

Five regions of localised damage were found which clearly were not the result of ground impact:

(i) The left aileron trailing edge had been bent upwards over a spanwise distance of approximately 2 feet, with a maximum distortion of 3 inches just inboard of the aileron mid-span.

(ii) A slight dent in the left wing undersurface approximately 10 inches aft of the main spar and 18 inches in from the tip. A scrape mark ran rearwards and inboard from the dent and terminated in the distorted region of the left aileron.

(iii) White paint 'smears' on the left wing leading edge at a position coincident with the second rib inboard from the tip, and red paint 'smears' on the left wing tip fairing.

(iv) Heavy leading edge damage and red paint smearing on both propellor blades and red paint smearing on the remains of the spinner.

(v) Moderate distortion of the components forming the nose leg torque link assembly.

1.12.2 *Detailed examination of wreckage*

Following recovery of the wreckage a detailed examination was carried out, with the aid of scale models, to determine the sequence and relative attitudes at the time of the collision.

It was found that the damage on the propeller of ZC exactly matched the damaged wing structure on BJ. Similar compatibility of damage was found on the nose undercarriage of ZC and the right wing trailing edge of BJ, on the left aileron trailing edge of ZC and the fin leading edge of BJ, and on the left wing underside of ZC and the remains of the fin mounted VHF aerial on BJ.

It was clear from the geometric relationship between the collision contact points that the 'aileron to fin' contact and the 'propeller and nose leg to wing' contact occurred, for all practical purposes, simultaneously. The glancing contact between the top of the fin on BJ and the left wing underside on ZC occurred prior to the main collision. There were indications that the aircraft momentarily parted between this initial collision and the main collision.

Calculations based on the dimensions and orientation of the damage on BJ caused by ZC's propeller indicate that, at the time of contact between the propeller disc and the wing, the relative velocities of these elements were:

(i) Vertical – ZC descending relative to BJ at 27 feet per second (approximately 1,600 feet per minute).

(ii) Horizontal – ZC overtaking BJ by approximately 10 feet per second (approximately 7 mph).

(iii) Relative yaw – ZC was yawed to the left relative to BJ by approximately 6°.

(iv) Relative pitch – similar pitch attitudes.

The relative descent angle of ZC on to BJ, based on these calculations, matched very closely the grazing angle on the damaged fin leading edge of BJ.

The models indicated that the only area of BJ which could have produced the paint smears on the leading edge of ZC's left wing was the mid-fuselage crown skin and similarly only BJ's left wing upper surface could have produced the smears on ZC's left wing tip. Both these areas on BJ were burnt away during the ground fire and confirmation was therefore not possible.

BJ was examined for evidence of a pre-impact fire, but none was found. However, the circumstances of the accident were such as to make the survival of any evidence of pre-impact fire unlikely.

It was determined that at the time of ground impact, ZC was set up with two notches of flap and neutral elevator trim. There was some evidence to indicate that the carburetter heat control was selected to hot, but this was not conclusive. The ailerons were neutral at ground impact. The fuel selector was to right tank; the radio was set to 120.65 and was switched 'ON' with the volume at approximately ¾ maximum. The altimeter subscale setting was 1011 millibars on P1 instrument and 1016 millibars on the P2 instrument.

It was established that at the time of impact with the ground, BJ was set to full flap with slight nose up trim. The fuel selector was to left tank and both altimeters were set to 1011 millibars.

Neither aircraft exhibited any evidence indicative of pre-collision failure or malfunction. A sealed beam landing light unit with filament was recovered and it was established that this unit was illuminated at the time of ground impact. However, it was not possible to determine to which aircraft this unit belonged.

1.13 Medical and pathological information

Post mortem examination revealed no evidence which might have a bearing on the accident. Both pilots died as a result of the impact with the ground.

1.14 Fire

1.14.1 G–AVBJ

The eyewitnesses gave evidence that at the time of the collision there was an explosion and fire from the starboard side of G–AVBJ. The examination of the wreckage showed that considerable fire damage had occurred after impact with the ground, especially in the upper part of the cabin and the rear fuselage, but it was not possible to identify any area where an airborne fire had occurred owing to the very short interval between the collision and the impact with the ground.

