Air Accident Investigation Unit Ireland

FORMAL REPORT

ACCIDENT
Reims-Cessna F150H, EI-AST
Near Birr Airfield
11 November 2012

An Roinn Iompair
Turasóireachta agus Spóirt
Department of Transport,
Tourism and Sport

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In accordance with Annex 13 to the Convention on International Civil Aviation, Regulation (EU) No. 996/2010 and the provisions of S.I. 460 of 2009, the Chief Inspector of Air Accidents, on 12 November 2012, appointed Mr. Paddy Judge as the Investigator-in-Charge to carry out an Investigation into this Accident and prepare a Report. The sole purpose of this Investigation is the prevention of aviation Accidents and Incidents. It is not the purpose of the Investigation to apportion blame or liability.

Operator:	**Ormand Flying Club Ltd**
Manufacturer:	**Reims-Cessna**
Model:	**F150H**
Nationality:	**Ireland**
Registration:	**EI-AST**
Location:	**Near Birr Airfield (EIBR), Co. Offaly, Ireland** **N53° 03.840', W007°53.688'**
Date / Time (UTC)	**11 November 2012 @ 16:44 hrs UTC**[1]

SYNOPSIS

The aircraft was conducting student pilot training at EIBR on the day of the accident. Following a touch-and-go landing on Runway (RWY) 18, the aircraft was observed by witnesses climbing away. They heard the engine lose power and saw the aircraft making a steep descending turn to the left before disappearing from view. The aircraft impacted heavily in scrub land and came to rest inverted. Both pilots were found fatally injured within the wreckage of the aircraft.

The Investigation found that the engine power loss was caused by fuel starvation. No technical defect that might have contributed to the accident was found.

As a result of this Investigation eight Safety Recommendations are issued.

[1] **UTC:** Co-ordinated Universal Time (the same as local time on the day of the accident).

NOTIFICATION

The AAIU was notified of the accident at 18.25 hrs on 11 November 2012 by Birr Fire Services and shortly afterwards that the accident site had been located by a Garda helicopter. An AAIU response team routed directly to Birr Garda station for a briefing and subsequently visited the accident site.

Following notification, a non-travelling Accredited Representative (ACCREP) was appointed by the United States, the State of Design of the aircraft, to assist the Investigation. Advisors from the aircraft manufacturer Cessna and the engine manufacturer Teledyne-Continental were also appointed.

1. FACTUAL INFORMATION

1.1. History of the Flight

The aircraft, a Cessna F150H, conducted six training details at EIBR on the day of the accident, three in the morning and three in the afternoon. On each occasion the aircraft took-off from and returned to EIBR with the Instructor sitting in the right hand seat and another person on board. The first flight in the morning was a familiarisation flight for a foreign qualified pilot whereas the other flights were different training exercises with student pilots, each conducted according to the Flying Club's Private Pilot Licence (PPL) syllabus. The first series of three flights were recorded as being one hour duration each, commencing at 10.15 hrs and ending at 14.00 hrs. The aircraft was then refuelled.

Following this, the Instructor conducted a further two training details with different students. These details were a cross country navigation exercise and steep turns/simulated forced landings in the vicinity of Birr. The third detail, the accident flight, entailed circuit training at EIBR with the Student Pilot. Following a touch-and-go landing on RWY 18 the aircraft was seen by witnesses to climb away. Witnesses stated that during the climb out they heard the engine stop and they observed the aircraft make a steep descending turn to the left before disappearing from view behind trees.

A witness called the Emergency Services and a search for the aircraft was commenced but, due to approaching darkness and the black colour of the aircraft, the accident site proved difficult to find. A Garda helicopter subsequently located the accident site at 18.04 hrs using a thermal imaging camera and directed ground search teams to the accident site where both pilots were found fatally injured.

An initial examination of the wreckage was carried out by the AAIU investigative team. Following this, in coordination with the Emergency Services, the casualties were extracted. The site was then secured overnight by An Garda Síochána. The following morning the AAIU carried out a further examination of the scene. The wreckage was recovered and transported under escort to the AAIU facility at Gormanston, Co. Meath.

1.1.1. Interviews

1.1.2. Witness A

Witness A, a student pilot, stated that the Instructor had given him waypoints some days previously to allow him to construct a cross-country training navigation flight plan in advance of his flight. He arrived at the airfield at 11.45 hrs to undertake the flight with the Instructor, which he understood was to be during the second training detail after lunch. While the aircraft was being refuelled by Witness B, who was scheduled to fly first, the Instructor decided to switch details and conduct the cross-country navigation flight first.

Witness A stated that he went to the aircraft and, when the fuel tanks were dipped post refuelling, both he and Witness B observed 32 litres (l) in the right tank and 28 l in the left; a total of 60 l which was the standard club departure fuel load. He and the Instructor departed at 14.13 hrs and conducted the cross-country flight, which took one hour and 10 minutes. On arrival back at EIBR they stopped the aircraft's engine and he disembarked. Witness B's training detail then commenced, which lasted one hour, following which the engine was not stopped. The next detail commenced with the Student Pilot boarding the aircraft while the engine was running.

Witness A thought that about 3 left-hand circuits had been flown with touch-and-go landings when, during the climb out, he heard the aircraft gradually losing power, at about 100 to 150 ft, until it went silent. He said that it seemed to him that the aircraft was returning to the field as it banked left, to about 60°. He stated that the aircraft appeared to be in a high nose up attitude when it pitched down sharply into a field. He thought that the wings were beginning to level as it disappeared from his sight. He did not see the impact as his view was obscured. While Witness B rang the Emergency Services, he himself contacted a club member who immediately drove back to the club and they commenced a search for the aircraft.

Witness A confirmed that the aircraft had not been refuelled between details. He stated that the unusable[2] fuel load was 14 litres and that normal circuits were flown at 800 ft, each taking 10 to 12 minutes a circuit. He was unaware of any technical defects with the aircraft and the engine checks were all normal when he flew.

He stated that the weather was fine with good visibility, the wind at 2,000 ft was 260°/10 kt; the wind at the airfield was a light south-westerly breeze. He considered that light conditions at the time of the accident were good until about an hour afterwards. He had accumulated 5 hours flying, all in EI-AST.

1.1.3. Witness B

Witness B, also a student pilot, stated that he arrived at EIBR early that morning and spent most of the day waiting for his turn to fly. When his turn arrived he refuelled the aircraft to 60 l, which he said was enough for 3 hours flying. However, his detail was delayed with Witness A being taken first by the Instructor. When the aircraft returned to the ramp the engine was shut down.

[2] **Unusable fuel:** The quantity of fuel remaining under the most adverse feed condition in intended operations and flight manoeuvres, at which the first evidence of engine malfunctioning occurs. (Usable fuel + unusable fuel = total fuel quantity).

During his pre-departure inspection he opened the engine cowling to check the engine oil, which was between 5 and 6 quarts. He stated that he knew that there was sufficient fuel for the flight, as he had previously refuelled the aircraft, and thus he did not check it again. His detail with the Instructor then commenced and he stated that the engine run up was normal with normal magneto drops. They took off, flaps were selected up at 300 ft as usual and they turned to the west at 500 ft. They climbed and then practised steep turns and simulated engine failures. They further climbed to 2,000 ft and then completed 3 practice engine failures into EIBR. They landed afterwards and taxied to the ramp where he exited the aircraft with the engine still running. He said that the Instructor kept the record of the times of the flight, which he believed had taken an hour.

He said that the engine remained running while the Student Pilot embarked. The aircraft then completed three circuits and, as it climbed to less than 200 ft, there was a roar from the engine which then went quiet.

The nose of the aircraft went up slightly and it initially turned to the right. It then immediately turned steeply to the left with the nose coming back down and then it disappeared.

He called the Emergency Services while Witness A called club members. They then searched for the aircraft but did not find it, though they were close to the accident site. As darkness was approaching the Garda helicopter was requested; it found the accident site shortly after arriving on the scene.

When queried about engine failure practice he stated that following the normal engine checks in that situation, the aircraft should be trimmed to 70 mph and to look out ahead or to the side for a suitable field. He commented that the weather at the time was fine but that the day was dark. He had accumulated 33 hours flying EI-AST.

