FINAL REPORT

AAIU Formal Report No: 2008-013
AAIU File No: 2006/0040
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Operator:	National Flight Centre
Manufacturer:	Cessna
Model:	150 M
Nationality:	Irish
Registration:	EI-CHM
Location:	Raharney, Co. Westmeath, Ireland
Date/Time (UTC):	25 May 2006 @ approximately 08.59 hrs UTC [1]

SYNOPSIS

The aircraft departed Weston Aerodrome (EIWT) at a reported time of 08.20 hrs on a flight to the west of the aerodrome. The purpose of the flight was a revision detail for a pre-Instructors rating test of the right hand seat occupant. At approximately 08.55 hrs, witnesses who were working on a house close to Raharney, Co. Westmeath, heard the sound of a revving engine and on looking towards the West saw an aircraft spiralling vertically down to earth. A survey of the accident site determined that the aircraft impacted vertically; there was no wreckage path and both occupants were found fatally injured within the wreckage of the aircraft. An inspection of the engine did not reveal any abnormalities. No evidence of pre-impact aircraft malfunction was found. There was no fire.

NOTIFICATION

A member of An Garda Síochána notified the AAIU at 09.24 hrs on the 25 May 2006 that a fatal aviation accident had occurred in the town land of Raharney, Co Westmeath. A "Go-team", consisting of Mr Jurgen Whyte, Chief Inspector of Air Accidents and Mr John Hughes, Inspector of Air Accidents, routed to the scene and commenced the Investigation at 11.00 hrs. In accordance with the provisions of SI 205 of 1997, the Chief Inspector of Air Accidents, on 25 May 2006, appointed Mr John Hughes as the Investigator-in-Charge (IIC) to conduct a Formal Investigation into this accident. Mr Jurgen Whyte provided operational assistance.

[1] Local Time = UTC + 1 hour during summertime. All times in this Report are in UTC unless when referred to as Local.

FINAL REPORT

1. FACTUAL INFORMATION

1.1 History of the Flight

The aircraft, a Cessna 150 M, registration EI-CHM took-off from runway (RWY) 25 at EIWT at a reported time of approximately 08.20 hrs on a training flight to the west of the aerodrome. The Instructor, the Pilot-in-Command, was seated in the left-hand seat and a qualified pilot (referred to as Student Instructor henceforth in this Report) who was preparing to re-take his Instructors rating skill test was seated in the right-hand seat. The EIWT weather at the time was good with light winds. Weston Tower stated that the aircraft took-off and headed directly "West". No further communication was made between the aircraft and the control tower at EIWT or ATC Dublin. As EI-CHM was flying outside of controlled airspace there was no requirement to communicate with EIWT or Dublin ATC. However, the Mode C transponder on the aircraft (which is a requirement) was switched on, and this enabled the track, speed and pressure altitude en route to the training area to be automatically recorded at ATC Dublin (See Section 1.8.1).

A group of 4 builders were working on a house near the village of Raharney. Just before 10 o'clock, at approximately 08.55 hrs (09.55 hrs Local) their attention was brought to the sound of an aircraft engine to the west of their position. They then saw the aircraft spiralling down to earth. Two of the builders got into a car and raced in the direction of where they had last seen the aircraft. After some time they located the wreckage of the aircraft in an open field near the village of Raharney. On arrival at the wreckage they found two persons within the wreckage fatally injured. One of the builders dialled 999 on his mobile phone and alerted the emergency services.

1.1.1 Witness Reports

1.1.1.1 Witnesses Report No.1

This group of witnesses, comprised of the four builders above, were working on the second floor of a house east of the accident site (**Appendix A**). Their radio was on loud as they were awaiting the 10 o'clock morning news signal to take their break. At approximately 08.55 hrs (09.55 hrs Local), they heard the sound of a revving engine and looked west to see an aircraft spiralling vertically down with the propeller and engine pointing downwards. They thought the aircraft was spinning to the right. They said it appeared to spin 3 or 4 times in about 5 seconds. The aircraft went out of sight below trees with the engine dying out and then they heard a bang. They drove in the general direction of the last sighting, turned down a lane and saw nothing. They continued to the next road at Raharney and turned left down that road. They then saw the wreckage of an aircraft in a field on the left side of the road and they ran into the field where they found both occupants of the aircraft fatally injured. One of them called 999 on his mobile phone and alerted the emergency services. The time of this call as recorded on the witness's mobile telephone was 09.04 hrs (10.04 hrs Local)[2]. They considered that the drive from the building site to the accident site was somewhere between 5 and 10 minutes. All of these particular witnesses said that they were used to aircraft flying overhead and as a result they generally did not look up to see the aircraft.

[2] This time was later found to be erroneous. See Section 1.1.2

1.1.1.2 Witness Report No. 2

The witness was at the back door of his house with his son. The house is about 0.75 miles east of the accident site. He saw the aircraft spiral in close by. It made 3 to 4 spins straight down. The engine was running but spluttering. He said that the aircraft seemed to have come from an easterly direction before it went into a spiral. He said he did not know *"a lot about these things"*. He compared the sound to the sound of a lawn mower spluttering sound. He thought that the time was just shortly after 9.00 hrs. (10.00 hrs Local)

1.1.1.3 Witness Report No. 3

This witness was working at his house, southeast of Raharney, about 0.5 miles from the accident site. It is on the edge of a bog. He was familiar with the sound of aircraft flying overhead. He remarked that it was a nice day for flying. Aircraft were doing this all the time in the area and sometimes he would not look up at all. At one stage the aircraft passed overhead his place but he said that it was at a good height. He said the aircraft was in the area for what seemed to be about 25 minutes.

He got into his van to go down the road. On this road he met a local who told him that an aircraft had crashed in the field. This was 2 to 3 minutes after the aircraft had hit the ground (**See Analysis 2.2 for Investigation comment**).

1.1.1.4 Witness Report No. 4

This witness stated that it was a beautiful sunny morning and he was having a cup of tea outside on decking at the side of his bungalow. He heard the sound of the engine because the aircraft was so low. It was about 1 mile away at the time. He looked up to see an aircraft, with wings level, descending at an angle of about 20° to the horizontal, in an east to west direction. The engine was "stalling" and then the engine cut. He said that he formed the opinion that the occupants then tried to start the engine. The aircraft then went into a spiral dive and disappeared behind the tree line. He heard a bang as the aircraft hit the ground. Members of his family jumped into the car with him. They thought the aircraft might be out the Ballivor Road so they went down that road and then turned back. He checked the time in the car going through the village again. It was 9.15 hrs (10.15 hrs Local) He took a left turn at the village and down the road to where he found the accident site. He estimated the time of the accident to be between 9.00 hrs (10.00 hrs Local) and 9.05 hrs (10.05 hrs Local).

1.1.1.5 Witness Report No. 5

This witness lives in Castletown, Rathmoylan. Castletown is 10.75 miles due east of the crash site. He has a Student pilots licence with approximately 35 hours on a Cessna 172. He was in his kitchen. He said that many aircraft practice in the area. He heard the sound of an aircraft and went out into the back garden, which faces west. He did not have a wristwatch but thought it was after 9.00 hrs (10.00 hrs Local). He saw an aircraft flying straight and level with power, circling at 1,500 ft. He heard the engine cut. He looked to the east and saw the aircraft carrying out what appeared to be a forced landing exercise or glide approach. The aircraft appeared to descend down to approximately 500 ft and levelled with power along the line of houses towards the north.

He could see it was a white aircraft with blue marking and Registration No. EI-CR or CH. As the aircraft passed over the house the engine was powered up. The engine coughed a bit but it sounded OK. The aircraft climbed up on power, turned left to the west and continued to climb up to 1,500 - 2,000 ft looking south. The aircraft then continued to the east. He then lost sight of the aircraft behind some trees (**See Analysis 2.2 for Investigation comment**).

1.1.2 Timings

1.1.2.1 999 Call

One of the builders (Witnesses No. 1) confirmed that he made a 999 call on his mobile phone as he ran across the field towards the wreckage. The time of this call was recorded on his mobile phone as 09.04 hrs (10.04 hrs Local).

Subsequently, a review of the central 999 switch log confirmed that the mobile phone call was actually logged (automatically) at 09.08:21 hrs (10.08:21 hrs Local).

The HSE Ambulance Service confirmed that the Ambulance Service Mullingar received the call-out at 09.10 hrs (10.10 hrs Local).

1.1.2.2 Timing of Response by Witnesses No. 1

Witnesses No. 1 estimated that it took somewhere between 5 and 10 minutes to drive from the building site to the accident site. Subsequent to the initial interview, it was decided by the Investigation to attempt to narrow down the time scale for the transit to the accident site. In the company of two Inspectors of Air Accidents, one of the builders drove the route as taken on the day of the accident. This re-enactment from first sighting to arrival beside the wreckage was timed at 9 minutes. While this timing cannot be used as an exact time, it does indicate that the response time was at the upper scale of their estimate.

1.1.2.3 Probable Time of Impact

The 999 call was automatically recorded as being received at 09.08:21 hrs (10.08:21 hrs Local). Taking that the originator of the 999 call took approximately 9 minutes to transit from the building site to the accident site, the probable time of the impact would have been 08.59 hrs (09.59 hrs Local).

1.2 Injuries To Persons

Injuries	Crew	Passengers	Total in aircraft	Others
Fatal	2	0	2	0
Serious	0	0	0	0
Minor	0	0	0	0
None	0	0	0	0
TOTAL	2	0	2	0

1.3 Damage To Aircraft

The accident site (53° 31.171″N, 07° 05.069″W) was located in an open field approximately 0.5 miles out from the village of Raharney, on the left-hand side of the Raharney to Grange Beg road (**Appendix A**). When the aircraft impacted the ground, very little forward movement occurred and all the aircraft was found in the same location. The aircraft was destroyed in the ground impact. Details of the damage are given in Section 1.12.1.

1.4 Other Damage

Apart from damage to the vegetation surrounding the aircraft caused by fuel leakage, there was little damage elsewhere. It had been raining during the days leading up to the accident and the ground was soft and wet. The impact area was in a grass field used for cattle grazing with a slight slope from east to west. The softness of the ground allowed one of the propeller blades to penetrate the earth with relatively little damage to the blade. The nose wheel was half submerged in the soil but had broken off just above the fork. A large amount of earth had adhered to one side of the nose wheel.

1.5 Personnel Information

1.5.1 (Commander)

Personal Details:	Male, aged 38 years
Licence:	IRL CPL(A)
Last Revalidation:	13/05/2005
Medical Certificate:	24/02/2006 Class 1

The Instructor also had an AVRO RJ/Bae146 aircraft rating which included a Multi-Pilot Aeroplane (MPA) Instrument Rating (IR).

His Instrument Rating was valid from 11/02/05 to 10/02/06. His Instructor Rating was valid for Instruction for CPL(A), Instruction for the Instrument Rating and also for the Flight Instructor Rating.

