Air Accident Investigation Unit Ireland

FORMAL REPORT

ACCIDENT

Rollason D.62B Condor, EI-BDX

Gibletstown, Duncormick, Co. Wexford

6 October 2019

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 and contributory 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: 2023 - 012
State File No: IRL00919054
Report Format: Formal Report
Published: 10 November 2023

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 6 October 2019, appointed Paul Farrell as the Investigator-in-Charge to carry out an Investigation into this Accident and prepare a Report.

Aircraft Type and Registration:	Rollason (Druine) D.62B Condor, EI-BDX
No. and Type of Engines:	1 x Rolls Royce O-200-A
Aircraft Serial Number:	RAE/608
Year of Manufacture:	1965
Date and Time (UTC)[4]:	6 October 2019 @ 16:40 hrs
Location:	Gibletstown, Duncormick, Co. Wexford
Type of Operation:	General Aviation
Persons on Board:	Crew – 2 Passengers – Nil
Injuries:	Crew – 2 (fatal)
Nature of Damage:	Aircraft Destroyed
Commander's Licence:	Private Pilot Licence (Aeroplane), issued by the Irish Aviation Authority (IAA)
Commander's Age:	61 years
Commander's Flying Experience:	Approximately 8,000 hours, of which 71 were on type
Notification Source:	Irish Coast Guard (IRCG) Marine Rescue Coordination Centre (MRCC), and the Station Manager at the Shannon Area Air Traffic Control Centre (ATCC)
Information Source:	AAIU Field Investigation

[4] **UTC**: Co-ordinated Universal Time. All times in this Report are quoted in UTC; Local time was UTC + 1 hour.

SYNOPSIS

At approximately 16:10 hrs on 6 October 2019, the aircraft, a Rollason D.62B Condor, registration EI-BDX, departed ILAS Field (EIIF) near Taghmon, Co. Wexford, for a flight which was planned to last approximately one hour. There were two persons on board the aircraft: the Pilot, who was seated in the left seat, and an Instructor, who was seated in the right seat. Witnesses reported that at approximately 16:40 hrs, the aircraft emitted a loud noise and broke up in the air in the Duncormick area of Co. Wexford. Local persons proceeded to the scene and the emergency services that had attended determined that both occupants had been fatally injured. The aircraft was destroyed. There was no fire.

NOTIFICATION

On 6 October 2019 at 17:06 hrs, the AAIU Duty Inspector was notified by the IRCG MRCC, that a search was underway in the Duncormick area in Co. Wexford following reports of a possible aircraft accident. Subsequently, the Station Manager for the Shannon Area Air Traffic Control Centre (ATCC) informed the AAIU Duty Inspector that wreckage had been located at Gibletstown, near Duncormick, and that two fatalities had been confirmed. The AAIU Duty Inspector made contact with An Garda Síochána members at the accident site and four Inspectors of Air Accidents deployed to the site, arriving there at approximately 20:00 hrs.

PREAMBLE

The accident aircraft was owned and operated by a five-person group known as '*the BDX Trust*'. The Pilot was one of the members of the group, and the Instructor was the designated Chief Pilot of the group. The Irish Light Aviation Society (ILAS), which made the recommendation for the issuing of the Flight Permit on which the aircraft was operating, informed the Investigation that the aircraft occupants '*were closest to the operation of the BDX Group as Chief Pilot* [the Instructor] *and designated Owner & Maintainer* [the Pilot] *of the aircraft*'.

On the day of the accident, the Pilot completed two earlier flights in EI-BDX: the first to Cashel, which departed at 09:15 hrs and lasted one hour and 37 minutes; the second, which was a local flight, departed at 12:00 hrs and lasted one hour. The aircraft had also been used during an earlier flight by the Instructor (who was on board the accident flight) and a student. This earlier flight departed EIIF at approximately 14:40 hrs – it was the first of a number of flights the student planned to take in preparation for a licence skill test. The student reported that this flight included "*a few tight turns, a few stalls and then mostly circuits*". The aircraft handling and performance throughout this flight were reported to be normal and no anomalies were noticed. The aircraft returned to the airfield at approximately 15:45 hrs. The flight log sheet for the aircraft recorded the Flight Time for that flight as one hour.

1. FACTUAL INFORMATION

1.1 History of the Flight

The accident flight had been arranged on Friday 4 October 2019. When booking the aircraft via a text message, the Pilot, who was a personal friend of the Instructor, requested to fly with the Instructor on Sunday, 6 October 2019. The Pilot was advised by text that a slot was available at 17:00 hrs (local time) and he indicated that he would take that slot. Although the intended purpose of the flight was not clear from the text messages, the Investigation was subsequently provided with a copy of an email that the Pilot had sent to another member of the group that operated the aircraft. The email, sent on 5 October 2019, stated: '*I'm going down to ILAS Field*[5] *tomorrow to do my re-validation with* [the Instructor]'.

The Accident flight was undertaken with the '*Pilot*' occupying the left seat and the '*Instructor*' in the right seat.

The student from the earlier flight informed the Investigation that he asked the Pilot (of the accident flight) about the intended flight, and the Pilot responded '*I'm going up to do spins*'. As reported in the Investigation's Preliminary Report (AAIU Report No: 2019-011, published on 8 November 2019), later in the same conversation, there was some general discussion about aerobatics, including a query about the maximum '*g*' that would be experienced during a barrel roll, which the Instructor opined he would not expect to exceed 2g. The student subsequently contacted the Investigation to state that the discussion was initiated by him and '*was a small part of a conversation*'. He went on to state that there was never any suggestion that the pilots were *'going to do anything other than spins*.'

Prior to the accident flight, the Instructor was heard to remark that he would remove any loose items from the aircraft. The Investigation was informed that this remark is in line with the Pilots Notes & Maintenance Instructions for the aircraft which stated: '*the Condor is cleared for spinning throughout its normal C of G range but no attempt should be made to spin the aircraft carrying baggage or objects on the rear luggage shelf*". The Investigation notes that the restriction regarding the carriage of '*baggage or objects on the rear luggage shelf*' only applies to spinning.

The student from the earlier flight observed the Pilot walking around the aircraft carrying out what the student described to the Investigation as a '*full outside check*'. Upon boarding the aircraft, and prior to engine start, the student from the earlier flight observed that the Pilot had a checklist in his hand. The aircraft taxied to the northern end of the airfield and, at approximately 16:10 hrs, was observed to take off to the south, before turning right and circling back around, while climbing. The aircraft crossed to the north of the airfield, turned right and continued to climb to at least 3,000 ft and proceeded in a south-easterly direction[6] until it went out of sight. It was described as a '*completely normal takeoff – a completely normal climb'*.

[5] **ILAS Field**: Airfield near Taghmon (EIIF) operated by the Irish Light Aviation Society.

[6] The Investigation's Preliminary Report, AAIU Report No: 2019-011, published on 8 November 2019, recorded the direction of travel at this time as being south-westerly

The flight was operated in Class G [7]airspace under Visual Flight Rules (VFR); consequently, no flight plan had been filed with ATC, nor was one required to be filed. The aircraft was not equipped with an ATC transponder and there was no communication or interaction with ATC. A review of recordings, carried out by ATC, found no ATC recordings of the aircraft's track or communications.

Witnesses reported that at approximately 16:40 hrs, the aircraft, while operating over the Duncormick area, emitted a loud noise and broke up in the air. Local persons proceeded to the scene and the emergency services that had attended determined that both occupants had been fatally injured. Witnesses reported that the aircraft was destroyed and that there was no fire.

1.1.1 Witness Accounts

The Investigation interviewed, or obtained statements from, 18 persons who observed the aircraft prior to, or about the time of the accident. These witnesses were situated at various locations; some witnesses observed the aircraft during the flight, but prior to the accident, while others observed the aircraft's final manoeuvres. Interviewees were asked to demonstrate the manoeuvres they observed using hand actions and/or an object/model.

Two of these witnesses were walking together on farmland, 5.5 km southeast of the accident site. One of them took photographs of the aircraft a short time prior to the accident and these photographs were furnished to the Investigation. One of these photographs is shown at **Photo No. 1**.

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Photo No. 1: Photograph of EI-BDX during the accident flight (*provided by witness*)

[7] **Class G:** IFR and VFR flights can avail of a flight information service if requested.

Examination of the photographs allowed the Investigation to determine that at that time, approximately 10 minutes prior to the accident, the aircraft was intact with all control surfaces properly located on the airframe.

A further sixteen witnesses informed the Investigation that they had observed the aircraft during the flight. Based on their different locations they would have seen it from different vantage points, and in some cases at different times. These witnesses variously described the aircraft's motion as circling, flying around in loops or rings, descending and levelling before climbing again, spinning, spiralling, and rolling around in the sky. Some witnesses recalled hearing engine noises they described as the engine backfiring. Several witnesses recalled hearing bang noises and observing parts separating from the aircraft as it spiralled downwards in the final moments of the accident flight.

Family members of the Instructor and Pilot expressed their view to the Investigation that they believed that what witnesses were describing were banking and spinning manoeuvres.

1.2 Injuries to Persons

The two occupants were fatally injured in the accident (**Table No. 1**)

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

Table No. 1: Injuries to persons

1.3 Damage to Aircraft

The aircraft was destroyed.

1.4 Other Damage

There was minor damage to hedgerows and agricultural fields in the vicinity of the accident site.