1.1.4. Private Pilot

This pilot had a Private Pilot Licence (PPL) and owned a Cessna 172. He flew 8 circuits in EI-AST with the Instructor that morning on the first flight of the day, commencing at 10.15 hrs, to familiarise himself with the short runway at EIBR. Before the flight they had both looked in the fuel tanks where he saw plenty of fuel but did not know the exact amount; the Instructor told him that it was adequate for the flight. He confirmed that water drains had been checked and that there had been no problems with the aircraft or its engine that morning, all checks having been normal. He commented that the way that the Instructor had managed the flight that morning was "*quite professional*".

1.1.5. Chief Flying Instructor (CFI)

The CFI stated that the Flying Club had owned EI-AST for about 11 years and that it was used for basic training. The aircraft had originally been equipped with a tricycle undercarriage, was converted to a tail wheel configuration and reconverted back before it was owned by the Club. The aircraft's electronics were then upgraded with a transponder, ADF and DME to allow it to be approved by the Irish Aviation Authority (IAA) as a Club training aircraft. He believed the aircraft was in good order and that its 50 and 150 hour maintenance checks had been performed as required at an approved maintenance facility.

He said that aircraft fuel (AVGAS 100LL) was normally obtained from the approved filtered fuel system installed at EIBR. Fuel amounts on the aircraft were determined by dip sticks only, as he said that aircraft fuel gauges could not be trusted. Both a marked dipstick and a water drain sight gauge were carried on the aircraft.

He stated that the Club fuel policy required approximately 60 l of fuel on board at departure. This was due to the occasional soft nature of the airfield and the restrictive load capacity of the aircraft, the Empty Weight being 1,075 lbs while the maximum take-off weight (MTOW) was 1,600 lbs. He said that fuel burn was assumed to be approximately 22 l/hr and they did not lean fuel. This would depend on the type of detail and that after a couple of sorties the fuel should be topped up. He stated that it was part of the pre-flight to check the fuel quantity using the ladder and dipstick provided and that if fuel levels were even down a little, it should still be topped up, since at 60 l fuel quantity there was at least 2 hours endurance. At all times there should be a minimum fuel reserve which he said was 45 minutes endurance plus unusable fuel.

He stated that he had not flown EI-AST recently, as he had been concentrating on microlight aircraft, but that he had been monitoring the Instructor. He had recommended the Instructor for his Class 1 Rating[3] earlier that year. He was satisfied with him and believed the Instructor could have replaced himself as the CFI sometime in the future. The Instructor had initially been trained in the USA but he had monitored and coached him to ensure that they both instructed to the same standard. The Instructor was not paid for instructing by the Flying Club but was compensated for the costs of holding a commercial licence and travelling expenses by a charge per flying hour paid by students. Where ground instruction or no flight occurred there was no charge.

He commented that in any practice forced landing due to engine failure a pilot should never turn back. He stated that even if 600 or 700 ft is reached, the pilot is limited to a certain arc, about 30° either side. He did not understand why the aircraft had conducted a 180° turn saying that it did not make sense.

He said that full circuits took 10 minutes but "touch-and-goes" took approximately 5 to 8 minutes. He stated that the club recorded actual flight times since the tachometer hour readings were calibrated at a specific RPM and were not accurate in recording time.

1.2. Injuries to Persons

Both pilots were fatally injured.

Injuries	Crew	Passengers	Others
Fatal	2	0	0
Serious	0	0	0
Minor /None	0	0	0

[3] **Class 1 Rating:** Can authorise a first solo amongst other privileges. (S.I. No. 333/2000 - Personnel Licensing),

1.3. Damage to Aircraft

The aircraft was destroyed.

1.4. Other Damage

Minor impact and recovery damage to fields.

1.5. Personnel Information

1.5.1. Instructor:

The Instructor's logbook recorded that he commenced flying on 13 February 2006 in the USA where he completed an approved Commercial Pilot's Licence (CPL) course. The majority of his flying was conducted on the Cessna 150.

Personal Details:	Male, aged 31 years	
Licence:	JAA CPL (A), issued by the IAA	
Medical Certificate:	Class One	Valid until 23 June 2013 Corrective lenses required
Ratings:	SPA[4] Class Rating SEP SEP[5] (Land) and MEP[6] (Land)	Valid to 23 January 2014 Valid to 28 June 2013

His Flight Instructor Aeroplane rating was valid to the 30 April 2015 for instruction to CPL (A) standard. The Flying Club records showed that the Instructor was the most consistently active instructor on EI-AST. His flying occurred at weekends in the month preceding the accident.

Flying Experience:

Total all types:	603	hours
Total all types P1[7]:	389	hours
Total on type:	486	hours
Total on type P1:	365	hours
Last 90 days:	43	hours
Last 28 days:	12	hours
Last 24 hours:	5	hours

The Investigation was informed that the Instructor had travelled from Dublin on the morning of the accident and commenced flying at 10.15 hrs.

[4] **SPA:** Single Pilot Aeroplane
[5] **SEP:** Single Engine Piston
[6] **MEP:** Multi Engine Piston
[7] **P1:** Also known as the handling Pilot

1.5.2. Student Pilot

The Flying Club's records showed that the Student Pilot commenced his flying at EIBR on 17 October 2010. All his flying was conducted on EI-AST.

Personal Details:	Male, aged 31 years	
Licence:	SPL (A)	Issued by IAA Valid until 25 March 2017
Medical Certificate:	Class 2	Valid to 25 January 2016

Flying Experience:

Total all types:	19	hours
Total all types PI:	3	hours
Total on type:	19	hours
Total on type PI:	3	hours
Last 90 days:	5	hours
Last 28 days:	1	hours
Last 24 hours:	0	hours

1.6. Aircraft Information

EI-AST was a Reims-Cessna F150H[8]. This two seat aircraft type is a high-wing aeroplane equipped with a fixed tricycle landing gear and a steerable nose gear. It is powered by a single reciprocating engine, a Teledyne-Continental O-200-A, driving a McCauley fixed pitch, two bladed propeller. It has a wingspan of 9.67 m and is 7.76 m long. The fuselage and empennage are of an all-metal semi-monocoque design.

The wings are externally braced with electrically actuated wing-flaps which when selected UP allowed automatic retraction of the flaps, flap extension required holding the spring loaded switch down. The aeroplane is equipped with dual controls and can be flown from either of the two cockpit seats.

[8] **F** in the model number indicates that the aircraft was built in France. **H** indicates that it was a 1968 model aircraft.

1.6.1. Leading Particulars

Aircraft type:	Cessna F150H
Manufacturer:	Reims-Cessna
Serial number:	0273
Year of manufacture:	1968
Certificate of registration:	16 April 2002
Certificate of airworthiness:	21 February 2012
Certificate of Release to Service:	11 October 2012
Total airframe hours:	9,416
Total cycles:	N/A
Engine:	Teledyne-Continental O-200-A
Total Engine Hours:	1,466
Maximum authorised take-off weight:	1,600 lb
Empty Weight:	1,135 lb
Estimated take-off weight:	1,561 lb
Estimated weight at time of accident:	1,553 lb
Centre of Gravity limits (at accident weight):	50.7 - 57.8 (lb-ins/1000)
Centre of gravity at time of accident:	51.4 (lb-ins/1000)
Initial Climb Speed	73 mph (63 kts)
Stall Speed, Flaps up, Power off	55 mph (48 kts)
Stall Speed, Flaps down, Power off	48 mph (42 kts)
Rate of climb at sea level	670 ft/min

The aircraft logbooks recorded that following a landing occurrence in 1996, the aircraft was converted from a tail wheel to a tricycle configuration in 1998 in accordance with FAA[9] Supplemental Type Certificate (STC) SA2846SW.

A number of Aircraft Weighing Reports were provided to the Investigation, each maintenance facility using a different form. This documentation showed that the aircraft was last weighed on the 13 August 2009. This recorded an empty weight of 1,135 lbs with the Centre of Gravity at 35.7 inches aft of the datum but did not state if the weight of unusable fuel and oil was included. As a previous weighing of the aircraft in 1998 recorded that the aircraft, with full oil and unusable fuel on board, weighed 1,125 lbs, the Investigation considers that the weight of 1,135 lbs included oil (11 lbs) and unusable fuel (22 lbs).

