ACCIDENT

Aircraft Type and Registration:	Dyn'Aero MCR-01, 21-YV (callsign F-JQHZ)
No & Type of Engines:	1 Rotax 912 piston engine
Year of Manufacture:	1997
Date & Time (UTC):	11 April 2008 at 1620 hrs
Location:	Highclere, Hampshire
Type of Flight:	Private
Persons on Board:	Crew - 1 Passengers - None
Injuries:	Crew - 1 (Serious) Passengers - N/A
Nature of Damage:	Aircraft destroyed
Commander's Licence:	Private Pilot's Licence
Commander's Age:	40 years
Commander's Flying Experience:	950 hours (of which 60 were on type) Last 90 days - 16 hours Last 28 days - 7 hours
Information Source:	AAIB Field Investigation

Synopsis

On approach to a small private landing field, the aircraft rolled left and crashed in the garden of a private house. The loss of control was probably caused by loss of airspeed in gusty conditions as the pilot attempted to approach the confined landing area. The investigation found no indication of any mechanical defect that would have contributed to the accident.

History of the flight

The pilot was returning from Panshangar in Hertfordshire to a field at his wife's home on the edge of Highclere village in Hampshire. Visibility was good with a strong westerly wind, reported locally as gusting up to 28 kt. Departing Panshangar at around midday, he arrived overhead the landing field shortly before 1330 hrs, making one low approach and go-around into a right-hand circuit, in order to inspect the field before landing. On the subsequent approach he encountered a strong crosswind and turbulence and decided to divert to Popham, landing there at 1334 hrs. After shutting down the aircraft he walked to the clubhouse and asked the radio operator to advise him "if the wind drops".

Around one hour later, when advised that the wind speed had decreased to approximately 9 kt, the pilot told the radio operator that he would "have another look at Highclere". He took off at 1442 hrs and made one further approach to the landing field. However, the conditions were such that he decided to return to Popham, where he landed at 1500 hrs. Here, he uplifted 22 ltr of fuel and was seen to leave the aircraft as though having no intention of further flight that day. On returning to the clubhouse he remarked to the radio operator that he had approached the landing field at 40 kt and that the crosswind required him to offset the aircraft heading by 40° in order to maintain the approach track. The pilot remained at Popham until after the clubhouse closed.

Shortly after 1600 hrs, the pilot decided to make one further attempt to land at the field. He recalled that, after an unremarkable takeoff and short flight to Highclere, approximately two minutes before arriving at the landing field and before turning to make another approach, he looked at the cockpit moving map display. He had no recollection of subsequent events.

On this attempt to land at the field, the aircraft departed to the left of the approach path and crashed in a small garden between closely spaced houses. It came to reset inverted and was destroyed, but there was no fire. The pilot, having sustained a severe head injury and broken ribs but no other major fractures, was able to vacate the aircraft with assistance from local residents who had rushed to the scene.

An ambulance arrived shortly afterwards and within 15 minutes had been joined by the Police, Fire and Air Ambulance services. The Fire Service began to inspect the wreckage and found a panel marked with the letters '*BRS*'. When so advised, the AAIB informed them that this denoted the presence of a ballistic recovery parachute system, consisting of a parachute and pyrotechnic rocket launch system. Coincidentally, one of the firemen worked at a nearby airfield and was also aware of the significance of these markings. There was no evidence that the system had been deployed, indicating that the pyrotechnic might still be live, so no further interference was attempted until an AAIB recovery specialist was able to secure its firing mechanism.

Meteorological information

Between 1600 hrs and 1630 hrs, a 'weather station' belonging to the pilot, located at the north end of the strip, recorded a south westerly wind gusting to 25 kt. The pilot reported that the directional element of the system was calibrated to ±10° using a handheld compass, but that it was not calibrated for wind speed. He added that the manufacturer's specification sheet gives the wind speed accuracy as ±3 km/hr and wind direction accuracy as ±7°.

An unofficial wind report for Popham during this period indicated a wind varying in direction from 220° to 270° at speeds up to 28 kt.