1.5 Personnel Information

1.5.1 Instructor

The Instructor's details are set out in **Table No. 2**

Personal Details:	Age 61 years
Licence:	Part-FCL Private Pilot Licence (PPL) Aeroplane (A) issued by the IAA, with Single Engine Piston (SEP) (Land) and Touring Motor Glider (TMG) ratings, both valid to 31 July 2021
Last Periodic Check:	Flight Instructor (Aeroplane), 12 September 2018; rating valid until 30 September 2021 with privileges to instruct for SEP (Land) and TMG
Medical Certificate:	Class 2, valid until 20 March 2020

Table No. 2: Instructor's details

The Instructor's Flying Experience is set out in **Table No. 3**:

Total all types:	8,000 hours
Total on type:	71 hours
Total on type P1:	71 hours
Last 90 days:	104 hours
Last 28 days:	17 hours
Last 24 hours:	2 hours

Table No. 3: Instructor's flying experience

1.5.2 The Pilot

The Pilot's details are set out in **Table No. 4**:

Personal Details:	Age 52 years
Licence:	Private Pilot Licence (PPL) Aeroplane (A), issued by the United Kingdom (UK) Civil Aviation Authority (CAA) 10 October 1995
Last Periodic Check:	Single Engine Piston (SEP) Land, valid until 31 October 2019
Medical Certificate:	Class 2, valid until 28 December 2019

Table No. 4: Pilot's details

The Pilot's flying experience is set out at **Table No. 5**:

Total all types:	909 hours
Total on type:	29 hours
Total on type P1:	26 hours
Last 90 days:	11 hours
Last 28 days:	6 hours
Last 24 hours:	2.6 hours

Table No. 5: Pilot's flying experience

In addition to his 909 hours of powered flying experience, the Pilot had 492 hours of experience as a glider pilot.

The Pilot's logbook listed 23 flights (between 5 August 2017 and 19 September 2019) that he had undertaken as Pilot in Command in EI-BDX prior to the day of the accident. These flights were completed on 10 different dates, with several flights being undertaken on certain dates.

The Pilot's flying logbook also recorded three flights on the accident aircraft, with the Instructor on board, when he (the Pilot) was not acting as Pilot in Command (**Table No. 6**)

Date	Capacity	Hours	Remarks
05/08/2017	P u/t[8]	1 hr 40 mins	Entry endorsed by the Instructor
14/10/2018	P u/t	1 hr	Entry endorsed by the Instructor
19/09/2019	P2	50 mins	Entry not endorsed by the Instructor

Table No. 6: Extracts from Pilot's logbook for non-P1 flights in EI-BDX

1.5.3 Flight Crew Prior Activities

The Instructor was due to fly on 5 October 2019 (the day before the accident). However, due to weather being unsuitable, the flights that he was booked to complete on that day were cancelled. The Instructor was reported to have had eight and a half hours sleep on the night before the accident. On the day of the accident, he arrived at the airfield at approximately 11:30 hrs, having attended a prior engagement earlier that morning. The Instructor completed two flights prior to the accident flight: a one-hour training flight with a student in a Scheibe SF25C Motorfalke and, a one hour training flight with another student in EI-BDX.

The Investigation was informed that the Pilot regularly stayed in Bed and Breakfast accommodation local to the airfield on the night before flying to avoid a considerable drive before the intended flight. The Pilot was in contact with family members on the day prior to the accident. It was reported that he arrived at the accommodation early on the evening before the accident and was looking forward to flying the next day. The Pilot appeared to be well rested on the day of the flight.

[8] **P u/t**: Pilot under training.

The Pilot completed two earlier flights in EI-BDX on the day of the accident: the first to Cashel, which departed at 09:15 hrs and lasted one hour and 37 minutes; the second, which was a local flight, departed at 12:00 hrs and lasted one hour.

1.6 Aircraft Information

1.6.1 General

EI-BDX (**Photo No. 2**) was manufactured by Rollason Aircraft and Engines Ltd in the United Kingdom in 1965, and test-flown at Redhill Aerodrome, UK, under the registration G-ARSB. It was constructed primarily from spruce and plywood with metal fittings and fabric-covered flight surfaces. It was powered by a Rolls-Royce O-200-A engine driving a two-bladed, fixed-pitch propeller. The Condor design has an enclosed cockpit with two side-by-side seats. The undercarriage arrangement is '*conventional*' with two main undercarriage legs, one under each wing and a steerable tail wheel. EI-BDX was not equipped with trailing edge flaps — a modification (WAR 160) was available to install wing flaps on the D.62B, but this modification had not been incorporated, nor was it required to be.

On 20 June 1972, the aircraft manufacturer issued a Technical News Bulletin designated RAEL/TNS/D62/14, relating to the installation of steel brackets at the top longeron to engine bulkhead joint, which stated:

> '*This MANDATORY modification, is requested by the CAA to be embodied on ALL "Condor" aircraft, that have not yet had the Modification W.A.R.224 embodied (steel brackets at top longeron to engine bulkhead joint).*'

The Investigation notes that a Logbook Entry document, dated 18 June 1992, which was provided to the Investigation, stated that Modification W.A.R. 224 was embodied on the aircraft on 30 November 1972. The Investigation's inspection of the wreckage confirmed the presence of the brackets referred to in W.A.R. 224.

The Irish Light Aviation Society (ILAS), which made the recommendation for the issuing of the Flight Permit on which the aircraft was operating, provided the Investigation with the following aircraft details:

- G-ASRB / Aircraft serial number RAE/608 was constructed by Rollason Aircraft and Engines Ltd in 1964. The initial Certificate of Airworthiness was issued on 28/01/1965. The aircraft remained in the ownership of the manufacturer Rollason Aircraft and Engines Ltd until 13/06/1980.
- The aircraft underwent a major rebuild in the years 1989-1992, following which a Star Inspection[9] was carried out in accordance with CAA LAMS[10] Fixed Wing Schedule for C of A [Certificate of Airworthiness] renewal in the Private Category and the aircraft was certified Fit for Release to Service on 16/10/1992.

[9] **Star Inspection:** An Annual Check and detailed inspection. The UK CAA required that a Star Inspection must be completed before a recommendation could be made for the renewal of the Certificate of Airworthiness.
[10] **LAMS:** Light Aircraft Maintenance Schedule

- In 2005, a Star Annual Inspection was carried out on G-ASRB by an approved maintenance organisation.
- The then registered owner made a '*Permit to Fly*' application to the UK Popular Flying Association (PFA) (now the Light Aircraft Association (LAA)). A '*Permit to Fly*' was issued on 07/03/2006 by the CAA in respect of G-ASRB. This was last renewed on 19/06/2011 and expired on 18/06/2012.
- The UK CAA had direct oversight responsibility for airworthiness of G-ASRB for a continuous period of almost 50 years, during which time the aircraft logged 3,395 hours and had five registered owners, the latter two being resident in Ireland. G-ASRB was de-registered by the CAA on 08/01/2016.
- An application for the '*Addition of New Aircraft Type to ILAS List*' (Appendix F) was submitted to the IAA on 14/01/2016 in respect of the subject aircraft and was subsequently approved on 30/03/2016 as '*factory built with restorations overseen by ILAS*'.

Photo No. 2: The accident aircraft, EI-BDX (*file photo*)

The last maintenance entry in the Aircraft Logbook was dated 29 October 2018, initialled by the designated owner, and endorsed with initials and a stamp by an ILAS-designated Inspector on 31 October 2018. This entry stated, '*100 hr/Annual inspection carried out — ILAS maintenance schedule'*, at 3,475 hours and 26 minutes. The same text entry, with the same dates and initials, was identified in the Engine Logbook, at a '*Time Since New or Complete Overhaul*' of 1,566 hours and 56 minutes.

The Investigation reviewed the Flight Log sheets for EI-BDX and noted that in 2016, the total of the recorded flight times was 3 hours and 19 minutes; in 2017, the total of the recorded flight times was 38 hours and eight minutes; in 2018, the total of the recorded flight times was 40 hours and 58 minutes; in 2019, the total of the recorded flight times was 64 hours and 37 minutes.

ILAS informed the Investigation that the Flight Log entries by individual pilots would be rounded up to the nearest five minutes and therefore overstated the hours in the air as opposed to the hours recorded by the engine tachometer, which ILAS said was more objective. ILAS identified that based on engine tachometer readings, the 2019 total was 58.65 hours. ILAS went on to state that if an allowance of eight minutes ground running time was assumed for each of the 78 recorded flights in 2019, '*it is quite likely that the 50 flight hour point for maintenance purposes had not been exceeded before the weekend of the accident*'.

ILAS noted that the aircraft manufacturer's Technical News Bulletin RAE/TNS/D62/10 contained a 50-hour recommendation which applied to EI-BDX on the Irish Register, but which was not related to the ILAS Annual Check. ILAS also noted that the Flight Log Sheets, which had been designed by the Instructor, contained an entry indicating the tachometer time of the next check, which on the day of the accident read 1,304 hours and appeared to refer to a 25-hour engine oil change; in this regard the Investigation notes that, when recovered, the total hours shown on the aircraft's tachometer was 1,308.

1.6.2 Transfer to the Irish Register

EI-BDX was being operated on a Flight Permit issued by the IAA. Prior to an Initial Flight Permit being issued, the registered owner is required to make an Initial Permit application to ILAS, which holds the privilege to make Flight Permit recommendations to the IAA under the terms of its IAA-approved procedures manual. The Flight Permit application process requires a number of inspections and documents to be completed.

