AAIU Report No. 2000/002
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Aircraft Type and Registration:	Steen Skybolt EI-CIZ
No. and Type of Engines:	1 Lycoming 10-360 AIB 6D withHartzell HC-C2Y-4BF Variable Pitch Propeller.
Aircraft Serial Number:	001
Year of Manufacture:	1980
Date and Time (UTC):	8th Nov. 1999 13.20 hrs
Location:	Near Abbeyshrule, Co. Longford.
Type of Flight:	Private
Persons on Board:	Crew -- 1
Injuries:	Crew -- Minor
Nature of Damage:	Considerable Damage to Aircraft
Commanders Licence:	Private Pilots Licence -- Aeroplanes
Commanders Age:	49 years
Commanders Flying Experience:	1000 hours + Last 90 days - 12 hrs Last 28 days - 4 hrs
Information Source:	Owner of Aircraft AAIU Field Investigation

SYNOPSIS

The home-built aircraft took off from Abbeyshrule Airfield Runway 28 at 13.20hrs. After reaching a height of between 200 and 300 feet, the aircraft's engine lost power abruptly. The pilot selected a suitable field in which to land, running at 90 degrees to the left of his direction of flight. He turned the aircraft, descended, side-slipped over a hedge and landed the aircraft. The undercarriage was damaged on impact with the ground and the aircraft came to a halt approx. 30 metres further on. The pilot exited the aircraft. Apart from a slight bump to the head there were no other injuries to the pilot. There was no fire.

1. FACTUAL INFORMATION

1.1 History of the Flight

Prior to the flight, the pilot took a sample of fuel from the gascolator and satisfied himself that there was no water or contaminant present in the fuel. He then conducted the aircraft walk around, following which he entered the rear cockpit and strapped himself in. He started the engine, did some preliminary power checks and taxied to the start of Runway 28. He conducted a magneto check, full power check and cycled the propeller. He did the take off checks (trim, throttle, fuel and harness secure). All indications appeared normal. The aircraft accelerated down the runway and took off under full power. The aircraft rotated and climbed over the river Inny. The climb out speed was in the region of 100 MPH and the rate of climb was 1000 ft/min. When the aircraft reached a height of between 200 and 300 feet the engine suddenly stopped.

The pilot observed houses in line with his direction of flight. He noticed a small field to his left at 90 degrees to his direction of flight and decided to put the aircraft into that field. He put the nose down and did a side slip over the hedge and into the field. He tried to flare the aircraft but found that he had little elevator authority. The aircraft hit the ground quite hard and it came to rest 30 metres further on. The pilot exited the aircraft promptly.

1.1.1 Eyewitness Recollections

The first eyewitness on the scene came from the direction of the houses west of the field. He saw the aircraft taking off but just as it was passing overhead at about 200 feet, the engine cut out. The aircraft turned and came over the hedge. Finally "the tail lifted up and fell back down again". The aircraft then hit the ground and slid for about 30 metres.

Two witnesses arrived from the hangars. One came from the east of the field and later the other witness arrived from west of the field. This later witness observed the fuel selector lever was in the "Off" position and that the pilot was standing at the front of the aircraft. All witnesses said that the engine had stopped suddenly with no backfiring or any other noise.

On interview the pilot indicated that the "fuel" check prior to take off involved ensuring from the gauge that there was sufficient fuel for flight and checking the fuel selector lever position. He said that prior to the flight the "wing" tank was empty. As a rule he never put fuel into that tank. Following the incident, and after he had exited the aircraft and somewhat recovered, the pilot said that he returned to the aircraft, turned the fuel selector lever to "Off", turned off the magnetos and removed the key from the ignition in accordance with standard safety procedures.

1.2 Injuries to Persons

The pilot sustained a bump to the head which was caused by his head coming in contact with the instrument panel coaming. The pilot did not consider that this required any immediate medical attention.

1.3 Damage to the Aircraft

Visible damage to the aircraft included:

(a) Collapsed undercarriage due to broken cross tubes on impact with the ground.

(b) Cracked engine bearer arm

(c) Crack in engine exhaust pipe, port side.

(d) Damaged engine cowlings and denting of aircraft skin front starboard side.

(e) Cracked longeron beneath rear cockpit.

(f) Bent propeller blade.

1.4 Other Damage

Skid marks on grass of 30 metres length in landing field. Damage slight.

