Department of Trade

ACCIDENTS INVESTIGATION BRANCH

Avions Pierre Robin HR 200/100 G-BCCO Report on the accident south-east of Sywell Aerodrome, Northamptonshire, 27 March 1976

LONDON
HER MAJESTY'S STATIONERY OFFICE

List of Aircraft Accident Reports issued by AIB in 1977

No.	*Short title*	*Date of publication*
1/77	Hawker Siddeley HS125 Series 600B G-BCUX Near Dunsfold Aerodrome, Surrey November 1975	May 1977
2/77	Cessna 310 G-BCKL at Black Hill, Perthshire, Scotland March 1976	June 1977

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Department of Trade
Accidents Investigation Branch
Shell Mex House
Strand
London WC2R ODP

10 May 1977

The Rt Honourable Edmund Dell MP
Secretary of State for Trade

Sir,

I have the honour to submit the report by Mr P J Bardon an Inspector of Accidents on the circumstances of the accident to Avions Pierre Robin HR 200/100 G-BCCO which occurred south-east of Sywell Aerodrome, on 27 March 1976.

I have the honour to be
Sir
Your obedient Servant

W H Tench
Chief Inspector of Accidents

ADDENDUM

It should be noted that the Aircraft Owners and Pilots Association (AOPA) Instructors Manual, an extract from which appears on page 12 of this report, was first published in September 1976, that is after the accident. Although the quoted section of the Manual makes no mention that the pilot should first ensure that the use of partial power for the spin entry manoeuvre is permitted for the particular aircraft type, this condition is stated however several times elsewhere in the chapter that is concerned with spinning.

On page 14 of the report, it is stated that the condition that the throttle be closed for the entry manoeuvre applies to all spinning approvals. It should be noted that this is applicable only to those aircraft certificated to British Civil Airworthiness Requirements.

Accidents Investigation Branch
Aircraft Accident Report No. 3/77
(EW/C555)

Operator:		Brooklands Aviation Ltd
Aircraft:	*Type*	Avions Pierre Robin
	Model	HR 200/100
	Nationality	British
	Registration	G-BCCO
Place of Accident:		1 nm south-east of Sywell Aerodrome
		Latitude 52° 17'N Longitude 00° 46'W
Date and Time:		27 March 1976 at 1331 hrs
		All times in this report are GMT

Synopsis

The accident was notified to the Department of Trade on 27 March 1976 by the London Air Traffic Control Centre (LATCC). The investigation was carried out by the Accidents Investigations Branch of the Department of Trade with operations and engineering groups established by the Inspector in charge. During a spin entry demonstration exercise, the aircraft entered a stable spin not previously experienced by the pilot. Repeated attempts by the instructor to recover from the spin were unsuccessful and the aircraft continued spinning into the ground. Both occupants were seriously injured.

The aircraft had been approved by the Civil Aviation Authority for the demonstration of the spin entry manoeuvre following a series of tests which appeared to establish that it could not be spun with either pro-spin controls applied or as the result of mishandled aerobatics. Though the spin entry technique used by the pilot was a standard instructional technique and had been evaluated during the course of the tests, it was not approved for the spin entry demonstration exercise. The optimum spin recovery technique applicable to the type had not been determined at the time of the accident.

1. Factual Information

1.1 History of flight

The purpose of the flight was to carry out an instrument flying test revision exercise with a student which the instructor authorised himself. The aircraft took off from Sywell Aerodrome in good weather conditions at 1300 hrs. After completing the exercise the instructor then climbed the aircraft to 5,000 feet altitude south-east of the aerodrome in order to demonstrate a spin entry manoeuvre and normal recovery. The spinning safety checks were completed and a spin entry manoeuvre to the left was carried out in the following manner:

Engine rpm approximately 1,500.
Nose up to a gentle climb attitude.
Left rudder applied as the speed passed 50 knots.
Control column fully back and then to the right.

On entry into the spin and after pointing out the instrument indications of the manoeuvre, the instructor took the conventional spin recovery action, that is, full opposite rudder, followed by a pause before progressively moving the control column fully forward. Soon after commencement of the spin, the engine stopped and the pilot found that he had not time, having regard to the recovery procedures and subsequent emergency actions, to restart it. It soon became apparent that the recovery action was having no effect on the aircraft's rate of rotation nor on the pitch attitude, which was about 20 degrees nose-down.

On reaching 3,000 feet altitude a distress call was made to Sywell tower. The aircraft continued to spin and after passing 2,000 feet, the emergency actions were completed including turning off the ignition and fuel and making a further distress call. As a last resort the flying controls were moved to the original spin entry position of full left rudder and control column fully back followed by an immediate return to the normal spin recovery position of right rudder and control column fully forward.

The aircraft struck the ground, still spinning, close to the village of Mears Ashby at 1331 hrs. Although the aircraft's descent had been seen by witnesses, it was several minutes before the aircraft was finally located and the emergency services arrived.

An aircraft engaged in local flying was directed by Sywell ATC to carry out a search and the pilot quickly located the crash site. Details of the accident were passed to the police and the first ambulance arrived at 1347 hrs.

1.2 Injuries to persons

Injuries	*Crew*	*Passengers*	*Others*
Fatal	–	–	–
Non-fatal	2	–	–
Minor/none	–	–	

1.3 Damage to aircraft

The aircraft was destroyed.

1.4 Other damage

Nil.

1.5 Personnel information

1.5.1 The Instructor (male)

Age:	24 years.
Licence:	Private pilot's licence valid until 5 November 1980, with RTF licence.
Certificate of experience:	Valid until 13 April 1977.
Ratings:	Flying Instructor valid until 29 August 1977 with restrictions; no night flying instruction.
	No aerobatic flying instruction except spinning.
	IMC valid until 25 September 1976 Aircraft rating Group A.
Medical certificate:	Valid until 12 December 1977, with limitations arising from defective colour vision.

Flying experience

Total time as pilot:	2,411 hours.
Time in command:	2,328 hours.
Time in command on type:	414 hours.
Time in previous 28 days:	41 hours.