On 1 November 2015, the Pilot applied to ILAS for the addition of a new aircraft type to the ILAS list using a form, '*Appendix F, ILAS Version 1.6 — March 2015*'. On 14 January 2016, ILAS endorsed the application and forwarded it to the IAA. On 30 March 2016, the IAA informed ILAS that the application was acceptable to the Authority and that the ILAS procedures manual should list the aircraft as '*Druine D.62B Condor (Rollason Aircraft and Engines) factory built with restorations*'. ILAS documentation indicated that the Instructor had conducted test flights on the accident aircraft .

EI-BDX was issued with a Certificate of Registration by the IAA on 24 June 2016. It had last flown with UK registration G-ASRB on 6 June 2011, at which time it had accumulated just over 3,395 hours of flying time.

Prior to ILAS recommending to the IAA that a Flight Permit be issued for EI-BDX, the following works were carried out:

- The engine and brakes were serviced.

- The wing walkways[11] were repaired – this involved separating the fuselage from the wing structure, removal of existing plywood, replacement of damaged structural members and fitting of new multi-plywood skin. Glue joints were inspected and moisture content checks of wood and plywood were carried out and all deemed satisfactory. This work was carried out as per US Federal Aviation Administration (FAA) Advisory Circular (AC) 43-13-1B (Acceptable Methods, Techniques and Practices – Aircraft Inspection and Repair).

- A new battery was installed.

- New tyres were installed.

- The aircraft placards were renewed.

- A compass swing (check of compass for accuracy) was carried out.

- The aircraft was inspected in accordance with the ILAS inspection schedule for fixed wing aircraft; the aircraft was subsequently issued with a Flight Permit by the IAA.

1.6.3 Permitted Manoeuvres

The D.62 Condor Flight Manual contains, *inter alia*, the following limitation:

> *'MANOEUVRES*
>
> *Operation is limited to normal flying manoeuvres and no aerobatic manoeuvres except spins are permitted.*
>
> *Spins may be carried out provided that they are made with power off (engine speeds not to exceed 1000 rpm) and are not allowed to continue for more than three turns. Weight must not exceed 1400 lb (635 kg) but no restriction of the normal centre of gravity range is necessary. Luggage must not be carried on the luggage shelf and approved shoulder harness must be fitted for both occupants.*
>
> *During recovery from a spin, the control column should not be put too far forward or an unnecessarily steep nose-down attitude will result.*
>
> *The maximum positive normal acceleration i.e. load factors which the structure has been designed to withstand without permanent deformation are 4.4g for pull-out from a spin (1400 lb) and for all normal flight (1475 lb) 3.0 g and 2.0 g with the wing flaps extended (if fitted). Intentional manoeuvres shall be confined to those with load factors below these values.'*

ILAS provided the Investigation with a copy of the aircraft *'Pilots Notes and Maintenance Instructions'*, published by the aircraft manufacturer, which stated, inter alia:

[11] **Wing walkways**: The area on the upper surface of the wing suitably strengthened for persons gaining access to the cockpit.

'If in spin aileron is used at the point of entry, the aircraft is very reluctant to spin and usually enters a spiral dive with the consequent risk of overstressing the aircraft as the speed builds up very rapidly in the spiral […] *It must be emphasised that the stick should be moved gently forward as an abrupt forward motion of the stick can result in the aircraft coming out of the spin in an attitude over the vertical and this creates the risk of overstressing the aircraft during the recovery from the ensuing dive.'*

1.7 Meteorological Information

After the accident, *Met Éireann*, the Irish Meteorological Service, provided the following aftercast of weather conditions at the time and location of the accident (**Table No. 7**):

Meteorological Situation:	A weak high-pressure ridge was across the country	
Wind:	Surface:	South to southwest 5-8 kt, isolated gusts 10-12 kt
	2000 feet (ft):	Southwest 15 kt
	Between surface and 300 ft:	Stable conditions would have resulted in little variation in direction and speed in this layer
Visibility:	Greater than 25 kilometres (km)	
Weather:	Dry, with a mix of sunshine and cloud	
Cloud:	Few (1-2 okta[12]) fair weather cumulus, with bases around 2,500-3,000 ft and scattered (3-4 okta) stratocumulus clouds with bases 3,000-4,000 ft	
Surface Temp/ Dew Pt:	14/9 degrees Celsius	
MSL Pressure:	1016 Hectopascals (hPa)	
Freezing Level:	9,000 ft	
Other Comments:	Nil	

Table No. 7: Aftercast of weather conditions at the time and location of the accident

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

1.8 Aids to Navigation

Not applicable.

1.9 Communications

The departure airfield (EIIF) has an operating radio frequency (which may be unmanned) and no other aircraft from that airfield were operating locally at the time. The Aerodrome Controller at Waterford Airport did not have any communications with EI-BDX nor was any flight plan filed – no flight plan was required as the aircraft operated entirely in Class G airspace. There is no evidence that the aircraft communicated with any station during the accident flight.

1.10 Airfield Information

The airfield from which the aircraft was operating is located two Nautical Miles (NM) southwest of Taghmon, Co. Wexford. There is a single, grass runway, 600 metre (m) in length, designated Runway (RWY) 18/36.

1.11 Flight Recorders

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

1.12 Wreckage and Impact Information

The wreckage from the aircraft was spread over a wide area spanning four agricultural fields. The largest section of wreckage comprised the instrument panel forward to the propeller; the entire right wing complete with main undercarriage leg (**Photo No. 3**); and the inboard section of the left wing including the main undercarriage leg (**Photo No. 4**). This section of wreckage came to rest, inverted, in the boundary hedgerow of an agricultural field.

Photo No. 3: Right wing and main wreckage

Photo No. 4: Inboard section of left wing (inverted) that remained attached

Control cables remained attached to the main wreckage (**Photo No. 5**) and were stretched to a length of approximately 28 m.

Photo No. 5: Entangled and damaged control cables attached to main wreckage

The other end of the cables remained attached to the left, and centre sections of the horizontal stabiliser (**Photo No. 6**).

Photo No. 6: Control cables from the aircraft tail still attached to the main wreckage

The cables exhibited significant distress including severed strands, hockles[13] (with open and closed patterns) and bird-caging[14].

The outboard section of the left wing had broken up and various pieces were scattered throughout the debris field. The longest wreckage sections of the left wing were segments of the front wing spar (**Photo No. 7**) and rear wing spar.

Photo No. 7: Separated front spar from the left wing

These spars are known as '*box*' spars, and comprised a spruce timber framework of upper and lower members (referred to as '*booms*') and short vertical members (spacing blocks, referred to as '*soldiers*') running between the booms, which provided rigidity and facilitate the attachment of wing ribs. The webs of the spar were comprised of front and rear plywood faces: the orientation of the plywood faces was what is described as 0-90, meaning that the grain in the layers of the plywood was alternately oriented at 0 or 90 degrees, which the Investigation noted conformed to the Rollason Aircraft and Engines Ltd construction drawings.

[13] **Hockle**: A loop formed in a cable by twisting/rotation. A rotation that tends to separate the strands is termed '*open*' and a rotation that tends to tighten the strands is termed '*closed*'.

[14] **Birdcaging**: A section of cable in which the outer strands are too long; formed when a cable is opened up by twisting or by being twisted around its own axis.

Two metal bonding straps, which were part of the aircraft's lightning protection system, were routed along the forward face of the front spar web and were fractured after being pulled through the plywood surface, outboard of the left wing root section (**Photo No. 8**).

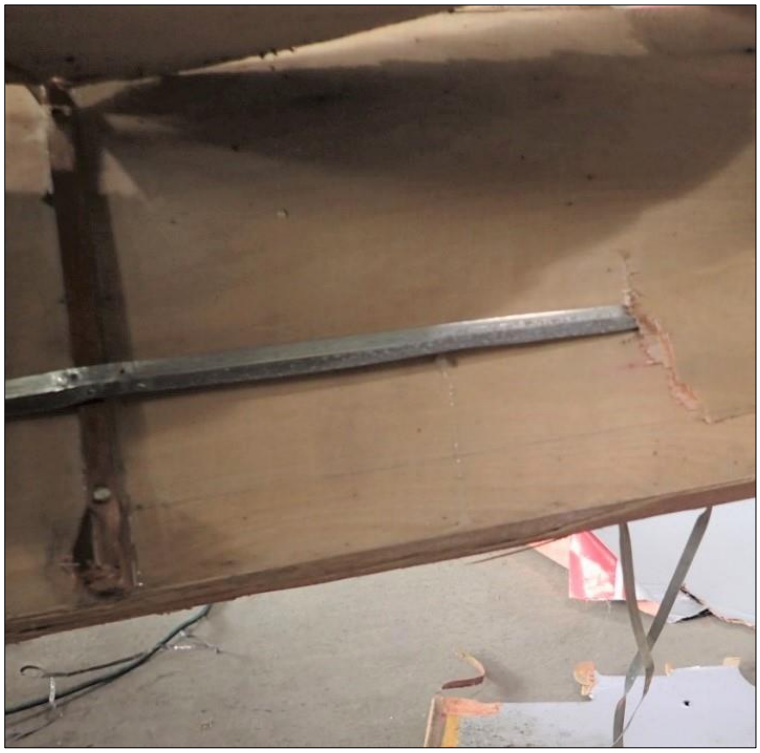

Photo No. 8: Bonding straps pulled through front spar web (viewed from front)

It was noted that the upper and lower booms of the left wing front spar had both fractured; the fracture on the lower boom extended over approximately 40 cm, whereas the fracture on the upper boom was concentrated over approximately 25 cm. Examination of the fractures revealed a predominant presence of pulled fibres at the fracture of the lower boom and a significant incidence of buckled fibres at the fracture of the upper boom.

