Air Accident Investigation Unit Ireland

FORMAL REPORT

ACCIDENT

Rutan Long-EZ, EI-CPI
Knockahavaun, Co. Waterford, Ireland

27 March 2017

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

Foreword

This safety investigation is exclusively of a technical nature and the Final Report reflects the determination of the AAIU regarding the circumstances of this occurrence and its probable causes.

In accordance with the provisions of Annex 13[1] of the International Civil Aviation Convention, Regulation (EU) No 996/2010[2] of the European Parliament and the Council, and Statutory Instrument No. 460 of 2009[3], safety investigations are in no case concerned with apportioning blame or liability. They are independent of, separate from and without prejudice to any judicial or administrative proceedings to apportion blame or liability. The sole objective of this safety investigation and Final Report is the prevention of accidents and incidents.

Accordingly, it is inappropriate that AAIU Reports should be used to assign fault or blame or determine liability, since neither the safety investigation nor the reporting process has been undertaken for that purpose.

Extracts from this Report may be published providing that the source is acknowledged, the material is accurately reproduced and that it is not used in a derogatory or misleading context.

[1] **ICAO Annex 13**: International Civil Aviation Organization, Annex 13 to the Convention on International Civil Aviation, Air Accident and Incident Investigation.

[2] **Regulation (EU) No 996/2010** of the European Parliament and of the Council of 20 October 2010 on the investigation and prevention of accidents and incidents in civil aviation.

[3] **SI No. 460 of 2009**: Air Navigation (Notification and Investigation of Accidents, Serious Incidents and Incidents) Regulations 2009.

AAIU Report No: 2017-013
State File No: IRL00917020
Report Format: Formal Report
Published: 4 December 2017

In accordance with Annex 13 to the Convention on International Civil Aviation, Regulation (EU) No 996/2010 and the provisions of SI No. 460 of 2009, the Chief Inspector of Air Accidents on 27 March 2017, appointed Mr Leo Murray as the Investigator-in-Charge to carry out an Investigation into this Accident and prepare a Report.

Aircraft Type and Registration:	Rutan Long-EZ, EI-CPI
No. and Type of Engines:	1 x Lycoming O-235-C2A
Aircraft Serial Number:	17
Year of Manufacture:	1997
Date and Time (UTC)[4]:	27 March 2017 @ 15.16 hrs
Location:	Knockahavaun, Co. Waterford, Ireland at Coordinates: N52 6.50' W007 34.39'
Type of Operation:	General Aviation
Persons on Board:	Crew - 1 Passengers - Nil
Injuries:	Crew - 1 (Fatal)
Nature of Damage:	Aircraft destroyed
Commander's Licence:	Private Pilot Licence (Aeroplanes), PPL(A), issued by the Irish Aviation Authority (IAA)
Commander's Age:	84 years
Commander's Flying Experience:	Approximately 542 hours, of which 120 were on type
Notification Source:	Station Manager, Shannon Air Traffic Control (ATC)

[4] **UTC**: Coordinated Universal Time. Unless stated otherwise, all times in this Report are in UTC. Add 1 hour to obtain local time on the date of the accident.

SYNOPSIS

The Pilot was undertaking a short local flight with the intention of returning to Waterford Airport (EIWF) for circuit work. Approximately 18 minutes after take-off, at an altitude of 2,000 ft, the Pilot declared an emergency and informed Waterford ATC that his engine had stopped. He gave his approximate position as near Dungarvan and told ATC that he had selected a field for a landing. Waterford ATC acknowledged the MAYDAY call, gave the wind information (at EIWF) and advised the Pilot to concentrate on landing. Following a flight path in a north-easterly direction, the aircraft impacted trees at a height of 4.4 metres (m). The Waterford-based Irish Coast Guard (IRCG) helicopter was airborne on a training detail at the time. The helicopter crew heard the MAYDAY call and arrived at the scene within minutes under the self-tasked callsign '*Rescue 117*'. The Pilot of EI-CPI was fatally injured in the accident. There was no fire.

NOTIFICATION

The Station Manager at Shannon ATC notified the AAIU of the accident at 15.54 hrs. An Garda Síochána (Dungarvan Station) contacted the AAIU at 16.05 hrs and provided details of the accident location, the registration of the aircraft and the status of the Pilot. Two Inspectors of Air Accidents deployed to the scene and commenced an Investigation on arrival.

1. FACTUAL INFORMATION

1.1 History of the Flight

The Pilot called EIWF Tower at 14.47 hrs for permission to start, stating that he had copied ATIS[5] information '*Zulu*'. He stated his intention was to '*do a short flight down as far as Dungarvan and back*' and some circuit work on return. The Pilot gave his endurance[6] as two hours and said that he would not be operating above 3,000 ft. The aircraft departed from Runway (RWY) 21 at 14.58 hrs and reported level at 2,000 ft at the Waterford Control Zone (CTR) boundary at 15.03 hrs, routing southwest along the coast towards Dungarvan. The Pilot closed his flight plan at this time but remained on the EIWF Tower frequency of 129.850 MHz. ATC advised the Pilot of other traffic inbound to EIWF and requested the Pilot to report when ready to re-enter the CTR.

At 15.14 hrs, the Pilot made a distress (MAYDAY) call on the tower frequency. ATC acknowledged the transmission; the Pilot advised that his engine had stopped, that he was near Dungarvan and that he had selected a field for a landing. ATC gave the wind at EIWF as 130 degrees at 10 kts and advised the Pilot to concentrate on landing.

[5] **ATIS**: Automatic Terminal Information Service; actual meteorological reports which are identified with time of issue (UTC) and a phonetic identifier.
[6] **Endurance**: The time the aircraft can remain in flight based on the useable fuel on board.

The crew of an IRCG Sikorsky S-92A helicopter (EI-ICU) on a training detail at EIWF heard the distress call and self-tasked immediately towards Dungarvan using the callsign '*Rescue 117*'. A light aircraft in the vicinity of Tramore offered assistance but ATC instructed that pilot to continue along the coast towards Tramore. ATC called EI-CPI at 15.18 hrs but there was no reply.

1.1.1 IRCG Waterford Search and Rescue (SAR) Report

'*Rescue 117*' located the scene of the accident at 15.35 hrs. The local Emergency Services were already in attendance. The helicopter landed close to the accident site and deployed two crewmembers to assess the situation. As the casualty had been declared deceased and other Emergency services were still in attendance, '*Rescue 117*' departed the scene at 16.10 hrs and returned to base.

1.1.2 Witness Statements

A number of witnesses were contacted who provided useful observations to the Investigation. The location of witnesses and the observed flightpath of EI-CPI is presented in **Figure No. 1**.

Figure No. 1: Location of witnesses and reconstructed flightpath of EI-CPI

Witness No. 1 was situated at Ballynagaul pier on the south side of Dungarvan Bay. He observed the aircraft flying past and that the engine sounded normal. The aircraft headed towards the Cunnigar spit but turned right and headed back towards him at Ballynagaul before turning left and proceeding across Dungarvan Bay towards the coast at Ballynacourty. At this time he heard the engine make what he described as '*two bangs or backfires*'.

