AIRCRAFT ACCIDENT REPORT 1/88

Air Accidents Investigation Branch

Department of Transport

Report on the accident to DH 89A Dragon-Rapide G-AGTM at Duxford Airfield, Cambridge on 21 June 1987

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Department of Transport
Air Accidents Investigation Branch
Royal Aircraft Establishment
Farnborough
Hants GU14 6TD

11 January 1988

The Right Honourable Paul Channon
Secretary of State for Transport

Sir,

I have the honour to submit the report by Mr M M Charles, an Inspector of Accidents, on the circumstances of the accident to DH 89A Dragon-Rapide, G-AGTM, which occurred at Duxford Airfield, Cambridge on 21 June 1987.

I have the honour to be
Sir
Your obedient servant

D A COOPER
Chief Inspector of Accidents

Contents

Air Accidents Investigation Branch

Aircraft Accident Report No: 1/88
(EW/C1024)

Registered Owner:	Russavia Limited
Operator	Russavia Limited
Aircraft Type:	De Havilland 89A Dragon Rapide
Model:	Series 6
Nationality:	British
Registration:	G-AGTM
Place of Accident:	Duxford Aerodrome
Latitude:	52° 05' 41"N
Longitude:	000° 07' 38"E
Date and Time:	21 June 1987 at 1648 hrs All times in this report are UTC

Synopsis

The accident was notified to the Air Accidents Investigation Branch at 1705 hrs on 21 June 1987 and the investigation commenced that day.

The aircraft was engaged on pleasure flying with the commander and 7 passengers on board. During take-off it swung to the right, left the runway and followed a near semi-circular path over the ground until it was stopped by impact with a row of parked motor vehicles. Minor injuries were sustained by the commander and three onlookers. The report concludes that the accident was caused by the failure of the commander to control the aircraft on take-off and makes no safety recommendations.

1. Factual Information

1.1 History of the Flight

The operating company held an Air Operator's Certificate permitting it to offer pleasure flights at Duxford and other aerodromes. It was based at Duxford and, when using Duxford aerodrome, customarily operated its aircraft from the grass runway. On the day of the accident, however, a flying display was held at Duxford and, because an area close to the grass runway was open to the public, the company's aircraft were operating from the paved runway. G-AGTM had been used before and after the display for pleasure flights for visitors and had operated normally. At approximately 1645 hrs the engines were started for a further flight for which there were 7 passengers, 2 of whom were voluntary helpers of the operating company. The pilot was an experienced airline captain who had recently qualified on the de Havilland Rapide. As he taxied over the grass to the threshold of runway 24, the runway currently in use, the aerodrome flight information service officer (AFISO) informed him that the surface wind was 350-360°/5 to 8 kt and asked if he would prefer to use runway 06. The pilot replied that he would use runway 24 for take-off and see how it went. He turned right on to the runway some 100 metres after its start to line up for take-off but turned too far and found himself on the right of the centreline. Aware of the slight tailwind and wishing to use the full runway length, he continued the right turn back on to the grass and taxied back to the start of the runway, where he lined up again. During these ground manoeuvres the aircraft responded normally to throttle and differential brake.

When ready for take-off, he released the brakes fully, applied some into-wind aileron and opened the throttles together. The aircraft rolled straight initially and he applied full power on both engines. He later stated that he believed he applied some left rudder to counteract the crosswind. Shortly after the tail came up, at a speed he believed was between 40kt and 45 kt, the aircraft swung to the right and ran on to the grass 238 metres beyond the runway threshold. As it crossed the shallow drain at the edge of the runway, he had the impression that it was bounced into the air. Accordingly, he did not apply the brakes or close the throttles but attempted to turn the aircraft to the left using rudder and aileron and continue the take-off. The aircraft, however, continued to swing to the right. When he saw the crowd line ahead of him he realised that he had to continue the right turn to avoid it. After the accident he recollected that, at this point, he tried to assist the turn to the right whilst trying to stop the aircraft but was reluctant to apply full brake for fear of nosing over. He did not remember using differential throttle but thought that he had closed both throttles when he saw that he was heading towards the crowd. The aircraft continued in a steadily tightening right turn until the tips of the left wings struck and fractured a tripod supporting a public address system loudspeaker located on the crowd line 168