Bolted joints located just inboard of the wing walkways attach the rear wing spars to the centre spar section (which runs through the fuselage). The Investigation noted that a short section of the centre spar section remained attached to the left rear spar at the bolted joint just inboard of the left wing walkway (**Photo No. 9**). There was a pronounced angle between the two components at the bolted joint. It was noted that this joint remained tightly fastened at the bolt and that even when significant force was applied, it was not possible to change the angle between the short section of the centre spar section and the left rear spar at the bolted joint just inboard of the left wing walkway.

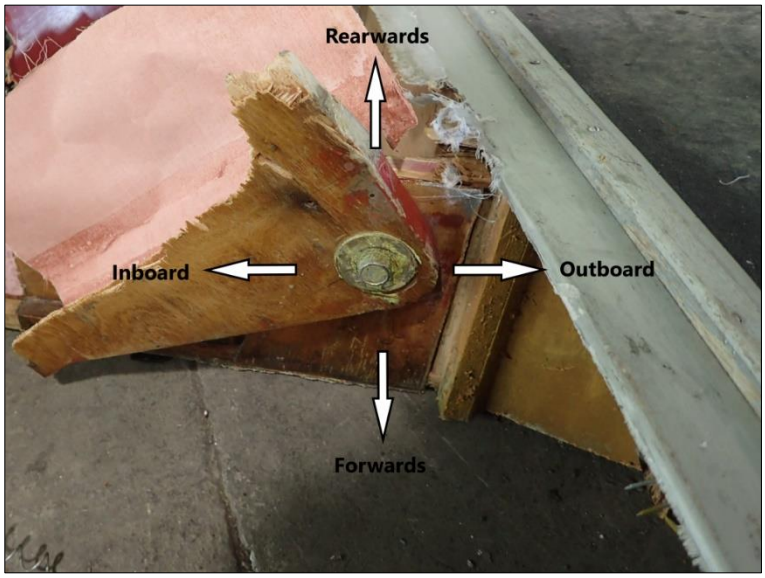

Photo No. 9: Bolted joint between rear spar and centre spar

Removal of the covering material and examination of the (still-attached) right wing revealed that the webs of the main spar exhibited fracture damage (**Photo No. 10**). Also, two of the wing ribs had suffered fracture damage in the vicinity of the area where load was transferred from the upper wing fabric surface, via stitched Dacron[15] to the lower surface of the ribs (**Photo No. 11**).

Photo No. 10: Fracture damage on the webs of the main spar of the right wing

[15] **Dacron**: Polyester-type fabric used for covering the aircraft structure.

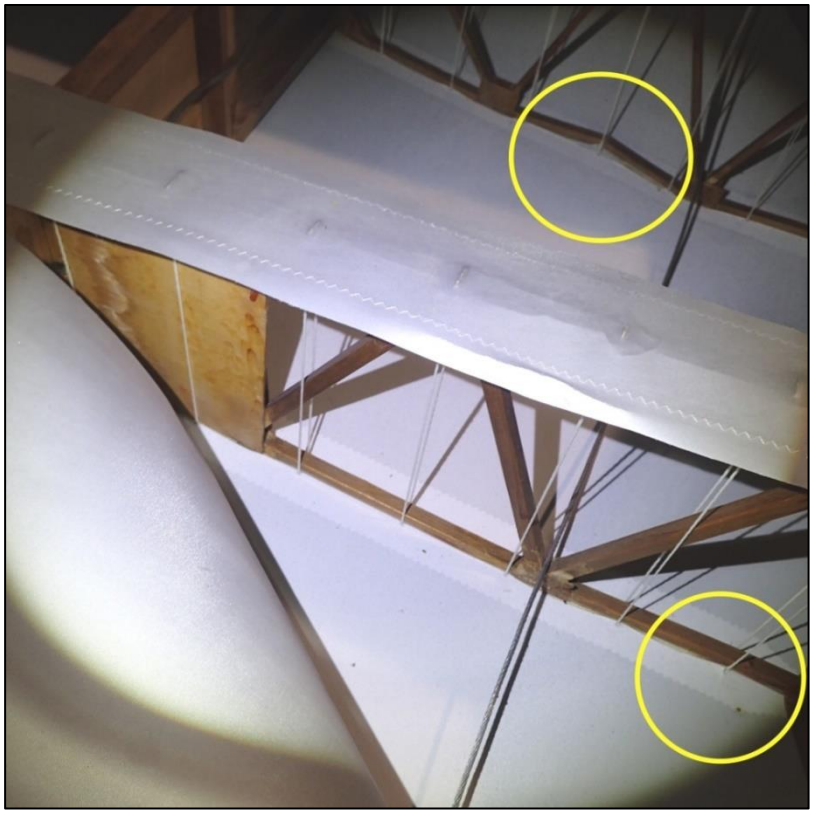

Photo No. 11: Damage to ribs of the right wing (circled in yellow)

The right-hand side of the tailplane, the vertical stabiliser and the rudder, had separated from the main wreckage and were located within the debris field, damaged but substantially intact.

The tail wheel had separated completely from the aircraft and the majority of its securing screws had pulled out of their retaining structure. The component was located in a hedgerow, a few metres away from the main wreckage (**Photo No. 12**).

Photo No. 12: Tailwheel assembly as located within the hedgerow

Components and structural elements from the fuselage and cockpit area were located throughout the debris field. The disposition of wreckage within the debris field did not follow a linear pattern, although items located furthest from the main wreckage tended to be smaller and lighter and included sections of plywood and fabric.

The AAIU conducted a detailed survey of the debris field. The wreckage was then recovered and brought under escort to the AAIU wreckage facility at Gormanston, Co. Meath. A wreckage layout was carried out (**Photo No. 13**). The cockpit area, including the seats and harness attachment points, had completely disintegrated.

Examination of the vertical stabiliser and rudder revealed that the rudder had separated from the vertical stabiliser at its upper hinge point and from the empennage at its lower hinge point (below the tailplane/elevator structure and above the tailwheel); each of these separations involved the attachment structure for each hinge separating from the vertical stabiliser and the empennage (respectively). Furthermore, the vertical stabiliser had separated (at its root) from the horizontal stabiliser (**Photo No. 14**). The rudder control cable attachment horns were bent downwards from their normal orientations.

Photo No. 13: Wreckage layout EI-BDX

Photo No. 14: Vertical stabiliser (red) and rudder (red/silver)

Examination of the rudder revealed that the section above the upper hinge had fractured and remained attached to the lower part only by the fabric (**Photo No. 15**).

21

Photo No. 15: Fractured and separated upper portion of the rudder

The upper part of the rudder was fractured in a left to right direction (when viewed from behind) (**Photo No. 16**).

Photo No. 16: Fractured surfaces of the separated upper portion of the rudder

1.12.1 Engine and Controls

The switches for each magneto were in the '*ON*' position; the carburettor heat knob was not pulled (it is pulled when carb heat is demanded by the pilot); and the throttle control knob was pulled out (pushing the throttle control knob in opens the throttle, increasing fuel flow to the engine and engine RPM). The engine was turned over by hand, and it was found that the spark generation system was delivering spark energy to all cylinders.

When the inverted wreckage was turned upright, the engine was found to contain a significant quantity of oil, with the dip stick indicating oil contents of approximately three and a half quarts.

When the main wreckage was lifted from the ditch it was observed that the two-bladed propeller was intact and neither blade was distorted.

1.12.2 Fuel

The main wreckage came to rest inverted, and there was a smell of aviation fuel in the ditch and surrounding foliage when the wreckage was lifted out and removed. Therefore, while there was some fuel remaining in the bottom of the tank when the wreckage was restored to an upright position, the fact that an unknown quantity of fuel had leaked from the aircraft into the ditch meant that it was not possible for the Investigation to accurately measure the fuel tank contents at the time of the accident.

According to the Weight and Centre of Gravity Schedule in the Aircraft Flight Manual (AFM), the aircraft had a single fuel tank with a useable capacity of 16 imperial gallons, which equates to 72 litres (L). Stencilled on the aircraft skin, adjacent to the fuel tank filler neck was '*AVGAS 100 LL*' and '*CAP 15 GALS*'. The position of the cockpit-mounted fuel shut-off valve, as recovered, was almost at the fully open position. The investigation notes that, as recovered, a furnishing panel from the aircraft wreckage was impinging on the fuel shut-off valve and therefore its position may have been affected during the impact sequence or the lifting of the inverted wreckage. The Investigation confirmed that the fuel shut-off valve, in the position as recovered, permitted fuel flow to the engine. Fuel was present in the gascolator[16], which is downstream of the fuel shut-off valve.

A small red notebook had been used to record details relating to the aircraft, primarily maintenance details. The notebook recorded that on the morning of the accident the Pilot had completed a '*Daily check*' and that the aircraft had '*full fuel*'. A flight log sheet was also maintained for the aircraft, which showed that on the day of the accident, there were three flights in EI-BDX prior to the accident flight. According to this flight log sheet, the aircraft started the day with '*Total Fue*l' of '*62'* L. A flight of one hour and thirty seven minutes duration was recorded, followed by a second flight of one hour's duration. The entry for the second flight of the day indicates that the '*Total Fuel*' remaining after the flight was '*32*' L, and an uplift of 40 L was then recorded. The flight log sheet records a third flight of one hour's duration, prior to the accident flight. From the available records, neither ILAS nor the BDX trustees had sufficient information to provide an estimate of the fuel quantity on board EI-BDX at the time of departure of the accident flight.