Flying Experience:

Total all types:	1,755	hours
Total all types P1:	1,422	hours
Total on type:	1,555	hours
Total on type P1:	1,390	hours
Last 90 days:	200	hours
Last 28 days:	65	hours
Last 24 hours:	3	hours

Duty Time:

Duty Time up to incident:	Not applicable
Rest period prior to duty:	16 hr 20 mins

1.5.2 Student Instructor

Personal Details:	Male, aged 38 years
Licence:	UK CPL(A)
Last Validation:	21/12/2004
Medical Certificate:	11/11/2005 Class 1

An Irish issued JAR-FCL PPL(A) licence was returned to the IAA after the issue of the UK licence on 30/03/2005 . The Student Instructor also had a UK Multi-Engine Pilot licence (MEP) valid to 11/01/06, but this had not been revalidated.

Flying Experience:

Total all types:	287	hours
Total all types P1:	127	hours
Total on type (150/152):	121	hours
Total on type P1:	46	hours
Last 90 days:	3.73	hours
Last 28 days:	3.73	hours
Last 24 hours:	0	hours

Duty Time:

Duty Time up to incident:	Not applicable
Rest period prior to duty:	Not applicable

1.5.3 Instructor – Training History

The instructor was issued with a Student Pilot Licence in April 1998 and the IAA issued a PPL licence in July 1998. A CPL was issued in June 2001 valid up to 30 May 2006. He had a total time of 244 hours flying experience at the time.

He completed a Flight Instructor Rating course at Weston and satisfactorily completed his skill test on 24 October 2001. A Flight Instructor's Rating was first issued on 2 November 2001. By 7 September 2001 he had a total of 283 hours flying time, 21 hours of which were on multi-engine aircraft (in a BE76 aircraft). He also had a total of 37 hours of instrument time. He satisfactorily conducted a skill test for an Instrument Rating (Multi-engine and Single engine aeroplane) on 18 July 2002.

Up to 13 February 2004, he had completed 340 hours of instruction out of a total of 574 hours flying. On 24 November 2004, he was the only pilot out of three to be tested and cleared as an authorised Single Engine (SE) Flight Instructors Course (FIC) Instructor for the Flight Training Organisation (FTO) at Weston. By 26 May 2005 he had completed 1,064 hours of instruction out of a total of 1,342 hours flying. All of the instruction was on C150 and C172 aircraft.

From May 2005 and February 2006 there was a period during which the ınstructor was flying multi-engine commercial aircraft. In February 2006 he resumed instructional flying at Weston and completed a further 213 hours up to the time of the accident.

1.5.4 Student Instructor – Training History

The student was issued with a Student Pilot Licence in September 2001 and the IAA issued a PPL licence in February 2003. A UK CPL was issued to the student in March 2005 valid to 2010. He had a total time of 207 hours flying experience at the time. Having completed a course (ground and air) for the initial issue of a Multi-Engine Instrument Rating, the student was put forward for the appropriate skills test. An IAA examiner conducted the test on 9 June 2005 and on 25 June 2005. The student failed the test on both occasions, but on a later re-test, in August 2005, was successful.

In June 2005, the Student Instructor commenced a Single-Engine Class Rating Instructor Course at an FTO. Following completion, the Head of Training at the FTO recommended to the Irish Aviation Authority (IAA) on 4 November 2005 that the Student Instructor was ready for a skill test for the issuance of a Class 2 Flight Instructors Rating.

In January 2006, the Student Instructor conducted a skill test with an IAA examiner for a Flight Instructor Rating. The pupil failed the test in the following sections:

(2a) *Visual Presentation and Content - Poor Pre-flight Briefing*
(3f) *General Airmanship/Safety - Broke minimum height rule before initiating a go-around from practice forced landing (P.F.L).*
(4c) *Forced Landing without Power.*

The IAA examiner responsible for the skill test recommended a further minimum re-training requirement of 2 hours on the aircraft and 2 hours of ground training.

Following further flights of 3 hours 44 min with the Centre's Instructors during which circuits, stalls, spins and spin avoidance lessons were conducted, the Head of Training recommended to the IAA on 3 February 2006 that the pupil was ready for a re-test. Although an IAA examiner was assigned, no examination took place. There was then an interlude of 3 months with flying resuming in May 2006 with 1 hour 46 minutes instruction and 1 hour 57 minutes solo flights. Both the qualified Instructor and the Student Instructor last flew together on 12 May 2006 when 5 take-offs and landings were conducted. The accident flight was being conducted as a pre-test exercise for the issue of a Flight Instructor Rating(A).

1.6 <u>Aircraft Information</u>

1.6.1 Leading Particulars

Aircraft type:	Cessna 150M
Manufacturer:	Cessna Aircraft Company, USA
Constructor's number:	150-79288
Year of manufacture:	1977
Certificate of Registration:	2 March 1993
Certificate of Airworthiness:	8 December 2005
Total airframe hours:	13,796 hrs

Total cycles:	N/A
Engines:	Continental O-200-A48
Maximum authorised take-off weight:	1,600 lbs
Actual Take off weight:	1,543 lbs
Estimated weight at time of accident:	1,525 lbs
Centre of Gravity limits (at accident weight):	32.6 inches to 37.5 inches aft of datum
Centre of Gravity at time of accident:	35.53 inches

1.6.2 General Information

The Cessna 150M is a high-wing aircraft, equipped with a fixed tricycle landing gear, electrically actuated wing-flaps, and is powered by a single reciprocating engine. The fuselage and empennage are of an all-metal semimonocoque design. The wings are externally braced and have two metal fuel tanks. The airplane was equipped with dual controls and two cockpit seats. The accident airplane had a certified maximum take-off weight of 1,600 lbs and a maximum load of 503 lbs. The Cessna 150M has a 6-inch increase in vertical fin and rudder height over previous 150 versions, which improves spin recovery.

The IAA issued a Certificate of Registration to the present owner on 2 March 1993. The aircraft was issued an Airworthiness Certificate on 4 Jan 2005, was certified in aerial work category, and was valid at the time of the accident. The accident aircraft had accumulated a total flight time of 13,796 hours since new. The engine tachometer time before flight was 0334.3 hrs

1.6.3 Aircraft Servicing

The last annual inspection in accordance with the Light Aircraft Maintenance Schedule CAA/LAMS /A/1999, was completed on 12 November 2005. This included a full Radio check including a check with a field test set of the Transponder in Mode C. A 3-year inspection of all aerials and feeders was also carried out at that time. The aircraft was test flown by a licensed pilot approved by the IAA to carry out such tests, and the flight test was certified as satisfactory.

The aircraft had accumulated 368 flight hours since that inspection. Airworthiness Directives were checked to Bi-weekly No. 2005-24 and IAA Airworthiness Notices were checked to the latest issue. The last airframe inspection, a 150-hour inspection, was performed on 12 May 2006, at 13,766 hours total time and 13 days prior to the accident. The aircraft had accumulated 30 hours since the last inspection. According to the aircraft maintenance logbooks, all applicable FAA Airworthiness Directives had been complied with as of the last inspection.

The engine was a 100 horsepower Teledyne Continental Motors 0-200-A48, serial number 275915-R. The engine had accumulated 674 hours since the last factory overhaul, which was completed on 6 June 2005. The engine was installed on the accident aircraft on 16 June 2005.

The last engine inspection, a 150-hour inspection, was performed on 12 May 2006, and the engine had accumulated 30 hours since the last inspection. The propeller was a two-bladed fixed pitch McCauley 1A102, serial number YK41002.

The Technical Log Sheet indicates that there was no aircraft defects reported following a one-hour instructional flight carried out on the previous evening, the 24 May 2006. The aircraft Flight Information Sheet for the morning of 25 May 2006 indicates that the Instructor authorised the one-hour flight in EI-CHM and the Student Instructor signed out the aircraft under "pilot's initials before flight".

1.6.4 Weight & Balance

The aircraft's Documentation included a "Weight and Balance Schedule Amendment" sheet, dated 28 July 1996 and stated:

New Empty Weight:	1096.5 lbs
New Empty Weight CG:	33.49 inches
New Useful Load:	503 lbs.
New Empty Weight Moment:	36,729 in lbs.

The Pilot's Operating Handbook (POH) listed the Cessna 150M certified maximum take-off and landing weight as 1,600 lbs. The aircraft fuel tanks were filled to full capacity of 22.5 US gallons (135 lbs) on the previous evening. A flight of 1 hr 40 min then took place and the estimated remaining fuel on board following that flight was 84.6 lbs (14 US Gals). This figure is confirmed by the Instructor's "fuel state" statement prior to the accident flight. Allowing for a flight duration of 30 minutes at a consumption of 6 US gals/hour gives a total on board load of fuel of 66.6 lbs at the time of the accident. This represents 49% of total usable capacity. The estimated weight at the time of impact was approximately 1,525 lbs.

1.6.5 Wing Flap System

The POH for this aircraft states:

"The wing flaps are of the single-slot type and are extended or retracted by positioning the wing flap switch lever on the instrument panel to the desired flap deflection position. The switch lever is moved up or down in a slot in the instrument panel that provides mechanical stops (detents) at the 10° and 20° positions. For flap settings greater than 10°, move the switch lever to the right to clear the stop and position it as desired. A scale and pointer on the left side of the switch lever indicates flap travel in degrees. The wing flap system circuit is protected by a 15-ampere circuit breaker, labelled FLAP, on the right side of the instrument panel."

The POH also states:

"In a balked landing (go-around) climb, the wing flap setting should be reduced to 20° immediately after full power is applied. Upon reaching a safe airspeed, the flaps should be slowly retracted to the full up position".

The 1977 model of the Cessna 150M was the first Cessna 150M aircraft to have flap control detents for 10, 20, 30, and 40-degree positions. This flap selector system was carried through to the Cessna 152 aircraft, which followed the Cessna 150M versions, although the maximum flap travel was reduced from 40 degrees to 30 degrees in the Cessna 152 aircraft.

1.7 Meteorological Information

1.7.1 Met Éireann, the Irish Meteorological Service, provided the following information to the Investigation:

General Situation:	The area was under the influence of a shallow ridge behind a frontal system oriented along the south coast of the UK and extending into mid Atlantic skirting the southwest coast of Ireland.
Wind:	Surface Wind: Slack, generally south-westerly, less than 5kt 2,000 ft: 260 05-08kt 5,000 ft: 280 10-15kt
Weather:	Nil
Visibility:	10+ km
Cloud:	FEW 2,000 to 2,600 ft BKN 20,000 to 24,000 ft
Temperature/ Dew point:	10/03 deg C
QNH Pressure:	1016 hPa

In addition, Met Éireann also stated:

"There are no indications that the wind speed was in excess of 10-15 kt up to 5,000 ft. There was a jet stream of 140 kt aloft the area at the time. However, even at 10,000 ft the wind speed would have been no more than 25 kt."

1.7.2 The weather forecast given to the Student Instructor by EIWT Tower prior to departure was:

Wind:	240/02 kt
Visibility:	10+ km
Cloud:	FEW 2,500 ft SCT 3,500 ft
Temperature:	10/06 deg C
QNH Pressure:	1015 hPa

1.8 Aids to Navigation

The aircraft was equipped with one Bendix/King KN53 VOR/ILS, an ADF KR87 and a KT76A Mode C Transponder.