1.6.2. Aircraft Maintenance

The aircraft was maintained by an approved facility with EASA Part M Subpart F (Approved Maintenance Organisation – General Aviation) and Subpart G (Continuing Airworthiness Management Organisation – General Aviation) approvals.

[9] **FAA**: Federal Aviation Administration.

Its Certificate of Airworthiness was issued by the IAA on 5 August 2008 while the current Airworthiness Review Certificate (ARC) was issued on 21 February 2012 by the maintenance facility under its Subpart G approval, date of expiry 20 February 2013. The aircraft was being maintained under the IAA approved MPLA - A (Maintenance Programme for Light Aircraft applicable to Aeroplanes). The Engine and Aircraft logbooks were kept at the approved facility and were updated when the aircraft arrived for checks.

Accordingly the last 18 hours were not entered in the logbooks. The Aircraft Logbook recorded that the work pack for the 50 hour check, dated 11 April 2012, included the statement "*gauge indications checked against fuel quantity on board and found to indicate correctly*". The work pack for the 50 and 150 hour checks, dated 1 June 2012, included a fuel quantity indicating system inspection (Cessna SEB 99-18 R1).

The most recent Annual Inspection was conducted on the 23 July 2012 (this included 50 and 150 hour checks) and included the requirement to check instruments and indicators for satisfactory condition, mounting, marking and operation. The most recent 50 hour check was recorded as completed on the 11 October 2012 at 9,400.96 tachometer time. The 50 hour check included cylinder compression, magneto timing and carburettor inspections. This check was not completed when due since the elapsed time interval was 58 hours, partly due to an unrecorded flight following the Annual Inspection.

Following this last check on the 11 October 2012 the aircraft accumulated 21 hours before the accident flight commenced.

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1.6.3. Fuel System

The F150H has two internal metal fuel tanks, located in the inner section of the left and right wings. The two tanks are interconnected and fuel flows to the engine under gravity through a fuel shutoff valve and fuel strainer to the carburettor (**Figure No. 1**).

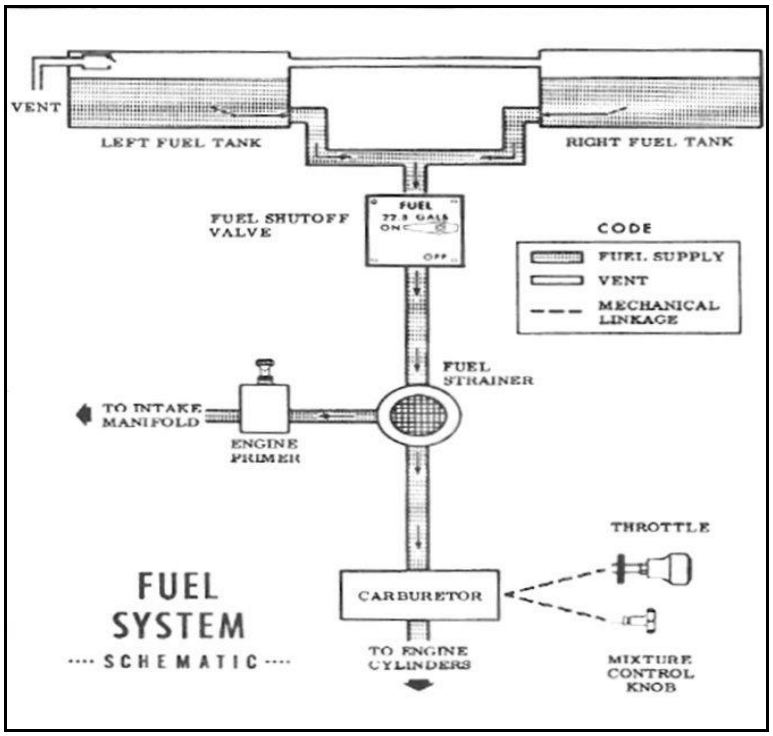

Figure No. 1: Cessna F150H Fuel Schematic

Fuel tanks can be refuelled or dipped through a fuel cap located on the upper surface of each wing. A fuel drain/water check valve is located under each wing and the fuel strainer also has a water check drain valve which can be operated from within the engine cowlings.

The Manufacturer's Owner's Manual (OM), which was the approved Flight Manual for the aircraft, states that each tank has a capacity of 13 USG (49.2 litres), giving a total of 26 USG (98.4 l) of which 3.5 (13.25 l) is unusable. Fuel consumption varies with the type of operation being conducted and was quoted by Club members as 22 l/hr. The Manufacturer, in the OM, quotes the following endurance times for cruise operations using all useable fuel (85.15 l) with the mixture fully leaned (**Table No. 1**).

Cessna F150H Endurance			
RPM	**USG/hr**	**l/hr**	**Hours**
2,750	7.0	26.5	3.2
2,700	6.6	25.0	3.4
2,600	**5.8**	**22.0**	**3.9**
2,500	5.1	19.3	4.4
2,400	4.6	17.4	4.9
2,300	4.1	15.5	5.5
2,200	3.6	13.6	6.3
2,100	3.2	12.1	7.0

Table No. 1: Cruise operations, mixture leaned

Fuel consumption of 22 l/hr equates to 2,600 RPM in cruise or 3.9 hours endurance with full tanks and mixture leaned. The Investigation was informed by both the CFI and club members that the mixture was not leaned when flying EI-AST.

1.6.4. Stalling

Boundary layer separation in the airflow over airfoils and wings is commonly referred to as a stall. In the case of a stall the airflow separates from the wing, the wing loses lift and control of the aircraft is lost for the duration of the stall. The aircraft is equipped with a pneumatic stall warning system that activates a horn in the cockpit as the aircraft approaches a stall. This audible warning activates 5 to 10 miles per hour (mph) above the stalling speed. The airspeed indicator showed mph and knots, with mph on the outer scale.

The mph stalling speeds for the F150H are given in Figure 6-2 in the OM. These are also converted to kts in **Table No. 2.**

	Stall Speeds Flaps Up, Power Off, Weight 1,600 lbs			
Angle of Bank	**0°**	**20°**	**40°**	**60°**
Mph	**55**	**57**	**63**	**78**
Kts	**48**	**50**	**55**	**68**

Table No. 2: Cessna F150H Stall Speeds

1.6.5. Aircraft Operational Information

The OM for this Cessna F150H advises, *inter alia,* in an emergency landing without power:

If an engine stoppage occurs, establish a flaps up glide at 70 mph. If time permits, attempt to restart the engine by checking fuel quantity, proper fuel selection valve position….

1.7. Meteorological Information

Witness A reported that the weather was fine with good visibility. The wind at the airfield was a light south-westerly breeze while the wind at 2,000 ft was 260°/10 kt. He reported that light conditions at the time of the accident were good until about an hour afterwards.

The weather reports for the adjacent airports about the time of the accident were as follows:

METAR EIDW 111630Z 25005KT 9999 FEW015 BKN140 08/05 Q1015 NOSIG METAR EIDW 111700Z 23007KT 9999 FEW015 BKN120 07/05 Q1015 NOSIG
METAR EINN 111630Z 19006KT 9999 -RA FEW015 SCT050 BKN080 08/05 Q1015 NOSIG= METAR EINN 111700Z 18006KT 9999 -RA FEW015 SCT050 BKN080 08/05 Q1015 NOSIG=
METAR EICK 111630Z 22008KT 9999 FEW022 BKN080 OVC250 08/05 Q1016 NOSIG METAR EICK 111700Z 23007KT 9999 FEW022 OVC070 07/05 Q1016 NOSIG

The official time for the end of visual flight rules (VFR) flying was 16.47 hrs.

1.8. Aids to Navigation

Not applicable.

1.9. Communications

VHF communications at EIBR were not recorded. Shannon ATC had earlier recorded the aircraft contacting Shannon Control Low Level frequency at 14.20 hrs stating that it was on a cross country flight from "*Birr routing to Cashel, to Ballyragget and back to Birr*..". It later left the frequency at 15.18 hrs, reporting that EIBR was in sight. The aircraft had no further voice contact with Shannon ATC.