The manufacturer's '*Pilot Notes and Maintenance Instructions*', page 11, quoted figures for fuel consumption of 7.9 Imp Gal/Hr at Max continuous power; 5.5 Imp Gal/hr at Max Recommended Climb/Cruise power; 5.2 Imp Gal/hr at Recommended Cruise power; and 4.7 Imp Gal/hr at Economy Cruise power.

1.12.3 Centre of Gravity

According to the AFM, the limits for the aircraft Centre of Gravity (CG) were +16.6 inches to +23.0 inches. The Instructor had completed sample CG calculations which were contained within the aircraft paperwork. The Investigation noted that the sample calculation for the most rearward CG was based on two occupants weighing a total of 196 pounds (lbs) and 50 lbs of luggage on the Parcel Shelf. As already noted, the Instructor had discussed removing loose items prior to the flight.

1.13 Medical and Pathological Information

Post mortem examination reports for the Instructor and Pilot stated that the cause of death was *'Multiple severe traumatic injuries sustained in a light aircraft accident'*; and, *'Multiple severe traumatic injuries sustained in a light aircraft crash',* respectively. The Toxicology Test Reports for each person stated that ethanol and drugs were *'not detected'*.

[16] **Gascolator:** An in-line fuel filter and water separator.

1.14 Fire

There was no fire.

1.15 Survival Aspects

The nature of the in-flight break-up and rapid rotation of the aircraft resulted in the disintegration of the cockpit area and the harness attachment points, leaving the occupants unrestrained. The occupants were located close to, but separate from, the main wreckage.

1.16 Additional Research

The control cables were found with considerable stretching and distress evident. The failure modes of such cables were researched and the following should be noted. Aircraft control cables consist of a number of steel strands. The failure of such cables can be complex and can involve several different modes of damage. Individual strand failures were readily identifiable within the wreckage, as was the significant stretching associated with those failures. Previous studies of the failure of such cables have identified certain characteristic damage patterns which are associated with certain types of loading:

- Cables that have been pulled over a sharp edge have a tendency to coil.
- A loop formed in a cable by twisting/rotation is referred to as a '*Hockle*'. Cables that are twisted exhibit patterns associated with the direction of twist; twisting in the '*opening sense*' opens the helix arrangement of individual strands and lengthens the cable, whereas twisting in the '*closing sense*' shortens the cable.

1.17 Organisational and Management Information

The '*Operating Rules of the BDX Group*' stated that EI-BDX was a '*non-EASA* (*Annex II*[17])' aircraft, operated on an IAA Flight Permit, and based at EIIF; one element of this permit administration involved an annual inspection of the aircraft by an ILAS-designated inspector, prior to the renewal of the validity certificate for the aircraft's Flight Permit.

EI-BDX was owned and operated by a five-person trust. The stated aim of the trust was to '*operate the aircraft for the promotion of recreational flying, the educational benefit of aviation and to preserve the aircraft for the enjoyment of future generations of pilots.*' The aircraft was registered to the trust and to the '*BDX Grou*p'. The BDX Group had a nominated Chief Pilot (the Instructor) who was also the Chief Flying Instructor (CFI) with a Declared Training Organisation (DTO) based at EIIF; this DTO organised the booking of the aircraft.

According to the "*Operating Rules of the BDX Group*":

> "*17. The group's aircraft will be operated in daylight, visual meteorological conditions and in sight of the surface at all times. No flight over unbroken cloud or beyond gliding distance from land.*

[17] **ANNEX II**: List of non-EASA aircraft under the Basic Regulation; replaced by *ANNEX I* to Regulation (EU) 2018/1139 which superseded Regulation (EC) 216/2008 on the common rules in the field of civil aviation.

18. The aircraft will also be operated in accordance with the conditions and limitations specified in the flight permit which will be kept on board the aircraft.

[…]

20. The group's aircraft will be operated in accordance with the flight manual

[…]

21. The pilot in command of the group's aircraft must be a member of the BDX Group and have authorisation from the Chief Pilot for the operation of the aircraft. A list of members authorised to fly the Condor will be kept in the aircraft.

22. Members are required to ensure that they have provided the Chief Pilot with details of their current pilot licence and aviation medical certificate before acting as pilot in command of the group's aircraft.

[…]

24. The Pilot in command will occupy the left hand seat unless s/he holds a valid flight instructor rating including authorisation from the Chief Pilot to act in that capacity in the group's aircraft.

25. A member of the BDX Group who has not flown an SPA (Single Pilot Aircraft), SEP (Single Engine Piston) or TMG (Touring Motor Glider) within the preceding 90 days will require re-authorisation from and possibly a check flight with the group's Chief Pilot.

26. The group's aircraft may be used for flight training including type familiarisation, tailwheel difference training and refresher training.

25

27. A member of the BDX group, authorised to operate the aircraft, may bring a guest as a passenger.

28. All members are required to sign for their copy of the pilots notes and to operate the aircraft in accordance with the procedures contains [sic] *within that document. However intentional spinning is not approved unless accompanied by an instructor authorised by the Chief Pilot.*"

The Flight Permit was issued on 1 November 2016, with an expiry date of 31 October 2019. However, it required an annual permit inspection and extension sign off on a Validity Certificate; extensions had been signed off on the Validity Certificate on 14 November 2017 and 1 December 2018. The Flight Permit states "*Aerobatic manoeuvres are not allowed for this aircraft*".

When queried by the Investigation, the IAA stated that '*Within the training industry, the performance of stall or a spin/incipient spin is not widely considered "aerobatics"*'.

1.18 Additional Information

1.18.1 Interviews

One member of the operating group described his own experience during a licence revalidation flight with the Instructor in July 2019. He recalled that the Condor required sensitive handling and that unlike other aircraft he had flown, delicate wrist-based movements were sufficient to exercise control of the aircraft – he said that this required an adjustment on his behalf.

1.18.1.1 Interview with Pilot A

The Investigation interviewed a pilot, hereafter referred to as '*Pilot A*', who flew the aircraft and had conducted spinning exercises in the aircraft with the Instructor on two occasions, once when he was being checked-out to fly the aircraft, and once during a licence revalidation flight. Pilot A informed the Investigation that in his experience the aircraft had a pronounced '*wing drop*'[18] (primarily the left wing) at the stall[19]; he described that in his experience there was very little '*natural*' warning of an impending stall and that the aircraft could suddenly roll to ninety degrees angle of bank as a result of a wing drop.

Pilot A reported that there was an amber stall warning light, activated by a stall warning vane on the aircraft wing, but there was no aural warning horn warning of an impending stall. He said that the Instructor did caution him that because of the suddenness of the aircraft's stall behaviour, a '*Finals Stall*' (a stall when the aircraft was turning onto the final leg of an approach to land) would likely not be recoverable because the aircraft would be operating in a flight regime where it was both low and slow with insufficient height to recover.

Pilot A informed the Investigation that on the 2017 check-out flight, the Instructor asked him if he wanted to do spinning, and following pilot A's agreement, spinning was practiced up to three full revolutions. During Pilot A's 2019 licence revalidation flight, the extent of the spinning was confined to the '*incipient spin*'/single rotation spinning. He also informed the Investigation that in his experience, the Instructor removed the Aircraft Flight Manual from the aircraft parcel shelf if he intended to practice stalling or spinning with a student. Pilot A noted that prior to the accident flight the AFM had been removed (and left at the airfield) which led him to conclude that it had been the intention to carry out stalling and/or spinning during the accident flight.

Pilot A described the aircraft as '*slippy*' which he explained meant that aircraft speed built up quickly when the aircraft nose was lowered, such as in the recovery from a spin. He said that the Instructor briefed him prior to spinning the aircraft that Vne (the maximum allowable speed) was a concern and a limiting factor when recovering from a spin in the aircraft; Vne[20] for the aircraft was 147 kts. During pilot A's spinning with the Instructor, he estimated that the aircraft reached a maximum speed of 135 kts and that the aircraft loading during recovery was approximately 4g.

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[18] **Wing drop**: A tendency for one wing of an aircraft to reach the critical angle of attack and stall before the other, resulting in un-commanded roll and yaw in the direction of the stalled wing.

[19] **Stall**: A condition where an aircraft is 'flown at or above the critical angle of attack for its wings', causing the airflow to detach from the wing surfaces with an associated loss of lift.

[20] **Vne**: Velocity to never exceed.

1.18.1.2 Interview with Pilot B

Another pilot, hereafter referred to as '*Pilot B*', was interviewed by the Investigation. Pilot B was a friend of the Instructor, and had known him for many years. Pilot B had not flown the accident aircraft but he had experience on Condor aircraft generally, albeit several years ago and on a variant with flaps. He described the Condor as an '*honest airplane*' which taught students how to fly well. Pilot B described the Condor as an aircraft that stalled, spun, took off and landed '*normally*'; he also noted that in a spin the rate of rotation of a Condor was quite fast. Pilot B also said that in his experience with the Condor type, entry to the spin could sometimes be associated with an accelerated stall.

1.18.2 Aircraft Manoeuvring Terminology

A '*Spin*' manoeuvre describes a descending, orbiting of a vertical axis (**Figure No. 3**).