1.5.2 The Second Pilot (male)

Age:	34 years.
Licence:	Private pilot's licence.
Medical certificate:	Valid until February 1977.

Flying experience

Total time as pilot:	96 hours.
Total time on type:	86 hours.

1.6 Aircraft information

The Robin HR 200/100 is an all metal two seater aircraft manufactured in France by Avions Pierre Robin and intended for club and flying training purposes. It has a non-retractable tricycle landing gear, single span cantilever low wing and an all moving tail-plane with an anti-servo/trim tab. The HR 200 series is certificated in the UK with two sizes of tail-plane, 22.2 square feet or 24.3 square feet (2.08 or 2.35 square metres). G-BCCO was fitted with the smaller tail-plane.

Details of the aircraft are as follows:

(a)	Type:	HR 200/100
	Year of manufacture:	1974
	Certificate of Registration:	10 June 1974
	Certificate of Airworthiness:	General Purpose Category valid until 6 June 1976. A Flight Manual dated June 1973 forms part of the certificate. The aircraft to be maintained in accordance with an approved maintenance scheduled, No.ARB/GPMS/FW 19.
	Total flying hours:	(i) Since new 1,214.40
		(ii) Since last Check 2: 49. 45
		(iii) Since last C of A 1,207.30
	Engine:	Lycoming 0-235 H2C.
	Total engine hours since new:	1,214.40
	Engine hours since last Check 2:.	49.45
(b)	Weight and centre of gravity:	
	Maximum weight authorised:	1,719 lb (780 kg).
	Estimated take-off weight:	1,570 lb (711 kg).
	Estimated weight at time of accident:	1,552 lb (703 kg).
	Centre of gravity range:	12.6 inches to 18.1 inches aft of datum at maximum weight authorised.
	Centre of gravity at time of accident:	Estimated 13.04 inches (0.33m) aft of datum.
(c)	Type of fuel:	Avgas 100/130 (100L)

1.7 Meteorological information

There is no official observer at Sywell Aerodrome and the estimated weather conditions were reported as follows:

Weather:	fair
Wind:	270/25 knots
Visibility:	more than 10 km
Cloud:	3/8 at 3,000 feet, with thin amounts above.

Weather conditions were not considered to be a factor in the accident. The accident occurred in daylight and the light conditions were good.

1.8 Aids to navigation

Not applicable.

1.9 Communications

Communication between the aircraft and Sywell Aerodrome were normal at the time of the accident.

1.10 Aerodrome and ground facilities

Not applicable.

1.11 Flight recorder

Not fitted and not required.

1.12 Wreckage and impact information

1.12.1 On site examination

The aircraft had crashed on undulating ground at an elevation of 335 feet above mean sea level (amsl). Damage to the aircraft and ground impact marks indicated that it had struck the ground with a pitch attitude of approximately 20 degrees nose-down while spinning to the left. It had little forward speed but a high rate of descent.

There was extensive damage to the front fuselage and cockpit floor in the area of the rudder pedals. There was also damage to the wings resulting from reaction loads transmitted up through the main undercarriage legs into the main spar. The tail unit sustained slight damage.

1.12.2 Subsequent examination

Despite an extensive examination of the wreckage no evidence of pre-crash malfunction or failure of the airframe or flying controls was found. The engine, which was not rotating on impact, was not stripped.

1.12.3 Total movement of flying controls

The control angles of G-BCCO were measured and though it was not possible to measure the tail plane angle precisely, the rudder angle was measured accurately. It was found that with the rudder fully to the right against its stop, the angle was 6 degrees in excess of the permitted maximum of 30 degrees. To the left, it was at the maximum permitted angle.

The rudder angles of G-BBJT, the aircraft used for the CAA certification tests, were also measured after the accident (i.e. 18 months after the tests) and were found to be as follows:

Fully left	–	31 degrees
Fully right	–	34 degrees

There was no evidence that the rudder setting of G-BBJT had been altered since the flight tests.

1.13 Medical and pathological information

Due to the high vertical rate of descent and subsequent crushing of the nose structure, both pilots received severe multiple injuries which included fractures of spine and limbs.

1.14 Fire

There was no fire.

1.15 Survival aspects

The fire and crash vehicle personnel were alerted by the crash alarm and were informed at about 1331 hrs by the control tower that the aircraft had crashed north-east of Mears Ashby village. The vehicle went to the area but as the crash site was not visible from the access roads they were unable to locate the aircraft and returned to the aerodrome at 1410 hrs. By this time police and emergency services had arrived at the site and the first ambulance was in attendance at 1347 hrs.

Both pilots were wearing a full safety harness, and in each case the metal buckle had failed where the two shoulder straps joined the single strap running aft to the attachment point on the aircraft structure. This permitted the upper parts of the pilots' torsos to jack-knife forward. Both pilots were conscious after the accident but due to their injuries, were unable to extricate themselves from the wreckage.

It was approximately 40 minutes before the trainee pilot could be released and 80 minutes before the instructor, by then semi-concious and receiving medical attention from a doctor, was removed from the wreckage. Neither pilot was wearing protective headgear or a parachute.

1.16 Tests and research

1.16.1 Spring mechanism in rudder circuit

Immediately after the accident it was discovered that because of a spring mechanism operating through the interconnected rudder/nosewheel steering, considerable force had to be applied to the rudder pedals to move them over their full range. This spring resistance was checked statically on another HR 200/100 aircraft and the force required to achieve full rudder deflection was 145 lb. This was with the nosewheel lifted clear of the ground so as to lock the steering mechanism in the fore and aft position.

1.16.2 Simulated spin entry and recovery

In order to check the effect of the spring on the amount of rudder applied, two instructors were asked to simulate on the ground, the control movements they would normally make for spin entry and recovery. The test was conducted with the nosewheel clear of the ground.

Ten simulated recoveries were made and in each case the pilot considered that he had applied full opposite rudder. However in only one case, did the rudder reach its stop. In the remainder of simulated recoveries, the distance of the rudder from its stop varied

from 1/8 to ½ inch (3 to 12 mm). As each 1/8 inch represents approximately 3 degrees of rudder movement, a ½ inch represents 40 per cent of the total rudder travel. (See Appendix).