metres from the runway edge and the tip of the lower left wing scraped along the sides of two parked cars. The first heavy impact occurred when the left engine and lower fuselage struck a stationary and unoccupied Skoda motor car. This impact momentarily lifted the aircraft off the ground and it was finally brought to rest when it collided with 3 more parked vehicles.

Neither the passengers on board nor the eye witnesses outside the aircraft heard any change in engine note until the aircraft collided with the cars. Clear tracks from the mainwheels were found on the runway surface running in a curve towards the right hand edge of the runway and from the runway edge to the site of the accident as shown in the diagram at Appendix 1.

1.2 Injuries to persons

Injuries	Crew	Passengers	Others
Fatal	nil	nil	nil
Serious	nil	nil	nil
Minor/None	1	7	3

1.3 Damage to aircraft

The aircraft had been severely damaged by impact with the stationary motor vehicles. The starboard mainplane outer panels had been twisted downwards, fracturing the main spars. The port wing panels had suffered less severe damage, mainly to the tips. The tubular metal lower wing centre section/ undercarriage/engine support structure was badly distorted and broken and the lower fuselage frames disrupted. Both propellers were severely damaged and the tailwheel mounting structure was torn off its lower mounting.

1.4 Other damage

Two vehicles were severely damaged by propeller slashes, one of these having had its roof flattened as the fuselage ran over it. A third vehicle was also severely damaged when the fuselage came to rest against it. Three other vehicles suffered less severe damage due to impact with the wings of the aircraft. A public address speaker tripod was also destroyed.

1.5 Personnel information

1.5.1	Commander:	Male, aged 43 years
	Licence:	Airline Transport Pilot's Licence valid until 24 April 1997
	Aircraft ratings:	DHC1, B737, 89A Dragon Rapide and DH89A Dragon Rapide 6
	Last medical examination:	20 February 1987, Class 1, no limitations, valid until 31 August 1987
	Instrument rating:	12 December 1986, valid until 11 January 1988
	Last company base check:	21 May 1987
	Flying experience:	Total flying hours: 9100 (approximately)
		Total hours on type: 2 hr 10 min
		Hours in preceding 28 days: 81
		Hours in preceding 24 hours: nil
		Rest period before duty on day of accident flight: 22 hours

1.5.2

The commander's previous experience on tailwheel aircraft was limited to less than an hour of Chipmunk flying some 10 years before the accident. He had flown 2 sorties on the Dragon Rapide before the accident flight. The first was a conversion and type qualification sortie flown 3 weeks earlier with an experienced type rating examiner who had successfully converted 19 pilots to the aircraft. This sortie was flown from a grass runway and the aircraft carried neither passengers nor ballast. The second sortie was also flown from grass 2 weeks later when the aircraft was loaded with 5 company employees to represent a typical operational load. On this occasion there was a significant crosswind on the runway and the commander carried out several take-offs and landings. He had not previously flown the aircraft from a paved surface. One of the two training captains who had flown with him stated that he had warned

him that the aircraft was more directionally sensitive on paved surfaces than on grass. The commander had no recollection of this warning and neither the company Operations Manual nor the Pilot's Notes included such a warning.

The minimum type experience required by the company was 5 hours for a pilot holding a Commercial Pilot's Licence and 2 hours for a pilot holding an Airline Transport Pilot's Licence.