1.8.1 Radar & Transponder Information

Two modes are generally associated with the Transponder. Standard Mode A (Alpha) is primarily a pulse format for an identification code interrogator (gives identification/position). Mode C (Charlie), if selected, will provide a pulse format for an altitude information interrogator (gives identification/position and altitude) and is referenced to a standard atmospheric pressure of 1013 hPa. The transponder is interrogated by the Secondary Surveillance Radar (SSR) every 4 seconds at 1030 MHz and replies at 1090 MHz. The SSR "update rate" is therefore 4 seconds.

The US Radio Technical Commission for Aeronautics (RTCA) Minimum Operational Characteristics for Airborne ATC Transponders DO-144, states that transponder flight tests should be carried out with the aircraft *"put through those manoeuvres normally associated with take–off, climb, holding procedures, descent and final approach." "It should be recognised that some aircraft attitudes with respect to the ground station will cause momentary loss of contact."* The aircraft antenna system has a radiation pattern omni directional in the horizontal plane and a vertical beam width sufficient to provide system operation during normal manoeuvres of the aircraft.

By setting a four-digit number (squawk) on the aircraft transponder, the same number will appear on the radar operator's screen thereby identifying the specific aircraft to controllers operating the area. Such aircraft returns are also recorded on tape.

Factors such as the distance between the aircraft and the radar head position, the effects of terrain masking and the earth's curvature, will normally determine the minimum height at which the radar returns first appear flying out of Weston and those that disappear when flying at low level in an area such as Raharney.

The Dublin Secondary Surveillance Radar (SSR) tapes were impounded by the AAIU on the day of the accident and were viewed some days later by the IIC. The Air Traffic Management Surveillance Tracker and Server (ARTAS) system enables ATC to select an amalgam of all returns seen by radar heads from just one or from all of Dublin Radar No.1, Dublin Radar No. 2, Cork, Shannon and Dooncarton radars. A review of the radar tape showed that EI-CHM was Squawking A7000, indicating that either Pilot had correctly selected Mode C and a Squawk of 7000. The range and bearing details from the local ARTAS playback are relative to the ARTAS system centre, which is at Dublin Radar 1 (53º 26' 17.95" N 6º 15' 27.33" W). The system then converts this range and bearing into coordinates of Latitude and Longitude.

1.8.2 Playback Information

The ARTAS tapes were replayed on the ATC playback machine and flight parameters of time, aircraft position, ground speed, flight level, and heading for intervening positions of the target were manually noted. These are reproduced in graphical form, along with aircraft track, starting from 08.47 hrs **(Appendix B).** It should be noted that the ground speed is that interpreted by the ground radar. The radar interprets the speed as a differentiation of the target distance from the radar head with respect to time. Also, that target positions recorded by the Investigation are at various points in the track and independent of radar signal intervals.

The picture at **Appendix C** shows the position of the aircraft during the flight, overlaid onto a map of the local area. The numbers denote points of correlation between the graph at **Appendix B** and the track at **Appendix C**. The ARTAS system recorded the maximum height as 4,100 ft (with reference to a datum of 1013 hPa), the final height recorded as 3,800 ft and the final reliable radar position of the target at 53° 31′ 07″ N, 007° 05′ 31″ W at a time of 08.53:50 hrs.

1.8.3 Surveillance Analysis Support System (SASS)

ATC were requested to conduct a track and analysis of the Dublin Radar No.1 returns for the entire flight. This would be a more accurate and detailed analysis than the foregoing. The data pertaining to the flight was considered best from Dublin Radar No. 1, so it is this data from which all of the screen dumps have been taken. The screen dumps at **Appendices D & E** show the entire track for the flight in question. The first and last plots have been labelled and show the track at 1.9 NM from Weston Aerodrome at 08.31 hrs and 1,000 ft.

The maximum-recorded altitude was 4,000 ft [3] and the final altitude as 3,700 feet. The final position of the aircraft was at a range of 30.1 NM and a bearing from Dublin Radar No.1 of 279.6°M at 08.53:44 hrs. Using a software conversion package, this point corresponds to a Lat/Long of 53° 31.133′ N, 007° 05.163′ W (or in degrees, minutes and seconds, 53° 31′ 08″ N, 007° 05′ 10″ W)

ATC indicate that the altitude given by the Radar is accurate to 100 ft and that ATC procedures accept a discrepancy of +/-300 ft for Mode-C verification. Because of the westbound track from Weston and its nearness to Dublin Radar No.1, it was considered that the SASS computer generated track and analysis would give a more accurate indication of aircraft height and position. However, the ARTAS playback is included here in order to graph the parameters of altitude, ground speed and heading as in **Appendix B**.

The screen dump at **Appendix F** shows the SASS system height (feet) v Range (NM). The range and bearing details displayed here are relative to Dublin Radar No.1 and are seen on the attached labels in terms of r (NM) and t (degrees). The height variations can be seen and also the secondary plots (green squares) are shown interspersed with return misses (black crosses). This is clearer here than in the previous screen dumps. One possible cause for these misses is probably due to the manoeuvring of the aircraft about its axes during flight at that time.

1.8.4 Transponder Test Flight

A test flight was conducted in the vicinity of the accident site, in order to determine at what height radar contact would be acquired and lost. A Cessna 172 with the same make and model of transponder as installed on EI-CHM was flown in a descending turn from an altitude of 4,100 ft at approximately 300 ft/min. Returns were received continually down to 900 ft when the signal was lost.

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[3] From local maps the height of the crash site terrain above sea level is recorded as 75 metres or 246 ft. The MSL pressure on the day was 1016 hPa and this was correctly set on the aircraft's altimeter. The maximum altitude of the aircraft prior to descending was 4,090 ft, the height above terrain being 3,844 ft.

The aircraft then climbed and during aircraft ascent the returns were received again at 1,500 ft. The test concluded that returns could be received from an aircraft with a similar transponder (and having the same sensitivity) if that aircraft was descending in a normal transient manoeuvre at a controlled rate of descent.

1.9 Communications

The aircraft had installed one Narco CP 126 Audio Panel and a Bendix/King KY97 communications transceiver.

1.10 Aerodrome Information

Weston Airport is a Licensed Public Airport, with Prior Permission Required (PPR).

1.11 Flight Recorders

1.11.1 Cockpit Voice Recorder

There was no cockpit voice recorder installed nor was one required.

1.11.2 Flight Data Recorder

There was no flight data recorder installed nor was one required.

1.12 Wreckage and Impact Information

1.12.1 On-site inspection

The forward fuselage came to rest on the terrain at an angle of 40° to the sloping ground. The lower floorboard in the area of the fuel selector was badly crushed. The fuselage behind the seats was bent upwards by the force of the main wheels hitting the ground. The nose gear was bent back under the fuselage and its wheel had separated. The nose wheel was found buried in the soft earth. Grass and soil adhered to one side of the nose tyre, the other side being free of any soil or vegetation. The main gear remained attached to the fuselage. The main wheels after impact, rolled backwards for half the circumference of the main tyre. During impact, the wings and upper fuselage centre section, including the cockpit area, moved forward towards the upper firewall, crushing the box section of the complete cockpit and reducing its volume. The upper forward portion of the rear fuselage separated just behind the aft cabin area during the impact. The engine was partly buried in the soft ground with one of the propeller blades protruding upwards to the left at an angle of about 40° to the ground and bent backwards. The other blade was just below the surface and appeared to be relatively undamaged. The flaps were found in the retracted position. The left wing had impacted the ground and its front wing spar was found fractured at the wing root.

The impact forces punctured the fuel tanks. During impact the fuel pipes separated from the fuel tanks. Fuel was found leaking from the tanks by personnel from the local Fire and Rescue Service. Foam fire extinguishing agent was sprayed to the front of the aircraft where most of the fuel was found. Two pilot's flight bags were found on the ground approximately one metre forward of the port wing.

Prior to aircraft recovery, a sample of fuel was drained from each wing tank. No evidence of water was present. The fuel carburettor was examined and a fuel spray was seen when the accelerator lever was moved. The fuel strainer was pinched between the firewall and the collapsed nose gear and was not examined at the site.

An inspection of the general area found no damage associated with the flight path of the aircraft. A large rectangular field measuring 325 metres in length and running in an east to west direction is located immediately to the east of the accident site.

1.12.2 Aircraft removal

Firemen used hydraulic cutters in order to gain access to the two fatally injured occupants. Under the supervision of an Inspector of Air Accidents the primary and secondary flight control cables were cut and marked prior to the removal of the rear fuselage from the aircraft. Hydraulic cutters were used to cut the forward door posts, control cables cut and marked, and both wings and centre section removed from the aircraft. The three sections of tail, wings and fuselage complete with engine were separated and then removed to the AAIU facility at Gormanston, Co. Meath, under Garda escort.

1.12.3 Examination in AAIU Facility

Representatives from the aircraft and engine manufacturer were present during this examination. It was found that the forward wing spar attachments to the fuselage had separated on the left side and bent forward on the right side. The rear spar attachments remained attached to the fuselage top centre section.

The elevator, rudder and trim tab were found to be moveable without restriction on examination of the empennage section. Flight control cable continuity was confirmed from the cockpit controls to the control surfaces for the rudder and elevator trim system. Elevator and aileron control cable continuity was confirmed from the cockpit controls and control surfaces to the area near the fuel selector, which was crushed during impact pinching the aileron cables and crushing the elevator push/pull control shaft. There was no evidence of any misrouting of control cables that would have caused reversed control surface movement. All control surfaces were accounted for and remained attached. Movement of the right aileron was restricted in the down direction due to impact damage.

There was evidence of slight upward bending along the span of both wings. There was evidence of diagonal creases to the underneath wing skin on the outboard section of both wings. There was also evidence of downward bending along the span of the left horizontal stabilizer and buckling of the bottom skin.

The correct modified rudder stops and stop bolts were installed.[4] There was no evidence of any distortion or over-travel of the rudder. Both control yokes were found to be separated from the control "Y" behind the instrument panel with the right control yoke separated from the shaft due to impact damage. The instrument panel was pushed towards the firewall causing the control "Y" to be bent just above the pivot point.

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[4] Cessna developed modification to assist in preventing the rudder overriding the stop bolt during the application of full rudder.

The flaps and flap actuator were found in the retracted position. The flap selector knob was found damaged due to impact forces and had rotated 90º about its own axis. The flap position indicator was found out of its vertical slot. The Carb Heat control was found pushed in (“COLD” position) and the corresponding flapper valve in the heater box was stuck in the almost closed (“COLD”) position. The carburettor mixture control arm was observed bent and the mixture control was found pushed in to the “rich” position.

The throttle control was out 3 inches in the rearward direction (low power position) and the throttle control rod was found to be bent. The Investigation is satisfied that the bent throttle control, with the friction lock in place, was as a result of impact damage. Following the removal of part of the damaged floor, the fuel selector was found in the “ON” position.

