Air Accident Investigation Unit Ireland

SYNOPTIC REPORT

ACCIDENT

Thruster, T600N-450, EI-GOE
Woolengrange, Co. Kilkenny

2 March 2021

An Roinn Iompair
Department of Transport

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] to the Convention on International Civil Aviation, Regulation (EU) No 996/2010[2] 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] **Annex 13**: International Civil Aviation Organization (ICAO), Annex 13, Aircraft 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] **Statutory Instrument (SI) No. 460 of 2009**: Air Navigation (Notification and Investigation of Accidents, Serious Incidents and Incidents) Regulations 2009.

AAIU Report No: 2022 - 007

State File No: IRL00921005

Report Format: Synoptic Report

Published: 11 July 2022

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 2 March 2021, appointed Clive Byrne as the Investigator-in-Charge to carry out an Investigation into this Accident and prepare a Report.

Aircraft Type and Registration:	Thruster T600N-450 Microlight, EI-GOE
No. and Type of Engines:	1 x Jabiru 2200A
Aircraft Serial Number:	0037-T600N-090
Year of Manufacture:	2003
Date and Time (UTC)[4]:	2 March 2021 @ 16.23 hrs
Location:	Woolengrange, Thomastown, Co. Kilkenny, Ireland
Type of Operation:	Private
Persons on Board:	Crew – 1 Passengers – Nil
Injuries:	Crew – 1 (Serious)
Nature of Damage:	Destroyed
Commander's Licence:	National Private Pilot Licence (NPPL) Aeroplanes (A) issued by the Civil Aviation Authority (CAA) of the United Kingdom (UK)
Commander's Age:	45 years
Commander's Flying Experience:	218 hours, of which 11 were on type
Notification Source:	An Garda Síochána
Information Source:	AAIU Report Form submitted by the Pilot AAIU Field Investigation

[4] **UTC**: Co-ordinated Universal Time. All times in this report are quoted in UTC unless otherwise stated; local time was the same as UTC on the date of the accident.

SYNOPSIS

During a local circuit flight conducted from a private grass airstrip, in the Woolengrange area of Co. Kilkenny, the microlight aircraft experienced engine difficulties when climbing away from the airstrip. The Pilot conducted a forced landing in an agricultural field close to the airstrip. During the landing roll the aircraft impacted with a line of raised ground which traversed the field. The aircraft decelerated suddenly, and slewed around coming to rest on a heading that was approximately reciprocal to its original direction of travel. The aircraft was destroyed in the impact sequence. The Pilot, who was the sole occupant of the microlight, sustained severe injuries as a result of the accident; extricated himself from the wreckage and was assisted by local residents who attended the scene. There was no fire.

NOTIFICATION AND RESPONSE

Shortly after the event occurred a member of An Garda Síochána notified the AAIU and secured the accident site. Two Inspectors of Air Accidents deployed to Woolengrange in Co. Kilkenny to commence an Investigation.

1. FACTUAL INFORMATION

1.1 History of the Flight

At 16.15 hrs, EI-GOE, with a single Pilot on board, departed a private airstrip at Woolengrange in Co. Kilkenny. After completing three local circuits, the aircraft made a low-level pass, in a north-easterly direction, along Runway (RWY) 06. When the aircraft was just over the north-east end of the runway, the Pilot applied full power and began a climbing left turn with the intention of commencing a left-hand circuit. The Pilot noted that during the climb-out for this circuit, at approximately 200–300 feet (ft) above ground level (AGL), the aircraft experienced a reduction in available engine power. The Pilot reported that as part of troubleshooting the issue, he closed the throttle and the engine power reduced to idle. He tried to apply full power again, but reported that it felt like the engine was flooding and '*despite running smoothly* […] *the power did not increase*'.

The Pilot said that he tried cycling the electric fuel pump off and on, in case the fuel pump was supplying too much fuel. The aircraft at this point was not gaining height and the Pilot assessed that there was only one field available for a forced landing. The Pilot said he manoeuvred the aircraft left and right to avoid obstacles and then '*put the nose down'* to approach the field. Witness reports suggested that the aircraft may have touched down briefly close to a row of houses in another field directly to the south of the accident site before becoming airborne again prior to the final landing.

The Pilot stated that, due to the speed of the aircraft, he tried to pass as low as possible over the hedge on approach to the landing field. He said that once over the landing field, he levelled the aircraft but noted that he was approaching a hedge line and overhead electricity lines, and he suspected that the aircraft had too much groundspeed. During the landing roll, the aircraft impacted with a line of raised ground in the field; the nose wheel dug into the ground and the aircraft decelerated suddenly. The aircraft slewed around and came to rest on a heading that was approximately reciprocal to its original direction of travel.

The Pilot was attended to by some local residents who assisted him and also assisted, under instruction from the Pilot, in attempting to make the aircraft safe by shutting off the fuel and electrical power.

Photo No. 1: Final position of EI-GOE

1.2 Interviews and Statements

1.2.1 Pilot

The Pilot informed the Investigation that he had planned to conduct some local circuit flying in the favourable weather conditions. He said that he carried out some maintenance on the aircraft's electrical master switch prior to the flight, due to a loose connection that had been previously identified. A new switch was fitted followed by an engine run and full power checks to confirm correct operation following the maintenance action.