1.6 Aircraft information:

1.6.1 Leading particulars

Type:	de Havilland DH89A Dragon Rapide 6
Constructor's number:	BCL89397
Date of manufacture:	1944
Certificate of Registration:	registered in the name of Russavia Limited
Certificate of Airworthiness: Category	issued on 9 April 1984 in the Transport (Passenger), renewed on 13 May 1986, and valid until 17 May 1989
Total airframe hours:	9124
Engines (2):	DH Gipsy Queen 3
Maximum weight authorised for take-off:	2,722 kg (6,000 lb)
Actual take-off weight:	2,388 kg (5,265 lb)
Estimated weight at the time of the accident:	2,382 kg (5,251 lb)
Estimated fuel remaining at the time of the accident:	180 kg (396 lb)

Centre of gravity (cg) limits at accident weight:	13 to 20.5 inches aft of datum
cg at time of accident:	18.7 inches aft of datum

1.6.2 Aircraft characteristics

The following characteristics are relevant. The aircraft has only one set of flying controls and one pilot's seat. The throttles are mounted on a single quadrant on the left sidewall of the cockpit. The brakes are cable and drum type and are operated by a lever moving in a notched quadrant on the left of the pilot's seat. The brake cables are interconnected with the rudder controls to provide for differential braking. The flap lever is on the right of the pilot but flaps are not used for take-off. The crosswind limitation for take-off and landing on paved surfaces is 15 kt. The maximum engine/propeller revolutions per minute (rpm) permitted for take-off are 2200. The Operations Manual includes the following advice on taxying and take-off:

> "Taxying. When moving off, immediately check brake operation by a gentle application of brake, then set the brake lever two notches up on the quadrant, which will provide light differential action upon use of the rudder pedals; adjust as necessary to taxy smoothly.
>
> Take-off. Open up carefully after first releasing the brakes. Do not leave any brake applied during the take-off, since the requirement of coarse use of rudder to keep straight may cause inadvertent application of brake and could lead to a ground loop. In practice, the aircraft will tend to run straight. In crosswinds use a little differential throttle to assist directional control, but if full throttle is reached on one side, it may be wise not to open the other throttle fully until more speed has been achieved, so as to maintain rudder availability in both directions for steering. As soon as possible both engines should be opened up fully. .....The aircraft will normally fly off at 52-56 kt."

In addition to the Operations Manual the company issued to its pilots a pamphlet describing in detail the flying characteristics of the Dragon Rapide

1.7 Meteorological information

There was no significant weather at the time of the accident. The Meteorological Office aftercast was that the wind was light, westerly, tending to north-westerly from time to time, the temperature was 13°C and the surface pressure was 1014 millibars. The surface wind measured at Duxford before take-off was 350-360°/5 to 8 kt.

1.8 Aids to navigation

None relevant.

1.9 Communications

There was satisfactory radio telephone communication between the aircraft and the AFISO on the aerodrome information frequency. No radio calls were made by the commander after he first received clearance to enter the runway for take-off. Radio communications were not recorded.

1.10 Aerodrome information

Duxford aerodrome was administered by the local county council in conjunction with the Imperial War Museum. It was licensed for public transport use only on Saturdays, Sundays and Bank Holidays. The single paved runway, 06/24, measured 1503 by 45 metres and had recently been resurfaced with asphalt and grooved. On the day of the accident, a crowd line had been marked with stakes and ropes 168 metres north of the northern edge of the paved runway. A permanently marked grass runway measuring 787 by 30 metres lay between the paved runway and the crowd line, its northern edge being some 13 metres south of the crowd line. The elevation of the aerodrome was 124 feet.

1.11 Flight recorders

None were required or fitted.