Accident site examination

The aircraft had initially struck a large tree bounding the roadside entrance to a detached house on the edge of a small housing estate, just to the left of the aircraft's approach path and almost abeam the threshold end of the intended landing field. It then crashed into the garden of another house beyond the tree, finally coming to rest inverted, against the rear of the building.

The aircraft was destroyed in the impact. The forward fuselage structure was totally disrupted back to a position approximately mid-way between the rudder pedals and the front edge of the seats. The firewall, the forward fuselage deck and integral main fuel tank, which broke open in the impact, and the instrument panel had all separated. Both wings were completely disrupted and had separated from the fuselage; the fin and tailplane were destroyed, but remained attached. There was no fire.

Debris on the ground beneath the tree comprised the whole of the right wing tip fairing, fragmented structure from the tip region of the right wing, the complete tip fairing from the right tailplane, and a number of broken tree branches of up to two inches diameter. The latter corresponded with visible damage to the tree at heights of between 26 ft and 30 ft above ground level, which displayed surface damage and embedded fragments of composite structure consistent with them having been struck by the wing leading edge. More fragments of wing debris were scatted over the ground forward of the tree strike, and the complete tip fairing from the left wing was lodged in the canopy of a smaller tree bounding the garden into which the aircraft finally crashed.

The principal ground impact marks comprised a deep scar made by the aircraft's nose and engine, and a related series of three progressively deepening propeller cuts into the turf of the lawn, of which the final two contained the embedded remains of their respective propeller blades. The character, relative positions, and orientations of these cuts were consistent with the engine having been running at high power at the time of ground impact. The plane of the propeller cuts was orientated approximately 30° to the horizontal, consistent with a fuselage angle having been approximately 30° from the vertical at the time of ground impact. Scrape marks and debris forward of the ground impact showed that the aircraft had subsequently slid along the ground, nosing over towards its left side as it did so causing the top of the canopy to strike the corner of a conservatory attached to the rear of the house. It was apparent that the pilot's head had struck a glancing blow against the brick wall of the conservatory at this location, before the aircraft became inverted fully and was brought to rest against the rear wall of the main building.

Impact trajectory

The distribution of debris and ground marks, together with inferences drawn from a three-dimensional CAD reconstruction of the impact sequence (using suitably scaled representations of the aircraft and principal ground features and objects), suggested that the aircraft was banked slightly left and travelling at significantly high speed, with a slightly upwards trajectory, at the instant it struck the tree. The impact between the right wing tip and the tree caused it to yaw violently to the right and, thereafter, it appears to have followed a slightly lofting trajectory whilst rolling left and pitching nose-down. Just before impact with the ground, the left wing tip struck the small tree bounding the garden into which it finally crashed. This sequence, taken from the CAD reconstruction, is shown in Figure 1.

Detailed wreckage examination

Detailed examination of the wreckage in-situ and subsequently, established that the aircraft was structurally complete and intact at the time it struck the first tree. Both electrically-driven wing flap screw-actuators were at positions which corresponded closely to the 30° setting, and the electric pitch trim mechanism was set approximately 10% on the nose-up side of neutral at the time of ground impact. All the flying controls were intact and connected, and no evidence was found of any malfunction or failure of the airframe or flying controls that could have explained the accident. No detailed examination of the engine was carried out, given the clear evidence of high engine power and airspeed at the time of impact with the house. Neither the propeller governor nor the oil pipes and unions associated with the propeller pitch control system, displayed any evidence of leakage. Sufficient oil remained in the tank to supply the propeller pitch control system. In summary, the