1.14.2 G–AXZC

In the case of this aircraft there was no fire either in the air or following the impact with the ground.

1.15 Survival aspects

The accident was non-survivable. A Search and Rescue (SAR) helicopter from the Royal Naval Air Station, Lee-on-Solent, was on the site at 1415 hrs, six minutes after the accident. A crew member and a doctor were lowered on to the mud flats but the pilots were already dead. Fire vehicles and three ambulances of the local services were also in attendance.

1.16 Tests and research

Nil.

1.17 Additional Information

1.17.1 Right of way

The following is an extract from the Rules of the Air and Air Traffic Control Regulations 1981, Rule 17:

> '(5) Landing
>
> An aircraft while landing or on final approach to land shall have the right-of-way over other aircraft in flight or on the ground or water.
>
> (6) Two or more aircraft landing
>
> In the case of two or more flying machines or gliders approaching any place for the purpose of landing, the aircraft at the lower altitude shall have the right-of-way, but it shall not cut in front of another aircraft which is in final approach to land or overtake that aircraft:
>
> Provided that –

(a) when an air traffic control unit has communicated to any aircraft an order of priority for landing, the aircraft shall approach to land in that order; and

(b) when the commander of an aircraft is aware that another aircraft is making an emergency landing, he shall give way to that aircraft, and at night, notwithstanding that he may have received permission to land, shall not attempt to land until he has received further permission to do so'.

1.17.2 Training syllabus – College of Air Training

The syllabus of the College of Air Training at Hamble is approved by the CAA for the training of student pilots for British licences. The two students involved in this accident were both Libyans, and had performed all the necessary exercises under the guidance of experienced and professionally qualified instructors before being sent solo.

Although English was not their first language, both students were required by their airline to be competent in English before they were selected for training, and they received further instruction in English as part of their 'induction course' at Hamble before they began the main syllabus. Both achieved a satisfactory standard of English in their 'induction course' and had also completed 48 hours training out of 50 in RTF procedures at the time of the accident. As part of their training both pilots were fully briefed on circuit procedures, and would have had explained to them that an aircraft on finals had in all normal circumstances priority over other traffic in the circuit. The pilot of ZC had demonstrated to his instructor that he could carry out an overshoot from the base leg.

1.17.3 Circuit procedures – Hamble

At Hamble, with a right hand circuit in force, Cherokee aircraft climb straight ahead after take-off to 500 feet above the aerodrome and then turn right, continuing their climb to 1,000 feet. The downwind leg is flown at 1,000 feet until the runway threshold lies behind the starboard wing-tip, when the aircraft turns on to the base leg. At this point, on a standard circuit, power is reduced and partial flap selected (two notches), with the object of starting the turn on to the final approach at about 750 feet. Full flap is selected as the aircraft becomes established on its final approach. Adjustments for wind are made so that, ideally, the crosswind and base legs will be at 90° to the runway, with the downwind leg parallel to it.

Student pilots were taught by their instructors of the need to maintain a good look-out in the circuit. However, in his early career a student who is solo ir the circuit is working at full stretch and his look-out may suffer accordingly. The difficulty was well understood and was the subject of continuous reminders by all responsible for flying training. Following an earlier accident, Cherokee aircraft at Hamble were modified to provide clear panels in the roof so as to improve upwards vision. The CAA issued an Aeronautical Information Circular (AIC), 13/1981, in February 1981, which discussed visibility from the cockpits of light aircraft, and provided valuable advice on dealing with the problem. The AIC provides an excellent summary of the difficulties which exist, and it is reproduced as Appendix D.

2. Analysis

2.1 Introduction

The collision occurred while both aircraft were on final approach to land and the engineering and eyewitness evidence make it clear that ZC, while in a shallow right bank having just completed its turn from a right base leg, struck BJ from above and behind on the latter's right hand side. There was no evidence of pre-collision failure or malfunction in either aircraft and the medical evidence revealed no factor which could have had a bearing on the accident. Both pilots were properly authorised for circuit training and neither the weather nor the sun's position were considered factors in the accident.

