

No: 10/91

Ref: EW/C91/6/2

Category: 1b

Aircraft Type and Registration: De Havilland DH89A Dragon Rapide Mk III, G-AHGD

No & Type of Engines: 2 De Havilland Gipsy Queen III piston engines

Year of Manufacture: 1945

Date & Time (UTC): 30 June 1991 at 1326 hrs

Location: Near Audley End, Essex

Type of Flight: Flying Display

Persons on Board: Crew - 1 Passengers - None

Injuries: Crew - Fatal Passengers - N/A

Nature of Damage: Severe damage to fuselage, engines and wings

Commander's Licence: Airline Transport Pilot's Licence with CAA air display authorisation

Commander's Age: 58 years

Commander's Flying Experience: 15,840 hours (of which 15 were on type)

Information Source: AAIB Field Investigation

History of the Flight

The pilot was an experienced air display participant; he had displayed multi-engined aircraft since 1981. In March 1989, following the introduction of new legislation concerning air displays, he was authorised by the CAA to display single and multi-engined fixed wing aircraft of less than 5700 kg MAUW. Later he was authorised to display the Catalina.

The pilot converted to the Dragon Rapide in March 1983. During the summer of '83 he flew the type part-time on revenue earning pleasure flights. He was asked to display GD at the Wings and Wheels show by its owners because neither they nor their usual ferry pilot held the required display authorisation. He agreed to do so and the Rapide was scheduled to fly during the first half of the show. During the second half, he was scheduled to participate again in his own N3N-3 biplane aircraft.

On the evening of Friday 28 June he collected GD from Old Warden and flew alone for 25 minutes to Audley End airfield. During that flight he carried out general handling practice including a deliberate stall during which he noted that the aircraft stalled at a speed below the lowest speed (60 kts) shown on the ASI. Later that evening he flew for a further 20 minutes with 4 passengers on board and returned

to Audley End. According to one of the passengers, who was a licensed aircraft engineer and an experienced pilot, the flight was well flown and there were no significant aircraft defects. After this flight the aircraft was parked on the grass where it remained until Sunday.

On Saturday, the day before the accident, the pilot flew three flights in a Catalina including an air display and again he performed well. Later that day he returned to Audley End airfield, which he knew well, and flew the N3N-3 to rehearse his display routine over the display line located some 600 metres north of the airfield adjacent to Audley End House. The display routine usually included a slow flypast at about 60 kts and a steady heading sideslip.

On Sunday morning the pilot attended the display briefing before pre-flighting the Rapide. One of the aircraft's owners checked its fuel and engine oil levels which were ample for the display. After starting engines the aircraft was "wing-walked" clear of the parking area and then pre-take-off engine checks were performed by the threshold. The aircraft took-off normally and arrived over the display area at the appropriate time where the weather was fine and warm although a south-westerly wind of 15 kts was producing moderate turbulence at low altitude. The early part of the Rapide display comprised straight and level flypasts interspersed with steep turns and shallow wingovers using up to 60° angle of bank. On completion of the fourth turn, which was wider than previous turns, the aircraft rolled out on a westerly heading and rpm on both fixed-pitch propellers was reduced to around idle. The aircraft decelerated in straight and level flight with the flaps lowered and in a progressively more nose-up attitude. At low airspeed, mid-way along the display axis, the aircraft rolled to starboard and entered a spin to the right from a height of between 400 and 500 ft. It crashed approximately 300 metres north of the display axis and behind a line of trees which obscured spectators' view of the impact.