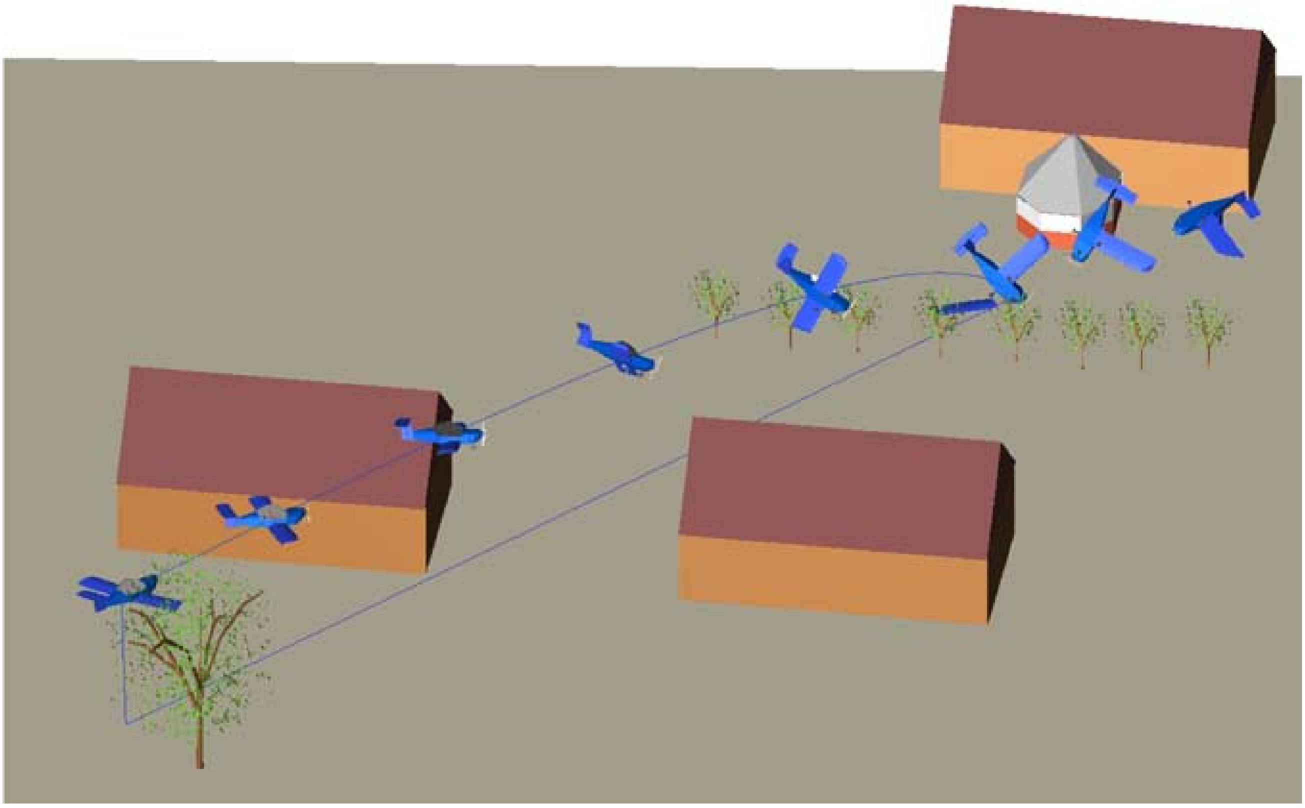

Figure 1
CAD representation of the impact sequence

aircraft appeared to have been fully serviceable at the time of the accident.

Ballistic parachute recovery system

The aircraft was fitted with a BRS Inc aircraft emergency parachute, housed internally in a compartment in the fuselage just behind the canopy and beneath a detachable cover which formed part of the fuselage upper surface. The parachute lines were anchored to the bulkhead structure immediately behind the seats. With this system the parachute is deployed by means of an upwards firing rocket projectile, housed in a container at the rear of the parachute compartment and which, according to the manufacturer's literature, is designed to accelerate to a velocity in excess of 100 mph within a tenth of a second of ignition.

Initiation of the rocket is at the command of the pilot, by means of a firm pull applied to a Tee handle located just beneath the instrument panel. This handle is attached to a bowden type cable connected to a firing mechanism at the base of the rocket motor pack. The system is rigged so that, when the handle is pulled, it first moves through a distance of more than two inches, sufficient for the handle to come completely out of its housing, before any tension is put into the cable; thereafter, a pull force of 30 lbf to 40 lbf is required, through an additional 7/16 inch of cable movement, to initiate the rocket.