It was only after ZC started turning from base leg on to finals that the possibility of a collision arose. BJ was already established on the final approach and its pilot, occupying the left seat of an aircraft without a bubble canopy, would have had difficulty in seeing the other aircraft which was then above him and to his right because of the numerous blind spots in that area. As for ZC with its superior altitude, once it started its right turn its left wing would have hidden BJ from view even after it had rolled out on finals. For the last few seconds of flight, therefore, each aircraft probably lay in the other's blind spots and it is easy to see how they could have remained undetected all the time they were on collision courses.

It was evident from the way that each aircraft manoeuvred, that neither pilot was aware that another aircraft was in his vicinity and posing a potential threat to his safety. When he made his downwind call, the pilot of BJ was told that there were two aircraft ahead of him (BK and AJ) and he would have later seen them both on the runway as they completed their landings. He would have realised that he had become number one to land and there was nothing therefore to make him suspect the presence of another aircraft converging on him from the right at so late a stage in the approach. In ZC's case, when it reported downwind it was cleared to finals, number three to land. The two aircraft ahead were in fact AJ and BJ. However, ZC was following AT round the circuit and its pilot may not have realised the significance of AT's actions in overshooting on base leg nor the effect these had on the landing sequence. It may well have seemed to him that the two aircraft which were ahead of him in the landing sequence were the Baron (AJ) and the Cherokee on base leg (AT). If this was the case, then AT would be the most obvious traffic on which to concentrate and he would no longer be anticipating the presence of another aircraft (BJ) on long finals. When he himself turned on to finals he reported 'landing left' and this indicates that, having seen AT overshoot, he now considered that he was first in the landing sequence and had discounted the existence of another aircraft which had priority over him. The collision demonstrates how circumstances can give a false sense of security that no other aircraft is in close proximity with the result that the pilots fail to see one another in time to manoeuvre out of the danger area.

2.2 Circuit traffic

So long as the three Cherokees on circuit training remained the only significant traffic, the pilots were able to co-ordinate their circuits successfully and they maintained adequate separation between their aircraft. However, just prior to the accident a Baron and another Cherokee had joined for landing and the subsequent movements of the five aircraft were examined in order to seek an explanation how the interval between BJ and ZC came to be reduced. The critical sequence of events began at time −6.42 when BJ received take-off clearance following a full-stop landing, with ZC on finals for a touch and go. It was not possible from the RTF recording to determine the interval this gave the two aircraft. However, it was not the practice to allow an aircraft to take off with another on late finals, even with the parallel runway system in use, and the controller stated that he was confident that adequate separation existed on this occasion. This is borne out by the observations of the Baron's pilot as he crossed the upwind end of the runway. He could see one Cherokee (BK) downwind with another (BJ) about to turn downwind (Appendix A Figure 2) and the fact that ZC was not mentioned by either ATC or AJ indicates that it was still in the course of its touch and go and its position was not significant to the aircraft at circuit height.

The commander of the dual Cherokee stated that the Cherokee ahead of him on the downwind leg (BJ) was further out than normal. Whilst it is accepted that students are not always consistent, in this case BJ's pilot was flying a circuit with which he was thoroughly familiar, and whose downwind leg had obvious landmarks in the form of the M27 motorway and the head of the Hamble river. It is likely, therefore, that BJ was flown on an intentionally wide circuit in order to increase its separation from AJ which had turned downwind ahead of it (Figure 4). There was nothing improper in AJ's rejoining procedure and subsequent circuit and in fact there was no likelihood of a conflict with BJ because of the superior performance of the Baron. However, it is not surprising that an inexperienced pilot should underestimate the capacity of the other aircraft to pull away and consequently attempt to adjust the spacing by widening his own circuit. An added confusion might have been the exchange of messages between the controller and AJ regarding the aircraft's future programme and the consequent omission of AJ's downwind report.