The Pilot said that he prepared the aircraft for flight and commenced a take-off from the south-westerly runway of the private airstrip using full power and then conducted some local circuits. He said that during the climb-out from the third circuit he reversed the circuit direction by initially turning the aircraft to the right and then completed a turn to the left to align with the north-easterly runway. He then passed over the runway at a low level. The Pilot said that when the aircraft was approximately over the north-east end of the runway, he applied full power and began a left turn with the intention of completing a left-hand circuit and then landing. The Pilot reported that during the climb-out, at approximately 200-300 ft AGL, the engine power reduced. The Pilot attempted to troubleshoot the issue, but to no avail.

The Pilot said, that with the engine power problem persisting and the aircraft not gaining height, he identified an agricultural field in which to complete a forced landing. The Pilot reported that he turned the aircraft left and right before putting the nose down to approach the selected agricultural field. The Pilot recalled that the aircraft was traveling with '*a lot of* [air] *speed*', which he estimated to be between 60 and 70 knots (kt). He reported trying to pass as low as possible over the boundary hedge on approach to the field to allow the speed to reduce.

The Pilot said that after the impact he was badly winded and he remained secured in his four-point seat harness. He released himself from the seat harness and fell forwards within the collapsed cockpit structure and was able to pull himself out of the aircraft through a gap on the left side of the cockpit. The Pilot was attended to by some local residents, one of whom he asked to turn off the fuel supply and the battery cut-off switch, having first described their locations.

1.3 Injuries to Persons

The Pilot was seriously injured as a result of the accident. Having received medical attention by the emergency services at the accident site, the Pilot was subsequently brought by ambulance to a local hospital.

1.3.1 Witness Statements

A number of witnesses to the accident were interviewed by the Investigation. Each of the witness accounts of the aircraft's flightpath, and the accident sequence were generally consistent. The aircraft was reported as being low ('*approximately 8-10 feet above the ground'*) as it passed to the left of a row of houses and over an adjacent field which was directly south of the accident site. The aircraft engine was noted by the witness to have been '*on'* and then '*went silent*' as the aircraft descended further into the adjacent field. A witness described the Pilot as '*… doing his best to avoid the houses and gardens'* on the approach over the fields. The aircraft was reported to have been heard making contact with the ground in the field directly south of the accident site with a '*bump*' whereupon the engine was variously described as having '*spluttered and came back into life again*' and '*revved'* before the aircraft gained altitude again and cleared a boundary hedge and lane prior to touching down in the accident site field. Shortly thereafter, a sound believed to be that of the impact was heard coming from the direction of the accident site.

Video footage of the aircraft, provided to the Investigation, shows the aircraft in the minutes before the accident flying straight and level and with no apparent issues.

1.4 Aircraft Information

1.4.1 General

The aircraft type, a Thruster T600N-450, is a two-seater, high-wing microlight aircraft and was manufactured in 2003. The structure of the aircraft is constructed from aluminium and steel tubing and the wing and tailplane areas are covered with lightweight Ultralam material. It has a fixed tubular steel tricycle landing gear configuration and has a Maximum Take-Off Weight (MTOW) of 450 kg. The aircraft is powered by an air-cooled Jabiru 2200A four-stroke, four cylinder engine which drives a two-bladed ground adjustable Warp Drive propeller. The engine, which is operated on MOGAS[5], is mounted to the front of the aircraft's central keel tube and is positioned above and forward of the cockpit giving a high centre of gravity. At the time of the accident, the aircraft had a total recorded flying time of 520 hours.

[5] **MOGAS:** When unleaded automotive gasoline is used in an aircraft, it is known as MOGAS.

1.4.2 Previous Registration

Between October 2003 and March 2017, the aircraft was registered in the UK and had changed ownership several times. Prior to purchase by the Pilot, the aircraft had been used in a flight training school in the UK. On 14 September 2016, the aircraft was involved in an accident where it became *'lodged'* in trees during an attempted landing and was the subject of an investigation and a report[6] by the UK Air Accidents Investigation Branch (AAIB). Following the accident, the airframe was repaired while the original engine was removed.

On 13 March 2017, ownership of the aircraft (without an engine fitted and still registered in the UK) was transferred to the Pilot. The Pilot informed the Investigation that he sourced a replacement engine, which was fitted to the aircraft approximately three months prior to the aircraft being removed from the UK CAA register on 25 February 2019.

1.4.3 Irish Registration

The aircraft was registered in Ireland on 13 August 2019, and was assigned the registration mark of EI-GOE. The subject aircraft was categorised as an Annex 1 aircraft as per Regulation (EU) 2018/1139 *'on the common rules in the field of civil aviation'.* It was therefore exempt from the Regulation but was subject to the requirements of Irish national legislation.

1.5 Flight Permit Process

Prior to an Initial Flight Permit being issued to an Annex 1 aircraft in Ireland, the registered owner is required to make an Initial Permit application to an Irish Aviation Authority (IAA) approved Irish national maintenance organisation that holds the privilege to make Flight Permit recommendations. The Flight Permit application process requires a number of inspections and documents to be completed. These include but are not limited to, a Flight Permit Inspection, a Weight & Balance Report and an Aircraft Check Flight Report. The check flight and a subsequent Check Flight Report were carried out by the owner six weeks prior to the IAA-issued Flight Permit being issued. This Report recorded, amongst other information, that the aircraft reached its '*MAX Static RPM*' (before take-off) of 3,300 RPM and that a '*Climb Rate at best rate of climb speed*' was noted as 980 feet per minute. The report declared that the aircraft operated as expected and '*displayed no unsafe or abnormal flight characteristics*'.