Witness No. 2 was in his garden shed on the Gold Coast Road at Ballynalahessery South, to the east of Dungarvan. He heard a high-pitched sound from an aircraft and went out to look for it. Although high-pitched it '*sounded normal*'. He observed the aircraft crossing Dungarvan Bay towards his house in a north-easterly direction. As it came overhead he heard the engine splutter and cough a few times, after which the engine stopped. He looked at his watch and noted it was 16.15 hrs (local time) and stated that the engine had stopped about one minute previously. He went to a nearby gate to get a better view. The Witness said that the aircraft initially '*veered to the left for Crooked Bridge before making a definite turn in a westerly direction towards Dungarvan golf course*' and that it was now so low that he lost sight of it behind some trees. It then came into view again heading east, followed by a turn back to a westerly direction at which point he lost sight of it as it continued to descend.

Witness No. 3 was situated at White Strand approximately 1 km east of Dungarvan. He stated that at first the engine sounded normal but then it spluttered and he heard no further noise.

Witness No. 4 was working at his house in Clonea and heard the aircraft and thought that '*the revs were very high*'. He then heard '*three massive backfires*' and the engine stopped immediately. He saw the aircraft bank to the left and head towards Ballinroad. He said that there was no smoke and the engine was silent.

1.2 Injuries to Persons

The Pilot, who was the sole occupant in the aircraft, was fatally injured in the accident.

Injuries	Crew	Passengers	Others
Fatal	1	0	0
Serious	0	0	0
Minor /None	0	0	

1.3 Damage to Aircraft

The aircraft was destroyed.

1.4 Other Damage

The aircraft collided with a tree which was part of a line of trees forming the boundary to a grass field. Following impact, the aircraft's forward fuselage disintegrated and the remains fell into a stream running at the base of the trees. Although the fuel tanks had disintegrated/ruptured the presence of fuel vapour could be detected at the site.

1.5 Personnel Information

The Pilot was the holder of a PPL(A) which was first issued on 16 August 1974. The Licence contained a SEP (Land) [7] Class rating valid to 31 December 2018 and an ELP Level 6[8] with Radiotelephony (R/T) privileges.

The Pilot's personal logbooks could not be located. Declarations made at the time of his last medical examination indicate that the Pilot had 542 hours total flying experience, of which 120 hours were on the Long-EZ type.

The Pilot held a valid Class 2 Medical Certificate. His most recent aeromedical examination took place on 21 February 2017. The Medical Certificate contained two limitation codes: '*VML*' for correction of vision and '*SIC*' to alert any other Authorised Medical Examiner (AME) to contact the Aeromedical Section prior to issuing a new Medical Certificate.

The Pilot had attended the same AME since 2011 for renewal of his Medical Certificates. With the Pilot's consent, the AME carried out cognition tests and found no evidence of cognitive decline which, the AME stated, is rare in a person of 84 years. The AME indicated that he '*did not see any evidence of a medical factor that would have contributed to the negative outcome from this accident, causing sudden incapacitation and he* [the Pilot] *certainly showed no evidence to support subtle incapacitation*'.

1.6 Aircraft Information

1.6.1 General

The Long-EZ (Model 61) was designed by the Rutan Aircraft Factory as a two-seat, long-range, sporting aircraft for amateur construction. The design is constructed using rigid foam cores and unidirectional glass fibre. The design is unconventional, consisting of a cantilever mid-wing monoplane of canard configuration with a foreplane (incorporating elevators), and an engine mounted at the rear of the aircraft driving a pusher propeller. Flight controls consisted of a side-stick situated on the right-hand side of the front cockpit and rudder pedals connected to the controls by means of wires and pulleys. The rudders on the Long-EZ are unconventional with each being mounted in a large winglet at the end of each of the wings (mainplanes).

[7] **SEP (Land)**: Single Engine Piston (Landplanes).
[8] **ELP Level 6**: English Language Proficiency, Level 6 (unlimited).

Operation is also unconventional in that each rudder only operates in an outward direction when its respective rudder pedal is pushed. This arrangement permits the use of the rudders as speed-brakes when deployed symmetrically in flight. A ventral speed-brake is also situated below the fuselage to facilitate a steeper approach and greater deceleration during landing flare. The speed-brake is typically deployed on downwind and is normally left in the extended position until after landing. The undercarriage is of the tricycle type with fixed main landing gear and a mechanically-retractable nosewheel.

1.6.2 Accident Aircraft EI-CPI

EI-CPI was built by the Pilot under the auspices of the Society of Amateur Aircraft Constructors (SAAC). The aircraft was built from plans supplied by the Rutan Aircraft Factory. EI-CPI was completed and first flew in December 1997.

Photo No. 1: EI-CPI taxiing at Waterford in September 2015 (*Jon Wickenden/Air Britain*)

In accordance with the plans, full flight controls were provided in the front cockpit position only and the aircraft was flown from the front cockpit position. Engine controls, consisting of Carburettor Heat, Throttle and Mixture, were grouped in a quadrant on the left side of the cockpit. A three-position (Left, Right, OFF) fuel tank selector was positioned in the floor just forward of the pilot seat. Manual pitch and roll trim controls were provided on the right and left sides of the cockpit respectively. Fuel was contained in two wing tanks constructed from unidirectional glass fibre. The tanks were built integrally with the wing which supply fuel to the engine via the fuel tank selector, gascolator[9] and electrically-driven fuel pump.

The fuel selector was mounted, as per the aircraft plans, in the floor of the cockpit in front of the Pilot's seat and protected against inadvertent movement by the surrounding structure.

[9] **Gascolator**: a component of the fuel system which incorporates a fuel strainer and water/sediment drain.

The 12 Volt electrical system was controlled by a dual Master/Alternator switch. Six rocker switches and associated 5 Amp circuit-breakers controlled the various electrical services. Following the accident the 'ELEC HORZ' and 'FUEL BOOST' were found in the 'ON' position, all other switches were positioned to 'OFF', including the Master/Alternator Switch.

1.6.3 Long-EZ Performance

According to the Long-EZ Owner's Manual, at sea-level and a throttle setting of 2,250 RPM, the aircraft would typically cruise in the region of 130 kts (the specific propeller installation may affect this figure). With a windmilling or stopped propeller, the aircraft will typically to glide for approximately 5 Nautical Miles (NM) from an altitude of 2,000 ft at best glide speed. This speed is dependent on the aircraft weight and is 85 kts at 1,200 lbs and 91 kts at 1,400 lbs (Gross Weight).

The Owner's Manual also outlines the procedures in the event of engine failure: '*In the event of an inflight engine stoppage, check mixture – RICH, fuel – switch tanks, boost pump – on, magnetos – both and attempt a restart. If the engine begins to run rough, check for induction icing, improper mixture setting or a bad magneto. If carburettor heat or an alternate magneto setting fail to correct the roughness make a precautionary landing as soon as possible and trouble shoot. … If stoppage does occur and restart is impossible execute the engine out approach and landing*'. '*In case of engine failure, the engine will probably windmill above 70 knots. However, as the engine cools down a higher speed may be required to maintain engine rotation. With some engines/props a glide speed as high as 100 knots may be required. Windmilling RPM decays slowly enough to give the pilot time to increase his speed to maintain rotation. Once the prop stops, a speed of 130 knots or more is required to regain rotation (2,000 feet altitude loss)*'.