Shannon Radar recorded the aircraft's transponder during its cross-country flight at altitudes above 2,000 ft. Its transponder was set to 7000, the standard code for VFR traffic. Radar intermittently recorded the aircraft from 15.28:30 hrs to 15.37:56 hrs during its next detail, while operating between 2,000 and 2,300 ft, approximately 5 nautical miles (nm) west of EIBR. The returns from the aircraft during that detail were consistent with the aircraft performing various turns to the left and right, some of which were steep. Radar did not record the accident detail as radar coverage in the EIBR area did not extend to such a low level.

1.10. Airfield Information

AVGAS is available from a dispenser which automatically records both time and volume dispensed. The system is activated by a tag/digital fob attached to the aircraft ignition key, each aircraft having its own fob. The system automatically records the aircraft fuel dispensed and includes the date, time and quantity delivered. When examined by the Investigation the dispenser clock was 1 minute 19 seconds slow. The system recorded that the aircraft uplifted 43.08 l on the day of the accident (**Appendix A**).

1.11. Flight Recorders

No flight recorder was fitted to the aircraft nor was it required to be.

1.12. Wreckage and Impact Information

1.12.1. Location

The accident site, (**Photo No.1**) which was located approximately 350 metres southeast of the end of RWY 18 at EIBR, was examined the morning after the accident. The site was in a small field that contained a plantation of immature saplings. The area of the field was approximately 1.5 hectares; the fields in the immediate vicinity were also small and irregular.

Photo No. 1: Accident site (photo courtesy of An Garda Síochána Air Support Unit).

1.12.2. Impact Site

Ground scarring showed that the aircraft had initially impacted heavily in a northerly direction approximately wings level but with a high rate of descent (**Photo No. 2**). The nose down attitude was estimated to be of the order of 20°.

The nose wheel was found 2.3 metres from the initial impact point. The aircraft came to rest inverted 16 metres from the initial impact point. All major parts of the aircraft were accounted for at the accident site location.

The Investigation found no evidence of any substantial fuel deposit at the accident site although a small amount leaked from the inverted wreckage when raised during the recovery operation, this was insufficient for fuel analysis. A subsequent inspection of the accident site found no evidence of the grass staining that is symptomatic of fuel contamination.

Photo No. 2: Initial impact site and final resting position of wreckage.

1.12.3. Wreckage

The cabin was crushed and the fuselage structure was fractured behind the cabin, remaining attached only by control and wiring cables. The empennage was intact and relatively undamaged. Control continuity was established with all control surfaces moving normally although unconnected due to impact damage. The flaps were retracted and consistent with the flap selector switch which was found in the UP position.

Several fractures were found in the engine bearer arm structure. The lower blade of the propeller, which showed no evidence of rotation at impact, was bent rearwards under the engine from mid span. The upper blade, which was slightly bent, also showed no evidence of rotation at impact.

The cabin space was crushed vertically. The instrument panel, which was forward of the leading edge of the wing, suffered less deformation.

Both control wheels remained cross coupled although heavily impeded by the impact damage. The rudder pedals were also found cross coupled and heavily impeded. The right hand pedal on the right hand or Instructor's side was twisted outwards to the right.

1.12.4. Further Examination

Following on-site examination, control cables were labelled and cut to facilitate transportation of the wreckage to the AAIU facility at Gormanston. The wreckage was re-orientated upright and the engine removed from the airframe for examination. In addition, the wing structures were separated from the fuselage to facilitate access and examination.

1.12.5. Engine Examination

The engine was intact but its underside, on which the carburettor and intake manifold were mounted, was severely damaged. The exhaust manifold was compressed but the welds were in good condition and no signs of leakage was observed. Following removal of the bent propeller and the engine cowlings, the engine could be turned. The spark plugs were removed and examined and found to be good condition. No. 1 cylinder plugs both top and bottom and No. 3 cylinder top plug were found heavily soiled with wet oil. As the engine was transported inverted and nose down, this oiling was consistent with seepage from the engine sump. The other plugs were grey and lightly sooted, consistent with normal engine operation. Following removal of the plugs the engine was turned by hand with a thumb compression being noted on all 4 cylinders.

1.12.6. Fuel System Examination

The float chamber of the carburettor had been severed during the impact. The fittings and connections attached to both fuel tanks were found intact during examination with the exception of the vent line from the port tank which had separated. Consequently, the port fuel tank (**Photo No. 3)** was removed and examined. It was adequately supported with all fittings intact, attached and connected. Other than a compression buckling on its outer side, the tank was relatively undamaged. The fuel quantity float transmitter was undamaged and clean with full and free movement.

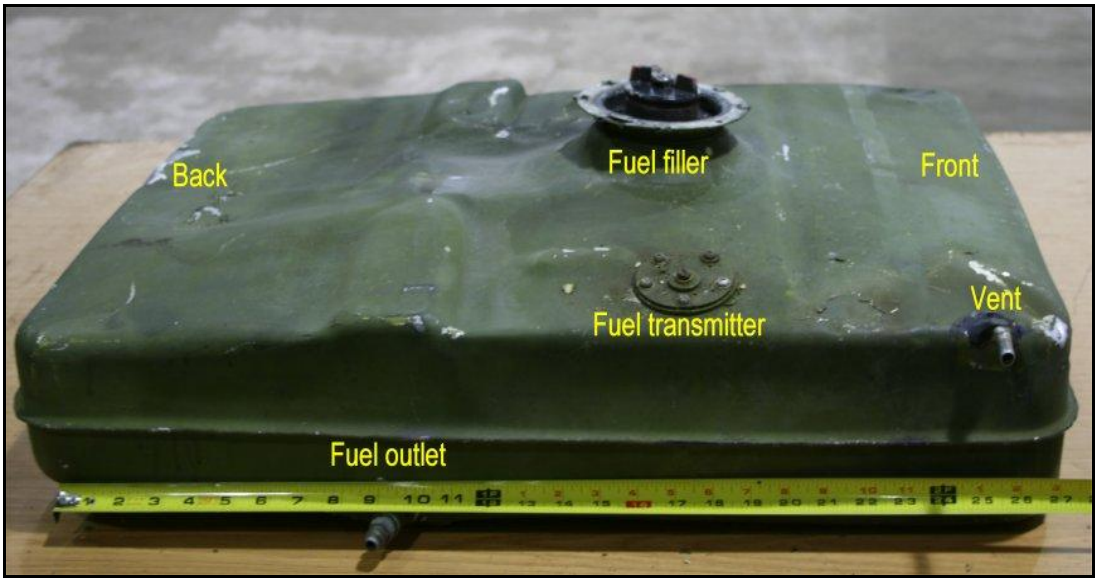

Photo No. 3: Port fuel tank EI-AST

The coarse filter (**Photo No. 4**) attached to the fuel tank outlet was clean. The outlet was located on the inboard wall slightly above a manufactured recess in the floor of the tank, approximately 1/3 of the tank length forward from the rear wall.

Photo No. 4: Internal filter in fuel tank outlet

Other than some minor surface staining on the bottom of this recessed area the internal surfaces of the tank were clean. As the tank was recovered from the still inverted wing, this staining predated the accident flight.

The starboard tank was examined in situ and was relatively intact.

When removed, the fuel strainer in the engine compartment was found to be clean and without sediment in the bowl. As the wreckage had been inverted and its fuel lines severed, the bowl did not contain any fuel.

1.12.7. Seats

The left hand or Student's seat was largely intact, although articulated forward. The seat base remained attached to the rails though the rails were significantly buckled by cockpit floor deformation.

The back of the right hand or Instructor's seat had fractured and separated. The seat base had detached from its floor rails due to cockpit floor distortion which forced the seat retaining brackets open. There was some evidence of sideways loading during impact, both to these brackets and the outer seat carriage which was severely deformed, whereas the inner side was relatively undamaged.