Two warning placards were displayed on the exterior of the aircraft; a BRS parachute logo on the parachute compartment cover, Figure 2, and a small red triangle on the fuselage top surface just aft of the parachute compartment, bearing the legend, *'DANGER FUSEE DEXTRACTION PARACHUTE'* (DANGER ROCKET EXTRACTION PARACHUTE), with an arrow pointing towards the parachute compartment, Figure 3. Neither contained any explicit reference to pyrotechnic or projectile hazards. The BRS logo was also displayed on the top surface of the parachute within the compartment, Figure 3.

Figure 2

Parachute compartment cover displaying the BRS placard

Figure 3

Red warning triangle and BRS placard (displayed on the parachute)

Recorded information

The aircraft was equipped with a GPS receiver that recorded the aircraft's track, geometric altitude and ground speed on each of the three sectors flown on the day of the accident. The tracks, timings and ground speeds were consistent with the information provided by the pilot and other witnesses.

Notably, the point at which the final flight appears to have deviated from the approach track at the start of the accident sequence, was close to the point at which the pilot executed a go-around on each of the previous approaches.

Aircraft operations

The pilot's handbook for this aircraft presents tables of stall speed in km/hr for two typical operating weights, are shown in Table 1.

The handbook also indicates that, at a weight of 450 kg, the takeoff ground roll is 150 m and the takeoff distance to clear a 15 m obstacle is 230 m. It indicates a landing distance, on a hard runway in standard atmospheric conditions, of 270 m. The manual states that the normal approach speed is 82 km/h (44 kt).

The pilot stated that he would usually approach the landing field at 45 kt to 50 kt. In doing so, he would compare the airspeed indicator and ground speed information on the GPS receiver in order to judge headwind. He would initially use 30° of flap then, approximately 50 m before crossing the boundary of the field, select 45° of flap if conditions were "not too gusty", but he could not recall what setting he used on the approach on the accident flight. He commented that he chose this aircraft type because of its good takeoff and landing performance, and that he had practised both stalling and going around. The torque effect of the propeller would tend to produce a left roll and he noted that, when stalling, this aircraft would commence an uncommanded left roll.

450 kg

	Flaps position	**0°**	**17°**	**30°**	**45°**
Bank angle					
0°		86	73	67	63
30°		92	78	72	68
60°		122	103	95	90

400 kg

	Flaps position	**0°**	**17°**	**30°**	**45°**
Bank angle					
0°		81	68	64	60
30°		87	73	68	64
60°		115	97	90	84

Table 1

The landing field

The pilot stated that he had completed between 20 and 30 landings at the field near his wife's home. He estimated that the field was approximately 350 m long. In fact, it provided a landing run of approximately 260 m, oriented north-south, but was edged by tall trees and other obstructions which reduced the practical landing distance. The landing ground run was usually between 100 m and 150 m, which he considered allowed "a reasonable safety margin". When approaching from the north, the aircraft would fly close to the built-up area of Highclere, over houses on short final approach and within 100 m of several dwellings.

The pilot had completed drainage and other works in the landing field intending to make it suitable for the operation of his aircraft. There was no requirement for the field to be licensed for aircraft operations, except that operations at the field on more than 28 days each year would constitute a 'change of use' under applicable planning legislation. Several neighbours had noted flying activity at the field and one had recorded all the movements he observed. Although this individual had no record of movements conducted in his absence, the information he provided indicated that flying activity had taken place on fewer than 28 days in the last 12 months.