1.12.4 Power Plant Examination

Compression and valve train continuity was established on all cylinders. Magneto continuity was established and a spark was confirmed on all leads. The carburettor had separated from the engine when the intake manifold coupler fractured during impact. The Number 3 intake riser was fractured during impact. Two different types of spark plugs were found on the engine. The top spark plugs were Champion REM40-E and all lower plugs were Autolite UREM40-E. Four plugs showed normal wear and the other four were worn beyond normal. However, all plugs sparked when electrically connected to the magnetos. Three of the cylinders were manufactured by ECI and the remaining cylinder was a TCM.

The exhaust system and oil sump were crushed. The vacuum pump was disassembled and the rotor was found fractured but the blades were intact. The engine propeller flange appeared to be visually bent by impact forces. The propeller remained attached to the engine. The spinner was crushed into the hub. One propeller blade was bent back approximately 40 degrees approximately one third of the distance out from the hub. This blade also had leading edge nicks and chord wise scratches. The other propeller blade was virtually undamaged.

1.12.5 Engine Strip Report

The engine was sent to an engine repair facility and a licensed engine inspector made a report summarised as follows:

The engine appeared virtually undamaged. A propeller was fitted to simulate normal operating conditions. A large difference in the crankshaft end float was noted and a degree of internal crunching heard. At this stage it was decided not to run the engine on safety grounds.

It was decided, however, to strip the engine. On removal of cylinder No. 3, two thrust bearings were found in the bottom of the crankcase. The remainder of the cylinders were removed and no further damage was noted. The rear cover was removed and no damage found. The "loaner" carburettor and its associated parts were removed and the engine removed from the test stand. The crankcase was then split to reveal the interior of the engine.

At this point it could be seen why the thrust bearings had been thrown out of their saddle. On impact with the ground, the forward propeller shaft flanged ring (slinger ring) had sheered off. This allowed the shaft to move rearwards allowing the thrust bearings to drop out of the location. It was also noted that the main bearings had moved rearwards approximately 0.050 inches due to the impact.

Internally the engine was found in very good condition. All the bearings, crankshaft and camshaft were in good condition. The crankshaft to camshaft timing was correct and the oil pump was in good working order. The scavenge filter in the oil pickup could not be checked due to the degree of crushing of the sump.

The engine's carburettor appeared to be in good working order prior to impact damage. The magnetos were in working order and in good condition. The ignition harness, while damaged during the impact, was in good condition, as were all the spark plugs. One exhaust manifold was badly crushed but all its welds appeared in good condition and were not leaking.

1.12.6 Independent Aircraft Survey

An independent licensed engineer from outside the State also examined the aircraft in the hangar in the presence of an AAIU Inspector and reported as follows:

Rudder: Controls, cables and pulleys satisfactory. Rudder hinge points secure. Rudder travel left stop to right stop complete. Rudder skin and spar intact, operating bellcrank serviceable. Rudder pedals no evidence of foreign object restriction.

Fin: Fin mounting bolts and brackets secure. New bolts found fitted to forward fin mounting.

Elevator: Travel satisfactory, elevator trim in neutral position.

Ailerons: Cables, pulleys and push rods satisfactory.

Flaps: Flap motor attachment satisfactory. Flap tracks good condition.

Fuel: Fuel filter bowl and strainer clear. Slight damage to bowl during impact meant no fuel in bowl.

Stall Warning: Intake on leading edge of wing clear. No restriction in rubber hose. However, the reed in the horn assembly was missing, which possibly detached itself at impact or during wreckage transit.

Seat Belts: Condition satisfactory. Right inboard seat rail badly worn and locking pinholes elongated and cracked.

Exhaust: Right and left exhaust heat exchanger shrouds removed. Exhaust mufflers checked for leakage - satisfactory.

1.12.7 Instrument Tests

A bench test of the instruments found as follows:

Vertical Speed: The Indicator displayed descent in excess of 2000 fpm. On test no movement of needle. On inspection of instrument internals it was found that the diaphragm was working and responded to positive and negative pressure. The mechanism appeared to have bent the stop on the descent side. (i.e. maximum rate of descent)

Gyro Horizon: Impact mark on left side of case. On test gyro was hard to run up. The damage to the erection system was probably caused by the impact.

Turn Coordinator: The indicator displayed aircraft left wing low. The instrument was unserviceable due to an internal electrical fault probably due to impact.

Clock: Displays 09.25 hrs. The instrument was unserviceable due to an internal electrical fault. This clock may have been unserviceable prior to the flight.

RMI and ADF indicators: The instruments were unserviceable due to impact damage.

Gyro Compass: The instrument was unserviceable due to impact damage.

Altimeter: There was an 800 ft error in the baro scale, which was probably caused by impact. The scale error test was accurate for this type of altimeter in a test from minus 100 ft to + 10,000 ft. The baro scale had been set to a reading of 1016 hPa.

Airspeed: The indicator was under reading by 15 knots. This was consistent throughout the operating range up to 140 kt.

RPM indicator: Unserviceable due to impact damage. The clock read 0334.7 hours.

Spark Plugs: All tested satisfactory except No.1 Bottom, which had a weak spark.

Navigation Aids: ADF set, Transponder, Nav Receiver, Control Panel Narco, VOR Receiver - All unserviceable due to impact damage.

1.12.8 Fuel Sample Analysis

Samples of fuel taken from left and right fuel tanks were forwarded to Independent Laboratory Ltd for analysis. In both cases the conclusion was as follows: *"The sample appeared clear and bright with a light blue colour. There was no free water or sediment present. The results of the tests are consistent with those of a typical 100L avgas fuel"*.

1.13 Medical Information

The Consultant Pathologist at the Midland Regional Hospital at Mullingar performed a post-mortem examination of both pilots. In his opinion, "*death was due to shock and haemorrhage due to multiple injuries associated with severe brain damage.*" These findings, he said, *"are consistent with involvement in an accident of the type described."* The report concluded that "*No alcohol was present in the blood or urine*" of either pilot.

Results of Toxicology Tests, conducted by the State Laboratory, were also negative.

1.14 Fire

There was no fire. The Emergency Services from Mulligar arrived promptly at the accident site at 09.25 hrs. The fire service laid foam around the aircraft wreckage to prevent risk of fire and used power cutters, in the presence of an AAIU Inspector, in order to extricate the occupants from the aircraft.

1.15 Survival Aspects

Both seats were fitted with a 3-point safety harness. The left-hand shoulder harness remained attached to the seat belt and was cut by the Fire and Rescue personnel. All seat belts including the right-hand shoulder harness remained attached to the aircraft structure.

1.16 Tests and Research

1.16.1 Metallurgy

At Gormanston a consultant metallurgist examined the aircraft and reported as follows:

- The fracture in the leading edge spar of the port wing (left side).

  "The fracture in the mating halves of the spar was bright and fibrous throughout, and was indicative of single event overload fracture" (due to impact with the ground).

- The creasing/rippling towards the wing tip on the starboard (right side) wing surfaces.

  "This possibly results from the supposed near vertical impact. The wing is relatively rigidly supported to the location of the tie, and rotation of the outer portion of the wing (in the plane of the wing) around the chord where the tie is located would produce creasing in the direction observed. There was a similar, but less pronounced effect on the port (LHS) side wing. This might be because fracture occurred in the spar on that side with the result that the same level of rotation of the wing tip relative to the rest of the wing did not occur."

1.16.2 Photographic Evidence

Photographs of the crash site were forwarded to the Safety and Accident Investigation Centre at Cranfield University in the UK. The report received included the following comments:

- The wreckage, damage to the instruments, and ground marks indicated that the aircraft impacted the ground with a high rate of descent and little or no forward velocity.
- The damage to the aircraft indicated that the aircraft was spinning to the left at the point of impact
- The damage to the propeller did not suggest that the engine power output was high at the time of impact

1.16.3 Operational

Details of the accident and aircraft track based on the ARTAS records were forwarded to the Safety and Accident Investigation Centre at Cranfield University in the UK. The report received included the following comments:

The analysis (**Appendix B & Appendix C**) suggested what appeared to be a normal stalling/spinning sortie, and the most likely sequence of events is given below.

Position 1. Steep clearing turn prior to stalling exercise – followed by completion of climb to 3,000 ft

Position 2. Stall with wing drop to the left – recovery & climb back to 3,000 ft

Position 3. Stall with wing drop to the left – recovery & climb back to 3,000 ft

Position 4. Stall with wing drop to the left – recovery & climb to 4,000 ft

Position 5. Heading change – climb continued

Position 6. Steep clearing turn prior to spinning followed by completion of climb to 4,000 ft

Position 7. Spin entry (*Followed by loss of radar signal*)

1.17 <u>Organisational and Management Information</u>

1.17.1 The National Flight Centre

The National Flight Centre, based in Weston, is a licensed Flight Training Organisation (FTO) approved by the IAA to conduct courses in the following areas:

Class Rating (Airplane) Course, Flight Instruction FI (Airplane), FI (Airplane) Refresher Seminars, FI (Airplane) Theoretical Knowledge, Instrument Rating IR (Airplane), Flight Instruction IR (Airplane), Multi-Engine Modular Course, IR (Airplane) Theoretical Knowledge.

Instructor's Briefing Notes are compiled by the Instructors themselves and use references from RD Campbell and The Air Pilot's Manual Vol. 1. The Senior Instructors assess these notes and Instructors are monitored periodically. The skill test for a FI(A) rating is set out in Appendix 2 to JAR-FCL 1.330 & 1.345. Para 9 of Section 1 states:

"During the skill test the applicant (Student Instructor) shall occupy the seat normally occupied by the FI (A) (flight Instructor - Aircraft), i.e. the right-hand seat. The examiner or another Flight Instructor shall function as the Student and occupy the left-hand seat. The applicant shall be required to explain the relevant exercises and to demonstrate their conduct to the "Student" where appropriate. Thereafter, the "Student" shall execute the same manoeuvre including typical mistakes of inexperienced Students. The applicant is expected to correct mistakes orally and/or, if necessary, by intervening".

Para 12 of Section 1 states:

"*The examiner shall be the pilot-in-command, except in circumstances agreed by the examiner when another FI (A) is designated the pilot-in-command for the flight."*

With specific regard to the accident flight, the qualified Instructor was seated in the left-hand seat, while the Student Instructor, who was preparing for a re-test of his initial Instructor Rating was seated in the right-hand seat. While the Student Instructor did sign for the aircraft, the Investigation is satisfied that the responsibility for the safe conduct of the flight, lay with the qualified Instructor as Pilot-in-Command.

1.17.2 Instructor Interviews

Instructors at the National Flight Centre indicated that, as a rule, spins would be conducted at a height of between 4,000 to 5,000 ft and would be completed by 3,000 ft. If a fully developed spin were required it would commence at the higher altitude. Generally, 1,000 ft could be lost in a 2-turn spin. Stalls would be carried out at 3,500 ft with flaps up and flaps down. Forced landings would be initiated at 3,000 ft to 2,500 ft with the exercise being terminated at between 600 to 700 ft above the ground.