There was no evidence of seat slippage or seat stop failure in either seat mechanism. Seat harnesses are discussed in **Section 1.15 Survival Aspects.**

1.12.8. Cockpit Instruments

Table No. 3 records the various cockpit instruments and controls positions as found at the accident site:

Throttle	Closed (full out), bent to the right
Elevator trim	Partly nose down
Artificial Horizon	Toppled and detached
Airspeed	0 mph
Altimeter	-150 ft
Altimeter subscale	1005 hPa
VSI	0 ft/min
Compass	290°
CDI VOR	005°
RPM	0 (zero)
Tachometer	9,419.86 (hours)
DC Amps	Electrical zero
Oil Temperature	Electrical zero
Oil Pressure	Electrical zero
L & R Fuel Quantities	Electrical zero
Circuit breakers	Closed
Vacuum Gauge	0 Inches of Mercury
Fuel selector	On
Fuel Primer	Broken
Fuel Mixture	Full rich
Carburettor heater	Off
Flap Switch	Up
Master Switch	Off
Ignition	Both
Transponder	7000, selected off
ADF	Off

Table No. 3: Cockpit settings

A Garmin GPSmap 196 was found with the Instructor's navigational equipment. Examination by the Investigation showed that no recent data had been recorded.

1.13. Medical and Pathological Information

The Instructor was medically examined for his Class One Medical Certificate by an IAA approved medical examiner on the 21 June 2012. The Student was medically examined for an initial Class Two Medical Certificate by an IAA approved medical examiner on the 25 January 2011; there were no limitations.

Following the accident, post-mortem examinations were performed on both fatally injured pilots at the Midland Regional Hospital, Tullamore, on 12 and 13 November 2012. The combined weight of both pilots was 390 lbs. The post-mortem reports stated under 'toxicology' that ethanol or drugs of abuse were not detected in either pilot. In both cases it was determined that death was due to injuries secondary to impact from a light aircraft crash.

The pathologist was consulted regarding whether it was possible to determine which pilot was operating the controls at impact from the nature of the injuries to the victims. However, such a determination was not possible.

1.14. Fire

There was no fire.

1.15. Survival Aspects

Following the accident the Emergency Services were immediately contacted and a search for the accident site was commenced by those at the airfield and others. Due to approaching darkness and the black colour of the aircraft the accident site proved difficult to find. A Garda helicopter subsequently located the accident site at 18.04 hrs using a thermal imaging camera and directed ground search teams. Both pilots were found fatally injured and, following initial site examination by the Investigation, were removed from the wreckage by the Emergency Services. The accident was not survivable, given the nature of the impact.

The two pilot seats were fitted with seatbelts consisting of a lap strap and a single diagonal shoulder strap. Both lap straps were attached to a common attachment point in the centre of the cockpit, behind and between, the seats. The diagonal shoulder straps were separately anchored above and behind the seats; the left seat over the left shoulder and the right seat over the right hand shoulder. From that anchor position the straps were connected to a point on the lap strap seat buckle. The seat belt straps bore no signs of fraying. The seatbelt attachment points and buckles were intact and in good condition although the central lap strap attachment point was bent. All seat straps were found cut in a way that is consistent with that used by the emergency services when recovering a casualty.

1.16. Tests and Research

Not Applicable.

1.17. Organizational and Management Information

The aircraft was being operated by the Flying Club, an IAA Registered Training Facility (RTF) which was first registered in 1999. The current Certificate of Registration for the RTF was issued by the IAA on 28 March 2012 and was in effect on the date of the accident. The Instructor and the CFI were both included on the Panel of Instructors listed on the RTF Certificate of Registration.

The last inspected Annual Inspection of the Flying Club was conducted by the IAA on 13 April 2011. There were no adverse comments recorded. The course material and standard flight exercise briefs being used by the Club were recorded as those provided in the Air Pilot's Manual (Trevor Thom).

The Flying Club Aerodrome Manual contains Club rules for the operation of its aircraft. These Rules cover both Ground Operations and Flight Operations. The Refuelling Operation in Section 3.6 of the Manual contained guidance on how to refuel Club aircraft. There was no requirement to keep a written record of the measured fuel quantity after refuelling.

VFR Operations in Section 2.3.5 of the Club rules includes, inter alia:

'The fuel quantity at take-off shall be calculated in such a way as to allow a reserve of at least 45 minutes at normal cruise power on arrival at destination.'

The Flying Club Rules did not contain any guidance on instructor duty time or the amount of flying that could be conducted by an instructor during one day; the general Flight Time Limitation (FTL) rules for this activity, published by the IAA, applied to JAR-FCL Flying Training Organisations (FTOs) and not RTFs.

1.18. Additional Information

1.18.1. Airfield Closed Circuit Television (CCTV)

A fixed CCTV camera belonging to a local Parachute Operation was mounted on the corner of an adjacent hangar. Its coverage included the clubhouse, the threshold and the initial section of RWY 18. It recorded approaches of various aircraft including the final landing of EI-AST. The resolution was insufficient to determine whether flaps were up or down at the time. The CCTV recording had a time error of 1 hour 25 minutes which is corrected in **Table No. 4**.

Time	Detail Recorded
16.43:09	EI-AST appears on a low left hand base
16.43:32	EI-AST on finals circa 200 ft
16.43:40	Lands and continues down the runway out of view
16.44:28	Individuals running into the clubhouse

Table No. 4: Final landing CCTV recording of EI-AST

1.18.2. Flight and Fuel Records

The Club's Record of Flights was kept in the aircraft. This documented each flight and was updated by the pilot with the details ultimately transferred into the aircraft's airframe and engine logbooks. The Record included *inter alia*, times, authorisation, tachometer hours and the names of those on board the aircraft but did not record fuel quantity on-board the aircraft.

The flights on the 4 November 2012 were incorrectly recorded as the previous day's date.

On the day of the accident the aircraft operated the training details shown in **Table No. 5**.

Depart time	Arrival time	Flight time	Detail	Tacho start	Tacho end	Elapsed Tacho	Fuel uplift
10.15	11.15	1 hour	Circuits	9,414.72	9,415.76	1.04	
11.45	12.45	1 hour	Circuits	9,415.76	9,416.65	0.89	
13.00	14.00	1 hour	Stalls	9,416.65	9,417.57	0.92	
14.02							43.08
14.10	*15.20*	1 hour 10 min	Cross county	9,417.57	Not recorded		
15.25	*16.25*	1 hour	Steep Turns & Practice Forced Landings	Not recorded	Not recorded		
16.25	*16.44*	*19 min*	Circuits	Not recorded	9,419.86	2.29	

Table No. 5: Flights by EI-AST on the day of the accident

Note: The values in *italics* are estimated values.

Fuel records at EIBR showed that the aircraft uplifted a total of 635.43 litres (l) of AVGAS over the period 29 September 2012 to the 11 November 2012. An additional 20 l of fuel was uplifted at Sligo Airport on 27 October 2012, during a cross country flight, giving a total fuel uplift of 655.43 l and a minimum fuel consumption rate of 21.16 l/hr (**Appendix A**).

As the fuel quantity following refuelling on the 29 September 2012 was not determined, this minimum fuel consumption rate over the period is based on the assumption that there was no fuel on board prior to refuelling on the 29 September 2012. Alternatively, had the fuel tanks been completely full after refuelling on that date and all unusable fuel consumed, 689.40 l would have been used, resulting in an average fuel consumption of 22.63 l/hr over the period. Therefore the average fuel consumption rate is between 21.16 and 22.63 l/hr.

1.18.3. Fuel Reserves

An average fuel consumption rate of 22 l/hr was used by the Club to estimate endurance. **Section 1.18.2** shows that this estimate was reasonably accurate and therefore 22 l/hr is used for fuel consumption calculations in this Report, while noting that a cross country flight would use less fuel but a detail of forced landings or circuits would have a higher consumption rate.

The Club fuel reserve policy was for 45 minutes fuel consumption plus unusable fuel. Accordingly, 45 minutes equates to 16.5 l at a fuel consumption rate of 22 l/hr. This 16.5 l added to 13.25 l unusable fuel required that at least 30 l of reserve fuel should have been on board EI-AST after every landing. Examination of the fuel and flight records for the previous month (10 October 2012 to the 10 November 2012) showed that the aircraft landed with less than 30 l on a number of occasions.