Checks were made of the inside leg measurements of the two instructors who took part in these tests as well as those of the instructor involved in the accident. The measurements were 34½ and 32 inches for the two instructors and 30½ inches for the instructor involved in the accident.

The seats fitted in G-BCCO were adjustable and the pilot of G-BCCO said that he always put his seat in the rear position to avoid interference between his legs and the lower part of the instrument panel. It has not been possible since to determine if the pilot could achieve full rudder pedal travel with his seat in the rear position, though he has since stated that as far as he was aware, he was always able to apply full rudder.

1.16.3 Spin technology – NASA report

The following extracts are from a report on spinning issued by the National Aeronautics & Space Administration, Washington DC in December 1971, entitled 'Summary of Spin Technology as related to General Aviation Airplanes';

> 'Tail configuration
>
> Criterion for spin recovery. – The tail configuration is a very important factor in the spin and recovery characteristics of airplanes, especially for light airplanes that are in the zero or near zero loading range (ie where moments of inertia in roll and pitch are about equal), – where the rudder is a primary recovery control. A relatively large moment is needed to recover an airplane from a spin, especially a flat spin; therefore, it is important that the airplane control surfaces, particularly the rudder, be effective at spin attitudes.
>
> The special problem is that during a spin, much of the rudder is usually in the stalled wake of the horizontal tail and sometimes the wing, over which the dynamic pressure is low, or abnormal airflow conditions exist.
>
> In some cases, it has been found that simultaneous reversal of the rudder and elevator gives unsatisfactory recovery characteristics, whereas the reversal of the rudder alone with the elevator up gives satisfactory recoveries. This result is believed due to the rudder being shielded by the downward movement of the elevator. For this reason, it is recommended that, when both rudder and the elevator are reversed for recovery, the rudder should be reversed first, then about one half to one turn later, the elevator should be deflected down. This technique was proved in full-scale spin tests conducted on several airplanes by the NACA in 1935, and the results from these led to the so called NACA recommended spin-recovery technique: briskly move the rudder to full against the spin; after the lapse of appreciable time (approximately one-half turn), briskly move the elevator to approximately full down, and hold these controls until the recovery is complete. It is important to note that when these results were obtained in 1935, the airplanes of that day probably were in the zero loading conditions previously discussed and today this recovery technique would only apply for airplanes of similar loadings'.

1.17 Additional information

1.17.1 French certification

The original Robin HR 200/100 type aircraft although structurally designed to be capable of aerobatics, was not approved by the French authorities (SGAC) as an aerobatic aircraft. During French certification flight trials the aircraft was demonstrated

to comply with the American Federal Aviation Regulations (FAR) airworthiness standards though this did not include compliance with FAR 23.221 (c) (Aerobatics category). The Robin HR 200/100 was certificated by the French authorities in the Utility category in 1973. This requires that a single engine normal category aircraft must be able to recover from a one turn spin or a 3 second spin, whichever takes longer, in not more than one additional turn, with the controls used in the normal manner for recovery. The SGAC did not consider the aircraft incapable of spinning but because it had not then been demonstrated to comply with the FAR 23.221 (c) – Aerobatics category, it was forbidden to attempt to spin the aircraft. This requires the aircraft to recover in 1½ turns after a 6 turn spin or 3 seconds if the aircraft displays spiral characteristics.

1.17.2 United Kingdom (UK) Civil Aviation Authority (CAA) certification of Robin HR 200/100.

The Robin HR 200/100 was introduced into the UK in 1973 and approved by the CAA for certification in the General Purpose Category in February 1974 after the CAA had completed a flight assessment of the handling qualities. After certification the Avions Robin (UK) Ltd representative applied to the CAA for clearance of the aircraft for training in spin entry and recovery techniques.

The CAA requested evidence of the aircraft's spinning characteristics and were supplied with documentation which included a memorandum prepared by Scottish Aviation Ltd. This memorandum reviewed the French documentation which consisted of aircraft recorder traces and flight logs of spin trials together with two reports on the aircraft's spinning characteristics, dated 1973. One of these reports was concerned with the results of wind tunnel spin tests conducted with a scale model HR 200 aircraft at the French Institute of Fluid Mechanics at Lille; the other was the flight trials certification report from the French Flight Test Centre (CEV) at Istres.

Scottish Aviation Ltd concluded from its study of this documentation that the aircraft did not enter into a classically well-developed spin, but entered a markedly non-steady spiral dive.

The recovery from the spiral dive was considered in the CEV (Istres) report to present no problems, it being sufficient in most cases to return controls to the neutral position when recovery would be affected within half a turn.

It was noted by Scottish Aviation Ltd that the Lille wind tunnel report was unfavourable and that it recommended modifications to the rudder to increase its size and to distribute the area more towards the bottom half. The addition of ventral fin was also recommended by Lille. None of these modifications was embodied on the aircraft.

Scottish Aviation Ltd gave as its opinion that it would be unlikely that the aircraft would be permitted to carry out more than a one turn manoeuvre, because of the danger that the spiral would increase to such an extent that the margin between the speed and acceleration necessary to recover, and the proof strength of the aircraft would be insufficient.

At this time, February 1974, no official spin trials had been completed and Scottish Aviation advised Avions Robin (UK) to discuss with the CAA Airworthiness Division how the problem should be further pursued and what clearance attempted. However, shortly after this, a CAA test pilot flew the aircraft on a preview test to examine its tendency to spin. None was found during the course of a series of tests made to provoke autorotation

normally and during mishandled aerobatics. A summary of the results of this test flight was made available to Avions Robin (UK). Following further lengthy discussions with the CAA, Avions Robin (UK) were offered the choice of applying for either approval for training in spin entry and recovery techniques or for an aerobatic approval in compliance with BCAR K2-12 under specified flight test conditions. As an aerobatic clearance would take a considerable time Avions Robin (UK) elected to apply immediately for clearance for spin entry and recovery from incipient spins. CAA indicated in August 1974 that this could be approved subject to certain flight manual amendments. However when it became known to the CAA that the manufacturer had not applied to SGAC for an aerobatic clearance, the Authority decided not to give its approval for any manoeuvre involving spinning until further flight testing had been carried out.