1.12 Wreckage and impact information

1.12.1 On-site examination

For a few hours after the accident mainwheel tyre marks remained visible on the runway surface for some 70 metres from a point just to the right of the centreline to where the aircraft left the runway. The marks then continued on the grass, describing a near semi-circular path as illustrated in Appendix 1. Apart from a few discontinuities where the aircraft bounced over the uneven surface, the marks were continuous up to the point where the aircraft collided with the Skoda car. Where the mainwheels had run on to the grass, soil had been thrown sideways across the runway. Comparison of the distance between the mainwheels of the aircraft and the distance between the wheel tracks showed that, soon after leaving the runway, the aircraft was yawed 17° to the right of its path over the grass. The angle of yaw increased through 27° at 76 metres from the runway edge to 36° where the left wings struck the loudspeaker tripod. No marks were found from the tailwheel until just before the aircraft came to rest and no signs of heavy braking such as skid marks or torn turf were found in the wheel tracks. The aircraft travelled 269 metres from the point where it left the runway to the final impact.

The loudspeaker tripod was 168 metres from the edge of the paved runway. Both the upper and lower left wing leading edges struck this tripod but remained relatively undamaged. Some 36 metres farther along its track, the aircraft encountered 3 parked cars, 2 of which received minor damage from contact by the lower left wingtip. The third car, the Skoda saloon, was run over by the underside of the fuselage and suffered 6 deep slashes along its right-hand side from the left propeller. This impact launched the aircraft into the air for about 28 metres and caused it to begin to yaw violently to the left. The right lower wing then struck a motorised caravan disrupting the main spar and pulling the upper wing down on to the roof of the caravan. At about the same time the right propeller struck an estate car leaving 5 deep slashes in the tailgate. The aircraft came to rest when the underside of the forward fuselage and the right engine nacelle rode over yet another motor car, which sustained severe damage to its roof and bonnet.

Despite the numerous impacts suffered by the aircraft, the passenger cabin and pilot's compartment remained intact and were not penetrated by debris. The seats, seat belts and associated structure appeared to be undamaged and the cabin entry door functioned normally but the wooden structure supporting the tailwheel was broken and the tailwheel had collapsed. The right upper and lower mainplanes were severely damaged and the tubular metal lower wing stub structure, which also supported the engines and mainwheels, was twisted and broken, particularly on the right side. Both propeller blades were extensively damaged but the engines and

their accessories appeared to be largely intact. The fuel tanks, situated in the engine nacelles aft of the mainwheel legs, were undamaged and there were no fuel leaks. Both mainwheel tyres remained inflated.

1.12.2 Subsequent examination

Contact with the Skoda car had caused significant damage to the underside of the fuselage over the length of the passenger cabin. The fuselage was constructed around a plywood box section with a further external covering of doped material over formers and stringers. The flying control, engine control and brake cables ran under the wooden cabin floor in the space between the floor and the fabric skin, the elevator and rudder circuits having duplex cables. Many cable pulleys had been crushed by impact but only one of the flying control cables, the upper right rudder cable, had actually been severed. There were no indications of any pre-accident malfunction of the flying controls. The mainwheel brake cables, although trapped at several locations by structural distortion, had remained intact, and the brakes still functioned. The distance between the first and second propeller slash marks on the Skoda car could not be measured because of the damage to the car. The distances that could be measured were 200 millimetres (mm) between the second and third marks, 220 mm between the third and fourth and 230 mm between the fourth and fifth. The slash marks on the car hit by the right propeller were on a near vertical surface and the distance between them could not be measured. The violence of the damage done by the propellers to both vehicles, however, indicated that both engines were rotating under considerable power at impact. The engines were removed for testing and details of these tests are in paragraph 1.16.

1.13 Medical and pathological information

Not applicable.

1.14 Fire

There was no fire.

1.15 Survival aspects

Safety harnesses provided adequate restraint and the occupants were able to leave the aircraft through the sole entrance door.

1.16 Tests and research

Both engines were despatched to an overhaul facility where they were installed in turn on a test stand. A ground test propeller was used to absorb the engine power. Apart from a brief check to ensure that the engines were in a safe condition to run, no rectification or adjustments were made to the engines or their accessories. Both engines started easily and ran smoothly at idling speed. Manifold pressure, engine speed, fuel flow, cylinder head temperature, oil pressure and other parameters were then recorded for a range of power settings up to the maximum power stop on the throttles. No abnormalities were recorded during the test and it was noted that, at the full power setting both engines were rotating within 5 rpm of each other. Acceleration times from idling to full power were rapid on both engines and, as best as could be determined, were identical.