The Pilot, who was also the registered owner of the aircraft, made an application to one such IAA-approved Irish national maintenance organisation for an initial Flight Permit on 12 July 2020. As per its procedures manual, the organisation stipulates that all aircraft operating on a Flight Permit, as recommended by the organisation, will be *'…owned, operated and maintained by members in good standing, and will comply with all procedures laid down in this Manual, and with all the requirements of the Irish Aviation Authority'.*

[6] **AAIB Bulletin:** https://www.gov.uk/aaib-reports/aaib-investigation-to-thruster-t600n-450-g-oasj

1.5.1 Flight Permit Inspection

The process for a Flight Permit Recommendation consists of, amongst other things, a Flight Permit Inspection of the aircraft. Upon request from the registered owner for a Flight Permit, an '*Owner's Declaration*' section in the relevant application form identifies the aircraft particulars and provides supporting information to the maintenance organisation regarding the aircraft and its associated documentation and records.

As part of the Owner's Declaration, the Pilot provided the maintenance organisation with the aircraft logbook, which contained a record of significant engine work including a *'Full Top End Overhaul in accordance with Jabiru Overhaul Manual JEM0001-19'*. The Pilot informed the Investigation that he had not completed any internal work on the engine's carburettor.

According to the maintenance organisation's procedures manual, a Pilot, by virtue of holding a valid Pilot Licence and being listed as a member of the organisation, is '*designated to certify and issue a CRS* [Certificate of Release to Service] *for maintenance on Irish registered aircraft types listed* […] *There is no further competency assessment or paperwork held for these individuals'.* In addition, the manual states that:

> *'The Pilot is always responsible for any maintenance that he performs. Before carrying out any maintenance, the pilot must satisfy himself that he is competent to do the task. It is the responsibility of the owners to familiarise themselves with the standard maintenance practices for the aircraft and with any manufacturer's maintenance recommendations.*
>
> *If the pilot is not competent for the task to be carried out, the task cannot be released by the Pilot. In this event, the task may be carried out by another person designated by the* [maintenance organisation] *e.g. Pilot,* [a maintenance organisation] *Aircraft Inspector or a person or organisation approved by the IAA per Aeronautical Notice A15'.*

Following on from the registered owner's application and in accordance with the maintenance organisation's procedures manual, an approved aircraft inspector from the maintenance organisation *'…shall carry out an inspection on the aircraft in accordance with* [internal documents] *as applicable'.* The '*Inspector's Declaration*' facilitates an aircraft inspector to further scrutinise the aircraft, its associated documentation and records, in addition to an external visual inspection of the aircraft and engine.

During a pre-inspection review of aircraft records, the Inspector's Declaration recorded that the engine had undergone *'Extensive engine overhaul IAW* [In Accordance With] *Jabiru Overhaul Manual No. JEM0001-19, 28/Nov/2019'* performed on 14 Jun 2020 @ 304.8 engine Hrs.

As part of the recommendation process, the inspector also completes an inspection of the aircraft and records the inspection via a tabulated Pass/Fail checklist. This checklist identifies specific areas of the aircraft which require examination. The 15 examination areas identified on the power plant area section of the checklist are functional checks and external visual inspections. No anomalies were noted on the Inspector's Declaration in relation to the power plant section of the checklist.

The Inspector's Declaration was completed and the aircraft was declared as having '*Passed*' the inspection on 12 July 2020. The completed application and necessary documentation was processed and a recommendation for issue of Flight Permit was submitted to the IAA. An IAA Inspector conducted a '*Physical Survey*' on the aircraft, and a Flight Permit was issued on 3 September 2020, with an expiry date of 2 September 2021.

The physical survey checklist used by the IAA facilitates a survey of the aircraft and its required documentation. The examination of the aircraft and its engine is conducted via external visual inspection.

The IAA-issued Flight Permit includes a list of conditions and limitations associated with the Flight Permit, which are set out on the Flight Permit certificate. Condition 1 outlines the owner's responsibility as follows:

> 1. […] *'The Registered Owner(s) is responsible for the aircraft's proper maintenance. Prior to each flight the pilot shall ensure that the aircraft is fit for flight.* […]'

1.6 Damage to Aircraft

The aircraft sustained significant damage during the impact sequence and was destroyed. There was significant structural damage to the cockpit and main fuselage area. Both doors remained attached to their respective hinges but were unlatched due to the distortion of the fuselage. The nose undercarriage had collapsed.

The engine and propeller nosecone displayed impact marks, one of the propeller blades was broken, and the engine was likely shock loaded. The left wing was buckled and broken rearwards and displayed evidence of ground impact at the wing tip area. The right wing leading edge tube was broken at the midpoint area. The wing struts and associated jury struts[7] on both wings were found buckled. The main undercarriage, which is of tubular steel construction, was fractured in a number of areas and exhibited significant splaying on both sides. **Photo No. 2** shows the final position of the aircraft adjacent to the line of raised ground where it came to rest.

Photo No. 2: Final resting position of EI-GOE and damage sustained

The aircraft's central keel tube, which forms the central spine of the aircraft, was fractured at the junction of the wing rear attachment point as shown in **Photo No. 3**.

[7] **Jury Strut:** Additional strut to the main wing strut to provide additional stiffness.

Photo No. 3: Fractured central keel tube

1.7 Other Damage

Minor ground scarring and damage to a temporary electric fence was observed at the accident site.

1.8 Wreckage and Impact Information

The accident site was preserved by An Garda Síochána pending the arrival of the AAIU. A site survey was carried out at the location of the accident site and the surrounding area in an attempt to establish the flightpath and any points of contact the aircraft may have made during the forced landing.

Minor ground scarring at, and just prior to, the aircraft's final position were evident and were used to identify the direction of flight. The right wing tip light was found detached from the aircraft and located to the right of the main impact area. Remnants of the aircraft's pitot tube, landing light, cockpit nose and window areas were found detached from the aircraft and retrieved from the face of the raised ground in the field.