1.17.3 CAA approval for aerobatics

The CAA subsequently proposed to Avions Robin (UK) that if the type could be demonstrated as being characteristically incapable of spinning an aerobatic clearance would be approved. Initially the CAA required that the flight tests be conducted at an extended aft c.g. and with the range of flying control movement increased, that is in accordance with the Appendix to BCAR K2-12. Following strong representations from Avions Robin (UK), the requirement for the extended control range was withdrawn. When the programme of flight tests had been agreed, Avions Robin (UK) contracted the Cranfield Institute of Technology to carry it out.

Avions Robin at Dijon had earlier stipulated that before any spinning tests were carried out on the aircraft in the UK, the test pilot concerned should first consult with Dijon and discuss the available data on the aircraft's spinning characteristics and safety measures to be taken. In the event this condition was considered to be inappropriate in relation to the declared purpose of the tests, which was that they did not constitute a spinning trial. Likewise the CAA was not informed of Dijon's views on this matter.

1.17.4 Cranfield Institute of Technology flight tests

A Robin HR 200/100 series aircraft G-BBJT was flight tested at Cranfield in November/ December 1974 and on page 1 of the report, entitled 'Robin HR 200/100 – Low Speed Handling', it states:

> ..... ' To enable an aerobatic clearance to be given to the Robin HR 200/100, the Flight Division of Cranfield Institute of Technology was approached by Avions Robin (UK) Ltd to carry out flight tests to satisfy the CAA that the aircraft would not spin under the following conditions:-
>
> | | |
> |---|---|
> | Weight: | Maximum certified for aerobatics |
> | C of G: | Full aerobatic range extended 3% aft of the aft limit |
> | Configuration: | Flaps up |
> | Rigging: | Rudder and stabiliser to be set to maximum permissible travels given in the flight manual. |
> | Entries: | Application of full rudder to port and starboard with full back stick in the following attitudes to cover possible inadvertent spin entry from mishandled aerobatic manoeuvres:- |
>
> Steep turns, stall turns, hammerhead stalls, top of loop including full forward stick. The pilot is to attempt to provoke a spin by mis-handling these manoeuvres, applying pro-spin controls at the critical point of recovery.

Power: Power off; maximum power; power off at entry with power on for recovery; power on at entry with power off for recovery.

Ailerons: Ailerons to be central throughout. At the conclusion of the above programme, a limited series of tests to be made to investigate the effect of ailerons, especially the application of out-spin aileron in the more critical cases.

Recovery: To be initiated;

(a) if the aeroplane enters a spin

(b) at the point at which increased indicated airspeed makes it necessary in order to avoid exceeding V_A – (manoeuvring speed).'

The report concludes in the Discussion of results that:

'The investigation indicated that the aircraft has insufficient yaw control to induce a spin when flown at C of G's up to 28% Standard Mean Chord (SMC), as the relatively far forward C of G produces a strong pitching moment which quickly overcomes any yawing moment that can be induced, and from the evidence of the behaviour of this aircraft, the model would appear to be spin proof when flown with flaps in and at a Maximum All Up Weight (MAUW) of 780 kg up to 28% SMC.

Conclusions:

As the speed builds up quite quickly in a spiral dive, it is recommended that any aerobatic clearance should emphasize the need to ensure that the flaps are up and the need to avoid over-stressing the aircraft in recovery from spiral dives. Additionally the only other restriction considered essential is to ensure that the luggage tray is empty. The C of G range will take care of itself if the AUW is kept to the authorised maximum of 780 kg'.

Cranfield found that with the aircraft loaded normally for aerobatics, it was impossible to achieve the aft limit of 18.1 inches. Therefore the requirement that the aircraft be flown at 3 per cent aft of that limit could not be met. The worst condition tested therefore was at a c.g. of 16.37 inches (27.7 per cent SMC), that is 3 per cent aft of the most aft c.g. normally obtainable.

1.17.5 UK CAA approval for aerobatics and spin training

The results of the Cranfield tests were validated by the CAA Flight Test Section and deemed to be acceptable to the CAA as 'establishing that the Robin HR 200/100 with a 22.2 sq ft area tail plane in the configurations as flown, was characteristically incapable of spinning'.

Therefore in January 1975 the CAA issued an airworthiness approval note to Avions Robin (UK) Ltd granting approval for Robin HR 200/100 and other aircraft of the same type fitted with a horizontal tailplane of 22.2 sq ft area to perform aerobatic manoeuvres including the demonstrations of spin entry and recovery procedures provided that it was operated in accordance with the limitations and procedures contained in the Flight Manual.

Following the accident when it was established that the aircraft had crashed whilst in a fully developed spin, a precautionary signal was sent on 29 March 1976 to all owners of this type of aircraft in the UK by the CAA Airworthiness Division and this was followed on 31 March 1976 by a prohibition on all aerobatic and spinning manoeuvres until further notice.

1.17.6 Robin HR 200/100 Flight Manual

The Robin HR 200/100 Flight Manual Chapter 4 states the following with respect to the spin entry demonstration and recovery:

'Chapter 4. – Normal procedures -

Demonstration of spin entry and recovery technique is authorised subject to the following conditions:-

1. Loading; the centre of gravity must not be aft of 14.72 inches (0.374m) aft of the datum (24.9% MAC). The baggage compartment to be empty.

2. Shoulder harness to be worn by the occupants.

3. One occupant must be familiar with the spiral dive characteristics of the HR 200/100.

4. Configuration, the flaps shall be retracted and the throttle closed throughout the manoeuvre. The aeroplane must be fitted with a horizontal stabilizer of 22.2 square feet area.

5. Recovery shall be initiated early enough to ensure that V_A(131 kts IAS) is not exceeded with any control surface fully deflected.