An IAA examiner said that he would start a spin at 3,500 ft, to be completed by 3,000 ft. In a half turn (spin) it would be normal to lose approximately 300 ft in height for the exercise. For complete spin demonstration he would start at 4,500 ft., abiding by the Controlled Airspace height limits en-route. For Practice Forced Landings (PFL) he would start at a height of 2,000 ft AGL. He emphasised that speed control in the circuit is very important especially in an overbank situation where speed can be lost rapidly.

The Investigation determined from a number of Instructors familiar with EI-CHM (the accident aircraft) that it was the most popular of the Cessna 150 aircraft fleet because its behaviour in flight was nearest to that expected for the Cessna 150 Type Certificated aircraft. It was stable in flight and the aircraft, in a stall condition like most 150 aircraft, had a tendency to stall to the left. The Instructor who flew the aircraft on the day prior to the accident said that he had "no defects" to report afterwards. He indicated that the stall warning system worked and was satisfactory. The only comment he had was that the cockpit heating did not function.

1.18 Additional Information

1.18.1 The National Flight Centre Flying Orders

The following Flying Orders are stipulated in the Centre's Flight Training Organisation (FTO) Manual (Part B).

Aerobatics

During flight the aircraft is to remain within the approved flight envelope detailed in the limitations/handling section of the Aircraft Flight Manual. Spins below 3,000 ft AGL are expressly forbidden under any circumstances.

Practice Forced Landings

Practiced forced landings may be carried out by Student Pilots when specifically authorised during training and by private pilots during continuation training. During descent, in carburettor equipped piston engine types, full carburettor heat should be on throughout. Carburettor heat should be set to cold after initiating the go around not below 500 ft above ground level (AGL).

Spins

The minimum height for practicing a spin is 4,000 ft AGL and recovery must be completed before 3,000 ft AGL.

Air Pilots Manual No.1 page 191 states, *"A spin and recovery will consume a lot of height – possibly 500 feet per rotation. Commence practice at a height plus an allowance that will allow you to fully recover before 3,000 ft AGL"*

Safety Altitude

Safety Altitude shall be calculated for all VFR flights that intend to depart the local circuit. Safety Altitude is to be calculated with reference to 1:500,000 Topographical Aviation Overprint Charts.

The Raharney area is in Class G airspace, having a maximum altitude of 4,500 ft QNH.

1.18.2 Pilot's Operating Handbook (POH)

The POH, which is provided by the aircraft manufacturer, "*recommends, where feasible, that entry to a spin be accomplished at high enough altitude that recoveries are completed 4,000 ft or more above ground level. At least 1,000 ft of altitude loss should be allowed for a 1-turn spin and recovery. Entry should be planned so that recovery is completed* <u>*well above*</u> *the minimum 1,500 ft above ground level (agl) required by FAR 91.71 (USA requirements)."*

However, the FTO Manual requires that recovery must be completed before 3,000 ft agl. Intentional spins with flaps extended are prohibited.

1.18.2.1 Spin Characteristics

The POH states:

"For the purpose of training in spins and spin recoveries, a 1 to 2 turn spin is adequate and should be used. Up to 2 turns, the spin will progress to a fairly rapid rate of rotation and steep attitude. Application of recovery controls will produce prompt recoveries of from 1/4 to 1/2 of a turn. If the spin is continued beyond the 2 to 3 turn range, some change in character of the spin may be noted. Rotation rates may vary and some additional sideslip may be felt. Normal recoveries from such extended spins may take up to a full turn or more. Aerobatics that may impose high loads should not be attempted. The important thing to bear in mind in flight manoeuvres is that the airplane is clean in aerodynamic design and will build up speed quickly with the nose down"

1.18.3 FAA

The FAA Aviation News (June 2006) states: "*an incipient spin lasts approximately 2 turns in about 4 to 6 seconds. In a fully developed spin, training aircraft lose approximately 500 ft for each 3 second turn"*.

1.18.4 Stalls

The stall characteristics of this aircraft are conventional. The stall warning horn produces a steady signal 5 to 10 knots before the actual stall is reached and remains on until the aircraft flight attitude is changed. Stall speeds for flaps at various bank angles at an all up weight (AUW) of 1,600 lbs with the centre of gravity rearwards, power off, are as follows:

Section 5 of POH - Most Rearward Centre of Gravity - Stall Speeds

Weight Lbs	**Flap Deflection**			**Angle**	**Of**	**Bank**			
		0º		**30º**		**45º**		**60º**	
		KIAS	KCAS	KIAS	KCAS	KIAS	KCAS	KIAS	KCAS
1600	Up	46	48	49	52	55	57	65	68
	10º	44	45	47	48	52	54	62	64
	40º	42	42	45	45	50	50	59	59

1.18.5 Spins

Spins are recognised as having four stages; entry, incipient, developed and recovery. If one wing tends to stall more deeply than the other, the wing that stalls first will drop, increasing its angle of attack and deepening the stall. The other wing will rise, decreasing its angle of attack, and the aircraft will yaw towards the more deeply-stalled wing. The difference in lift between the two wings causes the aircraft to roll, and the difference in drag causes the aircraft to yaw. This combination produces aircraft autorotation. The spin incipient stage is characterised by a significant nose down attitude with accelerating rotation. As the rotation rate increases about the spin axis, the spin becomes more developed. The centrifugal force may on occasions, cause the pitch angle to decrease and the nose to rise due to the centre of gravity being outside the spin axis. Generally, the faster the rotation in a spin the flatter the relative pitch angle.

A flat spin is characterised by a shallow pitch, the aircraft attitude is between horizontal and 45° below horizontal and can be caused by the aircraft's centre of gravity being too far aft. A flat spin is also characterised by the aircraft's lower height loss per turn. What is seen from the ground can be compared to a falling sycamore leaf in autumn. Recovery from a flat spin is more difficult because of the reduced airflow over the control surfaces and the aircraft may take more turns to stop following the recovery action.

As the spin becomes developed in the Cessna 150, a stable rate of rotation of about 200 degrees/second is reached with a descent rate of about 6,000 ft/min. On occasion, in the Cessna 150 and characteristically on low wing monoplanes, the spin does become flat. Additionally, a high rate of rotation, or gyroscopic precession (increasing power in propeller aircraft) can raise the nose and cause the spin to flatten. Again, characteristically, as the spin becomes flatter the rate of descent tends to reduce.

Spin recovery in the Cessna 150 is detailed in the POH as follows:

(1) Verify that ailerons are neutral and throttle is in idle position.

(2) Apply and hold full rudder opposite to the direction of rotation.

(3) Just after the rudder reaches the stop, move the control wheel briskly forward far enough to break the stall. (Full down elevator may be required at aft centre of gravity loadings in some aircraft models to assure optimum recoveries.)

(4) Hold these control inputs until rotation stops. (Premature relaxation of the control inputs may extend the recovery.)

(5) *As the rotation stops neutralise rudder and make a smooth recovery from the resulting dive.*

The recovery from a spin in the Cessna 150 is normally achieved in 1 to 2 turns. Recovery from a flat spin will take approximately twice as long. The manufacturers of the aircraft stated that they do not believe a C150 in an inadvertent spin initiated at a height of 600 ft, would make a 3 to 4 turn spin during a descent to ground level. They believe it would be closer to 1 to 1.5 turns.

The graphs shown at **Appendix G** cover descent rates achieved for a typical Cessna 150 aircraft in spinning from 10,000 ft down to 4000 ft. Although the initial/incipient spin descent rate of a Cessna 150 aircraft is about 2,000-3,000 ft/min, due to the residual horizontal inertia of the aircraft, the rate of descent then increases to about 8,000 ft/min as autorotation is stabilised. The spin then develops an almost vertical flight path before stabilizing at or over about 6,000 ft/min, the figure quoted by the manufacturer.

If EI-CHM initiated a spin at 4,000 ft ASL and descended in accordance with a typical descent rate, and using the coordinate values of height and time in graphs shown at **Appendix E & F**, then the time at which the aircraft would have reached terrain can be evaluated (See Table1). The calculation below assumes that a fully developed spin of an average of 6,000 ft/ min will take place after 10 seconds has elapsed (**Appendix G**).

TABLE 1						
Comments	**ROD ft/min**	**Height lost during this time**	**Altitude (ASL)**	**Height above terrain**	**Elapsed time Seconds**	**Time UTC**
Radar Fix Time	*Zero*	*Zero*	*4,000ft*	*3,754ft*	*Zero*	*08:53:36 Ref. APP. F*
Incipient Spin	*1,155ft/min*	*77ft*	*3,923ft*	*3,677ft*	*4 secs*	*08:53:40 Ref.APP.E1*
Incipient Spin	*3,345ft/min*	*223ft*	*3,700ft*	*3,454ft*	*4 secs*	*08:53:44 Ref.APP.E2*
Incipient Spin	*4,000ft/min*	*133ft*	*3,567ft*	*3,321ft*	*2 secs*	*08:53:46 Estimated*
Developed Spin	*6,000ft/min*	*3,321ft*	*246ft*	*Zero*	*33 secs*	*08:54:19 Ref.APP.G*

This results in an impact time of 08.54:19 UTC for a 6,000ft/min full spin scenario. If the average rate of descent of the developed spin is assumed at 7,000 ft/min then the timing reduces by 5 seconds. Conversely, a partial or full recovery from the spin would delay impact time. Spin turn rates, given by the same source at **Appendix G**, are 100º/second for the first spin followed by 150-200º/second for the second and subsequent turns.

If a lower descent rate were achieved such as the average recorded by radar over the first 8 seconds, a similar calculation can be made and this is represented in Table 2 below:

TABLE 2						
Comments	**ROD ft/min**	**Height lost**	**Altitude (ASL)**	**Height above terrain**	**Elapsed time Seconds**	**Time UTC**
Radar Fix Time			*4,000ft*	*3,754ft*	*Start descent*	*08:53:36 Ref. APP.F*
Known descent rate	*2,250ft/min*	*300ft*	*3,700ft*	*3,454ft*	*8 secs*	*08:53:44 Ref.APP.E2*
Developed Spin	*2,250ft/min*	*3,544ft*	*246ft*	*Zero*	*92 secs*	*08:55:16*

The Investigation has been unable to discover any published descent rates for a flat spin on the Cessna 150 series, or like model aircraft. If the rate of descent in a C150 could reduce to as little as 2,000 ft/min in a flat spin, a descent at that rate from a height of 3,454 ft above terrain would take 106 seconds to reach terrain and the impact time then would have been 08:55:30 hrs.