The students were instructed to judge when to turn on to the base leg from the perspective of the runway and consequently the probable outcome of being wide downwind is that this turn will be delayed resulting in an extended downwind leg. A lengthened base leg will follow and, if power is reduced after the usual interval, the chances are that the aircraft will end up on a long final approach in which it is lower and slower than normal. There is no firm evidence that this happened to BJ, but the time interval from its first finals call, supported by fragmentary eyewitness reports, suggest that this was the case. The slight decrease in the rate of descent which some observers noticed just before the collision, could be attributed to the late selection of full flap as the pilot tried to adjust to his low approach.

The original circuit sequence changed a second time as AT joined and ZC ended up behind it on the downwind leg (Figure 4). When the pilot of AT decided to overshoot on to the dead side of the runway, he made his turn on to the base leg earlier than if he had been planning to land. As a very inexperienced student, it is possible that ZC's pilot simply followed AT round the turn and by doing so made his own base leg closer to the aerodrome than would be normal.

Although the rejoining aircraft (AJ and AT) followed perfectly proper circuit procedures, it thus appears that their presence had a significant effect on the subsequent behaviour of the two aircraft involved in the collision. There is insufficient direct evidence to prove this point conclusively, but is does offer an explanation for BJ's long final approach and ZC's tight circuit. It was these actions by the aircraft that reduced the adequate separation which they had previously enjoyed. One of the consequences of a tight circuit is that it tends to lead to a steep approach, and this probably explains why ZC had such a comparatively high rate of descent when the two aircraft collided. A tight circuit also increases the workload of the pilot as he regulates his approach, and this will be at the expense of his look-out. It is also significant that an aircraft making a long and low approach will tend to merge into the background landscape as far as a pilot on either the downwind or base leg is concerned, and will not be so readily apparent to another pilot as one which is following a text-book circuit.

2.3 Air Traffic Control

The task of an aerodrome controller as defined in the Manual of Air Traffic Control is to '.....achieve a safe, orderly and expeditious flow of air traffic, and to assist pilots in avoiding collisions.....'. He is not expected to watch each aircraft as it continues round the circuit and in many cases it is not physically possible for him to see the aircraft at all times. Aircraft in the circuit operate under Visual Flight Rules (VFR) and the prime responsibility for following the standard circuit procedure and for avoiding collisions consequently lies with the pilots. At Hamble, the aerodrome controller had the benefit of a circuit diagram on which to track the movements of the various aircraft. Immediately before the accident, the RTF calls indicated that the aircraft in the area of the downwind leg and finals were well spaced and there was no reason why the controller should suspect that the aircraft were following unsafe paths. Even if he had understood BJ's first finals call at −1.49, the situation would have been no different because he was already aware that BJ was in that section of the circuit, and ZC's immediate downwind report did not suggest that a potential conflict was developing.

The controller then became involved with the aircraft on the runway. BK had, incorrectly in the circumstances, just landed on the right side of the landing area and as it was being flown by a student, the controller was particularly concerned that it should not turn left across the path of the landing Baron (AJ). On the information available to him, this was an area of very real concern, and he was right to regard it as his main priority. It was an unfortunate coincidence that this conflict occurred at a time when the controller might, in other circumstances, have turned his attention to see what was happening on the approach path. However, there is no suggestion that the conflict imposed an unreasonable work load on the controller, or created an excessive level of RTF activity.

With hindsight, it is possible to suggest that a more favourable ATC environment might have existed without the parallel landing system which was in use at the time. The runway system had been refined for safety reasons from the traditional practice at grass aerodromes of allowing aircraft to choose their own landing paths anywhere within the grass area. The parallel landing system allowed a greater frequency of movements and the College had operated the system for many years. The use of two landing paths, however, does occasionally lead to aircraft landing in a very close sequence and this increases the vigilance required of the aerodrome controller. Supervision of aircraft on the ground is a significant part of his duties but the more time that has to be spent on ground movements means that less attention can be paid to observing airborne traffic.