Spin recovery

In the case of a spin, follow the procedure hereunder:

Rudder in direction opposite to spin
Elevator half way up
Ailerons in neutral
Straighten the aircraft whilst trying to respect the limits of the flight envelope'.

1.17.7 Spin training at flying schools

(a) Brookland School of Flying Sywell

The evidence of four flying instructors at Sywell indicated that although the Robin HR/100 was a difficult aircraft to spin, all three of the school's aircraft had been spun, using partial engine power for the entry. It was not uncommon for the engine to stop shortly afterwards. On 8 March 1976 an assistant instructor experienced great difficulty in recovery from a developed spin in G-BCCO and lost 2,500 to 3,000 feet in the process. The incident was not reported to the CAA. The pilot has since stated as follows:

'I maintained spin entry control position for more than one turn and noticed the speed stayed low instead of increasing, as was my previous experience of the aircraft. At approximately 4,500 feet altitude I initiated standard recovery procedure, but the spin continued. The engine had stopped soon after entry to the spin which was not unusual with the aircraft in unusual attitudes, so I commenced to rock the elevators fully back and forward whilst maintaining opposite rudder. This did not seem to have any immediate effect, but after several attempts, the aircraft stood on its nose and tumbled into an inverted position. I commenced to pull through to regain the upright position and the engine restarted during the ensuing dive out'.

However the chief flying instructor who was on the staff of the school until January 1976 stated:

> 'I found I was unable to demonstrate sustained spins with the HR 200/100 because the normal entry technique of applying full pro-spin control, - ie full rudder, stick fully back with ailerons neutral at the basic stall always resulted in a spiral dive. Attempts had been made by myself on several occasions to enter a developed spin by using the standard technique with up to 2,000 rpm and ailerons neutral, but never with any success....'

(b) Goodwood flying school

The school at Goodwood also acquired three Robin HR 200/100 aircraft in 1974 and had demonstrated aerobatics and spin training after receiving CAA authorization. However the chief flying instructor knew of no instance of a truly developed spin occurring and all demonstrations of the spin entry manoeuvre had been given power off.

The chief flying instructor stated as follows:

> 'With normal spin entry control movement at the point of stall, ie full rudder, stick fully back, aileron neutral, produced a stall with a gentle wing-drop, which degenerated into an unstalled spiral dive when the nose dropped and the speed increased'.

1.17.8 Extract from the AOPA Instructor Manual (See Addendum at frontispiece)

The following extract from the Aircraft Owners and Pilot Association (AOPA) Instructor Manual is relevant to the accident:

> 'Spin entry characteristics
>
> Many training aircraft are often reluctant to enter a positive or incipient stage spin. This is largely due to a limited up elevator movement and a forward c.g. In these circumstances the student will be unable to appreciate the importance of spin training, and may conclude that inadvertent spin entries are very difficult to achieve and unlikely to occur. In this event, his motivation in learning and developing skill at spin recovery will be substantially reduced. However under certain aircraft conditions eg aft c.g. high power and low airspeed, many modern and seemingly docile training and touring aircraft can exhibit emphatic spin qualities. It is therefore important for the student to acquire a healthy respect for spin training and appreciate its value.
>
> Every effort should therefore be made to show him how easily a spin can occur when certain conditions exist. Most modern training aircraft are prohibited from deliberate spins unless in the Utility Category and often the nearest approach to a spin under these conditions is an autorotative spiral, with an attendant rapid increase in airspeed.
>
> It is therefore preferable for the instructor to demonstrate spin entries with a little power on, as this will enable a more positive effect to be achieved from the elevators and rudder, leading to a more effective spin entry during which the controls do not have to be moved so violently for spin entry to occur. An additional benefit from the use of power during the entry stage is that it introduces the use of throttle during recovery from the beginning of spin training, and the standard recovery phrase 'close the throttle' becomes more meaningful. Another factor is that the spin can be entered at a lower airspeed which in the case of the autorotative spiral will lower the speed reached during the recovery stage.

With many modern aircraft it is often difficult to produce a spin entry from a gliding turn without full and very harsh movement of the controls, therefore spin entries should normally be confined to descending turns, where a small amount of power is being used.'

1.17.9 Spin test of a Robin HR 200 with modified tail plane

During March 1976, the manufacturer conducted a spin test on a Robin HR 200/160, which was stated to be aerodynamically similar to an HR 200/100 but with the tailplane area increased to 24.3 square feet, (2.35 square metres). After 7 turns of a developed spin, recovery action failed to stop the spin within 4 turns and recovery was effected by the use of anti-spin rockets. The height loss in 10 turns was approximately 3,000 feet.

The aircraft weight was 830 kg and the centre of gravity 28.5 per cent SMC. It was concluded as a result of these tests that recovery would probably be possible if the control column was held fully back and full pro-spin aileron was applied after the application of full opposite rudder.

2. Analysis

There would seem to be no doubt that the aircraft was in a fully developed spin when it struck the ground. Moreover, the spin had been entered following the deliberate application of pro-spin controls in the course of a spin entry demonstration. The central issue arising from this accident therefore is not that the aircraft failed to recover from the spin but that it spun at all after it had been assessed by the Civil Aviation Authority as being incapable of doing so, whatever method of entry was employed. It was on the basis of this assessment that the aircraft was approved for aerobatics and the demonstration of the spin entry manoeuvre.

When the CAA was asked if it would grant an aerobatic approval shortly after the aircraft had come on to the United Kingdom Register, the Authority was aware that no such approval had been given by the French certificating authorities (the SGAC). The Authority was therefore understandably cautious and required of Avions Robin (UK) a demonstration that the aircraft would meet BCARs since the Authority was unable to validate any previous SGAC approval. However the Authority was prepared to approve the aircraft for the demonstration of the spin entry manoeuvre separately as the aircraft had been shown to meet the requirements of the French Utility Category. However when it learnt later that the manufacturer had not applied to the SGAC for an aerobatic approval, the Authority rescinded its earlier agreement to approve the demonstration of the spin entry manoeuvre and stated that the aircraft must first be shown to be un-spinnable as defined by BCARs before either an aerobatic or spin entry demonstration approval could be granted.