1.18.6 Flight Path and Impact Angle

The flight path angle of an aircraft is the angle between the flight path and the horizontal. The flight path angle of an aircraft descending toward the ground may be quite different from the pitch attitude of the aircraft (the angle between the longitudinal axis and the horizontal) due to the difference between the angle of attack and the longitudinal axis of an aircraft. The angle of impact is the angle formed by the velocity vector and the terrain surface. The angle of impact is not likely to be the same as the aircraft attitude at impact. (Ref AFP 127-1, US Air Force 1987)

1.18.7 Other Information

A Cessna 172N aircraft, fitted with a Lycoming engine, took off from Weston Aerodrome at 08.54 hrs on the same day and flew out to the west. The aircraft was operating under aerial work category in the Edenderry area, which is less than 12 miles from Raharney. The pilot said that he experienced what he said were “unusual symptoms of carburettor icing”. This aircraft had an engine carburettor temperature gauge and probe installed. The pilot said that he had great difficulty in keeping the instrument needle outside the yellow arc in order to avoid carburettor icing. The aircraft left the area, headed northeast and eventually returned to base at 12.18 hrs.

1.19 <u>Useful or Effective Investigation Techniques</u>

The eyewitness account of No.4 witness (**Appendix A**) was used to estimate the height of the aircraft when first seen. This witness looked up to see the aircraft descending at an angle of about 20° to the horizontal. The computed distance between Witness No. 4 and the accident site was 1,737 metres. The horizontal angle between this first sighting and the point where he saw the aircraft dive was established as approximately 21°. This angle translates to a horizontal distance of approximately 650 metres roughly east west along which the aircraft flew prior to its rapid descent. With the aid of a theodolite, the angle of elevation to where he saw the aircraft dive was established as approximately 5° 44′. This angle produced an elevation of 572 ft AGL at the environs of the accident site. The Investigation recognises that the descending angle of 20º as identified by Witness No 4 and the calculated elevation can only be considered as a “best estimate”.

2. ANALYSIS

2.1 General

Fatal General Aviation (GA) accidents, by their nature, can prove difficult to come to a definitive probable cause. Where there are no survivors, no significant witness accounts, no low level radar information, and no flight recorders, Investigations are challenged to determine:

- The cause of the aircraft departing from controlled flight and impacting the ground.
- The actions of the pilots prior to and during loss of control.

  and

- The identification of the handling pilot of the aircraft at the time leading up to or during loss of control.

2.2 Investigation Comments on Witness Reports

The Radar tapes clearly indicate that EI-CHM, the accident aircraft, arrived almost directly at Raharney from EIWT and thus could not have been operating in the vicinity of Raharney for 25 minutes as described by Witness No 3.

Having interviewed the pilots of aircraft which took off from Weston on the morning of 25 May 2006, the Investigation concludes that the aircraft which Witness No. 5 saw was EI-CML, which took off on a training flight to the West from Weston at 09.23 hrs and returned at 10.07 hrs. The pilot of EI-CML confirmed that the manoeuvres, which this witness observed, were those of his aircraft.

Therefore, the evidence of Witnesses No.3 and No. 5 is discounted.

2.3 Aircraft Damage

The forward fuselage came to rest on the terrain at an angle of 40° to the sloping ground. This is not necessarily the aircraft attitude prior to impact (Section 1.18.6). Although there was evidence of a turn to the left at the moment of impact, there was no evidence of rapid rotation or a steep attitude at impact.

There was no wreckage path; little ground scar and all components of the aircraft were attached to the aircraft. Virtually no forward movement was evident during impact and ground penetration was minimal. The destruction of the aircraft was limited, indicating a low energy impact in terms of vertical and horizontal velocity. No evidence was found that the aircraft had suffered any pre-impact damage while entering the field. In general, the aircraft damage and wreckage pattern was such to indicate that the aircraft suffered a loss of control at a relatively low speed. The evidence of witness No.4 indicates that this was also from a low height.

2.4 Technical Aspects

Following the on-scene activities and recovery of the wreckage, the Investigation sought to confirm the airworthiness of the aircraft and to determine whether the aircraft suffered any technical failure of the airframe that could, in any way, impede the controllability of the aircraft, or a technical fault with the engine that would contribute to loss of continued powered flight.

Following extensive examination of the accident site, the airframe, the engine, test and research, and all associated documentation, the Investigation is satisfied that:

- The aircraft was fully airworthy for the intended flight,
- There was no malfunction or failure of the airframe that could have contributed to a loss of control or impede recovery from an induced manoeuvre such as stalling or spinning.
- Apart from impact damage, the engine was in good condition and no technical fault was found that would impede the engine developing full available horsepower. The subject of carburettor icing will be discussed later in this analysis.
- The aircraft entered the field vertically with relatively low energy from an estimated height of between 500-600 ft.
- There was a near vertical impact with the ground during which the left wing impacted the ground, causing the front wing spar to fracture.

2.5 Operational Aspects

2.5.1 Activities prior to loss of Radar contact

The Dublin ATC ARTAS playback first recorded the appearance of EI-CHM on screen at 08.31:05 hrs at position 53° 21.28′N, 006° 31.44′W with a ground speed of 70 kts and at a height of 900 ft climbing. ATC Weston reported that EI-CHM was airborne Weston at 08.20 hrs and routed to the West. The radar information would indicate that if the aircraft did indeed take-off at the reported time of 08.20 hrs, that it took approximately 11 minutes to cover a distance of 1.9 NM. With a normal take-off and climb to 900 ft, the expected time taken to cover that distance would be in the region of approximately 2 minutes. The Investigation considers that this time discrepancy could be related to the aircraft conducting an exercise just west of EIWT shortly after take-off and prior to the selection of Mode C or the reported take-off time by Weston Tower was incorrect. In any event, this time discrepancy has no bearing on the accident itself.

The enroute segment of the flight identifies the aircraft flying in a general northwest direction as it climbs to altitude, while remaining within the height restrictions associated with the Dublin Control Zone.

In the latter stages of the climb to the northwest, heading and groundspeed changes are radar identified. The SASS evaluation shows that the transponder did not respond to all radar interrogations. Between 08.52:30 hrs and 08.53:00 hrs there were 6 radar returns lost/absent.

The changes in heading and groundspeed and the loss/absence of some radar returns would indicate that the aircraft was performing some significant manoeuvres whilst in the climb. These particular manoeuvres may have been tight climbing turns, stalls, stall recovery, etc and are considered by the Investigation to be consistent with what one would expect on such a detail while climbing to 4,000 ft.

The fact that the aircraft climbed progressively to approximately 4,000 ft provides some insight into what exercise was being conducted just prior to loss of radar contact. Normally the only specific training exercises conducted from such a height would be aerobatics, stalling or spinning. Radar evidence does indicate that stalling had already been conducted during the climb. Instructors within the FTO confirmed to the Investigation that spinning exercises are normally conducted between 4,000 - 5,000 ft. Previous flights leading up to the accident flight confirm that stalling and spinning exercises were being conducted by the Student Instructor with a qualified Instructor. In addition, part of the Instructor Skill Test includes spinning and is recognised as one of the more difficult elements of the skill test. Significant emphasis is normally put on practicing such an exercise.

The Investigation recognises that the Student Instructor passed Section 4(a) Spin Avoidance/Recovery and Section 4(b) Stalling, during his skill test on 11 January 2006.

Radar returns leading up to the last recorded position, indicates that a possible clearing turn was performed and that the aircraft was set up for entry into a spin.

2.5.2 Activities following intended entry into spin

The Investigation is satisfied that EI-CHM probably did enter an intentional spin manoeuvre at a height of between 4,000 - 4,100 ft. AMSL.

The last positive recorded ARTAS radar position was at time 08.53:50 hrs at 53° 31.07′ N, 007° 05.31′W with a ground speed of 58 kts and a height of 3,800 ft descending. This point is at a distance of 497 metres and a bearing of 260° from the accident site.

Using the SASS data as being more accurate, the final altitude recorded was 3,700 ft. The final position of the target was at a range of 30.1 NM and a bearing from Dublin Radar No.1 of 279.6° at 08.53:44 hrs. Using a software conversion this point corresponds to a position of 53° 31.13′ N, 007° 05.16′ W. This point is at a distance of 150 metres and a bearing of 250° from the accident site.

2.6 Discussion

The loss of the radar returns can be attributed to a number of technical, aerodynamic and/or environmental reasons. However, the loss of radar return would not necessarily be considered unusual at such a range, height and while the aircraft was manoeuvring. It must be recalled that evidence from the radar tape confirms that the aircraft /radar signal was lost on a number of occasions as the aircraft manoeuvred towards its final recorded climb height. It is also noted that radar returns from the Cessna 172 in this area were unreliable between 900 ft and 1,500 ft.

Alternatively, if the aircraft had continued spinning to a much lower altitude, in contravention of the Flying Orders, this could also have resulted in a loss of radar signal. However, in view of the pre-test nature of the flight, the Investigation believes this unlikely.

Radar returns can be lost for a number of reasons including, attitude and orientation of the aircraft, attenuation of the signal by distance, signal attenuation due to either the equipment or its installation or any combinations of those. The transponder could not be tested as it was damaged on impact. However the transponder system underwent a 3 year check in November 2005. Also, there were no reported transponder faults following a flight on the day prior to the accident.

While the Investigation is unable to fully resolve this loss of radar return, it is satisfied that the loss of radar returns had no bearing on the operation of the aircraft.

Using both sets of radar data, it is clear that the final manoeuvre recorded on radar is in close proximity to the accident site. Based on the foregoing, two likely scenarios are considered;

1. That the aircraft continued to spin and impacted directly from the last recorded radar position, with or without partial recovery,

   or

2. Following a standard spin recovery above the minimum height of 3,000 ft, the remaining height was utilized to perform another exercise and control was lost during that subsequent manoeuvre.

2.6.1 Spin Scenario

The accounts of some witnesses of seeing the final moments of an aircraft falling and spinning into the ground, the loss of radar returns from approximately 3,700 ft and the close proximity to the accident site could, on initial analysis, place more emphasis on the possibility that the aircraft "spun-in" from spin entry height. However, there are a number of further factors that must be considered:

- The weather was particularly good and clear on the day of the accident and would have had no bearing on the accident.
- No technical malfunction or control issue was found during the extensive examination of the aircraft that would have impeded either occupant from recovering from an intentional spin.
- The Cessna 150M is recognised as a very docile aircraft. It is a generally forgiving aircraft and is not considered difficult to recover from a spin. Its spins generally result in a spiral dive, but on occasion, a flat spin can occur.
- The level of experience of the two occupants was such that either individual was well capable and qualified to induce and recover from a spin.
- No "Mayday" call was transmitted from the aircraft at any stage during the flight.

- The Flying Orders require that a spin be completed by a height of 3,000 ft and it is improbable that a qualified instructor or student instructor would allow the aircraft to continue to spin to a lower height, especially in view of the pre-test purpose of the flight.

- For this aircraft type, a fully developed and sustained spin from 3,700 ft would take approximately 35 seconds to reach ground (See 1.18.5). Therefore, the time of impact would have been 08.54:19 hrs. Taking into account the average wind (260º/6.5 kts) the impact site would have been in the region of 50 metres South of the recorded accident site.

