AAIB Bulletin No: 9/94 **Ref: EW/C94/6/6** **Category: 1.3**

Aircraft Type and Registration:	Steen Skybolt, G-BODL
No & Type of Engines:	1 Lycoming IO-540-D4A5 piston engine
Year of Manufacture:	1978
Date & Time (UTC):	25 June 1994 at 0954 hrs
Location:	Trenow Cove, near Perranuthnoe, Penzance, Cornwall
Type of Flight:	Private (Airtest)
Persons on Board:	Crew - 2 Passengers - None
Injuries:	Crew - 2 Fatal Passengers - N/A
Nature of Damage:	Aircraft destroyed on impact
Commander's Licence:	Private Pilot's Licence Service Pilot with Helicopter Instructor Rating
Commander's Age:	33 years
Commander's Flying Experience:	Total: 4,040 hours (of which 18 were on type) Fixed wing: 500 hours Last 90 days: 97 hours (fixed wing) Last 28 days: 32 hours (fixed wing)
Information Source:	AAIB Field Investigation

History of the flight

On 30 May 1994, the owner flew the aircraft to Land's End (St Just) Airfield for work necessary for the renewal of its CAA Permit to Fly. By 23 June 1994, this work was completed and the aircraft was released, by the maintenance organisation, to fly for the purpose of the required airtest, for which a temporary permit had already been issued by the CAA.

When the Skybolt first arrived at the airfield the Senior Instructor at the Land's End Flying Club, who was an aerobatics enthusiast and was an authorised instructor in aerobatics, became intensely keen to fly it. He was he holder of a Commercial Pilot's Licence with Instructor Rating, aged 59 years and with a total flying experience of 6,448 hours. It was agreed that he, as a CAA registered airtest pilot, could occupy the front cockpit as an 'observer' to fill out the airtest checklist form.

It was reported that amongst the Senior Instructor's repertoire of aerobatic manoeuvres, which he almost always conducted over the sea, was one which comprised 'falling' off the top of a half loop and allowing the aircraft to spiral down, before levelling out and flying away. He had been seen to do this particular manoeuvre many times in the club's Cessna 152 aircraft. The instructor had never flown a Skybolt before.

Although the owner had not participated in any specific aerobatics training, he had completed the simple aerobatic exercises prescribed in the Royal Navy flying training and refresher courses. It is known that both pilots were aware that the aircraft's Permit to Fly prohibited aerobatic manoeuvres, but what discussion they held about it prior to the flight is not known.

Prior to the flight, the owner had agreed with the Land's End Air Traffic Control Officer (ATCO) that he could conduct the flight without radio, so it was a surprise to the controller when the aircraft firstly called for taxi clearance and then for take-off clearance on the Land's End 'Tower/Approach' radio frequency.

The owner is believed to have been the handling pilot when, at 0936 hrs, the aircraft took off and was lost to the sight of the ATCO as it climbed away to the east. There was no further radio communication with the aircraft.

The wind was 270°/10 kt, with thin layers of scattered cloud at 1,100 feet and broken cloud at 1,900 feet. About ten minutes after takeoff the Skybolt was seen through gaps in the thin layers of cloud, at a height thought to be between 3,000 and 6,000 feet, over an area just to the north of Marazion. Witnesses state that, for about a quarter of an hour, it remained in that area performing loops, barrel rolls and other similar manoeuvres and that, during these, the aircraft lost height. Evidence, including the particular manoeuvres then flown, suggests that at this time the owner handed control of the aircraft to the observer. Following these manoeuvres the aircraft was seen to roll upside down and fly level for a short time. It was almost certainly during this manoeuvre that a portable dry powder fire extinguisher, which was clipped to the floor in the rear cockpit, fell out of the aircraft onto the roof of a public house in Marazion, where it exploded on impact.

Having resumed upright flight, the aircraft was then seen to fly southwards, in a gentle descent, to a position over the sea between St Michael's Mount and Perranuthnoe. There it performed a 270° turn to the right followed by a half loop, off the top of which, at an estimated 1,000 feet, it fell into a spiral dive or spin from which it did not recover before impact with the sea.

Whilst performing this aerobatic sequence, the engine was heard being throttled back at the top of the loop and no further application of power was heard. This is consistent with the normal use of power during this manoeuvre.

Examination of the wreckage

The damage to the aircraft was generally indicative of a nose down (30° to 40°), left wing low impact. The left wings had been badly broken up and the left landing gear torn off. In contrast, the right wings were comparatively intact. Paint transfer between the upper left aileron and its shroud provided some evidence of downwards aileron deflection, ie right roll, applied at the time of impact. There was no evidence of any pre-impact failure of any part of the structure.

Inside the cockpits the magnetos were on 'BOTH' and the electrics master switch was 'ON'. However, it was noted that the intercom switch was in the 'OFF' position. This is a toggle switch located to the left of the radio in the rear cockpit. It was not possible to confirm whether this represented the pre-impact state, or if it had moved during the accident or the subsequent recovery. The rear instrument panel had moved vertically downwards in the impact. The broken tachometer face had an indentation, which had possibly been made by the indicator needle, showing a faint straight-edged imprint at 1,600 RPM. The throttle and propeller controls in both cockpits were found in approximately the mid positions. However, the throttle assembly had been torn off the bottom of the engine during the impact, thereby pulling on the teleflex-type operating cable. A similar cable operated the propeller control unit and it was clear that this too had moved in the impact with evidence on the cable itself suggesting it had moved in a coarsening direction from what appeared to be the fully fine position.

The rear cockpit rudder pedals were deformed in a manner consistent with the rear occupant's feet being in contact with them at the time of impact. The forward set of pedals had been pushed in a rearwards direction by the engine firewall, with a shoe being found on the left pedal.