The surface of a field directly to the south of the accident site was inspected in an attempt to ascertain possible touch points; however, none could be identified. The ground was firm underfoot and there were no notable ground markings apparent. In addition, the hedge lines and a wooden pole-mounted electric fence along the expected flight path did not appear to have been disturbed during the forced landing sequence.

1.9 Personnel Information

1.9.1 Applicable Pilot Licensing Requirements

In order to operate an Irish registered aircraft within Ireland, Pilots must consider, *inter alia*, the following from the IAA's Aeronautical Notice (AN) P.21, *'Acceptance of Flight Crew Licences',* Issue 3, Date 07.04.17 (extant at the time of the accident):

> *'3. The holder of an appropriate pilot licence or aviation qualification issued by another ICAO signatory state or its national aviation authority or qualified entity, which permits or is accepted as being appropriate to enable the holder to act as pilot-in-command within that state of an aircraft described in Annex II[8] of EU Regulation No 216/2008 (as amended), shall be exempt within the territorial limits of the State from the requirements of Article 5 of the Order while acting as a member of the flight crew of an aircraft being operated as a private aircraft.*
>
> *4. This Direction shall apply only provided that the appropriate pilot licence or aviation qualification holder has:-*
>
> *a) given prior notification to the Authority by submitting the appropriate details in the manner published by the Authority on its website;* [Form RPPL.F.127B or P.21 Form]
>
> […]
>
> *c) the valid medical certificate required by the state of issue, but in any case where no such certificate is required or where the certificate required is not an ICAO Class 2 or an EU Part-MED LAPL[9] medical certificate, a minimum of an ICAO Class 2 medical certificate or an EU Part-MED LAPL medical certificate;'*

When contacted by the Investigation, regarding paragraph 4 a) of the IAA's AN P.21, the Pilot acknowledged that the requirements of AN P.21 had not been complied with in this instance.

1.9.2 Flying Experience

The Pilot's flying experience prior to the accident flight is outlined in **Table No. 1**.

Total all types:	216 hours 15 minutes
Total on type:	13 hours
Last 90 days:	1 hour 30 minutes
Last 28 days:	1 hour
Last 24 hours:	Nil

Table No. 1: Pilot Flying Experience

[8] Annex II of Regulation (EC) 216/2008 has been superseded by Annex I of Regulation (EU) 2018/1139.
[9] **LAPL:** Light Aircraft Pilot License.

1.9.3 Pilot Licence and Medical Certification

At the time of the accident, the Pilot held an NPPL (A) that was issued by the United Kingdom (UK) Civil Aviation Authority (CAA). The Pilot held a UK CAA Pilot Medical Declaration. This is a self-declaration medical requirement permitting the holder to fly an aircraft no greater than 2,000 kg MTOW within the UK.

1.10 Engine Information

1.10.1 General

The Jabiru 2200A is a direct drive, four-stroke, four-cylinder, horizontally opposed, air-cooled engine and is fitted with a BING brand, pressure compensating float-type carburettor. According to the engine overhaul manual[10], the ignition system is provided by two flywheel mounted magnets that energise fixed coils mounted adjacent to the flywheel. The resulting high-voltage energy is distributed to the spark plugs by two gear driven distributers and associated high tension leads. The ignition system has fixed timing and is fully redundant, self-generating, and does not depend on battery power for operation. Spark energy is not generated below 275 rpm crankshaft speed. The Jabiru 2200 series engine is in use on a number of different aircraft types and therefore must be configured according to the specific aircraft manual specifications.

1.10.2 EI-GOE Engine Provenance

The Pilot informed the Investigation that a replacement engine was sourced and fitted prior to the aircraft being deregistered in the UK. On purchase of the engine, the Pilot was aware that it was in a seized condition due to overheating, and required some remedial work in order to return it to operation. The Pilot completed maintenance work on the engine and returned it to operation.

The Pilot advised the Investigation that there were no documents provided to him at the time of purchase of the replacement engine that recorded time in service or any work that had been completed on it prior to purchase. Consequently, the maintenance history of the engine prior to the Pilot acquiring it or the aircraft on which it had been installed previously could not be definitively established by the Investigation.

1.11 Engine Examination

1.11.1 General

The engine was removed from the aircraft by the Investigation, securely crated and shipped to an approved engine overhaul facility to determine the reason for failure. On receipt of the engine it was noted by the overhaul facility that the '*general condition of the engine was poor and reflects its age of some 25 years*'. The engine was mounted on an engine test bed and prepared for a test run. A number of attempts to run the engine on the test bed were unsuccessful and a very weak ignition spark was noted.

[10] Overhaul Manual For Jabiru 2200 & 3300 Aircraft Engines. Document No. JEM0001-20, 30th April 2020.

The distributor caps were removed and the rotor arms, although loose on their respective shafts were deemed functional. New ignition coils were fitted instead of the existing installed units; however, the spark remained very weak. Subsequent attempts to start the engine were unsuccessful.

1.11.2 Engine Cylinders

Differential compression testing[11] of the engine's four cylinders was carried out and cylinders No. 1 and No. 4 were reported as having low compressions. The Jabiru engine manual states that the maximum pressure loss is 25%. The results of the compression tests were as follows:

- Cylinder #1: 27.5% Pressure Loss
- Cylinder #2: 10 % Pressure Loss
- Cylinder #3: 7% Pressure Loss
- Cylinder #4: 35% Pressure Loss

The engine was disassembled further in an attempt to ascertain the reason for the engine not starting. The cylinder heads were removed and all showed evidence of sooting. Cylinder #1 and #2 showed evidence of leakage between the cylinder head and the spigot barrel.