CAP 428 – *'Safety standards at unlicensed aerodromes'*, published by the CAA, is a guidance document for the operation of unlicensed aerodromes. Its contents are not mandatory but are intended to provide *'sound practice'*, stating in part:

> *'The physical characteristics and operating standards should provide a safe operational environment.'*

In relation to runways it states:

> *'The runway should be of sufficient length… to meet the requirements of the aircraft that will operate from the aerodrome.'*

And:

> *'The runway should, wherever possible, be designed such that trees, power lines, high ground or other obstacles do not obstruct its approach and take-off paths. It is recommended that there are no obstacles greater than 150 feet above the average runway elevation within 2,000 metres of the runway mid-point.'*

In relation to low flying at an unlicensed aerodrome, CAP 428 notes:

> *'Rule 5 of the Rules of the Air, amongst other requirements, prohibits flights below 1000 feet over 'congested' areas except when aircraft are taking off or landing at a licensed or government aerodrome. It is therefore most important that climb out, approach and circuit paths at unlicensed aerodromes do not overfly built-up areas.'*

The Rules of the Air are contained in Civil Aviation Publication (CAP) 393, '*The Air Navigation Order*' (ANO), which has statutory force.

Rule 5 of the ANO states, in part:

> *'If an aircraft is flying in circumstances such that more than one of the low flying prohibitions apply, it shall fly at the greatest height required by any of the applicable prohibitions.'*

And:

> *'(3) The low flying prohibitions are as follows*
>
> *(a) Failure of a power unit*
>
> *An aircraft shall not be flown below such height as would enable it to make an emergency landing without causing danger to persons or property on the surface in the event of a power unit failure.*
>
> *(b) The 500 feet rule*
>
> *Except with the written permission of the CAA, an aircraft shall not be flown closer than 500 feet to any person, vessel, vehicle or structure.*
>
> *The 1,000 feet rule*
>
> *Except with the written permission of the CAA, an aircraft flying over a congested area of a city town or settlement shall not fly below a height of 1,000 feet above the highest fixed obstacle within a horizontal radius of 600 metres of the aircraft.'*

Aircraft approaching the landing field from the north would do so less than 1,000 ft above the highest fixed obstacle within a radius of 600 m of the aircraft. Rule 6 of the ANO states:

> *'The exemptions from the low flying prohibitions are as follows—*
>
> *(a) Landing and taking off*
>
> *(i) Any aircraft shall be exempt from the low flying prohibitions in so far as it is flying in accordance with normal aviation practice for the purpose of—*
>
> *(aa) taking off from, landing at or practising approaches to landing at; or*
>
> *(bb) checking navigational aids or procedures at,*
>
> *a Government or licensed aerodrome.*
>
> *(ii) Any aircraft shall be exempt from the 500 feet rule when landing and taking-off in accordance with normal aviation practice or air-taxiing.'*

Rule 6 (ii) does not exempt aircraft from rule 5 (3) (c).

Ballistic parachute system issues - FAA response

Responding to concerns expressed by regulatory, first responder and industry groups regarding the marking of ballistic parachute systems, the FAA issued Special Airworthiness Information Bulletin (SAIB) CE-09-01 dated 21 October 2008. It contained the following recommendation:

> *'We recommend that all make/model airplanes (so affected) be equipped with the ASTM[1] conforming placards suitable to draw the attention of first responders. ASTM F 2316-06 specifies that the aircraft should be externally marked with one danger placard at the exit point of the rocket/parachute and another warning placard on either side of the aircraft that is visible to those entering or approaching the aircraft.'*

The SAIB provided an example of suitable placards, available from the manufacturer of the system fitted to 21-YV. These placards are not dissimilar to those used to mark ejector seat systems on military aircraft and are shown in Figure 4.

Footnote

[1] The American Society for Testing and Materials.