If an engine-out landing is unavoidable, the Owner's Manual recommends that a glide be established at 70 to 75 kts for approach. The Manual advises that a glide with a windmilling engine will be considerably steeper than a pilot may be accustomed to when descending with the engine at idle power. The pilot is advised to shut off the fuel valve and the landing gear (nosewheel) should be extended for all off-airport landings. Pilots are advised to aim for the '*middle third*' of the selected landing area.

The Owner's Manual provides data for total landing distance (over a 50 ft obstacle) and landing roll, based on use of landing brake and zero wind conditions. At a weight of 1,300 lbs (590 kgs), the Long-EZ will typically require a ground roll of approximately 760 ft (232 m), with a total distance of approximately 1,915 ft (584 m) from a height of 50 ft.

The US military conducted an evaluation[10] of the Long-EZ type in 1983. On the subject of 'Cockpit Evaluation', the evaluation stated that vertically, the field-of-view of the pilot *'was limited from 9 to 16 degrees below the horizontal by the canard'* but that in general, '*the field-of-view from the cockpit is satisfactor*y'.

[10] **Evaluation**: USAAEFA Project No. 82-18, Preliminary Airworthiness Evaluation of the Rutan Aircraft Factory Inc Long-EZ. Final Report, June 1983.

1.6.4 Powerplant Information

EI-CPI was powered by a Lycoming O-235-C2A piston engine, Serial No. (S/N) L-9115-15, which was manufactured in April 1967. At the time of the last Flight Permit inspection, the engine had accumulated a total of 369 hours since new. This engine was originally used to power Slingsby Type T.67/SE5A reproduction aircraft used for filming between 1967 and 1970. It was out of use and stored for many years before being acquired by the Pilot for use in the Long-EZ build.

The engine was fitted with a wooden, fixed pitch, two-bladed '*Tifft*' propeller (S/N) 7256. The propeller had accumulated 120 hours since its installation as new on EI-CPI. The engine was fitted with the following:

	Make:	Model:	Part No (P/N):	Serial No. (S/N):
Carburettor	Marvel Schebler	MA-3PA	10-4978	X-0-1
Left Magneto	Bendix Corp.	S4LN-21	10-51360-30	962358
Right Magneto	Bendix Corp.	S4LN-20	10-51360-29	974550

The Carburettor was of a type recommended for the Lycoming O-235-C2A engine.

1.6.5 Maintenance

The aircraft's logbooks could not be located and thus were not available to the Investigation. However, as the aircraft had been subject to on-going airworthiness inspection under the auspices of the Irish Light Aviation Society[11], the records associated with these inspections provided the Investigation with much of the information sought.

EI-CPI was last issued with a Flight Permit on 1 August 2016 which was valid to 31 July 2017. Under the three-year permit cycle approved by the IAA, the Flight Permit could be extended, following suitable engineering inspections, up to 1 August 2019. The aircraft was inspected on 28 July 2016 by an ILAS Authorised Inspector for the purpose of Flight Permit renewal. The Inspection schedule on EI-CPI involved a total of 84 maintenance tasks in relation to the powerplant, induction system, ignition system and fuel system together with functional checks of the various systems by means of inspection and ground run. Apart from a minor adjustment required on the alternator drive belt, the Inspection was satisfactory and revealed no defects. The workpack documentation showed that the aircraft had flown just under 11 hours since this inspection was performed. Prior to the accident, the aircraft was last flown on 30 July 2016. This flight, which was carried out by the Pilot, was for the purposes of Flight Permit renewal. A copy of the Flight test report was made available to the Investigation and revealed all check items as '*satisfactory*' and all values within limits.

[11] **ILAS**: The Irish Light Aviation Society (ILAS) was formed in 2009 when members of the Classic Aircraft & Aerobatic Club of Ireland (CAACI) and the Society of Amateur Aircraft Constructors (SAAC) agreed to merge. The purpose of the organisation is to facilitate the construction, restoration and operation of aircraft for recreation in Ireland.

Following this flight on 30 July 2016, there is no evidence that the Pilot did any flying prior to the accident flight. It was established that the Pilot did run the engine on several occasions although the aircraft was not flown.

The engine manufacturer issued Service Letter *No. L180B* (dated 13 November 2001) which specifies the procedures to be taken for engine preservation for active and stored aircraft. The Service Letter notes that the '*need for preservation must be evaluated by the owner or operator of the aircraft based on environmental conditions and frequency of aircraft activity. The time periods given are recommendations based on normal conditions*.' The Letter states, *inter alia,* that '*Engine temperature and length of operating time are very important in controlling rust and corrosion*'. It is recommended that active engines are flown for a continuous period of 1 hour at oil temperatures of 165 - 200 °F (74 - 93 °C) at intervals not to exceed 30 days. If an aircraft is to remain inactive for 30 or more days, a procedure is described involving the use of preventative oil and desiccant material to help the prevention of corrosion, especially if the aircraft is located near salt water or a similarly humid environment.

1.6.6 Fuel Uplift

Colleagues of the Pilot stated that he only used Avgas 100LL (Aviation gasoline) which was available at EIWF. The Airport Operator confirmed that, on the day of the accident, the Pilot uplifted 20 Litres (L) of Avgas 100LL for EI-CPI at 14.30 hrs prior to the accident flight (uplift No*. 1578*). The previous uplift recorded at EIWF for EI-CPI was for 30 L of Avgas on 30 July 2016 (uplift No. *0763*). Quality control checks on the aviation fuel supply at EIWF were carried out on a daily basis. Records of the checks between 07.00 and 07.45 hrs on the day of the accident and prior to the uplift by EI-CPI were obtained by the Investigation. They showed that the storage tank sumps and bowser contained no visible water or solids and that the fuel samples (Avgas 100LL) were bright in appearance.

1.7 Meteorological Information

Met Éireann, the Irish Meteorological service, provided the Investigation with the following aftercast for the Waterford area valid for 15.45 hrs on 27 March 2017:

Meteorological Situation:	A high pressure situation obtained across the Waterford/Dungarvan region. The air mass was relatively dry and there was no precipitation or obvious aviation hazards relating to meteorological variables.
Wind (at surface):	110 degrees at 13 kts
Wind (at 2,000 ft):	130 degrees at 25 kts
Visibility:	15 to 20 km
Weather:	No significant weather
Cloud:	'Few' at 2,500 ft
Surface Temp/Dew Point:	Temperature 13 ˚C, Dew Point 7 ˚C
Mean Sea Level Pressure:	1019 hectoPascals (hPa)
Other Comments:	Nil

1.8 Aids to Navigation

Not applicable.

1.9 Communications

The accident occurred in Class G[12] airspace within the Shannon FIR[13]. Although the flight had exited the Waterford CTR, the Pilot made his distress call on the EIWF Tower frequency 129.850 MHz.

A certified transcript and recordings obtained from the ATS Manager at Waterford Airport show two unidentified transmissions were made at 15.13 hrs lasting 5 and 15 seconds respectively. They were assessed as being a push-to talk switch being pressed without any voice communication. The second such transmission ended 34 seconds prior to the Pilot of EI-CPI broadcasting his distress call at 15.14:16 hrs.