Video recordings of the display were obtained from members of the public. These showed the aircraft's turns and flypasts which appeared safe and well flown. The point at which flaps were lowered could not be determined but the flaps were seen to be down as the aircraft approached the point at which control was lost. In the final few seconds before that point, rapid and large rudder movements either side of neutral were observed and the elevators appeared to be at their uppermost limit (i.e. full back stick). As the aircraft rolled to the right, left aileron was applied but the elevators appeared to remain fully up. As it yawed into the erect spin, the rudder was seen to move to the right and then return to neutral; the ailerons returned to neutral but the elevators appeared to remain fully up. The aircraft completed little more than one turn before it disappeared out of sight behind trees. During that turn, left rudder was applied and both propellers appeared to be rotating at similar speeds well above idle power. As the aircraft disappeared from view, full up elevator was still applied.

The Dragon Rapide has tapered wing tips which tend to provoke a roll-off at the stall which, at light weight, occurs at about 48 kts with the flaps extended. Warning of approach to the stall is given by slight buffet from rudder and elevator about 2 kts above the stall itself.

Although the pilot had accrued about 15 hours on type, mainly through flying pleasure flights in 1983, he had logged only 45 minutes on type since October 1983. This time was accrued on the Friday evening prior to the accident but there was no evidence to suggest that he had practiced his display routine in the Rapide on that day.

Examination of the Wreckage

The aircraft had crashed in an extreme nose down attitude, estimated at some 70° to the horizontal, with a relatively high vertical speed into an undulating field of wheat. The configuration of the wreckage and damage made by the aircraft to this crop revealed that there had been no lateral motion of the aircraft, i.e. it had been descending vertically, and that it had been yawing to the right. This was consistent with the aircraft being in a spin to the right, an assessment validated by various video recordings taken by spectators at the display. At the moment of contact with the ground the aircraft's heading was 210° M. The cockpit of this aircraft is located at its very front and was the first part of the aircraft to strike the ground; this area and most of the passenger cabin being severely disrupted in the impact. The wings, engines, rear fuselage and tail surfaces had survived relatively intact. Although there was evidence on the crop of fuel splashing from the disrupted tanks behind each engine, there was no fire.

One blade on each of the two bladed propellers had broken off as the aircraft struck the ground and became embedded in the soil. Both these blades exhibited clear evidence that each engine had been producing a high level of power at the time of the impact.

The wreckage was removed to the AAIB at RAE Farnborough where a detailed examination was carried out. Assessment of the wreckage, and later analysis of the video recordings, revealed the aircraft to have been complete and structurally intact prior to impact. It was established that the flaps had been fully down and the tailplane trim had been set close to its mid position at the time of impact. All flying control circuits were examined for evidence of pre-impact discontinuity but none was found. In addition, evidence was looked for of foreign objects which might have caused a control restriction, but again none was found. No evidence was seen of in flight fire or birdstrikes.

The engines were audible on most of the video recordings as the aircraft was seen to descend in the spin. A frequency analysis was carried out of these sounds which revealed that, at about the time the right wing was seen to drop at the start of the spin, both engines increased speed together and, after approximately two seconds, were running at about 2500/2550 rpm, eventually rising to about 2700 rpm. The maximum permitted engine speed is 2400 rpm. Thus, both engines were producing high levels of power following entry into the spin.

Whilst the rudder and ailerons were seen to deflect as the aircraft descended, the elevators remained significantly (or fully) up. With this in mind a specific further examination of the elevator circuit was carried out to establish if there was any technical, as opposed to pilot induced, reason why they were

not moved towards down. It was evident from this examination that the potential for a restriction to the forward motion of the control column did exist in the cockpit.