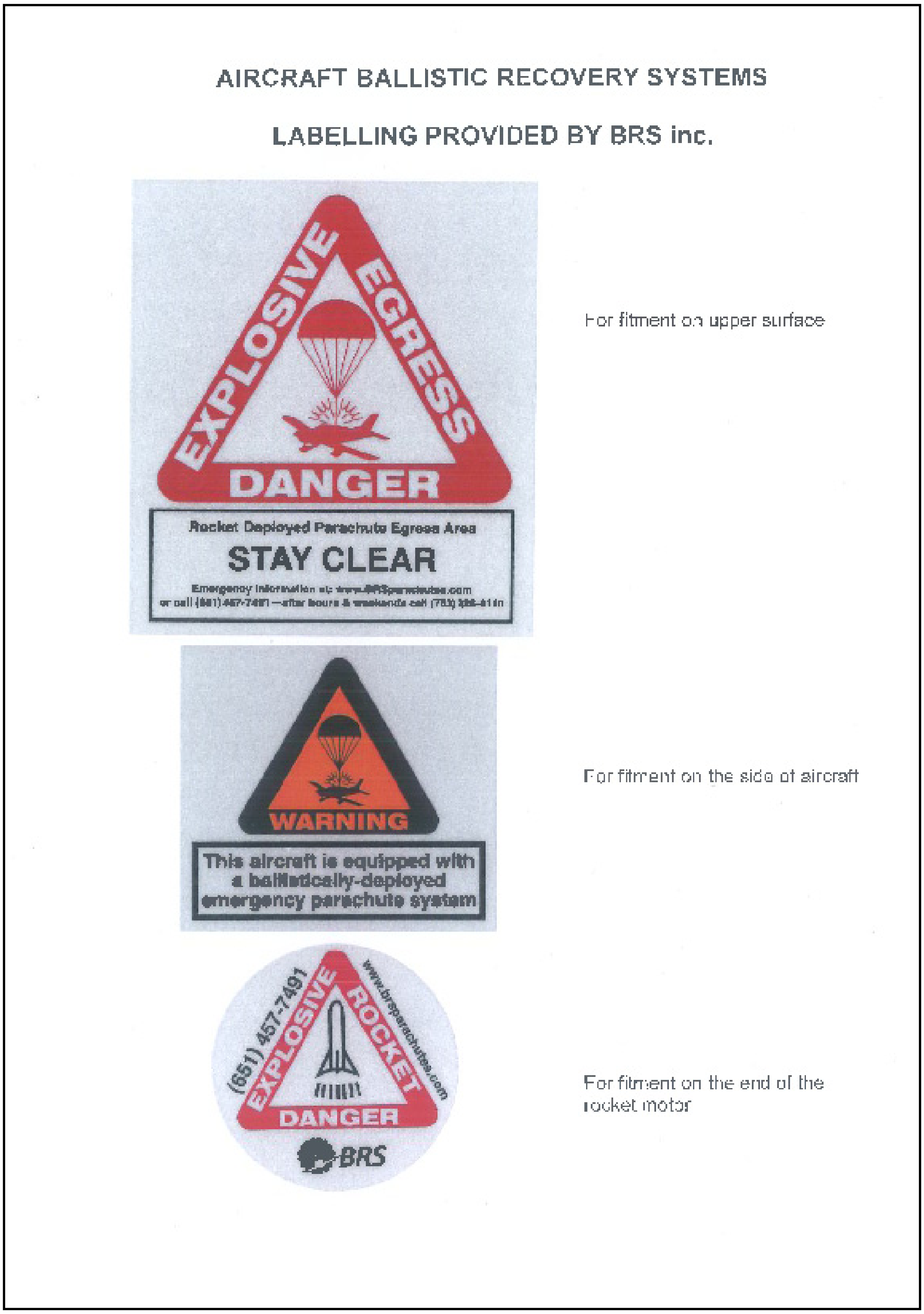

Figure 4

Placards provided by BRS Inc.

Analysis

Aircraft operation

The pilot stated that he had landed at the field on between 20 and 30 occasions prior to the accident which, when approaching from the north, involves flying close to a built-up area, over houses on short final approach and within 100 m of several dwellings. Rule 5 (3) (c) of the Rules of the Air precludes aircraft from operating in to this landing site, due to its proximity to a congested area, and Rule 6 does not exempt them from this rule.