1.10 Aerodrome Information

Not applicable.

1.11 Flight Recorders

Flight recorders were not installed nor were they required to be.

1.12 Wreckage and Impact Information

1.12.1 General

The aircraft wreckage was located in the vicinity of a fast-flowing stream running alongside a line of tall trees that formed the western boundary of a grass field. The field in the area were surrounded by trees and had several sets of power lines supported from wooden poles. A graphic showing the probable flight path and the obstacles present is provided in **Appendix A**.

The entire left wing was found embedded in the branches of a tree approximately 4.4 m above the ground with evidence of heavy impact on the trunk of the tree at the same level. The wreckage of the aircraft came to rest entangled in heavy branches which had broken away from the tree following impact. The forward fuselage sustained severe impact damage which resulted in its complete disintegration as far as the rear cockpit seat. The battery, which was split in two, was recovered 14 m beyond the impact point. Debris, consisting of glass fibre pieces and rigid foam, was scattered across the area.

[12] **Class G**: Airspace within which aircraft are not under the control of ATC.

[13] **FIR**: Flight Information Region. Airspace of defined dimensions designated by the appropriate ATS authority within which flight information service and alerting service are provided.

The left wing fuel tank had disintegrated completely with the loss of the left wing. The right wing fuel tank was disrupted and no fuel remained. The was a strong smell of fuel at the site and the inside of the right tank was wet with fuel.

The propeller was intact but exhibited some surface damage on one blade face; there was no damage to the propeller leading edges or blade tips. **Photo No. 2** shows the main wreckage prior to recovery the following day.

Photo No. 2: Main wreckage prior to recovery on 28 March 2017

Two small pieces of wreckage were recovered along the direction of the flight path. A single Vortilon[14] was recovered just past a hedge on the southern boundary of the field. This was identified to have come from the outer right mainplane leading edge. The hedge showed evidence of aircraft contact on the top surface. The leading edge tip of the right winglet was recovered beneath a set of power lines running across the field. No damage to the power lines was observed. A single tree, situated to the left of the probable final flight path over the field, showed evidence of recent damage to its outer branches but no significant pieces of debris were identified in this area.

1.12.2 Controls and Indicators

The primary flight control cables were disrupted but control continuity was determined between the Pilot controls and flight surfaces where possible. The roll trim control was in the mid-range position. The pitch trim control was in the mid-range position.

[14] **Vortilon**: One of three small surfaces mounted at the leading edge of each of the mainplanes which serve to improve the stall margin of the Long-EZ wing. These components were painted red on EI-CPI to aid their visibility and to prevent their inadvertent damage on the ground.

The engine controls (carburettor heat, throttle and mixture) were all in the forward position with tension on the three actuating cables. The fuel selector was found in an intermediate position between the LEFT and OFF tank selections (**Photo No. 3**).

The floor of the aircraft and the glass fibre structure surrounding the fuel selector had disintegrated due to impact forces.

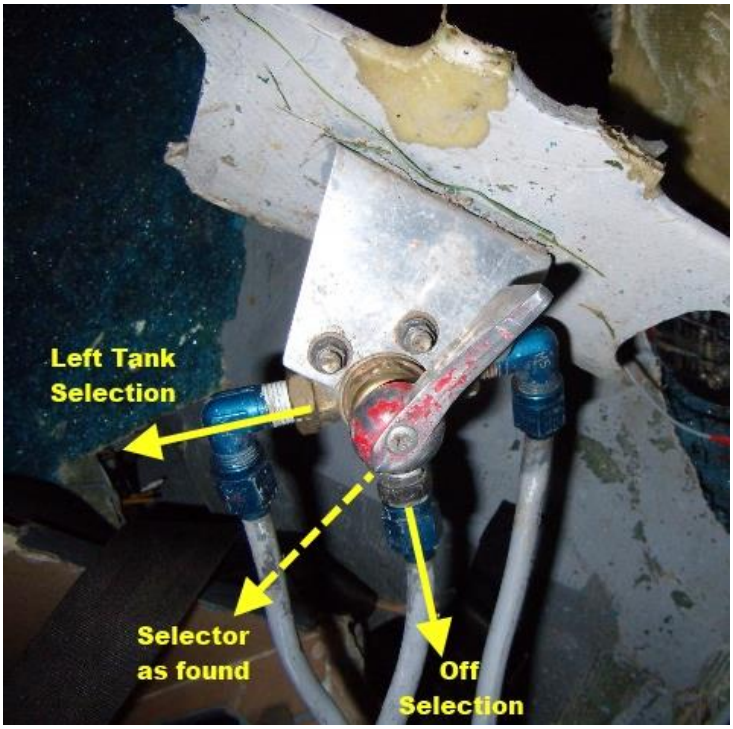


Photo No. 3: Fuel selector position as found, between LEFT and OFF positions

The ignition switch was found in the 'OFF' position. The ignition key was not recovered at the accident site. The Battery/Alternator switches were also found in the 'OFF' position. The positions of rocker switches controlling the electrical circuits were recorded by the Investigation. None of the circuit breakers had tripped.

1.13 Pathological Information

The Post-mortem Report for the Pilot was made available to the Investigation by the Coroner for Waterford East (Autopsy Report No. *AP000140R/17*). The Toxicology Test Report stated that drugs were not detected on preliminary screen and that ethanol was not detected. The cause of death was given as '*multiple injuries*' sustained in an '*aircraft crash*'.

1.14 Fire

There was no fire.

1.15 Survival Aspects

The Pilot was fatally injured. The aircraft was equipped with four-point harnesses in the forward and aft seating positions. The Pilot would have occupied the forward (front) seat position.

The safety harness had failed to secure the Pilot following impact due to the fuselage structure itself disintegrating. The Pilot was located by the Emergency Services on the ground at the base of the tree, a small distance from the main wreckage.

1.16 Tests and Research

1.16.1 General

An examination of the engine was carried out at the AAIU wreckage facility at Gormanston, County Meath, with the engine in-situ in the airframe. The rocker covers were removed; no damage was evident to the engine top-end components visible. With the spark plugs removed, the engine was turned over slowly by means of the propeller. No mechanical damage was apparent and the engine was capable of freely rotating. The sump contained a quantity of engine oil, with no metal particles evident.

The engine controls were examined. All control cables were continuous but under tension due to the disposition of the wreckage. The cockpit engine controls, comprising the carburettor heat (carb heat), throttle and mixture, were found to function properly. Each lever exhibited full and free movement. The air-box on the underside of the engine was twisted; the air filter was found to be dirty and distorted due to impact damage.

The fuel supply pipework was inspected and found in good condition. The fuel selector was free to rotate with a positive lock on each position, Left, Right and OFF. The gascolator was opened and contained a quantity of fuel. The appearance of the fuel was clean and bright blue, consistent with Avgas 100LL the fuel type uplifted prior to flight. The gascolator screen (filter) was clean with no debris present. The fuel pipework between the fuel pump and mechanical pump was disconnected and contained a quantity of fuel.