To assess the condition of the engine's valves, individual leak down checks were carried out and the following vacuum test results were reported:

- Cylinder #1: Inlet – 4.5 - Exhaust – 7.5
- Cylinder #2: Inlet – 7.5 - Exhaust – 8.0
- Cylinder #3: Inlet – 8.0 - Exhaust – 7.0
- Cylinder #4: Inlet – 4.5 - Exhaust – 8.0

A vacuum test reading of 8.0 is regarded as the normal serviceability limit. A reading below 8.0 indicates a poorly sealing valve / seat. The test results were described by the engine overhaul facility as being consistent with '*…blowback into the induction system which could result in a poor fuel air mixture being available to all cylinders'*.

The cylinder barrels and pistons were removed and examined. The cylinder base O-rings were of a '*new type'* and therefore indicated that there was work completed on the engine in the previous five years. The piston rings were free within the pistons. All cylinders bores displayed evidence of cross hatching from being quite recently honed; however, cylinders #1, #3 and #4 displayed considerable pitting which, in the opinion of the approved engine overhaul facility, would not have been regarded as being within serviceability limits.

1.11.3 Carburettor and Oil Pump

The carburettor was stripped and inspected and showed that due to its arrangement, excessive fuel was being provided to the cylinders, leading to the engine running rich. The needle jet was identified as being a larger diameter than that specified in the engine manual. The main jet was observed to be the correct size.

[11] **Differential Compression Test:** A test to determine whether or not an engine piston/cylinder is capable of generating the compression pressure specified by the engine manufacturer.

The needle fitted was identified as a type *46-252*; the specified needle for the carburettor is a *46-251*. The float needle valve was identified as a *46-968* soft spring; the specified float needle valve for the carburettor is a *47-969* hard spring. The idle mixture on the carburettor was noted as being set to '*very lean'*, which the overhaul facility surmised may have been an attempt to '*try and compensate for the overly rich set up'* on the engine. In addition, the carburettor air filter was described as being very small for the engine installation on this type of aircraft and was described as being approximately 50% smaller in surface area than that which would normally be used on the Thruster T600N-450 aircraft.

The oil pump was inspected and the wear was measured at 0.010 inch which was greater than the maximum wear limit tolerance for the oil pump which was 0.004 inch. The oil pump back plate was noted to have originated from a '*bed mounted'* engine system, indicating that the engine was previously mounted in a different configuration to that used on the Thruster T600N-450 aircraft.

1.11.4 Flywheel and Ignition Coils

The flywheel fitting and connection bolts were correct for the engine serial number. The engine manual requires both induction coil magnets to be within the range of 1.5 kg to 2.5 kg in a prescribed magnetic pull test.

The magnetic pull test conducted during the inspection recorded values of 1.7 kg and 1.2 kg which the overhaul facility stated '*… would support the poor ignition spark'* observed during attempts to run the engine. Additionally, the ignition coil pickups were noted as having *'significant corrosion*'.

The ignition harness resistance checks were assessed as satisfactory. There was no insulating washer[12] fitted on either of the two ignition coils; these insulating washers are noted in the engine overhaul manual as being *'essential as they greatly reduce the operating temperature of the coil, improving its longevity'*. The surfaces of the ignition coils were described as dirty with some corrosion.

The resistance readings of the primary windings of the two ignition coils were 1.3 ohms (Ω) and 1.1 Ω. According to the engine overhaul manual, the resistance range for the primary windings should be between 0.8 Ω and 1.0 Ω. The resistance readings of the secondary windings were 6.2 kiloohms (kΩ) and 6.1 kΩ. This was found to be within the engine overhaul manual limits of 5.9 kΩ and 7.1 kΩ.

It was noted in the inspection report that the tests on the ignition coils were completed *'*[…] *with the coils cold, coil failures are normally more frequent when they are hot and the primary resistances* [in this case] *were both above the normal range*.

[12] **Insulating Washer:** Insulating washers are fitted between the ignition coils and the mounting post – this is to minimise heat transfer into the coil. Jabiru Aircraft Engine Overhaul Manual JEM0001-20. Issued 30 April 2020

1.11.5 Engine Examination Summary

The independent engine inspection report carried out by the approved engine overhaul facility for this engine type concluded that the engine was in a generally very poor condition, well overdue a complete overhaul, and showing signs of unsuccessful attempts of service and maintenance. The carburettor and induction system were set excessively rich and the ignition system struggled to produce a satisfactory spark.

1.12 Fuel Analysis

Fuel samples were taken from the aircraft at the accident site and were sent to a specialist laboratory for analysis. The analysis concluded that the sample was '*Clear and Bright*' and was consistent with the properties expected of EN 228 [Automotive Fuels - Unleaded petrol - Requirements and test methods]. The sample failed the EN 228 specification due to a trace amount of particulates identified. However, the trace amounts were of such a small quantity that they were not deemed significant by the laboratory.

1.13 Airstrip Information

The aircraft was operating from a private grass airstrip located in the Woolengrange area of Co. Kilkenny. The single grass runway is oriented on reciprocal magnetic bearings of 060/240 degrees and is approximately 200 metres (m) in length and 15 m in width. The accident site was situated approximately 760 m to the north of the end of the runway (RWY 06) as indicated by the dashed yellow line in **Figure No. 1**.