1.18.4. Air Pilot's Manual

The Air Pilot's Manual used by the Club for training includes the following information regarding Emergencies during Take-Off:

Engine Failure After Take-Off
If engine power is lost in the climb-out following take-off, the options open to the pilot will vary according to how high the aeroplane is, the nature of the terrain ahead, the wind conditions and so on. An event such as engine failure close to the ground requires prompt and decisive action by the pilot.
No matter when the engine fails in flight, the first priority is to maintain flying speed. Immediately lower the nose to the gliding attitude to maintain flying speed.
A controlled descent and landing, even on an unprepared surface, is preferable by far to an unwanted stall in the attempted climb-out. Close the throttle, in case the engine comes back to life at an inopportune time.

Do Not Turn Back to the Field
The height at which the failure occurs determines how you manoeuvre but, in general, you should plan to land fairly well straight ahead. Height is rapidly lost in descending turns and, from less than 500 ft aal[10], it is doubtful if you would make the runway.
Look for a landing area ahead and within range.

Make yourself familiar with suitable emergency landing areas in the vicinity of your aerodrome, so that in the unlikely event of engine failure you already have a plan of action in mind.

Following engine failure, and having established the glide, quickly select the best landing area from the fields available ahead and within approximately ±30° if possible, otherwise ±60°. Make only gentle turns (say 15° angle of bank maximum).
Gliding turns at low level can be dangerous due to:
high rates of descent; and a tendency for the pilot to raise the nose to stop a high rate of descent and inadvertently stalling or spinning the aeroplane.

It further states:
Maintaining flying speed is vital, more important than any radio call or even starting the engine.

[10] **aal:** Above Airfield Level.

1.18.5. Air Accident Investigation Unit (AAIU) Database

The AAIU database contains 51 occurrences of forced landings, either to Irish registered aircraft or to aircraft operating in this State over the period of 1990 to 2013 inclusive. Of these occurrences, 31 are categorised as accidents (61%), one as a serious incident (2%) and the remainder are incidents (37%). In 12 of these cases the aircraft was destroyed (24%), 17 occurrences resulted in substantial damage (33%), minor damage occurred in 10 events (20%) and in 11 cases the aircraft was undamaged (22%); in one occurrence the damage was not recorded.

Three accidents resulted in fatal injuries (6%) to one or more of the occupants, a further 5 (10%) resulted in serious injuries and in the remaining cases there were either minor or no injuries.

2. ANALYSIS

2.1. General

Witnesses reported that shortly after take-off the engine was heard to lose power at a low height. The aircraft banked steeply left and disappeared from view. The Investigation therefore examined the cause of the engine power loss and the resulting unsuccessful forced landing.

2.2. Flight Crew

The licences of both pilots were valid and they were properly licenced for the purpose of the flight.

It is probable that the Student was the pilot flying the aircraft during the circuits and during the initial climb following the last touch-and-go landing. It was not possible to determine from the pathology reports or otherwise which pilot was operating the controls after the engine lost power. The right hand rudder pedal on the Instructor's side was found twisted, indicating that it is possible that his foot was on this pedal at impact. This would be consistent with the Instructor taking control of the aircraft after the engine power loss, as would normally be expected of an experienced instructor under the circumstances.

2.3. Meteorology

Weather conditions at the airfield at the time of the accident were reported as good with light winds and no precipitation. Although close to the end of VFR flying, the flight was still operated in daylight conditions. Consequently, weather was not a factor in the accident.

2.4. Aircraft

Examination of maintenance records showed that the aircraft had been maintained by an approved facility under the IAA approved maintenance program for the aeroplane. Although the 50 hour maintenance interval had been exceeded prior to its last check, this time exceedance had no bearing on the accident. Since the last check, EI-AST had accumulated 21 hours and its airworthiness status was valid.

All major parts of the aircraft were accounted for at the accident site where continuity of the flight controls was also established. Examination of the propeller indicated that it was not rotating at impact and that the engine was stopped. Further examination of the engine at the AAIU facility found no mechanical defect that would have caused the engine to stop.

In conclusion, no technical defect that might have contributed to the accident was found.

2.5. Fuel

2.5.1. Fuel Carried

Small amounts of fuel leaked from the aircraft when lifted and no evidence of grass staining from fuel contamination was subsequently found. No contamination was found in the fuel tanks and filters and the damage found was consistent with impact forces.

The Records of Flights, which contained the details of each flight, did not record any fuel information. Consequently, there was no record of the quantity of fuel on board prior to engine start at 10.15 hrs that morning. The PPL who flew with the Instructor on that detail stated that there was plenty of fuel on board but was unaware of the exact amount. The CFI stated that the fuel tank gauges could not be trusted and that therefore dipped readings were used to determine fuel quantity. Both Witnesses A and B, who dipped the fuel tanks, reported that 60 l of fuel was on board prior to the aircraft commencing the first of the last three details in the afternoon and that it had not been refuelled between those details. It should be noted that this dipped reading cannot be assumed to have the same level of accuracy as a calibrated reading due, *inter alia*, to the uneven nature of the ground on which the aircraft was refuelled. The Investigation notes that the use of dipsticks in general aviation aircraft to verify fuel quantity is common practice and is advocated by aviation authorities.

The Investigation examined records of the fuel uplifted and determined that the average rate of fuel consumption lay between 21.16 and 22.63 l/hr over the previous six weeks. This is consistent with the 22 l/hr quoted by the CFI and the student pilots. As previously stated, 22 l/hr is assumed (in **Table No. 6** below) to be the fuel consumption rate on the day of the accident.

The recorded fuel uplift of 43.08 l that day brought the reported fuel on board the aircraft to 60 l, of which 13.25 l were unusable, thus providing 46.75 litres of usable fuel. Consequently, the fuel on board prior to uplift was approximately 16.9 litres (60 - 43.08). If fuel consumption is back-calculated for the three flights that morning, the result shows that approximately 80 l of fuel was on board that morning before flying started.

Depart Time	Finish Time	Tacho Start	Tacho End	Elapsed Tacho Time	Fuel Uplift	Pre-Flight fuel	Fuel Used@ 22 l/hr	Post Flight Fuel	Post Flight Usable Fuel
10.15	11.15	9,414.72	9,415.76	1.04		*79.6*	*22.9*	*56.7*	*43.5*
11.45	12.45	9,415.76	9,416.65	0.89		*56.7*	*19.6*	*37.1*	*23.9*
13.00	14.00	9,416.65	9,417.57	0.92		*37.1*	*20.2*	*16.9*	*3.7*
14.02					43.08				
Depart after refuel	**Accident time**								
14.10	16.44	9,417.57	9,419.86	2.29		*60.0*	*50.4*	***9.6***	*-3.6*

Table No. 6: EI-AST Fuel consumption (litres) on the 11 November 2012

Notes: The values in *italics* are estimated values.
Post Flight Usable Fuel is equal to Post Flight Fuel less 13.25 l unusable fuel.

This estimate shows that, following the touch-and-go of the third circuit on the final flight, usable fuel had been exhausted and that only 9.6 l of fuel remained. Consequently, the supply of fuel was no longer assured. It is therefore likely that, with a nose up attitude during climb out, one or both fuel tank outlet ports became uncovered and that air entered the fuel supply lines, thus causing fuel starvation. Further evidence for this is the lack of fuel at the accident site and the fact that the engine was stopped at impact. Although Witness B reported a sudden increase in noise from the engine, which then went quiet, this is frequently symptomatic of a "lean surge", i.e. when a fuel/air mixture is suddenly leaned.

The Investigation is therefore satisfied that the cause of the engine stoppage was fuel starvation due to an inadequate fuel quantity remaining in the fuel tanks.

2.5.2. Reserve Fuel and Weight

The published Club policy was to land with 45 minutes of fuel plus unusable fuel. Back calculation of records showed that the aircraft had probably landed with less than this figure on a number of occasions during the previous month. In particular, the aircraft landed after the third detail that morning with approximately 16.9 l of fuel on board, which was close to unusable fuel. As one student pilot assumed that 60 l gave 3 hours flying, the Investigation is of the opinion that more specific instructions on this issue should be published by the Club and accordingly issues a Safety Recommendation in that regard.

The Investigation was informed that Club policy was to refuel to 60 l after flights. This policy was due to the payload restriction imposed by the 1,600 lbs MTOW of EI-AST less its empty weight. The empty weight used by the Club was 1,075 lbs, although the Investigation was unable to determine the origin of this figure. However, the most recent weighing report showed that the aircraft weighed 1,135 lbs, a difference of 60 lbs, which had not been incorporated into Club procedures.