The spark plugs were inspected for condition. Apart from one spark plug being oily in appearance the other seven spark plugs were serviceable. The condition of the high-tension (HT) leads was generally good. The No. 2 cylinder (top) lead exhibited evidence of chafing by the cowling. Further examination showed that this did not affect the functioning of the lead. The Left and Right Magneto P-leads[15] were inspected and were found to be in good condition and the Magnetos revealed no external damage. The master switch and ignition switches were bench tested and functioned correctly.

[15] **P-Lead**: a shielded lead that connects the primary winding of a magneto to electrical ground through the ignition switch.

1.16.2 Engine Testing

To verify the viability of the engine and accessory installation it was decided to test-run the engine under controlled conditions. Due to the disruption of the wreckage it was not feasible to conduct this test with the engine in the airframe.

A test-rig was constructed to enable testing of the engine out of the airframe using, where possible, the original components from EI-CPI. The engine and its bearer were removed from the airframe and suitably secured on a bench test-rig (**Photo No. 4**).

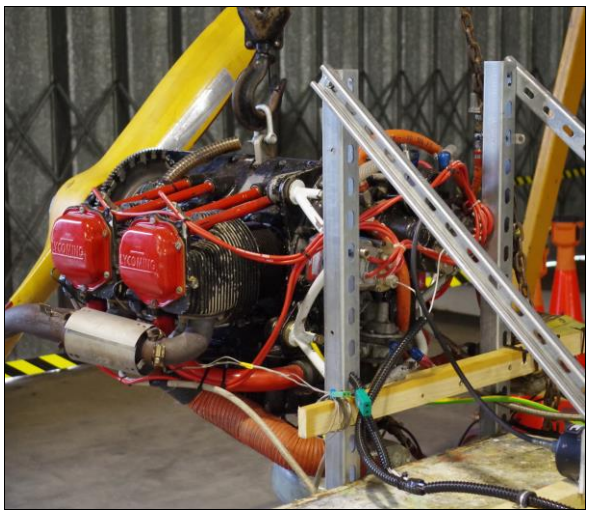


Photo No. 4: Engine mounted in test-rig

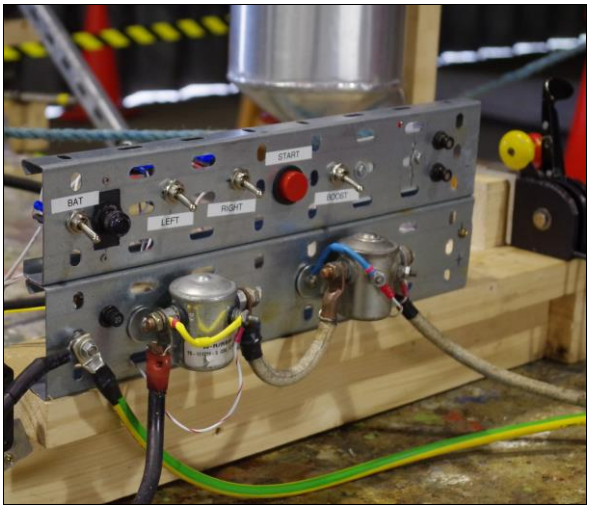


Photo No. 5: Test-rig control panel

A control panel was built incorporating the original master and starter relays, switching and ancillary electrical components (**Photo No. 5**). A purpose-built aluminium fuel tank was fabricated by an ILAS member specifically for the test. Following repair of minor damage to the propeller (sufficient for test purposes) the propeller was mounted to the hub flange. Instrumentation consisted of the tachometer and carburettor temperature gauge from the aircraft. The engine control quadrant, consisting of carb heat, throttle and mixture controls, was connected using newly-fabricated Bowden cables. A replacement 12 V lead-acid battery was sourced and connected to the control panel. The engine was grounded to the electrical system using 35 mm^2 bonding cable of similar cross-section to that of the starter cable. For safety reasons the master switch, magneto switches and fuel pump switches were replaced with new single-throw units. The Alternator was left disconnected as it was not required. The fuel supply was re-instated using components recovered from the aircraft: the fuel selector, gascolator, fuel pump and associated fuel lines. For safety reasons an additional fuel shut-off valve was installed as close as possible to the engine-driven fuel pump to facilitate stopping of the engine in case the magnetos could not be grounded[16].

[16] **Grounded**: To prevent a HT spark occurring with the Ignition switch positioned to 'OFF', the Magneto P-lead is connected (via the Ignition switch and bonding straps) to the Battery Negative. If a broken P-lead or poor bonding connection exists, this can allow a HT spark to be generated should the engine be rotated.

1.16.3 Engine Run Tests

Once mounted, the engine was first turned over by hand to confirm that no mechanical-type failures were present. The spark plugs were installed in the same positions and condition as they were found. The engine was then turned over by means of the starter motor with the ignition switches off, again to check if any mechanical failures were present. The engine rotated and no mechanical failures were evident.

The engine was primed by means of the electric fuel pump and with the pump off the engine was started with minimal cranking with the Left (impulse) magneto selected 'ON'. For this first run the engine was stabilised at 1,200 RPM for approximately 30 seconds and then shut down. The security of the engine on the rig was checked and no problems or defects were evident.

Following the initial run, the engine was run for 10 cycles for periods ranging between 2 minutes and 4 minutes 30 seconds. Maximum RPM was restricted to 2,000 RPM for safety reasons. The engine idled satisfactorily at 800 RPM.

The first run was conducted to check the functionality of the Left and Right magnetos and to check that the engine could be stopped by operating the fuel shut-off. This test also confirmed the position of the throttle lever with the engine operating at a steady 1,200 RPM. The first run was conducted without the air filter installed to provide a benchmark for subsequent runs.

For the next test, the original air filter was installed and the engine stabilised again at 1,200 RPM. The throttle position was unchanged in this condition. A magneto drop test was performed by switching off one magneto at a time and observing the RPM drop. Operation on the Left and Right magnetos individually showed an RPM drop of 100 - 120 RPM compared to (normal) operation on both magnetos. The engine ran smoothly on the Left magneto but exhibited some roughness while operating on the Right magneto.

For the final series of runs the normal air intake was blocked to restrict the airflow to explore if a rich-cut would occur. Despite several runs with both the normal and carburettor heat intakes fully blocked, the engine continued to run with only slight evidence of backfiring due to an over-rich mixture. Leaning of the mixture returned the engine to smooth running. As air was clearly entering the carburettor from some source, the air filter box was disassembled. On inspection, a crack (due to impact damage) was observed across the top of the box allowing the engine to function despite having its normal and alternate air supplies restricted.

Following the initial series of run tests, the spark plugs were again removed and inspected. One plug exhibited oily deposits. When this plug was cleaned, operation on the Right magneto alone was satisfactory. An additional test was conducted to verify the fuel flow with the fuel selector in an intermediate position similar to the 'as found' position. It was found that the engine continued to run with the fuel selector in this position.

On the entire series of tests the engine was run for a total of 45 minutes. Within the limitations of the test-rig itself, the engine functioned satisfactorily. Although a rich-cut (symptomatic of carburettor ice) could not be reproduced, the true and complex effects of induction icing were beyond the scope of the bench test.

1.17 Organisational and Management Information

Not applicable.