The fire extinguisher had been mounted transversely on the floor of the rear cockpit, approximately four inches ahead of the control column. This would have placed it in close proximity to the feet of the rear seat pilot had he withdrawn them from the rudder pedals when the front seat pilot was flying the aircraft. The extinguisher was a 0.6 kg dry powder cylinder, which is not of a type approved by the CAA, although its fitment in Private Category aircraft is allowed. The mounting clamp was a simple spring-loaded clip whose overcentring action was observed to be weak. A new extinguisher of an identical type was obtained and mounted in the clip from the aircraft where it was found that a force of only 2.5 lb (1.13 kg), or -1.9g, was required to dislodge it from the clip.

The engine bore no evidence of any pre-impact malfunction. The oil filter was clean and the plugs, although corroded as a result of sea water immersion, were otherwise normal in appearance. The interior of the engine also appeared normal, with no evidence of lubrication failure. The only anomalous feature was the absence of a pinch bolt that should have secured the alternator to its drive belt tensioning bracket. The drive belt tension would therefore have been minimal, although the belt itself bore no evidence of heavy slippage.

History of the aircraft

The aircraft had been constructed during the late 1970's and imported into the UK in 1989, having flown a total of 234 hours. As there was no formal design basis for this type of aircraft, it and the associated documentation were surveyed by the CAA, leading to the preparation of an Airworthiness Approval Note (AAN). This defined the aircraft configuration and included a paragraph detailing the increased weight of G-BODL compared to other Steen Skybolts on the UK register. This was mainly due to the heavier 260 HP engine and thicker steel tubing used in the fuselage construction. The empty weight of G-BODL, when it was weighed in the UK in 1989, was 1,587 lb, with an all-up weight suggested by the US Experimental Aircraft Association (EAA) paperwork of 2,055 lb. The other UK Steen Skybolts have been approved with a normal maximum take-off weight of 1,653 lb and an aerobatic weight of 1,503 lb. Thus the subject aircraft empty weight exceeded the currently approved aerobatic weight, and it was this factor that led to the CAA not granting approval for aerobatic manoeuvres. In addition, the manoeuvre limits were set at '+4g and -2g', compared with '+6g and -3g' for the lighter aircraft. These and other limitations formed part of the Permit to Fly.

The AAN also noted that the heavier engine had necessitated the addition of a 50 lb ballast weight in the tail of the aircraft. No such weight was found when the wreckage was examined after the accident. The constructor has stated that he did not install any ballast; at the same time he confirmed that the powerplant and other equipment were the same as that installed on the aircraft at the time of the accident. The CAA have examined the archival material used to prepare the AAN and there was no specific mention of any ballast weight, whose existence therefore appears to be based on hearsay. One reason for this may have been due to the fact that when the aircraft was weighed in the UK, there was an apparent weight increase of 127 lb from that recorded on the US weight and balance schedule following its construction. Apart from a different avionics fit, it was not possible to account for this discrepancy, although weighing errors could be responsible for some of it. Nevertheless, the centre of gravity of the aircraft was within the defined range for both weights.

The new owner bought the aircraft in September 1993 and based it at RNAS Culdrose, where he was serving as a naval officer. Following his purchase of the aircraft he had applied to have the aerobatics limitation lifted by the CAA who informed him that further analysis would be required before this was possible. The CAA's reply noted that, although the structure was undoubtedly strong, the higher aircraft weight would give rise to higher design speeds, including the V_{NE}. Thus the structure would need to be analysed to demonstrate that flutter would not occur at the higher speeds.

Additional information

During the flight the airtest checklist form had also fallen out of the aircraft and was later recovered from a crossroads to the east of Marazion, a little to the south east of where the initial aerobatic session had begun. It showed that only the 'ground manoeuvring' and 'timed climb' sections had been filled out by the observer. This and the position where it was found, having possibly fallen some 6,000 feet in a light north westerly wind, suggests that it had fallen or been blown out of the cockpit at the end of the 'timed climb'. If this were to be the case, it might explain why the airtest was then discontinued.

Post-mortem examination showed that the observer had died from multiple injuries and the pilot from a broken neck. The pilot had also sustained facial injuries consistent with his head having struck the instrument panel in the final impact and, possibly, having been struck by the fire extinguisher prior to that time. Although it is not certain that it was the fire extinguisher which struck the pilot, circumstantial evidence supports it. The pilot had clotted blood in his nostrils, indicating a nose bleed prior to his death, and this would be consistent with his having been struck by the extinguisher as it left the cockpit. This blow may even have rendered him temporarily incapable, or even unconscious, and the fact that he made no radio contact with Land's End, to report that the extinguisher had fallen into an inhabited area, supports this suggestion. Furthermore, it is most improbable that the pilot would not have told the observer about the loss of the extinguisher had he been able to do so, and it is unlikely that the flight would then have been continued as if nothing had occurred.

The emergency services

Reports of the accident were made by numerous members of the public, as well as the Land's End ATCO, to the police, LATCC and the Coastguard at 0955 hrs. The Penzance Coast Rescue Team (CRT), the Marazion inflatable lifeboat, the Penlee lifeboat, the Porthleven CRT and an SAR helicopter had all been alerted and tasked by 0958 hrs, and a private vessel had also offered assistance. The first to reach the scene was the helicopter, which arrived at 1003 hrs and deployed a diver to assess the situation. The Marazion inflatable, being closest to the scene, was the first surface vessel to arrive, at 1008 hrs and the others quickly followed.

The SAR helicopter brought flotation bags from RNAS Culdrose and they were attached to the wreckage, which was then towed to Marazion beach. It was loaded onto a naval lorry for onwards travel to the AAIB hangar, at Farnborough, for detailed examination.