The conclusion of the Scottish Aviation Ltd review of the CEV and Lille data that the aircraft 'did not get into a classically well developed spin, but entered a markedly non-steady spiral dive' was no longer considered adequate evidence for the proposed clearance. The issue was clarified as one which required Avions Robin (UK) to demonstrate afresh that the aircraft's spinning characteristics were as claimed. This was a perfectly proper decision in the light of what was known about the aircraft at the time, though it is probably true to say that the general feeling amongst all those concerned was that the aircraft would be shown to be incapable of spinning.

It was unfortunate that at about this time that Avions Robin (UK) was in receipt of a summary of a CAA flight test report which gave the results of a preview test flight, the purpose of which had been to examine the aircraft's tendency to spin, and which reported that none was found. This summary was mistakenly interpreted by the Robin (UK) agent as virtually constituting an aerobatic approval and he advised his clients accordingly. Thus

when the decision was made by the CAA that both the aerobatic and the spin demonstration approval was conditional on the aircraft being shown to be incapable of spinning, Avions Robin (UK) complained to the CAA that the Company had been caused some considerable embarrassment commercially by the Authority's withdrawal of its aerobatic approval. In fact no such approval had been given. Steps have since been taken by the CAA to ensure that a misunderstanding of this nature does not occur in future.

The Avions Robin (UK) agent also complained to the CAA that the requirement that the flying be done with the control range increased was unrealistic in the case of an aircraft with fixed control stops. This was not wholly accurate as the stops could be moved by a licensed engineer in accordance with a maintenance procedure though they were outside the sphere of influence of the pilot. However the CAA withdrew the requirement for the flying to be done with the flight control range increased and this was a perfectly legitimate action on the Authority's part. The requirement for increasing the flight control range was contained in the Appendix to the relevant BCAR and was not therefore mandatory. In the event, the requirement was shown perhaps not to be so unrealistic as a considerable variation in rudder angle settings was found on those aircraft that were examined. Whether or not the outcome of the Cranfield and CAA tests would have been any different had the aircraft been flown with the flight control range extended can only be a matter for speculation but in retrospect it might be considered that it would have been better had this been done.

For a proper understanding of the background to this accident, it has to be appreciated that the tests that were eventually carried out did not in any sense constitute a spinning trial but were merely to evaluate the aircraft's tendency to spin. The distinction is a fine one but is nevertheless important. Had a spin occurred at any time during the tests, they would have discontinued and the aircraft would not have been approved for aerobatics or the demonstration of the spin entry manoeuvre. However in the course of some 130 attempts by two experienced test pilots to make the aircraft spin by a wide variety of methods including the use of partial power for the entry, it exhibited no tendency to do so. It was therefore not unreasonable that the CAA should conclude that the results of the tests were acceptable 'as establishing that the aircraft, in the configuration tested ..... is characteristically incapable of spinning.' The aircraft was accordingly approved for aerobatics and spin training subject to certain conditions which were stated in the Flight Manual and which are quoted in full in paragraph 1.17.6 of this report.

At this point it might be helpful to explain the apparent contradiction in terms whereby an aircraft was approved for the demonstration of the spin entry manoeuvre on the basis that it would not spin. There was in fact no contradiction as the purpose of the approval was simply to enable the basic technique of initiating and recovering from a spin to be demonstrated. It did not necessarily follow that to be effective that the demonstration had to result in an actual spin.

It is now necessary to consider the pilot's actions in relation to the conditions of the approval. Whereas the approval stated categorically that the spin entry demonstration was to be made with the throttle closed, the pilot in fact used partial power. The condition that the throttle be closed was not just particular to the Robin HR 200/100 but was a standard condition that forms part of all spinning approvals. It is a condition that appears to be widely disregarded and in fact the AOPA Instructor Manual advocates the use of partial power so as to provide a more positive spin entry in the interest of achieving greater instructional value. * Therefore though it can be held that the pilot should have flown the aircraft only in strict accordance with the conditions of the approval, his reasons for not doing so were perfectly respectable. If a standard condition of this nature falls into disuse because it is found to be too restrictive and there is no clear reason for it to those who have to abide by it, then the matter should be resolved without delay.

* NB. See Addendum.

Aside from that, whatever the rights or wrongs of the pilot's actions, they should not have had the result that they did if the CAA's assessment of the aircraft had been correct, which, with hindsight, it demonstrably was not. The reason why the CAA, with its considerable expertise failed to make the aircraft spin when others succeeded in doing so on more than one occasion could not be established. The evidence rules out any possibility that G-BCCO was a 'rogue' aircraft as it is clear that the other aircraft at Sywell were also spun successfully, though they did not achieve the flatness of spin that was experienced twice on the accident aircraft. The other aircraft appear to have settled at a pitch angle of approximately 45 degrees nose-down in the spin (as indeed did G-BCCO on other occasions) but still exhibiting all the characteristics of a spin. The conventional recovery action was always effective; in fact on some occasions the aircraft would fall out of the spin of its own accord and enter a spiral dive.

The reason why G-BCCO spun on two occasions at a much flatter angle is not clear.

The two ingredients that appear to have been present on both occasions were, firstly, that partial power was being used and secondly, the engine stopped shortly after the spin was initiated. Thus one possible explanation for the aircraft entering a stable and flatter spin is that the use of partial power resulted in higher rates of yaw and pitch being achieved during the initiation of the spin, which combined with the sudden loss of tailplane lift when the engine stopped, caused the aircraft to start autorotating in a fully stalled condition, when otherwise it would have entered a steeper spin or a spiral dive.