- The final radar return indicated an initial descent rate of approximately 3,000 ft per minute. If the aircraft had maintained an average of this rate of descent, assuming a partial spin recovery, the time to impact under averaged wind conditions, would be 79 seconds later. Therefore, the time of impact in this particular case would have been 08.55:03 hrs. Of further significance though, the impact point would in this case have been approximately 130 metres East (downwind) of the recorded accident site.

- As already discussed at Section 1.1.2, the calculated timings suggest that the probable time of impact was approximately 08.59 hrs. In evaluating the different spin scenario's (best case/worst case) approximately 5 minutes are not accounted for, thereby indicating that some additional manoeuvre probably took place. As the last known radar return was recorded at 08.53:44 hrs and the probable impact time was approximately 08.59 hrs, the indications are that the aircraft flew for a further 5 minutes after loss of radar contact at 3,700 ft.

- If the aircraft entered a flat spin from its incipient spin, with a 2,000 ft/min rate of descent from 3,700 ft, then an impact time of 08:55:30 would result. Although this scenario results in an impact time closer to that calculated the Investigation has found no published information to indicate that it is possible for a Cessna 150M to average a descent rate of 2,000 ft during a flat spin. The Investigation is therefore of the opinion that a descent rate of 2,000 ft/min is unlikely and that the descent rate is very probably much in excess of this figure.

- Additionally, and very importantly, the evidence of witnesses cannot be discounted. Witness No 4 described an aircraft in a controlled flight, a stable descent, immediately prior to loss of control. Witness No 2 said that the aircraft seemed to have come from an easterly direction before it went into a spiral.

Therefore, taking all these factors into account, the Investigation is of the opinion that it is unlikely that the aircraft "spun-in" from the last radar recorded position, following initiation of the practice spin.

Experience has shown that in some spinning mishaps, pilots, having initiated immediate actions for spin recovery, have re-entered a spin in the opposite direction (through over-correction), which ultimately leads to a prolonged delay in recovery to normal flight and a significant further height loss.

It should be noted (**Appendix G**) that both entry and exit from a spin will result in an accelerated height loss and therefore the average rate of descent will increase. However, the height from which the exercise commenced, the nature of the pre-test flight, the evidence of Witness No. 2 and No. 4 and the time discrepancy militates against this scenario. In addition, no Mayday call was made and giving consideration for the level of experience onboard the aircraft, the Investigation is of the opinion that a re-entered spin is unlikely to have happened. The fact that no Mayday call was made indicates that whatever occurred did so very suddenly.

2.6.2 Another Exercise Scenario

Witness No. 2 stated that the aircraft seemed to have come from an easterly direction before it went into a spiral. In addition, the recall of events as witnessed by Witness No. 4, that he saw the aircraft descending at an angle of 20º to the horizontal in an east to west direction, prior to the aircraft spinning, is particularly significant. Further calculations indicate that the aircraft travelled across the witness's field of view for a distance of approximately 650 metres down to an estimated height of 570 ft. It is interesting to note that the best estimate calculation of 572 ft is above the minimum height for the termination of a practice forced landing (500 ft).

The scenario as described by Witness No. 4 does resemble the final stages of a PFL. A PFL simulates a power loss in flight and requires the handling pilot to configure the aircraft for a glide approach, while simultaneously selecting an appropriately large enough field to land in safety. Practicing and examining this emergency procedure is aimed at developing a pilot's required level of competence to handle an actual or partial engine failure.

Normally, this exercise would commence with an assumed engine failure between 3,000 – 2,000 ft. agl and in a position, which is within reach of a suitable landing area. During the descent phase, the pilot will generally establish a descending circuit pattern during which a crosswind, downwind, base leg and final approach would be carried out. The distance out from the landing area will vary with the aircraft height at the time and its position in relation to the proposed (simulated) landing area. The strength and direction of the wind may require further amendment to the planned descent route. In some cases a pilot may opt for a straight-in or abbreviated pattern in order to make the selected target landing area. The normal flight profile for the aircraft in question would be airspeed of 60 KIAS with Flap 20º. During final approach airspeed would reduce to 55 KIAS with Flap 40º once one was assured that the aircraft could make it into the intended landing area. From the simulation point of view, as soon as the outcome of the PFL can be clearly seen, i.e. that the handling pilot, if solo, or the Instructor, is satisfied that if the descent continued, that a safe entry into the selected field was possible, the aircraft should be climbed away. Irrespective of the success or failure of the PFL, the minimum height to which the aircraft should descend is 500 ft agl in open country.

Single engine pilots are generally well practiced in PFLs throughout their training and flying career. The PFL forms part of the formal skill test and is considered to be demanding for candidates as it requires good judgement/airmanship in a high workload environment, while at the same time flying with a high degree of accuracy.

During the Student Instructor's skill test in January 2006, the Examiner identified three areas in which further practice was required. Two referred to PFL's, including, -*" Broke minimum height rule before initiating a go-around from practice forced landing"* and general difficulties with the PFL. The Investigation therefore considers that the Student Instructor would have put significant emphasis on resolving these identified issues by seeking further practice. It is interesting to note that on examination of the general accident site area, a large rectangular field measuring 325 metres in length along an east – west axis, was located immediately behind the accident site. A second large rectangular field was located adjacent to this field. It is possible that this particular field was the simulated target field during the PFL.

The flight profile as described by Witness No. 4, the calculation of an estimated height of 570 ft over the accident site and the location of a large field immediately behind the accident site, leads the Investigation to form the opinion that EI-CHM may have been engaged in flying a PFL prior to the upset.

However, this scenario does not readily explain why the flaps were found in the retracted position on landing. The Cessna 150M flap selector is designed with a gate system where each incremental selection of flap has to be physically positioned. However, flap retraction to full up position can be achieved in one movement. It is therefore possible that a full up selection could have been made in a go-around if the person moving the flap selector was not paying sufficient attention when moving it, or on being distracted by a possible rough running engine, as was reported by the witnesses. If this were done at an inappropriately low airspeed, during a go-around, then loss of control would immediately result.

Witnesses describe the aircraft making 3 to 4 turns in about 5 seconds prior to impact. However, experience shows that witnesses, when observing a specific dramatic event, are prone to a lack of precision and their recollections are prone to inaccuracy. Consequently the actual number of turns may well have been less than that reported by the witnesses. The Manufacturers are of the opinion that at the most, 1.5 turns could be made in an initial spin from a height of 600 ft. However, this is based on a controlled entry to a spin from straight and level flight. Inadvertent entry into a spin from a turn and/or with high power settings can result in faster rotation rates. If a figure of a maximum of 2 turns is taken, and referring to the graph at **Appendix G**, 2 turns at the start of the incipient phase would correspond to a rate of rotation of 137.5°/sec and therefore a time to reach ground level of 5.24 seconds. This time figure approximates with that which witnesses observed. The rate of descent, assuming no success at recovery action, would then be 6,870 ft/min. This figure would agree with the descent rate expected after 5 seconds as seen from the graph at **Appendix G.** The Vertical Speed indicator displayed a descent rate in excess of 2,000 ft/min, its maximum full-scale deflection, following the accident.

2.7 Loss of Control

As already discussed, the PFL is a demanding and challenging exercise for pupils and Instructors alike. The final phase, the "go-around", is in itself a critical phase of flight. The aircraft has to transition from a power-off gliding configuration, to straight and level with power, and then initiate a climb away. During all this phase the handling pilot must manage power, Carb Heat, flap, airspeed, fly the aircraft and ensure that the minimum height of 500 ft is not penetrated.

As the aircraft is being flown relatively close to the stall, speed control is the crucial element. The stall speed will vary with weight, power, angle of pitch/roll and flap setting. The impact damage, the wreckage pattern and witness accounts, do indicate that the aircraft entered the field from a relatively low height (possibly 500 – 600 ft) and at a low forward speed. The likelihood is that control was lost as a result of a low speed stall.

This low speed stall could have occurred as a result of:

- Power speed control (speed too low) up to or during the go-around. However, one would expect that the qualified Instructor would have managed low speed control if evident on the approach.
- Flaps may have been retracted fully, either in error or through distraction, during the go-around. This would have increased the stalling speed. It is noted that the flaps were found fully retracted on the aircraft at the accident site.
- Prolonged engine cooling down from 4,000 ft. may have prevented the engine from instantly responding to a power demand at a lower altitude. Good airmanship requires that the engine be warmed periodically during descent so that the engine is ready to deliver power when required. It is normal practice to increase engine RPM for a few seconds every 500 to 1,000 ft of descent.
- If during the go-around an angle of bank were introduced, which would have increased stalling speed.
- On application of power from idle, the engine failed to respond due to Carb Icing and while attempting to resolve this condition airspeed was lost.
- Or any combination of the above.

Consideration must be given to the possibility that an abrupt application of power was applied at low airspeed which resulted in a “torque roll”. Here the aerodynamic forces from the controls are insufficient to counteract the accelerating rotation of the propeller caused by the increasing engine torque and the aircraft then rotates about its longitudinal axis in the opposite direction to the propeller rotation. Although this is a significant characteristic in a single engine aircraft with a powerful engine and a large propeller, its effects cannot be discounted in this low powered aircraft, as recovery would require the pilot to immediately close the throttle to regain control. However, for torque roll to happen in this case, considering that flaps were up at the time, it would have to be at such a low speed that other factors, such as stall, would have been aerodynamically dominant.

Nevertheless, it would account for the aircraft entering a spin to the left from a slow speed stall at a low height and the fact that the throttle was found at a low power position. In addition, eyewitness reports confirm the aircraft was spinning prior to impact.

For a sudden and unexpected low speed stall and spin with wing drop to occur, time and height remaining (in this particular case 500 – 600 ft) would provide little opportunity to recover the aircraft and impact would follow within seconds.

2.8 Pilot in Control

The Investigation is satisfied that the particular flight was a practice detail, under instructor supervision, whereby the right-hand seat occupant (Student Instructor), a qualified pilot who was seeking to become a flight Instructor, was gaining further practice in preparation for a second attempt at an Instructors skill test. In order to achieve this legally, it was necessary for a qualified Instructor to be onboard. Part of the role of the qualified Instructor (left-hand seat) is to function as a typical "inexperienced pupil" under instruction. In this type of pre-test flight, the qualified Instructor is required to critique the performance of the Student Instructor as if he was an Instructor giving a lesson to a Student pilot. Ultimately, a qualified Instructor is the Pilot-in-Command and thus is responsible for the overall safe conduct of the flight. In addition, where an in-flight emergency occurs or where the right-hand seat occupant endangers the safe conduct of the flight or is unable to maintain safe controlled flight, it is the responsibility of the qualified Instructor to take-over control of the aircraft. This is done irrespective of the ability or experience of the right-hand seat occupant. All Instructors are aware of these responsibilities following successful completion of a recognised Instructor course and Instructor skill test.

In general three possible scenarios exist regarding who was flying the aircraft throughout the detail and leading up to the point where control was lost.

The first scenario is where the right-hand seat pilot, the Student Instructor, was demonstrating a particular lesson to the left-hand seat occupant (qualified Instructor acting as pupil). In this particular case, the Student Instructor would fly the actual lesson from the right-hand seat and the acting pupil would only observe.