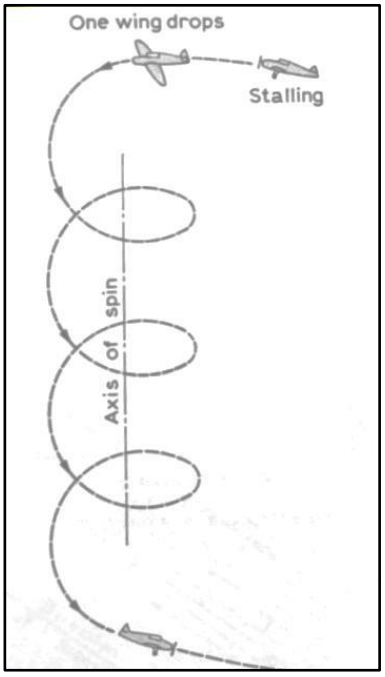

Figure No. 1: Spinning manoeuvre (*Kermode*)

EU Regulation (EU) No 923/2012 (on the common rules of the air), Article 2, has the following definition of 'aerobatic Flight':

> *5. 'aerobatic flight' means manoeuvres intentionally performed by an aircraft involving an abrupt change in its attitude, an abnormal attitude, or an abnormal variation in speed, not necessary for normal flight or for instruction for licenses or ratings other than aerobatic rating.'*

While a spin is considered to be aerobatic flight under the Common rules of the air above, such a manoeuvre was approved on the D.62 Condor with certain limitations.

1.18.3 Licencing Regulations

The Pilot's licence was a UK national licence issued by the Civil Aviation Authority, therefore UK legislation applied to the revalidation at the time. The UK legislation applicable to the revalidation at the time was '*The Air Navigation Order 2016*' and specifically, Schedule 8, Part 3, Chapter 1. The revalidation requirements are specified as being in accordance with '*FCL.740.A (b)(1) and (4) of Part FCL provided a SEP aeroplane with three axis control system is used*'.

Commission Regulation (EU) No 1178/2011, Annex 1 (Part-FCL), FCL.740.A (b)(1), amended by Regulation EU 2016/445, states:

> *'Single-engine piston aeroplane class ratings and TMG ratings.*
> *For revalidation of single-pilot single-engine piston aeroplane class ratings or TMG class ratings the applicant shall:*
>
> *(i) within the 3 months preceding the expiry date of the rating, pass a proficiency check in the relevant class in accordance with Appendix 9 to this Part with an examiner; or*
>
> *(ii) within the 12 months preceding the expiry date of the rating, complete 12 hours of flight time in the relevant class, including:*
>
> *— 6 hours as PIC,*
>
> *— 12 take-offs and 12 landings, and*
>
> *— Refresher training of at least 1 hour of total flight time with a flight instructor (FI) or a class rating instructor (CRI). Applicants shall be exempted from this refresher training if they have passed a class or type rating proficiency check, skill test or assessment of competence in any other class or type of aeroplane.'*

As the flight was for the purposes of licence revalidation which involved instruction, the Instructor was Pilot in Command.

The Pilot flew on a regular basis, and consequently for previous revalidations and for this intended revalidation, he had exceeded the specified minimum flying experience. The refresher training flight which the Pilot undertook would have fulfilled the requirements of option (ii) above.

The Instructor held a PART-FCL Private Pilot Licence with a valid SEP land class rating and instructor rating issued by the IAA. Under Commission Regulation (EU) No 1178/2011 the Instructor was qualified to provide the refresher training required by the Pilot.

Having completed the refresher training, the Pilot could present his licence and logbook to a UK authorised Examiner or to the Civil Aviation Authority who after confirming the requirements had been met would extend the validity of the class rating for a further two years from the expiry date. These administrative arrangements were included in UK CAA Standards Document 14, '*Guidance for Examiners and Information for Pilots of Single Pilot Aeroplanes - Class, Type and Instrument Rating Skill Tests and Proficiency Checks*', published by the UK Civil Aviation Authority.

1.18.4 Arrangements for Flight Training

Commission Regulation (EU) No 1178/2011, Annex 1 (Part-FCL), FCL.740.A (b)(1) (as amended by EU 2016/445) applied at the time to training flights in EI-BDX. It specifies that refresher training is to be completed with an instructor. There is no requirement for the refresher training to be completed with a training organisation.

The IAA informed the Investigation that:

> *'*[I]*t is permitted for an individual instructor to fly with any pilot for the purpose of conducting refresher training. This may be done in a flying school or club aircraft or in a private aircraft. There are no additional approvals or acceptance/recognitions required for this activity. It is common practice for already qualified pilots and/or pilot/owners to find a suitable instructor to conduct the bi-annual refresher training required to keep the SEP (A) valid. The content of this training is usually determined by the instructor and the pilot according to the individual circumstances.'*

1.19 Useful or Effective Investigation Techniques

1.19.1 Examination by Subject Matter Experts

During its examination of the wreckage, the Investigation found no evidence of any pre-existing defects that may have been relevant to the accident. All the structural woodwork appeared to be in good condition and well maintained. Furthermore, comparison of the structure after the accident with photographs taken in 2016, when the aircraft underwent work prior to being registered in Ireland, indicated that there had been no noticeable deterioration of the structure.

The Investigation contacted a UK-based aircraft engineer with experience inspecting aircraft of wood and fabric construction, and who had previously examined other such aircraft structures following accidents.

Of necessity, because of COVID-19 restrictions at the time, the UK-based engineer could only review the Investigation's detailed photographic survey of the aircraft structure and the engineering drawings which are retained by the UK Light Aviation Association (LAA). Based on that review, he concluded that '*the internal condition of the structure appeared to have been very good for an airframe of this age, without signs of mould, damp, glue failure or other forms of distress suffered by elderly wooden aircraft*.'

Following the relaxation of COVID-19 restrictions, the Investigation arranged for another UK-based expert to attend the AAIU's wreckage examination facility and carry out an in-person examination of the wreckage of EI-BDX. This expert had previously assisted the UK Air Accidents Investigation Branch (AAIB) with such examinations of wreckage. The expert had been involved in the construction, maintenance, repair, and examination of wooden and composite aircraft for over thirty years and had represented the UK on a number of committees and technical bodies in relation to technical issues involving adhesives for use in aircraft applications. On conclusion of the examination, the expert provided the Investigation with the following observations:

1. *'All available wreckage was examined*
2. *No anomalies were found with any of the wooden structure*
3. *No anomalies or failures were found with any of the glue joints*
4. *No anomalies were noted in relation to any control surfaces or their attachment mechanisms*
5. *The aircraft fabric was serviceable and in good condition*
6. *The primary failure appeared to have been a fracture of the main (fwd) spar in the left wing approximately mid-way along its span which resulted in the separation of the outboard section of the left wing*
7. *Examination of the left wing main spar fracture indicated that the failure mode was in upward bending*
8. *Examination of the right wing indicated that failure of the spar structure had been initiated, but it had not progressed to a separation of the outboard section*
9. *The combination of the failed left wing spar and the damage to the right wing spar was consistent with a structural overload in positive G*
10. *The aircraft tail structure had been severely compromised in the accident: the rudder had separated from the vertical stabiliser; the fin[21] had separated from the horizontal stabiliser; and the right hand portion of the horizontal stabiliser had separated from the remainder of the stabiliser at the inboard end*
11. *The separated rudder was noted to have a fracture that was caused by a force being applied to its top from the left side, as viewed from behind the aircraft*
12. *The overall pattern of the failure of the left wing with later failures of the tail structure, is consistent with information contained in one of the earlier iterations Manual of Accident Investigation, which stated:*

> *"When the wing fails first due to upward static overload, the separated wing will bend up and back over the fuselage. At the same time, the unbalanced lift from the opposite wing causes a rapid roll acceleration with the side of the aircraft missing its wing rotating downward. In some instances, the roll rate is rapid enough to cause a torsional failure in the empennage. The separated wing often impacts the tail surfaces causing matching impact marks and smears between the broken off wing and the leading edges of the tail. The impact with the tail may be severe enough to cause secondary failures in the tail structures."*

[21] **Fin:** Vertical stabiliser.

13. *Considering the damage pattern exhibited by the wreckage, a possible/likely failure sequence was that the left wing failed first. The separated wing section impacted the tail, fin, and specifically the rudder, from the left side, causing both fin and rudder to separate. The right side of the horizontal stabiliser separated due either to impact with the separated left wing section, or the aerodynamic loading caused by the roll rate associated with the failure of the left wing, or a combination of these two effects*

14. *As a general observation, and considering the age of the airframe, the wreckage condition suggested that the aircraft was in good condition and no evidence was found of age-related deterioration such as moisture ingress or glue joint failure that could have contributed to the failures of the structure that were identified during my examination.'*

In relation to point 12, the Investigation notes that the ICAO commentary was accompanied by three figures; these figures are reproduced at **Figure No. 2** and **Figure No. 3**.