1.18 Additional Information

1.18.1 Radar Data

A review of the ATC radar tapes was conducted shortly after the accident and ATC confirmed an intermittent return in the vicinity of Dungarvan at 15.07 hrs as belonging to EI-CPI. The screenshot in **Photo No. 6** shows EI-CPI on a south-westerly heading approximately 7 minutes prior to the accident.

Photo No. 6: Screenshot of ATC radar showing return from EI-CPI (circled yellow).

1.18.2 Recovered Electronic Devices

A Garmin GPS *Pilot III* was recovered intact from the aircraft at the accident site. The device did not exhibit any external damage but power-up of the unit was not successful. The power board and display were replaced on the accident unit with components from a second serviceable unit but power-up of the *Pilot III* could not be achieved nor was any data retrieved.

An Asus *Nexus 7* (tablet computer) was also recovered at the accident site. The device was severely damaged in the accident. The device may have been used by the Pilot to assist with navigation. Due to the extent of the damage sustained in the accident it was not possible to power-up the unit nor was any information retrieved.

1.18.3 Induction Icing

Induction icing is the build-up of ice in the fuel induction system of piston-engine aircraft. Induction icing may take three forms: impact icing, fuel icing and throttle icing, although the various forms are often referred to as 'carburettor icing'.

Impact ice is formed on the internal components of the carburettor such as the air scoops, and throttle butterfly valves. It occurs due to the impact of moist air at temperatures between -10 °C and 0 °C and is typically found in conditions of visible moisture.

Fuel ice forms as a result of fuel being vaporised within the carburettor itself and occurs when moisture in the intake air freezes due to the latent heat of vaporisation of the fuel. Fuel icing usually occurs whenever the relative humidity is greater than 50% and at temperatures between 4 °C to 27 °C, but may occur at higher temperatures.

Throttle icing is caused by the condensation and freezing of the induction air due to the drop in pressure as the air passes through the throttle valve venturi. The optimum temperature for forming throttle ice is in the range 0 °C to 3 °C although a combination of fuel and throttle ice could occur at higher temperatures. Throttle icing is the most common form of icing and is also most likely to form with the throttle valve closed or nearly closed (at low or reduced power settings).

For aircraft with a fixed pitch propeller, carburettor icing first manifests itself by a reduction in RPM for a given throttle setting, followed by rough running of the engine and vibration before the engine stops due to lack of a suitable fuel/air mixture. A carburettor icing chart with the ambient conditions plotted for EI-CPI on 27 March 2017, is presented in **Appendix B**.

Information on Induction icing may be found in the Civil Aviation Authority Safety Sense Leaflet No. 14 '*Piston Engine Icing*', European General Aviation Safety Team (EGAST) Leaflet GA5 '*Piston Engine Icing*' and SKYbrary Aviation Safety publication '*Piston Engine Induction Icing*'.

1.19 Useful or Effective Investigation Techniques

Not applicable.

2. ANALYSIS

2.1 General

The aircraft was of amateur construction and was being operated on a Flight Permit under the auspices of ILAS. Documentation obtained by the Investigation from ILAS indicated that the aircraft was maintained correctly and had been inspected by an ILAS Authorised Inspector for the purposes of Flight Permit renewal on 28 July 2016. Following that inspection, the only item requiring rectification was a minor adjustment to the alternator drive belt.

Although the aircraft had not been flown for some months, the Pilot ground-ran the engine on regular occasions. While this may appear to keep the engine in good condition, such operation does not allow the engine to reach the temperatures that would normally be achieved in flight.

The engine manufacturer recommend in a Service Letter *No. L180B* that if the aircraft is not to be flown for a period of 30 days then the engine should be inhibited as recommended. The Investigation is satisfied that despite lack of flight for some months this did not contribute to the engine stoppage.

The aircraft was refuelled and had been airborne for approximately 15 minutes when the engine stopped with, as witnesses reported, "*spluttering"* and "*two*" or "*three loud backfires*". Approximately 35 seconds prior to the distress call, ATC heard a non-voice transmission which may have been inadvertently made by the Pilot. Any attempt to re-start the engine was unsuccessful. The Pilot stated to ATC in a distress call that he had identified a field to carry out a forced landing.

2.2 Engine Stoppage

The engine testing carried out by the AAIU demonstrated that the engine did not stop as a result of a mechanical failure. The Investigation looked at other possible causes for the stoppage including examination of the fuel, ignition and induction systems.

2.2.1 Fuel System

Due to damage to the aircraft fuel tanks it was not possible to directly ascertain the fuel state of the aircraft prior to the accident. The Pilot had uplifted 20 L of Avgas 100LL prior to the flight and stated to ATC that he had sufficient fuel for an endurance of 2 hours of flight. Quality checks had been carried out earlier that day on the fuel bowser contents.

On first inspection at the accident site, the fuel tank selector was found in an intermediate position. The selector was situated in the floor of the aircraft, in front of the Pilot seat. The fuel selector was checked for proper function and was observed to provide positive locking in all of the selected positions. Due to its protected position, it is considered unlikely that the Pilot inadvertently moved the selector whilst in flight.

It is more likely that the selector was moved from its selected position during the impact sequence as the fitting and its associated supply tubing were torn free of the surrounding structure. In any case, during engine testing, when the selector was placed in the intermediate position, the engine continued to run.

Inspection of the fuel system as recovered, revealed that the gascolator and fuel line to the engine both contained fuel. When a fuel supply was re-established for the engine run tests the fuel supply was continuous and confirmed no defects with the fuel supply from the fuel selector to the carburettor. The Investigation is satisfied that the fuel system was capable of delivering fuel to the engine and that fuel was available for delivery.

2.2.2 Ignition System

Inspection of the ignition system HT leads showed that the leads were generally in good condition, with one upper lead exhibiting some chafing due to contact with the upper cowling. The functioning of this lead was unaffected.

Using the original starter motor, the engine was started and ran satisfactorily on the Left magneto. Operation on the Right magneto was also satisfactory but with some roughness due to a fouled spark plug. This plug was possibly contaminated with oil subsequent to the accident. When this plug was cleaned, operation on the Right magneto alone was satisfactory. Under test conditions, the engine operated satisfactorily with both magnetos selected 'ON'. A single fouled spark plug would not cause the engine to stop running.

2.2.3 Induction System

While the air filter was not in optimum condition, the engine was initially run without the filter to provide a benchmark prior to fitting the filter. Operation with the filter installed did not materially affect the operation of the engine under test.

Plotting the outside air temperature and dew point on a Carburettor Icing Probability chart (**Appendix B**) shows that the engine was operating in conditions where there was a risk of '*serious icing at any power*' with a corresponding relative humidity of 66%. Operation in such conditions may lead to a variety of outcomes, singly or in combination, that include a gradual loss of power, rough running, vibration and engine stoppage. The conditions were compatible with the formation of 'fuel icing' where ice forms in the carburettor as a result of moisture in the intake air freezing due to the effects of the fuel vaporisation. Such icing usually occurs when the relative humidity is greater than 50% and at temperatures between 4 °C to 27 °C.

Witnesses observed that the stoppage was accompanied by two or three loud backfires and spluttering, which could be symptomatic of the ignition of an over-rich mixture as a result of the induction air being restricted by icing.