Figure No. 1: Airstrip and Accident Site (Google Earth)

1.14 Meteorological Information

Met Éireann, the Irish Meteorological service, provided the Investigation with the following estimated meteorological conditions for Woolengrange, Co. Kilkenny at the time of the accident. This was based on conditions at the most representative stations at Mount Juliet, Thomastown, Co. Kilkenny, approximately 5km to the south and Oak Park, Co. Carlow, approximately 35km to the northeast at 16.23 hrs UTC on 2 March 2021 (**Table No. 2**).

Meteorological Situation:	A high pressure system dominates over western Europe, giving a light easterly airflow across Ireland.
Surface Wind: **Wind at 2,000 ft:** **Between Surface and 300 ft:**	Variable 2-4 kt. East to south-east 5 kt. Variable 2-5 kt.
Visibility:	7-9 km.
Weather:	Largely clear skies, with patches of mist or haze.
Cloud:	Few (1-2/8th oktas[13]) stratus clouds with bases around 800-1200 ft.
Surface Temperature/Dew Point:	10/5 degrees Celsius.
Mean Sea Level (MSL) Pressure:	1028 hPa [hectoPascals].
Freezing Level:	6,000 ft.
Other Comments:	Nil.

Table No. 2: Aftercast of meteorological conditions at Woolengrange at time of accident

2. ANALYSIS

2.1 Accident Sequence

2.1.1 Approach and Impact

During local circuit flying conducted from a private grass airstrip in the Woolengrange area of Co. Kilkenny, the aircraft conducted a pass at low altitude over RWY 06 on a north-easterly heading. As the aircraft passed over the end of the runway, the Pilot applied full power and began a climbing left turn with the intention of completing a left-hand circuit. During the climb-out, at approximately 200-300 feet AGL, there was an un-commanded reduction of engine power. Despite a number of attempts by the Pilot to resolve the problem, the issue persisted. The aircraft at this point was not gaining height and the Pilot assessed that there was only one field available for a forced landing. The field chosen for the forced landing required the Pilot to manoeuvre the aircraft to the left so as to avoid a row of houses, followed by an immediate right turn in order to line up for the landing.

Witnesses reported that as the aircraft passed to the rear of the row of houses it was '*approximately 8-10 feet above the ground*' and the engine was noted to have been '*on'* and then '*went silent*' as it continued to descend. The engine was described as having '*spluttered and came back into life again*' and '*revved',* whereupon the aircraft gained altitude and cleared the adjacent boundary hedge and lane, before touching down in the accident field.

[13] **Okta:** An estimate of cloud coverage in the sky on a scale from 0 to 8; completely clear sky is described as 0 oktas, while completely overcast sky is described as 8 oktas.

The Pilot estimated that the aircraft had approached the accident site field at an estimated airspeed of 60 to 70 kt. As the aircraft traversed the field the Pilot was aware of '*a hedge and electricity lines*' ahead of him. The Pilot was unaware of a line of raised ground which traversed the field, and the aircraft's nosewheel dug into the raised ground. As the nose wheel impacted the line of raised ground, and due to the engine's location and the aircraft's associated high centre of gravity, the aircraft pivoted forward and the engine and propeller impacted with the ground. The damage found to the right wing and orientation of the aircraft post-impact, indicated that the right wing tip also impacted the ground. The aircraft slewed around coming to rest on a heading that was approximately reciprocal to its original direction of travel.

2.1.2 Estimated Flightpath

Based on witness reports, combined with details provided by the Pilot, the estimated flightpath of the aircraft between completion of the low level pass on RWY 06 to the point of impact is illustrated in **Figure No. 2**. The accident site is located approximately 760 m north of the end of RWY 06.

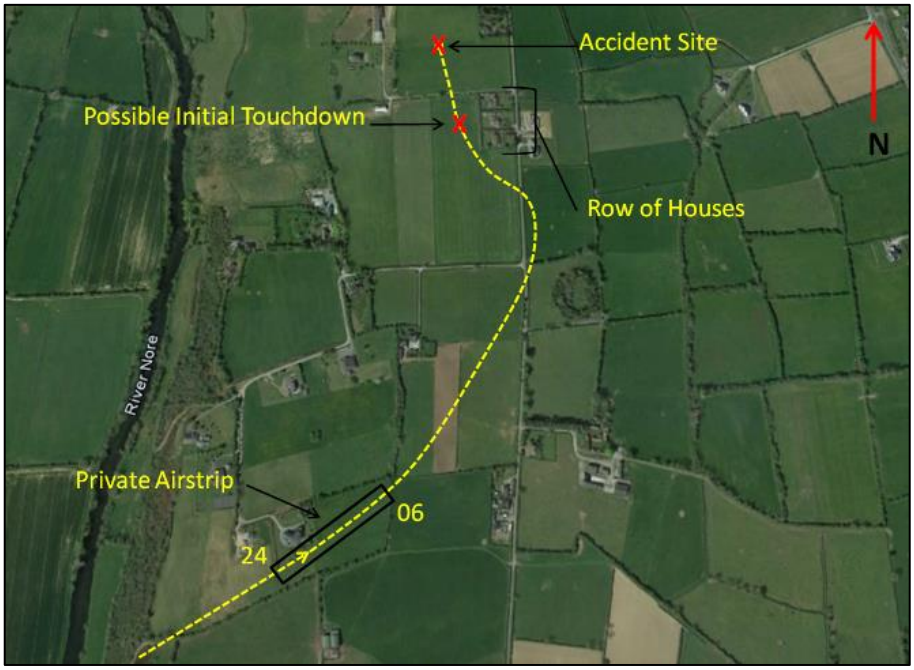

Figure No. 2: Estimated flightpath of EI-GOE

Witness reports had suggested that the aircraft initially touched down briefly in the field adjacent to the accident site; however, the Pilot did not recall such an initial touchdown and an inspection of the field did not identify any touch down points.