As a result, the maximum allowable usable fuel load, given the weight of the Instructor and Student, was 75 lbs (47 l) whereas Club procedures assumed that an additional 60 lbs (38 l) of fuel could be carried (**Table No. 7**) i.e. a total of 98 l or full tanks (47+38+13 unusable fuel).

	Weight lbs	Quantity litres
Empty Weight	1,135	
Pilots	390	
Operating Empty Weight (OWE)	1,525	
Maximum Take-Off Weight (MTOW)	(from) 1,600	
Maximum usable fuel allowable	75	47
Less 45 minutes fuel reserve		-17
Operating Fuel		**30**

Table No. 7: Operating weight and fuel

When 45 minutes reserve is deducted (unusable fuel being already included in the Empty Weight), this provides an Operating Fuel load of 30 l or 1 hour and 22 minutes flying time @ 22 l/hr. Thus, at the stated fuel quantity policy of 60 l at departure (47 l + 13 l unusable fuel) the aircraft with the pilots on board would have been at its MTOW.

Back calculation indicates that when the aircraft commenced flying that morning with approximately 79.62 l of fuel and two pilots on board, the aircraft may have exceeded MTOW.

Since the centre of gravity was within the prescribed limits and the aircraft weight was less than MTOW (**Table No. 8**), neither the centre of gravity position nor weight were causal factors in the accident.

	Weight lbs
Operating Empty Weight	1,525
9.6 l Fuel (**Table No. 6)**	17
Aircraft Weight	1,542
	(from)
Maximum Take-Off Weight	1,600
Underload	**58**

Table No. 8: Estimated weight at the time of the accident

The Investigation notes that the Empty Weight Weighing Reports for EI-AST prior to 2000 stated that this weight included unusable fuel and oil whereas the records post 2000 do not contain the information. The IAA states that the aircraft should be weighed in accordance with the Manufacturer's instructions. As some models of the C150 are weighed with unusable fuel and/or oil excluded, the Investigation considers that absence of this information can lead to confusion regarding the weight of an aircraft. Consequently, a Safety Recommendation is issued to the IAA that it should consider a requirement that empty weight weighing reports state whether or not unusable fuel and oil is included in the Aircraft Weighing Report.

2.5.3. Club Record of Flight Details

Although the Club's Record of Flights included details of each flight, it did not record fuel uplifts or departure quantities. The Investigation notes that on a number of previous occasions the aircraft landed with less than the required fuel reserves on board. As departure fuel and fuel uplifts were not recorded it was not possible for the CFI to monitor adherence to Club fuel policies. This could have been only accomplished by the CFI personally examining fuel tank quantities post flight, an exercise that was neither practical nor appropriate in an RTF environment.

The Investigation considers that, as a matter of course, fuel quantity and uplift should be recorded by the pilot before flight, thus emphasising the critical nature of fuel requirements and improving fuel husbandry. If these parameters are recorded a CFI can easily monitor and manage adherence to flight planning and fuel reserve procedures.

To that end the Investigation issues a Safety Recommendation to the Club that it should amend its Record of Flights to include fuel uplifts and fuel on board prior to each departure.

In addition, the Investigation is of the opinion that this operational practice should be a standard procedure at all RTF facilities. Accordingly, a Safety Recommendation is issued to the IAA that it reviews incorporating this as a procedural requirement at such facilities.

Furthermore, the Investigation considers that in the wider sphere of general aviation, pilots should show good airmanship by recording on their flight log the actual fuel quantity on board prior to flight and comparing that to the duration of the proposed flight. As the General Aviation Safety Council of Ireland (GASCI) is a national forum that promotes the safety of general aviation in Ireland, a Safety Recommendation to that effect is directed to GASCI.

2.6. Events Subsequent to Loss of Power

Both Witness A and B commented that they heard the engine lose power at an estimated 100 to 200 ft, that it appeared to have a high nose up attitude and that the aircraft then commenced a steep bank to the left. Whereas it is possible that the aircraft was higher than these estimates, it had not yet commenced a turn onto a crosswind leg. As the flaps were found retracted after the accident, they may have been retracted in accordance with normal procedures at 300 ft; it is also possible that a flapless touch-and-go landing had been conducted and that the flaps were already up.

The Air Pilot's Manual used by the Club recommends a landing straight ahead, or with minimal turns, during a forced landing without power shortly after take-off. It emphasises the need to maintain flying speed and establish a gliding attitude.

Earlier that day the Instructor had conducted practice forced landings with Witness B, both on and off the airfield. Therefore the Investigation is of the opinion that the Instructor was current in and *au-fait* with forced landing procedures and would have been aware of the guidance given that:

> *No matter when the engine fails in flight, the first priority is to maintain flying speed.*

In addition, the Air Pilot's Manual states: ***Do Not Turn Back to the Field***

> *The height at which the failure occurs determines how you manoeuvre but, in general, you should plan to land fairly well straight ahead. Height is rapidly lost in descending turns and, from less than 500 ft aal[11], it is doubtful if you would make the runway. Look for a landing area ahead and within range.*

The aircraft impacted on a northerly heading and was tracking in the direction of the airfield, having turned through approximately 180˚ after power loss. The Investigation considers that the impact was at a low airspeed. Evidence of low airspeed arises from the fact that the debris trail was short at 16 metres, which included the aircraft inverting. The impact had a significant vertical component, as evidenced by the level of crushing of the aircraft nose and the estimated 20˚ nose down pitch attitude. Furthermore, the propeller was not rotating at impact; this could only have happened if the engine was not generating power and the airspeed was so low that it was insufficient to cause propeller windmilling.

Regarding the steep turn observed by the witnesses and the evidence of low airspeed found at the accident site, it is possible that, due to the close proximity of the airfield, an attempt was made to turn back towards the airfield immediately following the engine power loss. At the low height estimated by witnesses such an attempt was unlikely to have had a successful outcome. In such a situation the aircraft may have stalled with insufficient height to recover.

The aircraft was close to its maximum weight where the stall speed in a steep bank ranged from 63 mph at 40° bank to 78 mph at 60° bank. As both the initial climb airspeed and the procedural glide airspeed of the aircraft following loss of power were close to 70 mph, a steep turn could have placed the airspeed in the stall regime.

Both student pilots observed the aircraft with a high nose up attitude before turning steeply to the left with Witness B reporting that the aircraft initially banked right. This is possibly symptomatic of the aircraft stalling, the subsequent left bank being the outcome of a left wing drop. Therefore it is possible that the aircraft impacted on a heading back towards the airfield as the result of a stall and not during an attempt to return.

Maintaining airspeed and control of the aircraft during a forced landing from a low height is critical so that in the worst case, if impact should occur it should be in a horizontal plane thus allowing some deceleration, rather than in the vertical plane where no deceleration is possible. In addition, the aircraft can be steered towards a flight path with least obstacles.

For that reason the guidance given is '*No matter when the engine fails in flight, the first priority is to maintain flying speed. Immediately lower the nose to the gliding attitude to maintain flying speed'.* However, the accident site evidence showed that the aircraft impacted with a 20˚ nose down attitude, a significant rate of descent and a low forward airspeed.

[11] **aal:** Above Airfield Level.

2.7. Human Factors

As the three morning details had taken three hours, the Instructor may have assumed that similar endurance was available post refuelling at 14.02 hrs. Following those morning details the aircraft landed with close to unusable fuel on board and it is estimated that there was subsequently approximately 20 l less fuel on board after refuelling than prior to commencing the first flight that morning. It is possible that the Instructor may not have been aware of this. In addition, as there was approximately 10 l of fuel on board at the time of the accident, it is likely that the fuel gauges were still showing some fuel on board immediately before the accident, even though such gauges are generally not considered to be reliable at low fuel quantities.

The nature of club flying training, especially if weather is unsuitable for such activity, tends to concentrate flying into limited periods when the weather is suitable. In addition, at that time of year (November) the hours of daylight were limited. Furthermore, as the Instructor otherwise worked, the instruction provided by the Instructor meant that flight training happened at the weekends. It is possible that the last flight was undertaken to try to give all his students flights that day and to fit in a last few circuits with the Student before the end of VFR at 16.47 hrs.