1.5 Personnel Information

The pilot who had a private pilots licence was the owner of the aircraft and had the aircraft for 6 years. He was 49 years of age and had 1050 hours total flying experience. The average flying time on this aircraft was 12 hours every 3 months. The pilot flew a total of 4 hours on this aircraft in the previous 28 days.
The pilots total flying time on this aircraft was approximately 300 hours.

1.6 Aircraft Information

(a) The aircraft is a two-seat home built aerobatic biplane with a fabric covered fuselage of welded structure of chrome molybdenum steel tube. The landing gear is non-retractable and consists of two side V's and half axles hinged to the fuselage structure.

This aircraft was built in the U.S. in 1980, imported into the UK in Nov 1990 at 482 hours flying time, assembled and given a "Permit to Fly" under CAA approval.. In Jan 1994, at 532 hours, the aircraft underwent an inspection for the "Permit to Fly" issued by the Irish Aviation Authority and was placed on the Irish register.
The aircraft is permitted to fly in Ireland under the IAA's scheme for homebuilt aircraft using a flight permit issued by SAAC (Society of Amateur Aircraft Constructors). This scheme permits aircraft to operate with a full certificate of airworthiness. Permit No.9048 was issued for this aircraft. The aircraft received its last annual inspection at a recognised Maintenance Organisation on 18th June1999 at 885 hours in accordance with LAMS/FW/78 (Light Aircraft Maintenance Schedule / Fixed Wing). The engine of this aircraft had a recent history of metal particle deposits in the air filter.

On 20th Oct.1999 the engine was signed off having been bulk stripped and the crankshaft and tapped bodies replaced. The airframe and engine had completed 904hrs at the time of the incident.

(b) The aircraft is powered by a 200 HP Lycoming 10-360 AIB6D engine. The max take of weight is 748 kg. The nominal take off run is 400 ft and the rotate speed used by the pilot was 80 MPH.

(c) The fuel used was Avgas 100 LL

(d) The fuselage main tank is situated immediately aft of the firewall and has a fuel capacity of 29US gallons. The wing tank is installed in the centre-section of the upper wing and has a fuel capacity of 10 US gallons. The refuelling point is on the upper surface forward of the windscreen and on the top surface of the upper wing. The main tank has an internal baffle and a flop tube which ensures that the tank sump is always full when performing aerobatics. The fuel lines from the wing tank and main tank meet at the fuel selector valve which is mounted on the starboard side just behind the firewall. The outlet from the fuel selector valve then goes through the firewall to the electrical booster pump and then to the fuel gascolator underneath the booster pump. The fuel line is then taken from the gascolator to the engine driven fuel pump. The selector valve is operated by a lever in the rear cockpit (Fig.1) through a long handle passing through the front cockpit, past the main fuel tank and connected to the fuel selector valve near the firewall.(Fig.2). The fuel selector lever positions are - Off - Main- Wing.

1.7 Meteorological Information

The pilot stated that the wind was calm, the visibility 10 Km plus and no cloud.

Met Eireann said that there was a weak front in the area with the visibility ranging from 3 to 10 Km. with some cloud above 500 ft.

Temperature 12° C Dew point 11°C

1.8 Aids to Navigation

Not Applicable

1.9 Communications

Not Applicable

1.10 Aerodrome Information

The aerodrome is privately licensed and has a runway of directions 10/28 of tarmac surface with a length of 575 metres.

1.11 Flight Recorders

There were no flight recorders on board

1.12 Impact Information

The aircraft impacted the ground approx. 750 metres from the end of the runway. The undercarriage collapsed on impact and the aircraft skidded for another 30 metres at right angles to the runway direction.

1.13 Medical Information

The pilot did not receive medical attention.

1.14 Fire

There was no fire.

1.15 Survival

The pilot released himself from the four point aircraft harness and left the aircraft following impact.

1.16 Tests and Research

1.16.1 On Site investigation

On the day following the incident, the aircraft was inspected by the investigator at the crash site. The fuel line to the metering valve at the top of the engine was opened at the valve. No fuel was found in this pipe or in the valve. A small quantity of fuel was found at the exit of the engine fuel pump. The exit of the booster pump was examined and a negligable quantity of fuel found at this point. The entry pipe to the booster pump did not contain fuel. All pipelines were reconnected. The fuel selector lever was turned to "Main", the master switch turned on, and the booster pump run. The fuel system was immediately seen to pressurise and fuel samples collected at the cylinder entries. These samples appeared clear and free from contamination. The fuel flow was satisfactory. The main tank was ¾ full.