The pilot stated that he usually approached the field at between 45 kt and 50 kt and that he was able to achieve a landing distance less than that indicated by the manufacturer. On this occasion the ground speed recorded by the GPS unit fell to 41 kt in two instances – once when broadly crosswind and again at or about the point where the aircraft deviated from the approach path immediately before the accident. The wind speed and direction recorded at that time would suggest an airspeed of greater than 50 kt at that moment, but the gusty conditions make an accurate assessment of airspeed impossible. It is possible, therefore, that the gusting wind conditions resulted in a temporary reduction in air speed to below that at which the aircraft would stall. Also, the GPS record of ground tracks indicated that the position at which the aircraft appeared to deviate from the approach track was close to the position at which the pilot had executed go-around manoeuvres on each of the previous approaches. It is therefore possible that he had initiated a go-around at this point on the approach of the accident flight.

Either as a result of the stall itself, or the application of power close to the stall during a go-around, the aircraft commenced a roll to the left from which the pilot may have been in the process of recovering when the aircraft hit a tree. It then became uncontrollable and crashed.

BRS issues

The use of a bowden-type cable, and its routing between the Tee handle on the instrument panel and the firing mechanism in the aft fuselage, makes the mechanism inherently vulnerable to disturbance during an accident, with the risk that the rocket may be inadvertently fired, assuming that the pilot has not initiated the system before impact. This is particularly so if structural disruption during the impact stretches or pulls the cable sufficiently to take out the free length rigged into the inner cable, ie putting the cable into tension, which would then require very little additional movement of the cable to initiate the rocket. In such circumstances, any further slight disturbance of the associated structure, or of the cable itself, by first responders attending the scene, for example, whilst attempting to gain access to the aircraft's occupants, could fire the rocket, potentially causing serious injury or even the death, to anyone nearby.

The parachute system fitted to 21-YV, and similar emergency parachute systems that are fitted in increasingly large numbers both to microlight and conventional light aircraft, represents a significant hazard to any one attending the scene of an accident to such aircraft. It follows that there exists a clear and obvious need for people attending such an accident to be made immediately aware that such a system is fitted and also of its implications for their safety. They also need to know the location of the device and the likely trajectory of the rocket (or, in some systems a ballistic) projectile is likely to take in the event of it being inadvertently triggered.

This issue affects not just emergency services personnel, for whom awareness training is both desirable and feasible, but also members of the public who are likely to make the initial efforts to assist the occupants, and who could not be expected to have any prior knowledge of the potential danger. For the latter, there is a clear requirement for highly visible warnings to be placed on the aircraft, at positions where they are likely to be seen, regardless of the aircraft's orientation on the ground, capable of indicating to a lay-person both the nature of the hazard, the location and likely direction of discharge of any associated projectiles. Currently, there are no formal requirements concerning information placed on aircraft fitted with such devices. 21-YV displayed only a BRS parachute logo on the parachute compartment cover and on the top surface of the parachute within, neither of which contained any explicit reference to pyrotechnic or projectile hazards. The red triangle on the fuselage top surface, just aft of the parachute compartment, which bore the legend, *'DANGER FUSEE DEXTRACTION PARACHUTE* (DANGER ROCKET EXTRACTION PARACHUTE)*'*, was small and not considered to be visually compelling.

In the absence of clear information to warn them of its presence, neither the civilian first responders nor any of the emergency personnel were aware of the possibility that the aircraft might contain hazardous pyrotechnics. Furthermore, when interviewed subsequently, none of these personnel were aware of standing guidance about BRS provided to their respective organisations. Also, when interviewed about the accident, personnel at Popham demonstrated little awareness of ballistic parachute systems.