2.4 Communications

At the time, the occasional difficulties with communications did not appear significant and the RTF transcript shows that the controller's inability to understand BJ's distorted initial finals call at –1.49 was not crucial to the eventual conflict. When ZC reported at –0.32 that he was on finals, the controller first became aware that the situation might not be satisfactory although he was not in a position to assess the seriousness of the conflict. Looking out towards finals he could see only one aircraft, possibly because ZC was already masked from his view by BJ. Although BJ's transmissions at this time were again heavily distorted, the events were moving so quickly that, even if better radio reception had existed, it is unlikely that the controller could have acted to alert the aircraft in time to change the sequence of events.

Both students had successfully coped with their instruction in the English language, and would be expected to understand both the ATC situation and RTF procedures. The tape recording of the tower frequency indicates occasional hesitations on the part of the Libyan students airborne at the time but does not suggest any serious lack of comprehension or fluency. It is considered therefore that language difficulties were not a factor in the accident.

2.5 Observations

BJ was established on its final approach before ZC had completed its base leg and had been allocated a higher landing priority by the controller. According to the Rules of the Air, therefore, BJ possessed the right of way and ZC's pilot should have adjusted his position to allow for this. According to his training he would have understood his responsibilities in this area and his experience was sufficient for him to deal correctly with the situation if only he had recognised it. Right of way can only be acted upon, however, if the aircraft are in visual contact and clearly ZC did not see BJ. It is always the responsibility of any pilot to ensure that his aircraft does not collide with another even if he has the right of way. There are greater difficulties in keeping an adequate look-out from the left seat of an aircraft which has side by side seating when the circuit direction is right handed. This accident illustrates the importance of being able to maintain visual contact with all conflicting aircraft in the circuit and it is considered that the extra restrictions on cockpit visibility associated with the use of a right hand circuit was a factor in the circumstances leading to the accident.

The collision occurred in good weather when there was nothing exceptional happening in the circuit and when traffic was only moderate. It is recognised, however, as AIC 13/1981 emphasises, that the circuit is a particularly demanding area in which to fly and that great vigilance is required even by experienced pilots. It is a fact that the ability to maintain a good look-out and achieve an awareness of all that is going on, only develops with experience and that during the early stages of his career, a student pilot will be mainly concerned with the problems of flying his aircraft accurately. This is particularly so in the approach phase where his concentration will be mainly directed to the runway, and because of this he will be less receptive of stimuli not connected with the task of getting his aircraft safely on the ground. One should not be too critical, therefore, of the performance of ab initio pilots if they fail to recognise the development of a conflicting situation. The circuits followed by BJ and ZC were not wild departures from the normal and the conduct of the two students prior to the accident was consistent with a satisfactory standard being achieved in their training.

3. Conclusions

(a) *Findings*

(i) Both aircraft had been maintained in accordance with an approved maintenance schedule and their documentation was in order.

(ii) Both student pilots had valid medical certificates and did not require licences.

(iii) There were no significant defects in either aircraft that could have had a bearing on the accident.

(iv) The two aircraft were carrying out circuit training exercises and were properly authorised for their details.

(v) Before being sent solo, both student pilots had completed the exercises laid down in the syllabus of training.

(vi) The maximum number of aircraft in the circuit in the period preceding the collision was five.

(vii) The two aircraft collided while lined up on finals to land. ZC struck BJ from above and behind on the latter's right hand side, while ZC was in a shallow right bank with a much greater rate of descent and a slight overtaking speed.

(viii) ZC embarked on a collision course with BJ when it started its turn on to finals and from that moment it is probable that each aircraft was hidden in the others 'blind spots'.

(ix) BJ was established on finals before ZC and had been given a higher priority to land. It therefore had the right of way over ZC.

(x) A potential conflict between aircraft on the runway landing area held the aerodrome controller's attention at a time when the two aircraft were converging.

(xi) Both pilots' look-out was adversely affected by the operation of a right hand circuit.

(b) *Cause*

The collision was caused by the pilot of ZC turning on to finals without realising that BJ was already established on an approach to land ahead of him. Blind spots in cockpit visibility, aggravated by the operation of a right hand circuit, were major factors in the failure of each pilot to detect subsequently the approach of the other aircraft. The level of inexperience of both students was also contributory.

4. Safety Recommendations

Nil.

L S H SHADDICK
Inspector of Accidents

Accidents Investigation Branch
Department of Trade

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