At no stage during the Cranfield tests did the engine stop nor was any attempt made to induce a spin by deliberately stopping the engine as this was considered to be unrealistic in relation to the declared purpose of the trial which was simply to satisfy the CAA that the aircraft could not be spun under certain defined conditions. As has been said, Cranfield's brief was not to conduct a spinning trial. Likewise, there was no instance of the engine stopping during the CAA tests nor was any attempt made to spin with the engine deliberately stopped. This was not unreasonable as it is not normally considered to be a standard test condition. Nevertheless, it is not unknown for the engine of a light aircraft to stop during a spin and it is for consideration in the future that when an aircraft is being evaluated for the purposes of demonstrating that it is incapable of spinning, it might be appropriate to assess the effect of the engine stopping during the entry manoeuvre.

Having become established in the spin, there was nothing that the pilot did that had the slightest effect in bringing about a recovery. This is because the conventional recovery technique used by the pilot has since been shown to be inapplicable to the Robin 200/100. As can be seen from the diagram at the Appendix to this report, the effect of applying full down elevator when the aircraft is in a fully stalled condition is to blanket the rudder, thereby rendering it largely ineffective. The pilot did not persist with the recovery procedure given in the Flight Manual because it did not seem appropriate to the flatness of the spin. Whether or not it would have been effective had he persisted with it is a matter for speculation. It just so happens that the Flight Manual recovery procedure bears some resemblance to what is now believed may be the most effective technique for recovery from a stable spin, that is to keep full up elevator applied for longer than normal after the application of full opposite rudder. The pilot would have had no means of knowing this. But if he had persisted with the procedure given in the Flight Manual, he would have uncovered more of the rudder than in fact he did, in which case it is just possible that the aircraft might have recovered. But it should not be concluded from this that the Flight Manual recovery procedure was thoroughly proven in relation to the aircraft's stable spin characteristics because these cannot have been known at the time. It is more likely that the approved procedure was written more with the aircraft's spiral dive characteristics in mind. There is no conclusive evidence to show that full rudder was not applied because of the strong self centering spring in the rudder control circuit or because the pilot used a seat position that may have been inconsistent with his leg length.

As regards the other pilot who did recover from a stable spin by rocking the elevator control backwards and forwards, it is probable that he succeeded in doing so because the rudder took effect whilst the elevator was momentarily fully up.

It is worth noting in passing that the test schedule called for by the CAA apparently made no provision for emergency spin recovery devices to be installed in the aircraft for either the Cranfield tests or its own; however both pilots were wearing parachutes. As the manufacturer's tests later demonstrated, both the Cranfield and the CAA tests pilots might have had the greatest difficulty in recovering from a fully developed spin had one occurred. The manufacturer found it necessary to use anti-spin rockets to recover from just such a spin when testing a different series of Robin 200, but which was stated to be aerodynamically similar to the 100 series.

In conclusion, it seems that the lesson of this accident is that there is an inherent risk in approving an aircraft for the demonstration of the spin entry manoeuvre on the basis that it will not spin. Pilots will not necessarily know this, and if they subsequently succeed in spinning the aircraft, they may not regard this as being particularly significant as it is no more or less than what the aircraft is apparently permitted to do.

Therefore if it is the intention to continue with approvals of this nature, it would appear to be necessary for the approval to state, firstly, that the aircraft is considered to be incapable of spinning and that no attempt is to be made to induce a spin *per se.* Secondly, it should be emphasised more strongly than was done in this instance the conditions under which spin training may be carried out, and furthermore, it should be stated that no variation of these conditions is permitted. As can be seen from the extract from the Flight Manual in paragraph 1.17.6 of this report, the condition that the throttle be closed was not given any particular prominence.

Alternatively, it may be worth considering the abandonment of the whole concept of 'aircraft characteristically incapable of spinning' and only approve for spin training those aircraft that have demonstrated safe but positive spinning characteristics.

3. Conclusions

(a) Findings

(i) The aircraft had been issued with a valid certificate of airworthiness and had been maintained in accordance with an approved maintenance schedule.

(ii) The pilots were properly licensed to carry out the flight and the instructor was qualified to demonstrate the spin entry manoeuvre.

(iii) The demonstration of the spin entry manoeuvre was not carried out in the approved manner inasmuch as the pilot did not have the throttle fully closed at the time of initiating the manoeuvre. However the AOPA Instructor Manual the use of partial power to demonstrate spin entries. *

(iv) The aircraft entered a stable spin and did not respond to the conventional recovery technique which was both inapplicable to the aircraft and not an approved procedure. The spin recovery procedure contained in the Flight

* See Addendum

Manual was not persisted with by the pilot. This procedure differed from what is now believed may be the most effective technique for recovery from a stable spin.

(v) The aircraft had not been approved for aerobatics or the demonstration of the spin entry manoeuvre by the certificating authority of the State of Manufacture, namely France.

(vi) The aircraft had been approved by the Civil Aviation Authority for the demonstration of the spin entry manoeuvre after a series of tests from which it was concluded that the aircraft could not be spun. These tests included the entry technique later used by the pilot of G-BCCO but with a negative result.

(vii) The stopping of the engine during the initial spin may have contributed to the development of the stable spin. The rudder was unable to take full effect during the attempts at recovery because of the shielding effect of full down elevator.

(b) *Cause*

The accident was caused by the pilot being unable to recover from a fully developed spin which had resulted from his use of an unapproved though fully evaluated and widely used technique whilst carrying out a demonstration of the spin entry manoeuvre. Approval for this manoeuvre had been granted by the Civil Aviation Authority after it had been established by flight tests that the aircraft could not be made to enter a fully developed spin, whatever method of entry was employed.

4. Safety Recommendations

It is recommended that:

1. Consideration be given to the inclusion in the appropriate tests referred to in BCAR K2-12 paragraph 3.1.3 of a test involving the stopping of the engine during the attempted spin.

2. Consideration be given to the inclusion in the Appendix to BCAR K2-12 paragraph 1 a condition of test requiring the installation of a suitable device additional to the normal flight controls to ensure recovery from a spin in an emergency.