5 hours and 10 minutes of training flights had already been conducted before the accident flight commenced with little break between flights; the maximum time on the ground in between flights was the 30 minutes recorded after the first flight. The combination of travelling from Dublin, followed by five disparate training details prior to the accident detail could have induced a level of fatigue in the Instructor.

To what extent fatigue may have played a part in a miscalculation regarding fuel management or events following the engine power loss cannot be assessed. Nevertheless, the Investigation found no restriction or guidance in the RTF's procedures regarding the number of instructional flights that could be conducted by an instructor during a day's flying, nor any provision for a rest during that period. The Investigation considers that it should and therefore issues a Safety Recommendation to the RTF on this issue.

2.8. Supervision and Oversight

The Investigation is concerned that the level of supervision and oversight of the Club's activities was inadequate. Evidence for this includes the inadequate fuel planning which resulted in some flights being operated with less than reserve fuel, undocumented fuel policies and the incorrect Empty Weight being used for performance calculations.

The Investigation considers that these shortcomings in supervision should be addressed and a Safety Recommendation is issued to the Club in this regard.

The Investigation notes that these shortcomings were not identified during the IAA inspection of the RTF in 2011, as these areas were not specified on the IAA's inspection Form. The Investigation is of the opinion that this Form should be reviewed and issues a Safety Recommendation to the IAA in this regard.

2.9. Forced Landings General

AAIU records of reported forced landings (**Section 1.18.5**) show that the majority result in an accident where the aircraft suffers at least substantial damage. This shows that practice forced landings should be conducted regularly and on an on-going basis so that, if it occurs for real, the pilot is adequately practiced and mentally prepared for such an eventuality. This is particularly so since forced landings can occur in difficult terrain and where small uneven fields are prevalent.

3. CONCLUSIONS

(a) Findings

1. The airworthiness certification of the aircraft was valid.
2. There were no pre-existing technical problems with the aircraft.
3. Both pilots were properly licensed with valid medicals.
4. The Instructor was correctly rated on the aircraft.
5. The RTF was registered by the IAA.
6. The aircraft was within centre of gravity limits and close to its maximum weight at the time of the accident.
7. The fuel consumption of the aircraft was in accordance with the manufacturer's published data during the period examined.
8. After refuelling to 60 l, the aircraft conducted two training details and commenced a third detail without further refuelling.
9. During the third detail, while climbing out following a touch-and-go landing, the engine lost power at a low height.
10. At that time the estimated fuel quantity was 9.6 l, which was less than the 13.25 l unusable fuel quantity published by the Manufacturer.
11. The engine power loss was caused by fuel starvation.
12. The aircraft turned steeply left and impacted at a low speed, in a nose down attitude with a high rate of descent.
13. The propeller was stopped when the impact occurred.
14. The aircraft inverted and came to rest 16 metres from the initial point of impact.

15. The aircraft impacted on a northerly heading tracking in the direction of the airfield, having turned through approximately 180˚ after the power loss.

16. The Instructor and the Student were fatally injured.

17. It is likely that control was lost as a result of inadequate airspeed leading to a stall.

18. Weather was not a factor in the accident.

19. Fatigue may have been a factor in the accident.

20. The aircraft had landed with inadequate fuel reserves on a number of occasions during the previous month.

21. The Empty Weight used for the aircraft was incorrect.

22. Club fuel policy and procedures were inadequately documented.

23. The level of local supervision of the Club's activities was inadequate.

24. The oversight inspection of the RTF by the IAA in 2011 did not identify the shortcomings found by the Investigation.

(b) Probable Cause

1. Stall and associated loss of control following power loss due to fuel starvation.

(c) Contributory Cause(s)

1. Failure to maintain adequate airspeed following a power loss.

2. Inadequate fuel management.

4. SAFETY RECOMMENDATIONS

No.	It is Recommended that:	Recommendation Ref.
1.	The Ormand Flying Club should publish further guidance regarding its fuel policies and procedures in its Club Rules	IRLD2013020
2.	The Ormand Flying Club should amend its on-board Record of Flights to include fuel uplifts and fuel on board prior to each departure	IRLD2013021
3.	The Ormand Flying Club should review and publish guidance regarding the number of instructional flights conducted by an instructor in a day and the associated rest requirements	IRLD2013022
4.	The Irish Aviation Authority (IAA) should consider a procedural requirement that Registered Training Facilities amend their on-board Record of Flights, or equivalent documentation, to include fuel uplift and the fuel on board prior to each departure	IRLD2013023
5.	The General Aviation Safety Council of Ireland (GASCI) should consider promulgating advice that general aviation pilots should record fuel quantity prior to each flight	IRLD2013024
6.	The General Aviation Safety Council of Ireland (GASCI) should consider promoting awareness among the General Aviation (GA) aircraft community of the dangers of loss of control following a sudden engine failure close to the ground.	IRLD2013025
7.	The Irish Aviation Authority (IAA) should consider amending the Registered Training Facility Inspection Form to include a check of documented fuel policies and a record of the aircraft's Empty Weight	IRLD2013026
8.	The Irish Aviation Authority (IAA) should consider a requirement that general aviation aircraft empty weight weighing reports state whether or not the weight of unusable fuel and oil is included	IRLD2013027

View Safety Recommendations for Report 2013-013

Appendix A

EI-AST fuel uplifts and consumption, from 29 September 2012

Date	Uplift (l)	Tachometer	Notes
29.09.12	64.45	9389.39	Total quantity after refuelling not determined
06.10.12	67.10	9394.32	
07.10.12	49.02	9396.39	
07.10.12	55.59	9398.72	
13.10.12	27.63	9400.54	
14.10.12	48.26	9401.57	
14.10.12	45.47	9403.15	
27.10.12	41.36	9405.53	Pilot reported 80 l fuel quantity post refuelling
27.10.12	20.00	9407.93	Fuel uplifted at EISG
29.10.12	17.52	9408.95	
29.10.12	27.37	9409.94	
4.11.12	50.89	9410.99	
4.11.12	51.44	9412.77	
8.11.12	46.25	9414.61	
11.11.12	43.08	9419.86	Tachometer reading at the accident site
	655.43		Total uplift
	-10.70		Less estimated unusable fuel at occurrence time
Total fuel	644.73		Estimated fuel used over period
Total time		30.47	Total elapsed tachometer time (29.09.12 - 11.11.12)
Fuel consumption rate		**21.16 l/hr**	

GLOSSARY

AAIU	Air Accident Investigation Unit
ACCREP	Accredited Representative
ARC	Airworthiness Review Certificate
CCTV	Closed Circuit Television
CPL	Commercial Pilot's Licence
EIBR	Birr Airfield
ft	feet
FTL	Flight Time Limitation
FTO	Flying Training Organisation
GASCI	General Aviation Safety Council of Ireland
hr/s	hour/hours
IAA	Irish Aviation Authority
ins	Inches
JAR	Joint Aviation Regulations
Kts	Nautical miles per hour
l	Litres
lb	Pounds
MEP	Multi Engine Piston
Mpg	Miles per gallon
mph	miles per hour
MPLA	Maintenance Programme for Light Aircraft
MTOW	Maximum take-off weight
MTOW	Maximum Take-Off Weight
nm	nautical miles
OM	Manufacturer's Owner's Manual
OWE	Operating Empty Weight
PPL	Private Pilot Licence
RTF	Registered Training Facility
RWY	Runway
SEP	Single Engine Piston
SPA	Single Pilot Aeroplane
STC	Supplemental Type Certificate
USG	United States Gallon
VFR	Visual flight rules

- END -

In accordance with Annex 13 to the Convention on International Civil Aviation, Regulation (EU) No. 996/2010, and Statutory Instrument No. 460 of 2009, Air Navigation (Notification and Investigation of Accidents, Serious Incidents and Incidents) Regulation, 2009, the sole purpose of this investigation is to prevent aviation accidents and serious incidents. It is not the purpose of any such investigation and the associated investigation report to apportion blame or liability.

A safety recommendation shall in no case create a presumption of blame or liability for an occurrence.

Produced by the Air Accident Investigation Unit

AAIU Reports are available on the internet www.aaiu.ie

An Roinn Iompair
Turasóireachta agus Spóirt

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