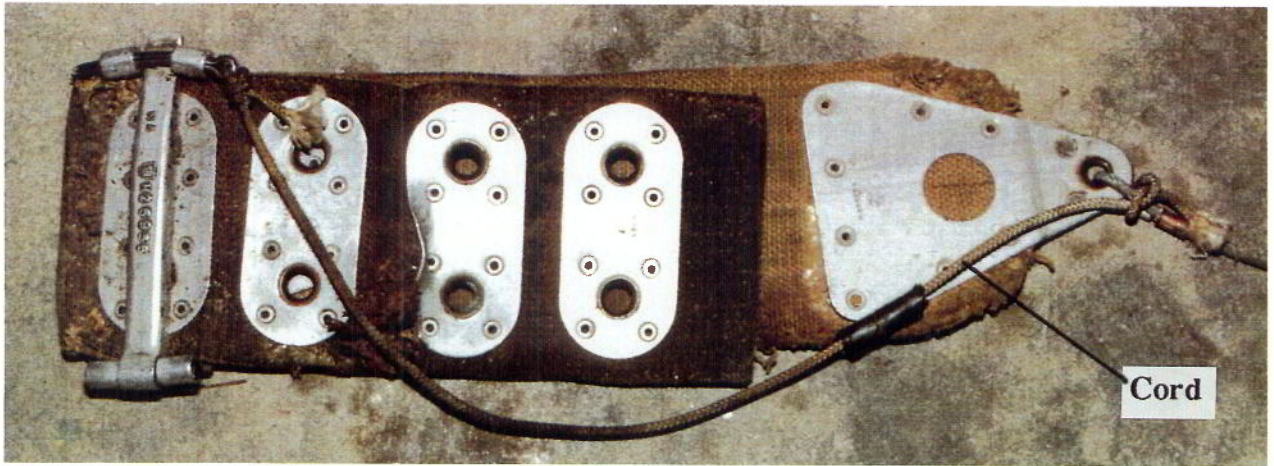
The aileron control wheel on this type of aircraft is pivoted at the top of the elevator control column and is made in the shape of a letter 'W', the handgrips being open topped. With full up elevator applied, the control wheel comes close to, or into contact with, the chest/stomach of the pilot, depending on his stature, as the seat position is not adjustable.

In GD the pilot was restrained by an original standard lapstrap, the two halves of which were keyed together at the centre by a locking lever attached to the left strap. This lever was itself made secure by the insertion of a split pin which, to avoid being lost and becoming a hazard in the cockpit, was attached to a length of strong terylene cord. The other end of this cord was found tied around the fitting at the end of the left strap, where a short wire strop connected this strap to the aircraft structure. The length of this cord between these two points, at 16 inches, was such that a bow was formed.

The waistband, complete with cord, was taken to another Rapide where a person of a stature similar to that of the pilot of G-AHGD was sat in the fixed pilot's seat. It was demonstrated that with the control column fully back and with the control wheel rotated to demand left roll, it was possible for this bow in the cord to easily engage over the left handgrip of the control wheel (see figure 1). It was apparent that in this situation it was unlikely the cord would be broken by forces applied by the pilot or that the pin could be fully withdrawn, and thus a severe restriction to forward movement of the control column could occur. Close examination of the cord, split pin and left handgrip from G-AHGD revealed inconclusive direct evidence that this had actually happened, but the relatively soft and rounded nature of these components made it unlikely that witness marks between them would result from such a restriction. Figure 2 shows extracts from the original De Havilland assembly drawings for this lapstrap where, as may be seen, the length of the safety pin retention cord is specified at 3½ inches. It was not established at what time in the aircraft's history the safety pin cord had been changed.

The aircraft was certificated in the private category and possessed a Certificate of Airworthiness valid until 20 September 1992. The last maintenance carried out was on 5 October 1990 and was an Annual check carried out in accordance with the CAA Light Aircraft Maintenance Schedule FW/1978. Since that time it had flown for approximately 10 hours, the next maintenance being required after a further 40 hours flying or by 4 October 1991.