P J Bardon
Inspector of Accidents

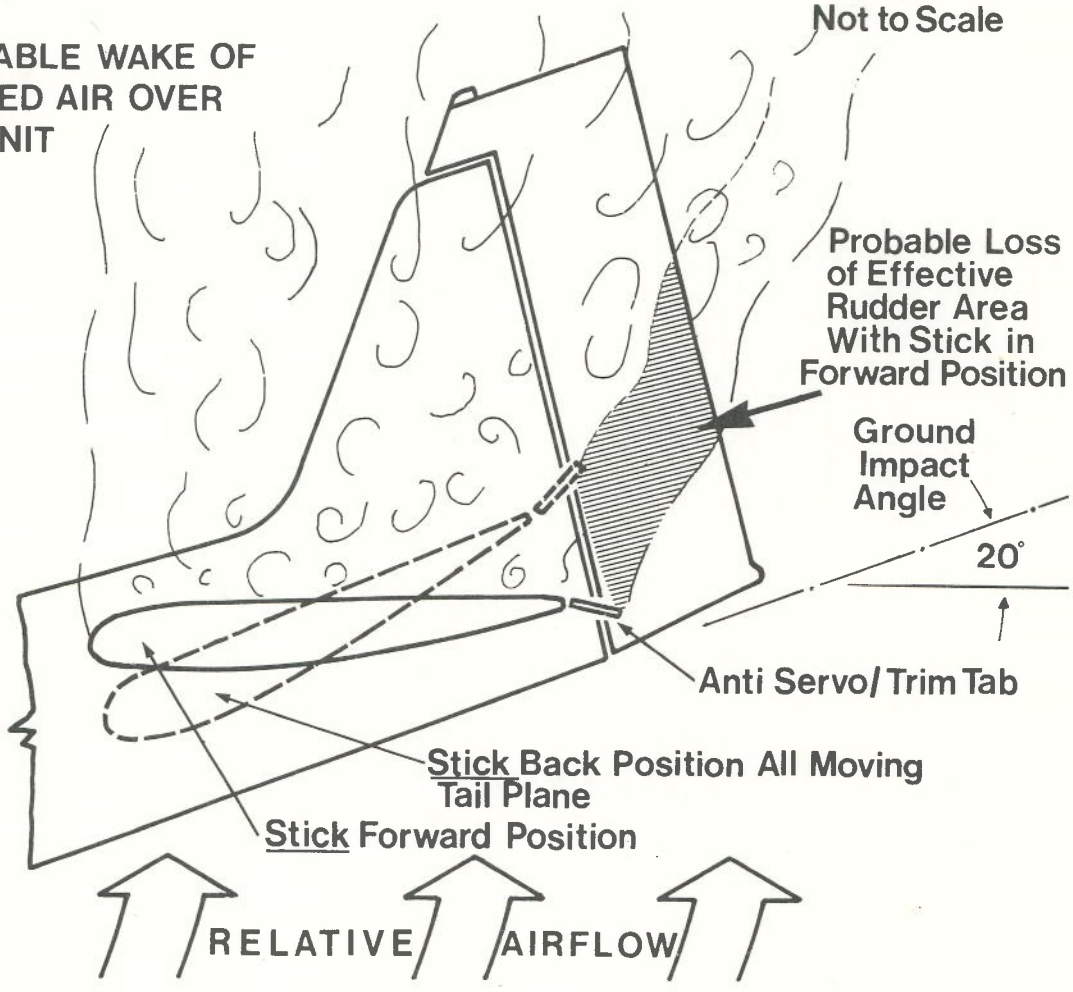
Accidents Investigation Branch
Department of Trade

May 1977

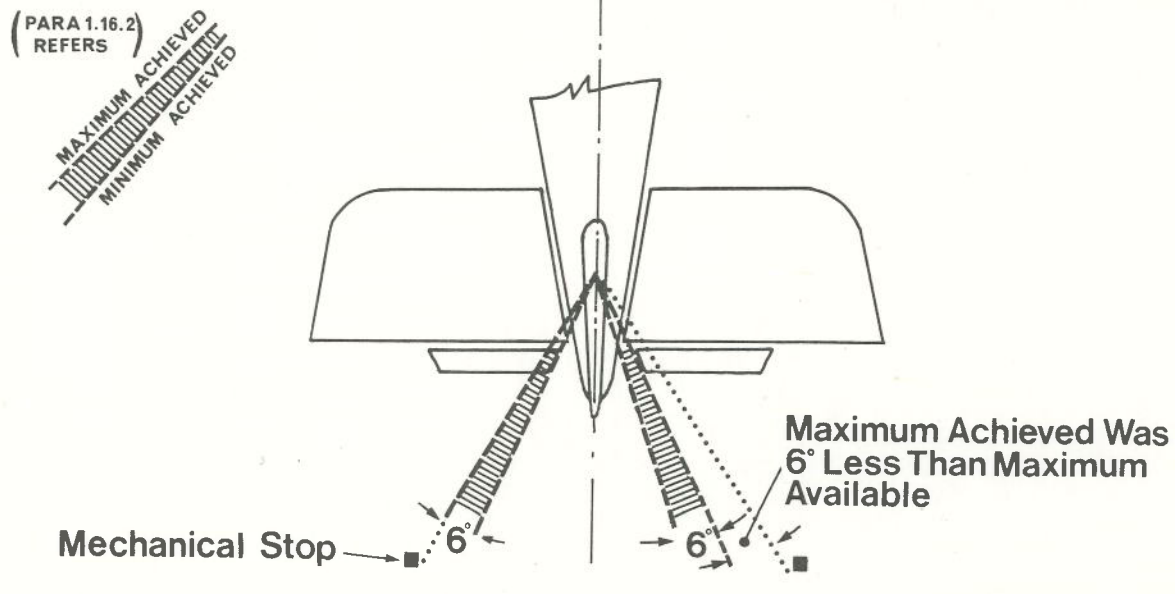
ROBIN HR 200/100 G-BCCO

Appendix
Not to Scale

① PROBABLE WAKE OF STALLED AIR OVER TAIL UNIT



② RANGE OF MAXIMUM RUDDER MOVEMENT ACHIEVED BY TWO INSTRUCTORS DURING STATIC SIMULATION OF SPIN RECOVERY:-



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