1.17 Additional information

None

2 Analysis

The main features of this accident were that an experienced airline pilot in a slow and not very powerful aircraft swung off the runway when taking off and failed to bring the aircraft to rest. The swing itself should not have caused an accident for, if the throttles had been closed, the aircraft would most probably have stopped before it encountered any obstructions. This analysis must therefore consider why the pilot failed to bring the aircraft to rest when it left the runway, whether he was competent to fly the aircraft, and whether any failure in the processes of training and supervision might have contributed to the accident.

The start of the accident sequence was a swing to the right during the take-off ground roll. It is characteristic of the Dragon Rapide that it tends to swing to the right during take-off and, as long as the tailwheel is on the ground, the rudder is less effective than differential throttle in correcting such a swing. Also, in common with all tailwheel aircraft, if a yaw is allowed to develop when the wheels are on the ground, it becomes increasingly difficult to check because the side force on the mainwheels, acting forward of the centre of gravity (cg), produces a moment in the direction of the swing, which increases with the angle of yaw. This behaviour differs from that of a nosewheel aircraft where the sideforce on the mainwheels provides a restoring moment that helps to check the swing. A rearward cg aggravates the situation because it increases not only the moment arm but also the length of time that the rudder effectiveness is reduced by the taildown attitude. On the occasion of the accident the natural swing of the aircraft was reinforced by a crosswind from the right of between 5 and 8 knots. The swing was not corrected promptly for, by the time the aircraft left the runway, it was yawed nearly 17° to the right and the wheels were already developing considerable side force as shown by the soil thrown to the left at the runway edge. The commander had opened both throttles together, against the advice in the Operations Manual, and it is likely that rudder alone was not enough to check the swing. Moreover, the tendency to swing would have been reinforced by the high friction of the grooved macadam runway surface and greater than the commander had previously experienced on grass. It seems, therefore, that he was caught unawares and did not react in time to check the swing.

The correct action for the commander to take would have been to close the throttles and discontinue the take-off as soon as it was apparent to him that he had lost directional control of the aircraft. It may be that he did not appreciate at this stage that he had lost directional control for his experience was predominantly of nosewheel aircraft, which have no tendency to ground loop. He may well have expected, therefore, that full rudder would straighten the aircraft. However, by the time the

aircraft left the runway the tailwheel was off the ground and the yaw was increasing. He appears then to have been inhibited from closing the throttles by his impression that the aircraft had been bounced into the air. His subsequent attempt to fly the aircraft off probably lost him several vital seconds and, as his speed at this time was unlikely to have been less than 45 knots, the aircraft had probably travelled at least 70 metres before he realised that it was still on the ground and heading towards the crowd line. If he had closed the throttles at this point, although he might not have been able to stop the aircraft quickly, he might have reduced the radius of the turn enough to avoid crossing the crowd line. However, no witness testified to hearing any change of engine note between the aircraft leaving the runway and its collision with the parked vehicles. Moreover, when the aircraft collided with the Skoda car, its tailwheel was still in the air and the whole aircraft was lifted off the ground for some 28 metres. It is unlikely, therefore, that its speed at this impact was less than 25 kt. At this speed the distance of 220 mm between the second and third propeller slash marks on the car represent a propeller speed of more than 1900 rpm, indicating that the throttle of this engine at least was well advanced.