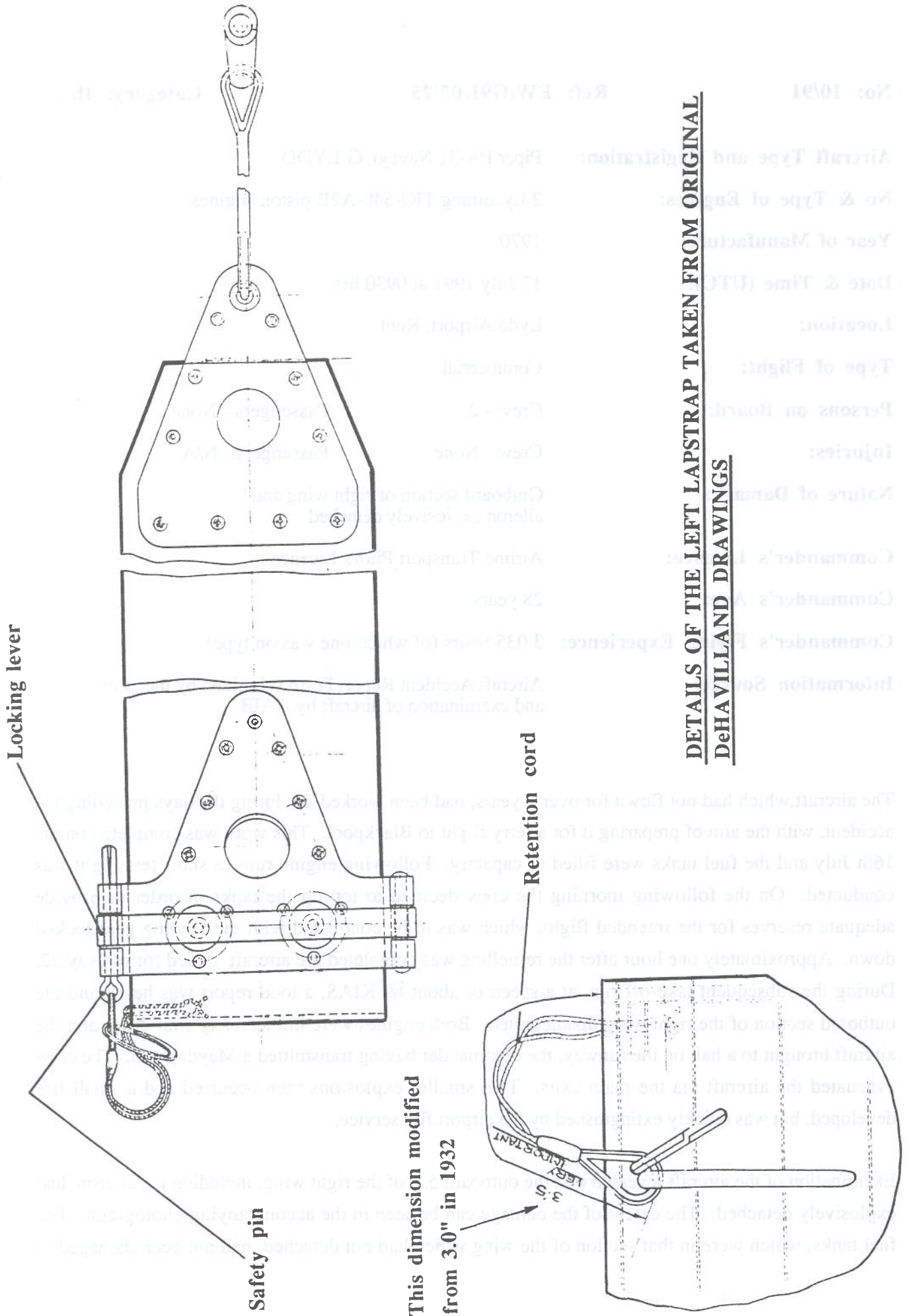
As a result of this accident, recommendations have been made to the CAA regarding the type of lapstrap fitted to 'GD and pilot recency requirements for air displays.



Left side of lapstrap as removed from the wreckage - view looking aft



Possible snagging of control column by safety pin cord when pulled aft with left roll demanded



DETAILS OF THE LEFT LAPSTRAP TAKEN FROM ORIGINAL DeHAVILLAND DRAWINGS

Figure 2