1.16.2 Engine Run

The aircraft was removed to the airfield and strapped to a mobile cradle. A replacement propeller was installed. The engine fuel system was primed, the engine started and run. It was not possible to run the engine at full power for any length of time (due to cracks in the engine bearer arm) but the engine ran satisfactorily and with no backfiring. The engine speed was set at approx. 2000 rpm and during the run the fuel selector lever was turned to the "Off" position. The engine ran for a further 32 secs. and then cut. The fuel selector lever was then turned to "Main" and the engine run again. The engine speed was increased to 2700 rpm momentarily, with no sign of malfunction.

1.16.3 Hangar Inspection

A further inspection of the aircraft's fuel system was carried out in the hangar. The outlet from the main tank was opened and the internal flexible pipe inspected. The following pipes were removed and inspected internally:

(a) pipe from fuel cock to gascolator.
(b) pipe from gascolator to booster pump.
(c) pipe from booster pump to engine pump.

The filter and filter bowl were examined. The filter was clear and the bowl contained almost no sediment.

No foreign matter was found which would have restricted the flow of fuel to the engine. The fuel selector valve was very stiff to operate but operated correctly in turning the flow from the main tank on and off.

1.16.4 Workshop Investigation

The 3 position fuel selector valve (Off-Main- Wing) was removed from the aircraft. Its operation on a fuel test bench was checked and the operation found to be satisfactory. It was found very stiff to operate requiring a torque of 43 in lbs to rotate the spindle. This varied depending on the position of the spindle. A detent could be felt in each of the three positions indicating that the valve spindle was "home". Due to the stiffness of the spindle and the length of the operating handle from the rear cockpit to the forward engine bulkhead it is possible that the cockpit indicator might indicate "Main" whilst the valve spindle might not be exactly in a position to allow full fuel to flow from the main tank.

1.17 Organisational and Management information

Not applicable

1.18 Additional Information

Contact was made with the manufacturer of this aircraft kit in the US. They indicated that the builder of this particular aircraft used an "Imperial" 3 way fuel valve which was, at the time, certified for aircraft use. The problem with this valve is that it has a "brass to brass" cone shaped seal which frequently binds when moved and can also bind in between ports. The original manufacturer of the kit never gave any recommendations for the fuel system components. The present manufacturer bought over the business in 1990 and has written a builders guide which includes a section on the fuel system.
They pointed out that the type of valve installed on this aircraft can also be found on some other light aircraft In one of these, an aerobatic sports aircraft, an extension to the rear cockpit is also used.

They recommend the use of an "Allen" valve which is a very high quality valve with teflon ball seats and the positions have very definite detents.

1.19 Investigative Techniques

The take off run for this type of aircraft is quoted at 400 ft (122 metres). Assuming a lift off speed of 80 MPH would give an acceleration of 17 ft/sec/sec and a roll time of 6.85 secs.

At this stage the aircraft would have 450 metres to go to the end of the runway. At a forward speed of 100 MPH and a climb speed of 1000 ft/min the aircraft would be over the end of the runway in a further 10 secs.

The distance from the end of the runway to the area of the impact site is a further 676 metres. At a speed of 100 MPH it would take a further 15 secs to arrive over this area.

The total time therefore, from the commencement of the roll at the start of RWY 28 to the point at which the engine power failed, would have been in the region of 32 secs.(6.85+10+15) The theoretical height at this time, if the aircraft had been climbing at 1000 ft/min would be 400 ft. In practice, however, there is usually a period of horizontal acceleration, low rate of climb, immediately after take off which could bring the height attained nearer to 300 ft.

2. ANALYSIS

On inspection of the aircraft in the field on the day following the incident, no fuel was found in the engine metering valve, injector, engine driven fuel pump and booster pump. The fuel selector lever was found in the "Off" position. When the fuel valve was turned to "Main" and the booster pump (used for starting purposes only) switched on, there was an immediate flow of fuel to the engine cylinder entries.

The engine was subsequently run with the booster pump switched off after starting, thus confirming the correct functioning of the engine driven fuel pump.

The pilot had started the engine of his aircraft outside the hangar, did some preliminary power checks and then taxied the aircraft to the start of RWY 28. This distance is in the region of 440 metres and even at taxi speed the engine would have consumed a considerable amount of fuel. If the fuel selector lever had been in the "Off" position outside the hangar there would not have been enough fuel in the lines to enable the aircraft to reach the final impact area. It must be assumed therefore, that the fuel selector lever was in the "Main" position at that time and that there was free flow of fuel to the engine.