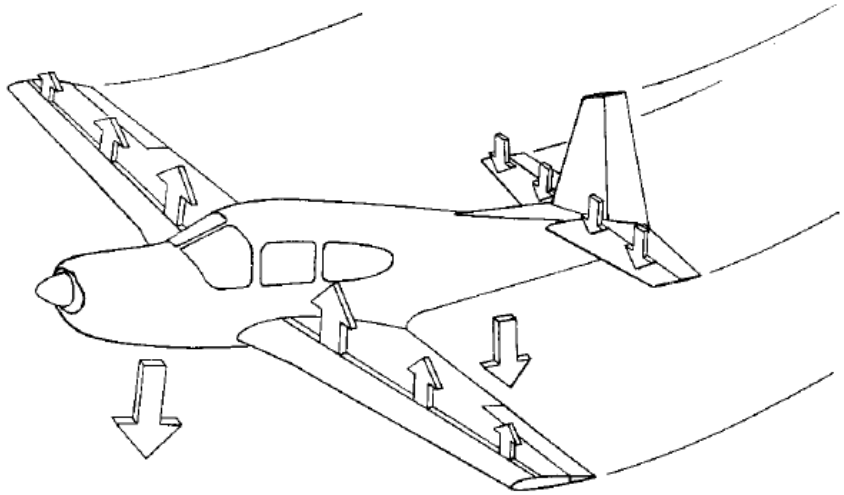

Figure 1
In a high-speed maneuver, the wings are loaded to high positive G and the tail to high negative G

Figure No. 2: Figure from ICAO guidance on in-flight break-up investigation

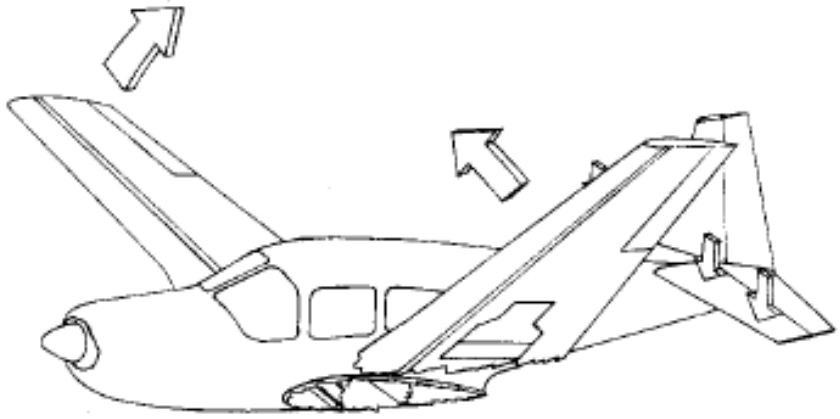

Figure 2
The wing fails due to excessive upward loading, the aircraft rolls abruptly

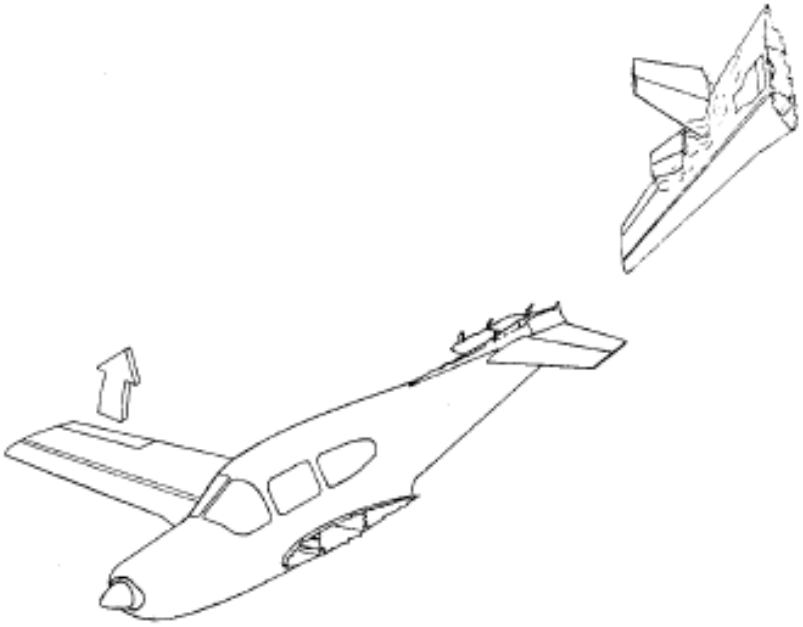

Figure 3
The separated wing often strikes the tail causing secondary failures and / or smears.

Figure No. 3: Two further figures from ICAO guidance on in-flight break-up investigation

2. ANALYSIS

2.1 The Accident Flight

The aircraft was owned and operated by a five-person Trust. The stated aim of the Trust was to '*operate the aircraft for the promotion of recreational flying, the educational benefit of aviation and to preserve the aircraft for the enjoyment of future generations of pilots.*' The Instructor was the designated Chief Pilot of the *'BDX Group.'* The Pilot occupied the left seat and the Instructor occupied the right seat; these are the normal seating positions for an instructional or revalidation flight.

The aircraft was on a local flight from EIIF and departed at 16:10 hrs approximately. According to an email that the Pilot sent to a friend on the evening before the flight, the flight was being undertaken as part of the Pilot's biennial licence revalidation.

During the flight the aircraft was operated in Class G (uncontrolled airspace), it did not make contact with ATC nor was there any requirement to do so. The aircraft was not fitted with a transponder. Consequently, there was no flight path data recorded by ATC.

2.2 Detailed Wreckage Examination

A detailed examination of the wreckage was carried out at the accident site and the wreckage was subsequently removed to the AAIU's wreckage facility at Gormanston, Co. Meath, for further examination.

The intact propellor, and the absence of distortion of propellor blades, suggests that at the time that the wreckage came to rest in the ditch, the engine was running at low power or had stopped.

Several witnesses reported hearing a bang and observing parts separating from the aircraft as it spiralled downwards in the final moments of the accident flight. The spiralling motion described suggests asymmetric aerodynamic loading of the aircraft's wings. Such asymmetric loading is consistent with a structural failure of one wing.

In timber spar boom fractures, pulled fibres are typical of a tension failure while buckled fibres are typical of a compression failure. The presence of predominantly pulled fibres on the fracture surfaces of the lower member with buckled fibres on the fracture surfaces of the upper member, combined with the greater length of the lower boom fracture versus the upper boom fracture, is consistent with a bending failure due to a combination of tension below the neutral axis and compression above it, and indicates a failure of the wing in positive g loading.

Further evidence that the left wing failed in positive loading can be found in **Photo No. 9**, which shows that the rear spar at the bolted joint (just inboard of the left wing walkway) had rotated upwards relative to the inboard centre spar section. The Investigation noted that this bolted joint remained tightly fastened and resisted movement even when significant force was applied, which indicated that the relative movement was not as a result of post-accident wreckage distribution or handling.

Accordingly, it appears that the left wing's front spar had failed in bending, with the outboard section subject to an upwards force. Additional damage observed on the web of the intact right wing was consistent with also being overloaded in an upward direction. The upward overloading of both wings could only occur while the aircraft tail was still attached and generating aerodynamic forces. Therefore, it is likely that the loud bangs reported by witnesses emanated from the failure of the main wing box-spar of the left wing.

Once the left main spar failed, the aileron control cables would have torn through the wood and fabric of the left wing. The bonding straps on the forward face of the main spar had torn through to the back of the spar, indicating that the failed section of the spar moved rearwards relative to the remaining root section. It is likely that parts of the failed wing section, most probably the fractured main spar and/or the wing end-cap (which incorporated part of the aileron mechanism), impacted the top of the rudder, fracturing it, and compromising the structure in the vicinity of the rudder's upper hinge attachment point. With the rudder hinge attachment structure compromised, its hinge separated, triggering the disintegration of the empennage and the fuselage.

The tail wheel assembly had separated completely from the aircraft and exhibited damage consistent with being subjected to a significant downwards force which caused the majority of its securing screws to pull out of their retaining structure; it was located in a hedgerow, a few metres away from the main wreckage, suggesting that it separated from the aircraft early in the accident sequence.

Examination of the fractured portion of the upper section of the rudder indicated that the fracture was caused by a force applied to the left side of the rudder (**Photo No. 16**). The downward bending of the rudder's control-cable attachment horns suggests that the rudder's upper hinge had separated, allowing the rudder to rotate backwards and downwards. Given the fracture of the rudder was above its upper hinge point, it is likely that part of the failed left wing struck the upper portion of the rudder on its left side, fracturing the upper portion and initiating the separation of the upper hinge from the aircraft's vertical stabiliser structure. The downwards rotation of the rudder, and the associated pulling of its control cables would have compromised the structure at the rear of the empennage.

The compromised empennage further disintegrated into three main sections: the vertical stabiliser; the right horizontal stabiliser and elevator; and a section comprising the left horizontal stabiliser, elevator and horizontal stabiliser centre structure. The left horizontal stabiliser, elevator and centre section remained attached to the main wreckage by the elevator control cables.

The cables exhibited significant distress including severed strands, hockles (with open and closed patterns) and bird-caging. The extent of the cable damage was consistent with the attached tail section being subject to complex, varying, aerodynamic loading as the damaged aircraft rotated rapidly and descended. The varying aerodynamic loads would also have resulted in the cables applying significant mechanical loads to the wood and fabric aircraft fuselage and cockpit area, and likely contributed to the rapid disintegration of the aircraft which was described by the witnesses.

During its examination of the wreckage, the Investigation found no evidence of any pre-existing defects that may have been relevant to the accident. All of the structural woodwork appeared to be in very good condition and well maintained. Furthermore, comparison of the structure after the accident with photographs taken in 2016, when the aircraft underwent works prior to being registered in Ireland, indicated that there had been no identified deterioration of the structure.