Ballistic parachute systems are already fitted to approximately 300 different types of aircraft around the world, including General Aviation aircraft such as the Cirrus, Cessna 172 and 182, as well as many microlight aircraft. One manufacturer has reportedly sold approximately 28,000 units and stated that around 200 lives have been saved so far. Military aircraft which contain pyrotechnic devices, such as ejection seats, canopy detonating chord and stores jettison systems, have standard, easily recognisable decals applied to the airframe close to these potentially dangerous systems. Historically, as civil aircraft have contained few if any pyrotechnic devices, there has been no need to develop standard placards for informing rescue personnel of their presence following an accident. Aircraft manufacturers and, in this case BRS Inc., apply their own warning decals to aircraft, but these differ between aircraft, and do not conform to any internationally agreed standard. The BRS manufacturer has stated that they have had difficulty in establishing an agreed warning labelling system.

Various documents, such as BCAR Section S (Sub-section K), ICAO State Letter No AN6/26-05/46, and BMAA TIL No 16, contain information relating to warnings that should be applied to aircraft fitted with a ballistic recovery system, but the format of such warnings is not specified. It is, however, a CAA requirement that a warning placard relating to an installation must be visible on the outside of a microlight aircraft close to the *'stored energy device'*. The small red decal on 21-YV was not readily visible to rescue personnel due to the attitude of the fuselage, and was not considered to be visually compelling.

As the number of aircraft fitted with a ballistic recovery system is likely to increase, first responders, who are likely to be members of the public, to an accident involving such aircraft are likely to be exposed to an increased risk of injury where these devices remain live within the wreckage.

In 2005, The Australian Transport Safety Board made a Safety Recommendation to ICAO concerning the application of warning placards on aircraft fitted with a ballistic parachute system.

In response to that recommendation, ICAO have stated, in part, the following:

'Due consideration to the recommendation was given, including relevant discussions by the ICAO Airworthiness Panel and the issuance of a State Letter. Below is a summary of the actions undertaken by ICAO in that regard:

a) States advised of the potential dangers of rocket-deployed emergency parachute systems (ballistic parachute) installed in aircraft are invited to review the adequacy of the warning placards required for such devices and to ensure that emergency responders, such as police, ambulance, rescue/fire service and accident investigators as well as maintenance personnel, are aware of the potential hazards posed by such devices and of the correct means to render such devices safe (State letter AN6/26-05/46, dated 12 August 2005 refers);

b) Incorporation into the Manual of Aircraft Accident and Incident Investigation (Doc 9756) and in Circular 315, Hazards at Accident Sites, of reference material addressing the potential hazards of such devices, as well as guidance on appropriate safety precautions; and

c) Consideration by the Airworthiness panel of an amendment to Annex 8 - Airworthiness of Aircraft - requiring warning placards in aircraft fitted with ballistic parachute systems, in order to draw attention to potential associated hazards. During its deliberations, the Panel concluded that requiring such warning placards would not increase safety at accident sites. Warning placards might not be visible in some conditions such as during low visibility and it was also agreed that personnel close enough to read the placards would already be inside the danger zone of the equipment.'

However, this response is not considered to address the real possibility that a first responder is highly likely to be a member of the public, with no knowledge of the potential danger that such systems pose in the event of an accident. In order to minimise the risk, the following Safety Recommendation is made:

Safety Recommendation 2009-007

It is recommended that the International Civil Aviation Organisation publish a Standard which defines internationally agreed warning placards for application to all aircraft fitted with ballistic parachute recovery systems, that give as clear an indication as possible at the greatest distance reasonable of the dangers posed to first responders to an accident aircraft fitted with a ballistic parachute recovery system.

Whilst providing a model that might address these issues, the SAIB issued by the FAA is not an airworthiness directive and, consequently, is not mandatory. Accordingly, the following Safety Recommendation is made.

Safety Recommendation 2009-008

It is recommended that the Federal Aviation Administration, the Civil Aviation Authority and European Aviation Safety Agency, cooperate to require the application of warning placards of a common agreed standard, to be applied to all aircraft fitted with ballistic parachute recovery systems for which they have airworthiness responsibility, to maximise the possibility of first responders being made aware of the danger posed by a live system following an accident. These placards should be applied in such a manner that at least one such placard should remain visible regardless of the stationary attitude of the aircraft.