In attempting to explain the commander's failure to close the throttles it is relevant to consider the layout of the controls in the cockpit. The throttles and brakes are both normally operated by the pilot's left hand. If the commander omitted to close the throttles before applying the brakes, they would remain where they were unless either his left hand momentarily left the brake lever or his right hand was crossed over to close them. The commander's own recollection of the events immediately preceding the impact with the parked cars is not clear; he said that he thought he had closed the throttles but there can be no doubt that the throttles were not closed. He also said that he thought he had tried to stop the aircraft but the wheel marks showed no sign of heavy braking. In view of the commander's inability to recall clearly what went through his mind after the aircraft left the runway, the possibility that he tried to continue the take-off must be examined. It is possible that, as the aircraft approached the grass runway, he was unaware of the rate at which it was skidding to the left. He was familiar with this runway, it was clear of obsructions, and his sight line was within 30° of the 06 take-off direction and closing rapidly. Moreover, after over-turning on his first attempt to line the aircraft up for take-off and the subsequent taxy back to the start of the runway, he might have had a strong incentive not to abort the take-off.

The pilot has said, however, that he never considered a reverse direction take-off. It seems likely, therefore, that he simply omitted to close the throttles before moving his hand to the brake lever and that his mind was then so filled with the visual perception of the approaching collision that he subsequently remained unaware that the throttles were still at high power. The latter hypothesis is only tenable in view of his limited experience on this aircraft type and raises the question of his competency to fly the Dragon Rapide in the public transport role.

It must be asked, therefore, if the minimum pilot type experience specified by the operating company was realistic. The instruction that can be given in the air in a Dragon Rapide is limited by its having only a single pilot's seat so that the instructor can only demonstrate or observe and cannot himself control the aircraft when his student is in the pilot's seat. Much of the conversion of a pilot to the type must be done by ground briefing and, in this respect, the operating company showed a high degree of responsibility. The handling notes in the Operations Manual, supplemented by the additional pamphlet describing the aircraft's handling characteristics, were comprehensive and, if carefully followed, should have prepared a pilot of average ability to fly the aircraft safely. In this light, the minimum of 5 hours type experience required for holders of Commercial Pilot's Licences seems reasonable. It is less reasonable that this minimum should have been reduced to 2 hours for holders of Airline Transport Pilot's Licences. Total flying hours and an ability to handle large airliners are not necessarily very good indicators of a pilot's likely ability to handle a Dragon Rapide and are less relevant than previous experience on light aircraft and, in particular, tailwheel aircraft. Because of the commander's very limited experience on tailwheel aircraft, it would have been prudent for the company to have required him to gain more type experience before allowing him to fly passengers.

The flying training given to the commander was comprehensive except for the omission of experience of paved surface operation. As well as the normal exercises required for the type rating, he had flown the aircraft with a normal operational load and had carried out several crosswind take-offs and landings under supervision. However, all this training had been done on a grass runway.

Although the primary cause of this accident was that the commander failed to take the correct action after a swing on take-off, a contributory cause was his lack of experience on tailwheel aircraft in general and on the Dragon Rapide in particular. It was also significant that the pilot had not previously operated the aircraft from a paved runway.

3 Conclusions

(a) Findings

(i) The commander was properly licensed and qualified to conduct the flight.

(ii) The aircraft had a valid Certificate of Airworthiness and a valid Certificate of Maintenance and there was no evidence of any defect in the aircraft that could have contributed to the accident.

(iii) The weight and centre of gravity of the aircraft were within the permitted limits.

(iv) The commander had previously flown only two sorties in the aircraft type, had little experience on tailwheel aircraft and had not previously flown the aircraft from a paved runway.

(v) The commander failed to control a swing on take-off and subsequently failed to bring the aircraft to rest.

(vi) The aircraft left the runway and followed a near semi-circular path over the ground before colliding with motor vehicles parked well to the right of the runway.

(b) Cause

The accident was caused by the failure of the commander to take proper corrective action when the aircraft swung on take-off. Contributory factors were the commander's low level of experience on tailwheel aircraft and the fact he had not previously flown the Dragon Rapide from a paved surface.

4. Safety Recommendations

None.

M M CHARLES
Inspector of Accidents

Air Accidents Investigation Branch
Department of Transport

November 1987