2.3 Attempted Forced Landing

The attempted forced landing was not successful. The Pilot made a distress call to Waterford ATS following the engine stoppage, stating that he had selected a field for landing. It would be reasonable to assume that the Pilot had selected a large field to carry out the forced landing. However, the impact occurred in a small field and there was evidence that the aircraft made contact with several obstacles in that field before the final impact.

2.3.2 Final Flight Path

The known flight path, from the first evidence of obstacle contact in this field to the final resting point, occurs in a straight line with no manoeuvring to avoid obstacles despite an open area existing to the immediate right of the flight path. The Investigation considered the possibility that the Pilot may have suffered some form of incapacitation or impairment was considered by the Investigation. The Pilot had been examined for renewal of his Class 2 Medical Certificate one month prior to the accident and passed as fit. In addition, the Pilot's AME was of the opinion that there was no evidence of a medical factor that would have caused sudden or subtle incapacitation. Furthermore, the Investigation noted that the Post-mortem did not identify any pre-existing condition that may have contributed to incapacitation. Although such an event cannot be absolutely ruled out, there was no evidence to indicate that the Pilot suffered from incapacitation or impairment during the forced landing. It was noted by his AME that the Pilot had been in very good health for a person of 84 years.

The Long-EZ Owner's Manual indicates that at a weight of 1,300 lbs (590 kg) and 70 kts airspeed, the aircraft would typically have required a total distance of 584 m from 50 ft above the ground, including a landing roll of 232 m in zero wind conditions. After passing over the hedge, EI-CPI impacted a tree after a distance of 180 m. The orientation of the final flight path was such that a tailwind condition existed. This would serve to increase both the ground speed and the distance required to land the aircraft.

What can be determined is that, following the engine stoppage, the Pilot was faced with an unexpected and serious situation. Many factors, including the nature of the terrain and obstacles, the flight characteristics and ergonomics of the Long-EZ design, the increased groundspeed due to tailwind and the Pilot's lack of recent flying meant that the task of safely landing the Long-EZ without power was a considerable one. In addition, forward visibility in the Long-EZ is partially obscured below the horizon due to the presence of the canard, especially at airspeeds and pitch angles found on approach.

The US military conducted an evaluation[17] of the Long-EZ type in 1983. On the subject of 'Cockpit Evaluation', the evaluation stated that vertically, the field-of-view of the pilot *'was limited from 9 to 16 degrees below the horizontal by the canard'* but that in general, '*the field-of-view from the cockpit is satisfactor*y'.

[17] **Evaluation**: USAAEFA Project No. 82-18, Preliminary Airworthiness Evaluation of the Rutan Aircraft Factory Inc Long-EZ. Final Report, June 1983.

2.4 Survivability

The Pilot's seat was equipped with a 4-point harness and the harness was fastened. The harness did not restrain the Pilot following impact as the glass-fibre structure around the securing points itself failed under impact forces. The nature of the impact forces were such that the accident was not survivable.

3. Conclusions

3.1 Findings

1. The aircraft was amateur-built under the auspices of the Society of Amateur Aircraft Constructors (SAAC).

2. The aircraft was maintained under an approved Inspection Schedule for fixed-wing aircraft under the auspices of the Irish Light Aviation Society (ILAS).

3. No significant pre-existing mechanical defects were identified with the aircraft or engine.

4. The aircraft had not been flown for 8 months prior to the accident flight.

5. The Pilot passed a Class 2 Medical Examination one month prior to the accident and was considered by his AME to be in very good health.

6. The Pilot uplifted 20 L of Avgas 100LL fuel prior to the accident flight and according to his flight plan, had sufficient fuel for the planned flight.

7. Local weather conditions in the vicinity of Dungarvan were such that there existed a risk of serious induction icing at any engine power setting.

8. The Pilot made a distress call to Waterford ATS following the engine stoppage, stating that he had selected a field for landing.

9. Evidence of contact and debris recovered show that the aircraft struck several obstacles before the final impact, despite an open area existing to the right of the flight path.

10. The final flight path was such that a tailwind component existed.

11. The safety harness did not continue to restrain the Pilot following impact as the glass-fibre structure around the securing points itself failed under impact forces.

12. The Post-mortem report states that the Pilot died from '*multiple injuries'* sustained in '*an aircraft crash*'. Drugs were not detected on preliminary screen and ethanol was not detected.

13. There is no evidence that the Pilot suffered incapacitation or impairment during the forced landing.

14. There was no evidence that the Pilot had recent flight experience, or recent practice at dealing with a forced landing scenario in the Long-EZ.

15. Forward visibility in the Long-EZ is partially obscured below the horizon due to the presence of the canard.

16. The final flight path resulted in the aircraft striking several obstacles and impacting a tree at a height of 4.4 m above the ground.

17. On the evidence available, it was not possible to determine the circumstances that led to the final flight path of the aircraft.

3.2 Probable Cause

Collision with a tree during an attempted forced landing following an engine stoppage in flight.

3.3 Contributing Factor

Flight in meteorological conditions where there was a high probability of serious induction icing at any power setting.