A UK-based aircraft engineer, with experience inspecting aircraft of wood and fabric construction, reviewed the Investigation's detailed photographic survey of the aircraft structure and concluded that '*the internal condition of the structure appeared to have been very good for an airframe of this age, without signs of mould, damp, glue failure or other forms of distress suffered by elderly wooden aircraft.*'

Another UK-based expert conducted an in-person examination of the aircraft wreckage and found no anomalies with the wooden structure, the glue joints, the control surfaces or their attachments mechanisms. Based on the nature of the damage, that expert opined that the left wing main spar had failed in upward bending, while the main spar in the right wing had started to fail, but had not progressed to a separation of the outboard section. The expert referred the Investigation to guidance from ICAO and he opined that:

> '*a possible/likely failure sequence was that the left wing failed first. The separated wing section impacted the tail, fin, and specifically the rudder, from the left side, causing both fin and rudder to separate. The right side of the horizontal stabiliser separated due either to impact with the separated left wing section, or the aerodynamic loading caused by the roll rate associated with the failure of the left wing, or a combination of these two effects*'. (**Figure No. 2** and **Figure No. 3** from ICAO guidance, illustrate such a scenario.)

The expert also noted:

> '*As a general observation, and considering the age of the airframe, the wreckage condition suggested that the aircraft was in good condition and no evidence was found of age-related deterioration such as moisture ingress or glue joint failure that could have contributed to the failures of the structure that were identified during my examination.*'

While noting that there may have been some confusion regarding the exact timing of the aircraft manufacturer's recommended 50 hr maintenance, and that the tachometer reading for the next scheduled check (a 25-hour engine oil change) appeared to have been exceeded by four hours, the aircraft had been operating for some time without adverse comments on the wing structure. The aircraft had also been subject to annual inspections and no adverse findings had been made regarding the aircraft structure. The Investigation also notes that ILAS stated that the aircraft occupants '*were closest to the operation of the BDX Group as Chief Pilot* [the Instructor] *and designated Owner & Maintainer* [the Pilot] *of the aircraft*'— it is therefore considered unlikely that they would have flown the aircraft if they had any doubt about required maintenance or airworthiness. Furthermore, the Investigation found no evidence of pre-existing damage to the left main spar or any pre-existing defects with the aircraft or engine that were considered relevant to the accident. The aircraft structure appeared to be in good condition and well maintained. Accordingly, it seems likely that the failure of the left wing spar was due to an overload occurring in flight.

2.3 Wreckage Distribution

The wreckage from the aircraft was spread over a wide area spanning four agricultural fields, with smaller and lighter elements situated furthest from the main wreckage. This distribution is consistent with an in-flight break-up, with lighter elements being carried by the wind further away from the main wreckage.

2.4 Fuel

According to the flight log sheet, the aircraft started the day with '*Total Fue*l' of '*62'* L. A flight of one hour and thirty seven minutes duration was recorded, followed by a second flight of one hour's duration. The entry for the second flight of the day indicates that the '*Total Fuel*' remaining after the flight was '*32*' L, and an uplift of 40 L was then recorded. The flight log sheet records a third flight of one hour's duration, prior to the accident flight. From the available records, neither ILAS nor the BDX trustees had sufficient information to provide an estimate of the fuel quantity on board EI-BDX at the time of departure of the accident flight.

Calculations from full fuel (72 L) to 32 L, over the two hours and 37 minutes recorded for the two flights, would indicate a fuel consumption of 3.4 Imp Gal/hr; whereas from 62 L to 32 L, would indicate a fuel consumption of 2.5 Imp Gal/hr. Neither of these figures falls within the range of the fuel consumption specified in the Pilot Notes and Maintenance Instructions (5.4 Imp Gal/hr).

Repeating the calculations for just the first flight (one hour and 37 minutes duration) gives a fuel consumption of 5.4 Imp Gal/hr (if the tank was at full capacity of 72 L) or 4 Imp Gal/hr (if fuel was at 62 L capacity). Accordingly, the Investigation is of the opinion that, prior to the first flight of the day, the aircraft was at full fuel capacity of 72 L as stated in the maintenance notebook and that the figure of 62 L in the flight log was an error. It also seems that the aircraft was returned to full fuel after the first flight because there is an entry of an uplift of 40 L which, combined with the reported 32 L remaining fuel would give a full fuel load of 72 L.

Assuming the aircraft had full fuel before the second flight of the day then at the time of the accident the aircraft been engaged in another three flights: one flight with the accident Pilot, which was of one hour duration; one flight with the Instructor and a student, which was of one hour duration; and the accident flight, which was approximately a half hour in duration. Therefore, from full fuel, the aircraft had operated for 2.5 hours. Using the fuel consumption figure determined above from the earlier flight of 5.4 Imp Gal/hr, the aircraft would have consumed approximately 13.5 Imp Gals. Therefore, the fuel remaining in the tank at the time of the accident is estimated to have been 2.5 Imp Gals.

2.5 Centre of Gravity

As already noted, the Instructor had discussed removing any loose items prior to the flight. Pilot A informed the Investigation that in his experience the Instructor removed the AFM from the aircraft parcel shelf if he intended to practice stalling or spinning with a student, and since the AFM had been removed from the aircraft (and left at the airfield), Pilot A opined that it indicated that there had been the intention to carry out stalling and/or spinning during the accident flight. As the AFM had been removed and left at the airfield, the Investigation is of the opinion that the Instructor would also have removed any loose items prior to the accident flight.

Repeating the Instructor's most rearward sample calculation, with no weight on the Parcel Shelf, at full fuel (115 lbs), the calculated CG was +20.7 inches. With an estimated 2.4 imperial gallons remaining on board at the time of the accident, and assuming occupant weights of 196 lbs each (as used by the Instructor in his sample most rearward CG calculation), the calculated CG was +22.2 inches. Therefore, while acknowledging that the exact fuel quantity in the aircraft at the time of the accident cannot be accurately estimated, it seems likely that at the time of the accident the CG of the aircraft was within the allowable range of +16.6 inches to +23.0 inches.

2.6 Spinning Manoeuvres

Prior to the flight the Pilot indicated that spinning would be conducted during the flight. Furthermore, the Instructor removed items from the parcel shelf which the Investigation was informed was a typical preparation for a flight that would involve stalling and spinning practice.

The approved Flight Manual for the aircraft states '[…] *no aerobatic manoeuvres except spins are permitted*' whereas the IAA-issued Flight Permit states '*Aerobatic manoeuvres are not allowed for this aircraft.*' However, the IAA informed the Investigation that '*Within the training industry, the performance of stall or a spin/incipient spin is not widely considered "aerobatics"*'. The Investigation therefore considers it reasonable to conclude that spinning was permitted on the aircraft.

2.7 Aircraft Manoeuvres

In the absence of recorded data or video imagery, it is not possible for the Investigation to determine definitively what manoeuvres were being conducted during the flight generally, and specifically, immediately prior to the in-flight break-up of the aircraft. However, the evidence indicates that it had been planned that spinning manoeuvres would be carried out during the flight. In this regard, the Investigation notes that the aircraft *Pilots Notes and Maintenance Instructions* caution that '*If in spin aileron is used at the point of entry, the aircraft is very reluctant to spin and usually enters a spiral dive with the consequent risk of overstressing the aircraft as the speed builds up very rapidly in the spiral'.*

The aircraft *Pilots Notes and Maintenance Instructions* also caution that *'the stick should be moved gently forward as an abrupt forward motion of the stick can result in the aircraft coming out of the spin in an attitude over the vertical and this creates the risk of overstressing the aircraft during the recovery from the ensuing dive.*' Therefore, although spinning was an approved manoeuvre for this aircraft type, and the Pilot had stated that they were '*going up to do spins*', there were known risks of overstressing the aircraft when conducting spinning manoeuvres.

2.8 Survivability

Given the extent of disintegration of the aircraft during the inflight break-up, the Investigation considers that the accident was not survivable.

3. CONCLUSIONS

3.1 Findings

1. The aircraft was operated on a Flight Permit issued by the IAA, following a recommendation made by ILAS.

2. The Pilot of the aircraft was one of the five–person Trust that owned and operated the aircraft.

3. The Instructor on the flight was the Chief Pilot of the Trust that operated the aircraft.

4. The wreckage condition suggested that the aircraft was in good condition and no evidence was found of age-related deterioration such as moisture ingress or glue joint failure that could have contributed to the failures of the structure that were identified.

5. The aircraft was on a local training flight which was part of the Pilot's revalidation requirements for his Single-Engine Piston Aeroplane Class rating licence revalidation.

6. Prior to the flight, the Pilot indicated that spinning manoeuvres were planned, and the Instructor removed loose articles from the parcel shelf which was required when stalling or spinning was planned.

7. The Aircraft Flight Manual for the D.62B Condor states that, '*Operation is limited to normal flying manoeuvres and no aerobatic manoeuvres except spins are permitted*.'

8. There were known risks of overstressing the aircraft when conducting spinning manoeuvres.

9. The aircraft wreckage was distributed over a wide area, consistent with an in-flight break-up.

10. The in-flight break-up probably commenced when the left wing spar failed in positive g loading, followed by components from the failed wing striking the empennage causing the rudder to separate and bend backwards and downwards leading to the further disintegration of the aircraft.

11. Once the left wing had failed, the aircraft was no longer controllable and it descended with rapid rotation.

12. The nature of the in-flight breakup and rapid rotation of the aircraft resulted in the disintegration of the cockpit area and the harness attachment points, leaving the occupants unrestrained.

13. The accident was not survivable.

3.2 Probable Cause

During manoeuvring, the aircraft wings experienced an overload in positive g, with the left wing failing, and a subsequent in-flight break-up.

3.3 Contributory Cause(s)

Nil

4. SAFETY RECOMMENDATIONS

This Investigation 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

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