Ground checks were carried out at the start of RWY 28 in preparation for take off and the verification of fuel quantity and position of the fuel valve were part of these checks. If the fuel selector lever were moved in order to verify its position at this time, it is possible, considering the construction of the valve and its leverage, that the internal valve ports were not aligned. This would produce a severe restriction or even cut-off in the fuel flow from the main tank to the engine.

A detailed examination of the fuel selector valve was carried out which confirmed the kit manufacturer's doubt about the suitability of this valve for installation in this aircraft.

It is estimated that the height of the aircraft at the time of engine failure was nearer to 300 ft rather than 200 ft as observed by one of the witnesses. The time taken from the start of the aircraft's roll to when the engine cut was in the region of 32 secs. This length of time corresponds to the time taken for the engine to cut on test following the closing of the fuel selector valve.

There is a possibility that the fuel selector may have been cycled at some stage prior to the flight and when finally switched to "Main" that the valve ports did not line up fully. This could have supplied enough fuel flow for starting and taxying. However, when full power was applied the engine fuel consumption rate exceeded the fuel flow rate through the partially open valve resulting in a lean cut shortly after take off.

The possibility of engine icing was considered by the investigation. Induction system icing is more likely at low power settings with engines using a carburretor fuel system rather than a fuel injection system, as in this case. During this particular flight the engine was at a high power setting.

3. CONCLUSIONS

It is concluded that the internal parts of the fuel valve were not aligned at take off, thus restricting the amount of fuel available for flight.

4. SAFETY RECOMMENDATION

4.1 It is recommended that the Society of Aircraft Constructors (SAC) inform their members that this type of fuel valve with "brass to brass" bearing surfaces should not be used in the construction of aircraft fuel systems. **(SR 1 of 2000)**

4.2 It is recommended that the FAA, as the authority in the state of manufacture, should take on board the problems associated with this type of valve and consider appropriate action. **(SR 2 of 2000)**

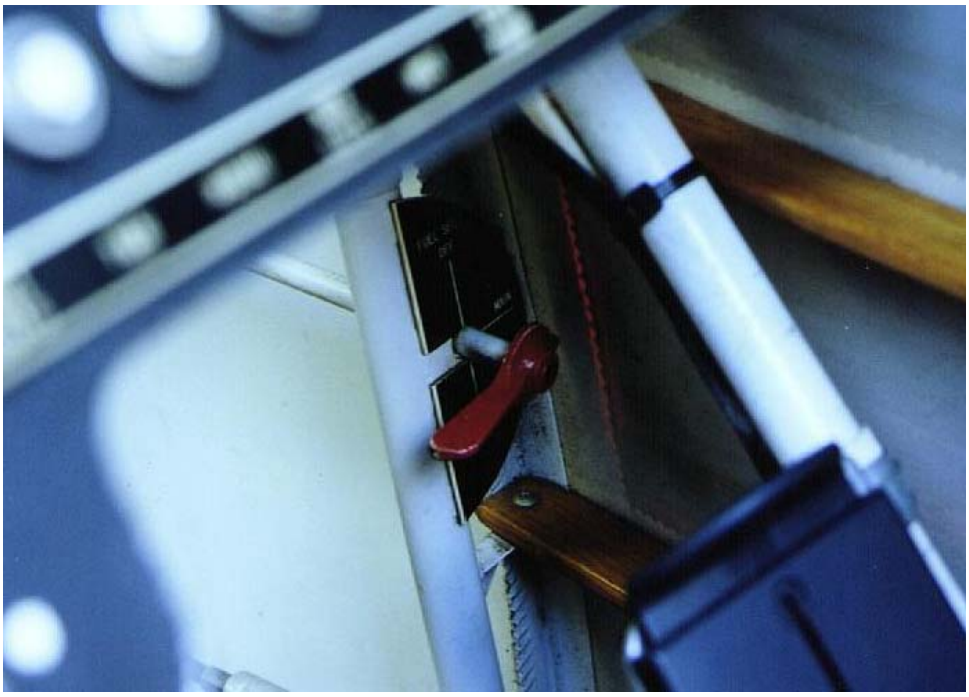

FIG. 1 FUEL SELECTOR -- REAR COCKPIT

FIG. 2 FUEL SELECTOR VALVE EI-CIZ