2.2 Engine Examination

The engine was removed and sent to an approved engine overhaul facility for technical examination. On receipt of the engine at the facility, it was noted that the '*general condition of the engine was poor and reflects its age of some 25 years*'. The engine was mounted on a test bed but attempts to start it proved unsuccessful. The engine inspection uncovered a number of issues regarding the condition and standard of maintenance on the engine during its operating life.

2.2.1 Engine Cylinders

Sooting of the cylinder heads indicated that the engine had been running on a rich mixture. Differential compression testing of the engine cylinders identified that there was poor compression being achieved on cylinders #1 and #4. The pitting found on the cylinders likely contributed to the poor compression. Individual leak down checks on the valves suggested possible blowback into the induction system which would result in a poor fuel/air mixture being made available to all cylinders and sub-optimal engine performance.

2.2.2 Carburettor

Several discrepancies were noted with the carburettor. An incorrect jet and an incorrect float needle valve were fitted. The idle mixture setting was noted as '*very lean*' which, as suggested by the overhaul agency, indicated an attempt to '*try and compensate for the overly rich set up*' on the engine. The carburettor air filter was noted to have been approximately 50% smaller in surface area than that which would normally be used on the subject aircraft.

The Pilot informed the Investigation that he had not completed any maintenance on the engine's carburettor or its internal arrangement.

2.2.3 Ignition System

On receipt of the engine by the overhaul facility, a number of attempts to start the engine on the test bed were unsuccessful and a very weak spark was noted. Despite replacing the originally installed units with new ignition coils, the spark remained very weak. Further examination of the ignition system sub assembly items identified that the magnetic strength of one of the induction coil magnets was below the lower limit and the second induction coil magnet was very close to the lower limit. The ignition coil pickups were noted as having *'significant corrosion*'. Neither of the two ignition coils had an insulating washer fitted and the coils were reported as dirty and showing signs of corrosion. The insulating washers are referred to in the engine manual as *'… essential as they greatly reduce the operating temperature of the coil, improving its longevity'*.

The resistance of the primary windings of both ignition coils above, the normal range as quoted in the engine manual. In terms of the secondary resistance readings for the ignition coils, both were close to the lower end of the range quoted in the engine manual.

2.2.4 Engine Examination Summary

The configuration of the carburettor was such that an excessively rich fuel/air mixture was being delivered to the cylinders. This was evidenced by the presence of soot on the cylinder heads. The ignition system magnetos were not producing satisfactory sparks. The engine displayed a number of serviceability anomalies, including but not limited to: cylinders #1, #3 and #4 displayed considerable pitting, which in the opinion of the approved overhaul facility would not have been regarded as being within serviceability limits; absence of insulating washers; and incorrect carburettor arrangement. The numerous anomalies identified with the engine during the detailed inspection either individually or in combination would have resulted in sub-optimal performance of the engine.

Aircraft engines, due to their intended use and the likely serious consequences of engine failure are normally maintained in accordance with specified criteria. The keeping of clear maintenance records is also vital in assuring safe operation. The loss of engine performance in the subject event, coupled with the fact that the engine could not be started, during the workshop examination, highlights the importance of adhering to these criteria.

2.2.5 Registered Owner's Responsibility

The Flight Permit Recommendation process requires the registered owner to provide an '*Owner's Declaration*' to an IAA-approved Irish national maintenance organisation, which amongst other information includes details of engine maintenance carried out since last permit. The Pilot informed the maintenance organisation via the aircraft's log book that he had completed significant engine work including a *'Full Top End Overhaul in accordance with Jabiru Overhaul Manual JEM0001-19'*. This work was recorded under the Inspector's Declaration as *'Extensive engine overhaul IAW* [In Accordance With] *Jabiru Overhaul Manual No. JEM0001-19 28/Nov/2019'* on the 14/Jun/2020 @ 304.8 Hrs.

According to the procedures manual of the maintenance organisation, the combination of the Pilot's UK Pilot Licence and being listed as a member of the Irish national maintenance organisation, permitted the Pilot to complete and certify maintenance on the aircraft. Additionally, responsibility for maintenance completed on the aircraft, certification of same and the competency to complete such maintenance, as constituted in the Association's procedures manual, rests with the Pilot. The manual further states that where the Pilot is '*…not competent for the task to be carried out, the task cannot be released by the Pilot*'.

A list of conditions and limitations with regard to the IAA-issued Flight Permit are set out on the Flight Permit certificate. Condition 1 relates to the Registered Owner(s) responsibility for the proper maintenance of the aircraft and that prior to each flight the pilot shall ensure that the aircraft is fit for flight.

2.2.6 Flight Permit Inspection

The registered owner of the aircraft completed an application through an IAA-approved Irish national maintenance organisation which holds the privilege to make Flight Permit recommendations. A number of inspections and documents are required to be completed prior to a recommendation being made to the IAA for the issue of a Flight Permit.

As part of the Flight Permit inspection of the aircraft, the '*Owner's Declaration*' was completed and an associated entry was made in the aircraft log book, which was submitted as part of the application, and identified that extensive maintenance had been completed on the engine in accordance with the engine overhaul manual.

The maintenance organisation subsequently carried out an inspection using its applicable checklist which facilitates the aircraft inspector to further scrutinise the aircraft, its associated documentation and records and complete an '*Inspector's Declaration'*. The 15 examination areas identified on the power plant area section of the checklist require functional checks and external visual inspection to be completed. The '*Inspector's Declaration'* reported no anomalies regarding the engine. The aircraft and engine was declared as having *'Passed'* the inspection.