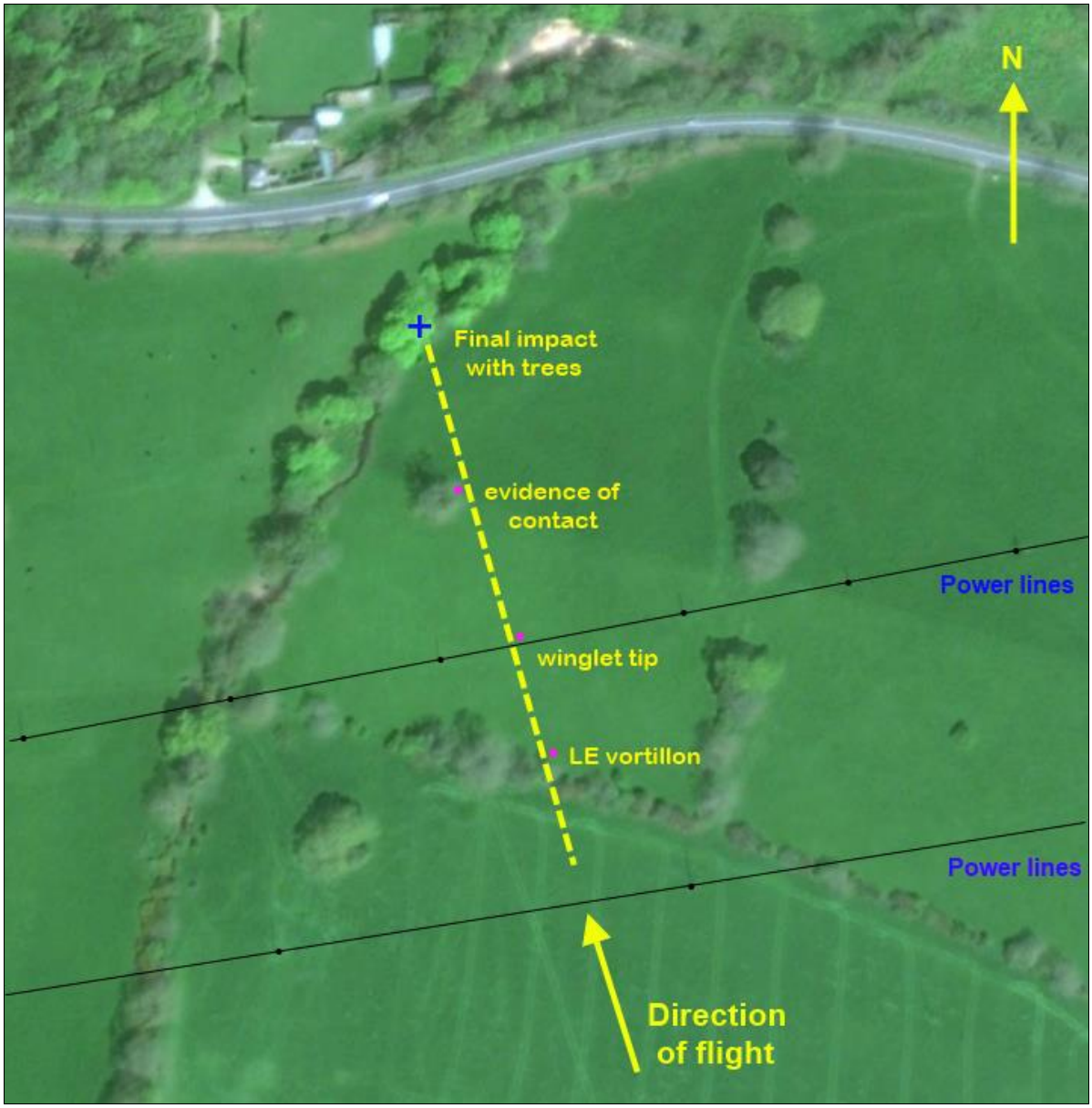
4. SAFETY RECOMMENDATIONS

This Investigation does not sustain any Safety Recommendations.

- END -

Appendix A

Probable final flight path of EI-CPI



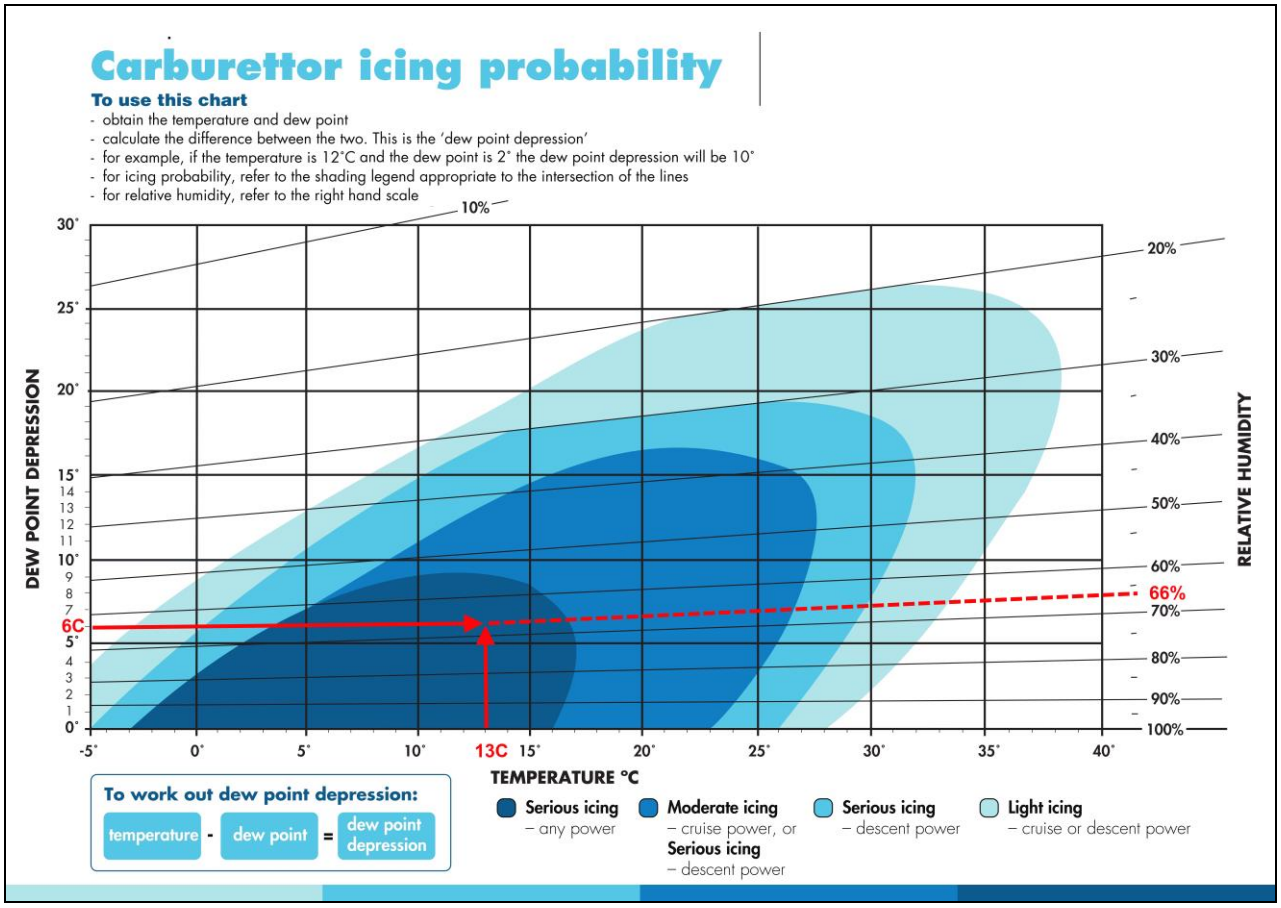
Witness marks/debris (indicated with magenta dots) show first contact was made over the hedge where a leading edge Vortillon was located, the tip of the right winglet was found under the power lines. There was evidence of contact with the solitary tree but no debris; final impact was made with the line of trees at the field boundary.

(*Google Earth-Digital Globe Image 2017*)

Appendix B

Carburettor Icing probability chart for EI-CPI on 27 March 2017

This chart is based on studies and information published by the Civil Aviation Safety Authority of Australia. The **Dew Point Depression** is equal to the **Outside Air Temperature** minus the **Dew Point Temperature** (13˚C - 7˚C = 6˚C). Enter the Chart on the left-hand vertical scale with the **Dew Point depression** of **6˚C**. Plot this value against the **Outside Air Temperature** on the bottom (horizontal) scale of **13˚C**. The intersection of these two values lies within the '**Serious icing - any power**' area. The plotted value extended to the right-hand scale shows a **Relative Humidity** of **66%**.



Carburettor Icing Probability Chart (*Civil Aviation Safety Authority, Australia*)

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) Regulations 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

Air Accident Investigation Unit
Department of Transport Tourism and Sport
2nd Floor, Leeson Lane
Dublin 2, D02 TR60, Ireland

Telephone: +353 1 604 1293 (24 hrs) or
+353 1 241 1777
Fax: +353 1 604 1514
Email: info@aaiu.ie
Web: www.aaiu.ie