A check flight and Check Flight Report completed by the owner of the aircraft, six weeks prior to the IAA-issued Flight Permit being issued, was provided as part of the Flight Permit application process. This indicated that the aircraft operated as expected during the check flight and '*displayed no unsafe or abnormal flight characteristics*'.

A recommendation for issue of a Flight Permit was submitted to the IAA and a physical survey of the aircraft and its engine was completed by the IAA. The physical survey checklist facilitates a survey of the aircraft and its required documentation. The examination of the aircraft and its engine is an external visual inspection. An IAA-issued Flight Permit was subsequently issued for the aircraft on 3 September 2020.

The '*Flight Permit Inspection'* and subsequent '*Physical Survey*' of the engine completed by the maintenance organisation and the IAA respectively were visual in nature and concentrated on the external area of the engine and therefore could not have identified the latent internal issues that were subsequently uncovered during the engine examination and disassembly carried out by the Investigation after the accident.

2.3 Engine Provenance

The original engine from the aircraft was removed following an accident. The aircraft was sold to the Pilot without an engine and the Pilot sourced a replacement. The exact provenance for the replacement engine could not be determined. However, with the configuration of the engine, the smaller than usual air filter arrangement and the back plate noted on the oil pump, it would appear that the engine may have been previously installed on a different aircraft type. At the time of purchase of the engine by the Pilot, there were no records available of prior maintenance or details of what aircraft type the engine was previously installed on.

2.4 Fuel Analysis

Laboratory analysis of the fuel taken from the aircraft found that the fuel sample was clear and bright and was consistent with the properties expected of EN 228 [Automotive Fuels - Unleaded petrol - Requirements and test methods]. The analysis identified that the sample had trace amount of particulates. However, the trace amounts were of such a small quantity that they were not deemed significant. The Investigation therefore considers that the fuel was not a factor in the occurrence.

2.5 Survivability

The aircraft sustained substantial damage during the impact and was destroyed. However, the Pilot's seat was fitted with a four-point harness which was being used during the flight and restrained the Pilot during the accident sequence. Although he suffered serious injuries, the Pilot was able to release the seat harness and fall forwards. He was subsequently able to pull himself free of the wreckage through a gap on the left side of the cockpit where the door had been displaced during the impact sequence. There was no post-impact fire.

2.6 Pilot Licence and Medical Certification

In order to operate an Irish-registered aircraft within Ireland, Pilots must consider, *inter alia*, the IAA's AN P.21, *'Acceptance of Flight Crew Licences'.* Paragraph 4 a) of AN P.21 requires prior notification to be submitted to the IAA. When contacted by the Investigation, the Pilot acknowledged that the requirements of AN P.21 paragraph 4 a) had not been complied with in this instance.

With regard to paragraph 4. c) of the IAA's AN P.21, the Pilot possessed the requisite medical declaration to exercise the privileges of a UK CAA-issued NPPL (A) within the UK; however, to operate an Irish-registered aircraft within the territorial limits of the Irish State while using a UK CAA-issued NPPL (A) licence, the Pilot is required to have '*a minimum of an ICAO Class 2 medical certificate or an EU Part-MED LAPL medical certificate*'. Therefore, the medical requirements detailed within the IAA's AN P.21 *'Acceptance of Flight Crew Licences'* were not met in this instance.

3. Conclusions

3.1 Findings

1. The Flight Permit for the aircraft was valid.

2. The provenance of the engine could not be established. However, it is probable that it had been previously installed in a different configuration on a different aircraft type.

3. Flight Permit inspections are external in nature and could not have identified latent internal issues within an engine.

4. A detailed post-accident engine examination and test identified multiple anomalies with the engine in terms of condition and configuration; the ignition and carburettor systems failed a number of serviceability checks.

5. The numerous engine anomalies identified, either individually or in combination, would have resulted in sub-optimal performance of the engine.

6. The Pilot held a UK CAA-issued NPPL (A) licence containing a Microlight rating. The Pilot affirmed his medical fitness to fly on a Pilot Medical Declaration form which permitted him to fly an aircraft in this category within the UK.

7. IAA Aeronautical Notice P.21 requires prior notification to the IAA before a UK CAA-issued NPPL (A) could be used to operate an Irish-registered aircraft within Ireland. The Pilot advised the Investigation that such prior notification was not submitted.

8. The Pilot did not hold an ICAO Class 2 medical certificate or an EU Part-MED LAPL medical certificate as required under the IAA's AN P.21, which was a requirement to fly an aircraft in the subject aircraft's category within Ireland.

3.2 Probable Cause

The aircraft's engine power reduced during climb-out at low altitude, resulting in a forced landing during which the aircraft was destroyed.

3.3 Contributory Cause(s)

1. The carburettor and induction system were set to deliver an excessively rich fuel/air mixture.

2. The ignition system was found to be producing a very weak spark.

3. Examination of the engine by an approved overhaul facility concluded that it was in a generally very poor condition and overdue a complete overhaul.

4. SAFETY RECOMMENDATIONS

This Report does not sustain any Safety Recommendations.

- 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 Unit website at www.aaiu.ie

An Roinn Iompair
Department of Transport

Air Accident Investigation Unit,
Department of Transport,
Leeson Lane,
Dublin 2,
D02TR60,
Ireland.
Telephone: +353 1 804 1538 (24x7)
Email: info@aaiu.ie
Twitter: @AAIU_Ireland