The second scenario is where having just demonstrated a lesson, the Student Instructor would handover control to the acting pupil and the acting pupil would fly the same lesson from the left-hand seat under instruction from the Student Instructor.

Where the acting Student inputs poor technique or error, it is the responsibility of the Student Instructor to resolve the issue through verbal guidance or intervention. If the Student Instructor were unable to resolve a particular issue or condition, the acting pupil would revert back to the position of qualified Instructor.

The third scenario is where the qualified Instructor was demonstrating a particular exercise to the Student Instructor, for example, if the Student Instructor were experiencing a difficulty in demonstrating (flying) an exercise, the qualified Instructor would fly and talk the Student Instructor through the exercise himself.

Any one of these three scenarios could have been occurring throughout the entire detail, but as to who was actually flying the aircraft to the on-set of loss of control or subsequently, cannot be determined and must remain a matter of conjecture.

It is, however, important to reiterate that irrespective of who was flying the aircraft to the on-set of loss of control, the instructional ethos is such that it is likely that the Instructor would attempt to recover the aircraft from any up-set that may occur. However, it cannot be ruled out either that under life threatening conditions, relatively close to the ground, that both occupants could be on the controls.

2.9 Carburettor Icing

The possibility that the engine suffered from carburettor (carb) icing must be considered. The atmospheric temperature on the day was 10° C and the Dew Point recorded was 3° C. Carb icing is not restricted to cold weather, and will occur on warm days if the humidity is high, especially at low power settings (throttle pulled out). Moisture in the air turns into ice at the carburettor venturi leading to a progressive loss of engine power. At the time, conditions ranged from the probability of serious icing at any power setting to serious icing at descent power. If the local Temp/Dew Point, as given to the pilots prior to departure, were 10º/06° C then conditions conducive for carb icing at any power setting would exist (**Appendix H**). Other aircraft, flying in the area, did experience severe carb icing at the same time.

Normally when the engine is under power, early symptoms of carb icing will show in the form of power reduction, followed by the engine running rough. These indications will usually occur well ahead of any situation in which a large build up of ice creates engine failure. However, if the icing has occurred and the engine actually failed during a glide, or operation at very low power (idle), it can remain unnoticed until the throttle is opened (power demand) during for example, the transition from the descent to level flight/climb, or for engine clearing purposes.

It is important during any prolonged idle power descent to open up to at least the half throttle position at regular intervals to ensure the engine is continuing to run correctly, to keep the plugs clear of excess carbon deposits, and to maintain a reasonably warm engine. The throttle should be left in the half open position for two or three seconds to be of value, and sudden and full power applications avoided. During a go-around, it would however, be normal for the Carb Heat to be selected "off" (Cold), prior to the application of power.

An examination of the wreckage determined that the flapper valve in the engine heater box was found stuck in the mostly closed position, which corresponds to Carb Heat "off". The pilot's knob on the instrument panel was found in the off (fully-in) position. While this indicates that the Carb Heat was off at the instant of impact, it provides no confirmation as to its usage during the descent or its position at the time of loss of control. The Investigation cannot rule out that the engine suffered carburettor icing at the time that engine power was applied. This in itself could have served as a serious distraction to the pilots onboard.

2.10 Engine Sounds

Witness No. 2 compared the engine noise to "sound of a lawnmower spluttering sound". This sound is quite different from the noise created by an aircraft's engine in a spin. In a spin, the Doppler affect will cause the engine noise to rise and fall during autorotation. However, as the witness was some distance from the aircraft it is likely that the sound would have reached him some 4 seconds after the event. In that case, he would have visually seen the aircraft spin as he heard an earlier spluttering sound. It is therefore probable that misfiring of the engine preceded loss of control.

2.11 Recency

The Investigation considered related issues of experience, recency and training. The Head of Training recommended to the IAA on 3 February 2006 that the pupil was ready for a re-test. Although an IAA examiner was assigned, no IAA examination took place. There was an interlude of 3 months with flying resuming in May 2006. It is noted by the Investigation that the Student Instructor had only flown 3.73 hours in 28 days prior to the accident flight.

3. CONCLUSIONS

(a) Findings

1. The flight Instructor (Pilot-in-Command) was properly licensed medically fit and appropriately qualified to conduct the flight.

2. The Student Instructor was properly licensed and medically fit.

3. The aircraft had been correctly maintained and had completed all maintenance in accordance with the maintenance schedule.

4. The weather conditions in the area were good. However, the temperature/dew point conditions were conducive to severe carb icing.

5. The en-route flight profile was consistent for this type of flight.

6. Evidence from the radar tape confirms that the aircraft /radar signal was lost on a number of occasions as the aircraft manoeuvred towards its operating height.

7. The aircraft climbed progressively to 4,000 ft and most likely entered an intentional spin.

8. The experience of both pilots' on board was such that entry and spin recovery should have been a relatively routine exercise.

9. There was no malfunction or failure of the airframe found that could have contributed to a loss of control or impede recovery from manoeuvres such as stalling or spinning.

10. The Investigation is of the opinion that the aircraft most likely made a standard 3,000 ft recovery from the induced spin and then used the remaining airspace (height) to conduct a second exercise.

11. An eyewitness report confirmed seeing the aircraft, with wings level, descending at an angle of about 20° to the horizontal, in an east to west direction for a calculated distance of 650m.

12. The requirement to conduct further practice forced landings (PFL's) and the final flight profile observed by Witness No. 4 is such to suggest that EI-CHM may have been performing a PFL just prior to loss of control.

13. The aircraft suffered no pre-impact damage prior to entry into the field.

14. The nature of the impact damage suggests that the aircraft impacted the ground in a turn to the left, with relatively high vertical speed and low forward speed, with the engine at a low power setting.

15. In general, the aircraft damage, the wreckage pattern and witness accounts are such to indicate that the aircraft suffered a loss of control at a relatively low speed and at a relatively low height, estimated at between 500 to 600 ft agl.

16. Temperature/Dew Point conditions were such that serious carburettor icing could have occurred at any engine power setting. Therefore, it cannot be ruled out that the aircraft suffered from carburettor icing while performing a standard go-around from a PFL.

17. The engine was in good condition prior to impact and no technical fault was found that would impede the engine developing full available power.

18. The aircraft flaps were found in the fully retracted position at the accident site. This would not be considered a normal flap position for a go-around, which would be 20° of flap. It cannot be ruled out that flap was selected to 0° in error or that during flap retraction; the handling pilot was distracted by some other event. The retraction of flap to 0° would have increased the stalling speed.

19. It was not possible to determine which pilot was flying the aircraft at the moment control was lost or during subsequent events.

20. Although not presently required, the Investigation feels that the absence of some type of on-board recording device hampered the progress of the investigation.

(b) <u>Probable Cause</u>

1. The aircraft suffered a loss of flying speed at low altitude, stalled and spiralled to the ground.

(c) <u>Contributory Factor</u>

1. The loss of speed may have been attributed to a loss of power resulting from carburettor icing.

2. The height at which the event occurred was insufficient to affect a safe recovery.

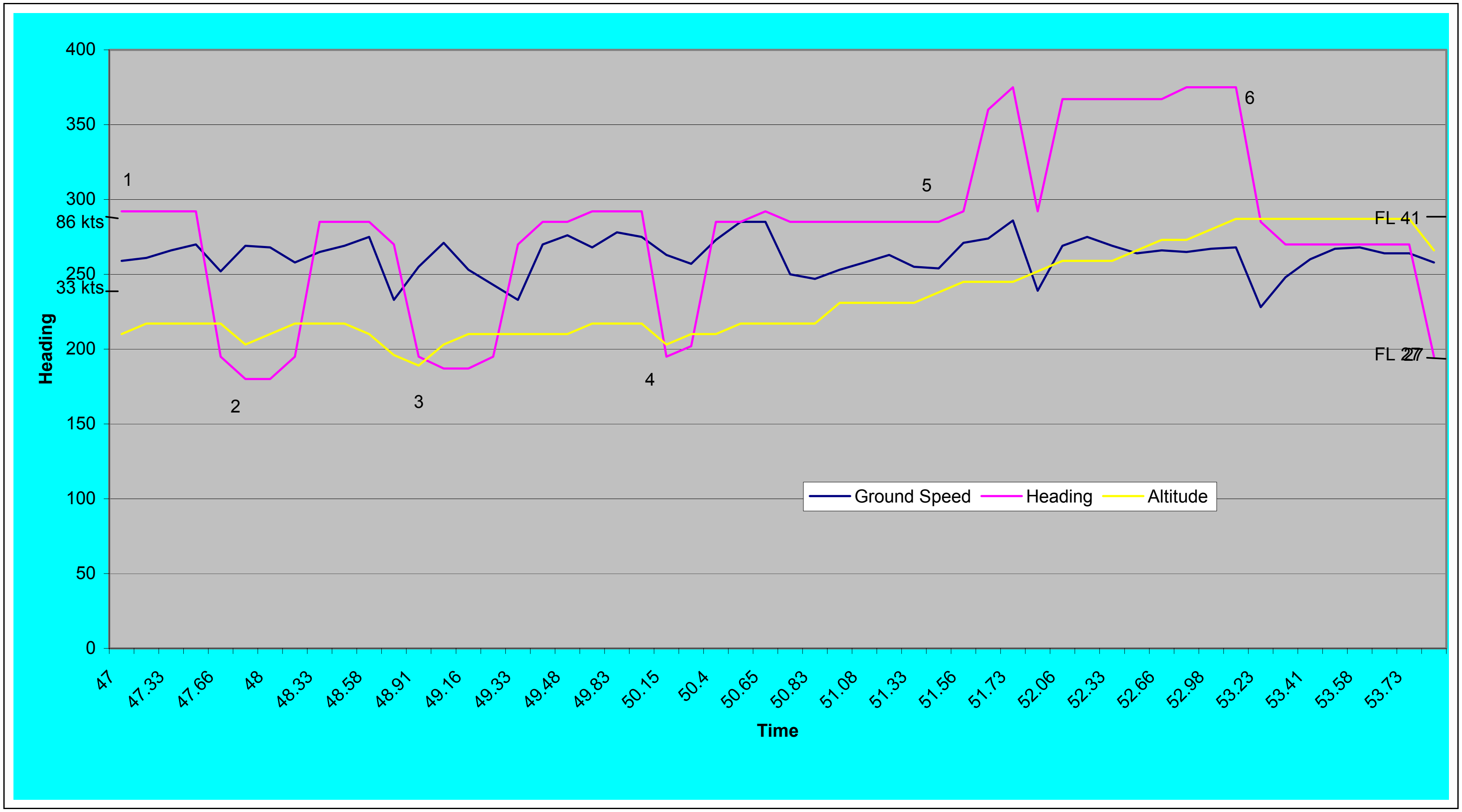
4. SAFETY RECOMMENDATIONS

1. EASA should initiate a study of the necessity for aerial work aircraft in the General Aviation category to have installed a simple on-board device to record basic flight parameters.
(SR 14 of 2008)

Appendix A

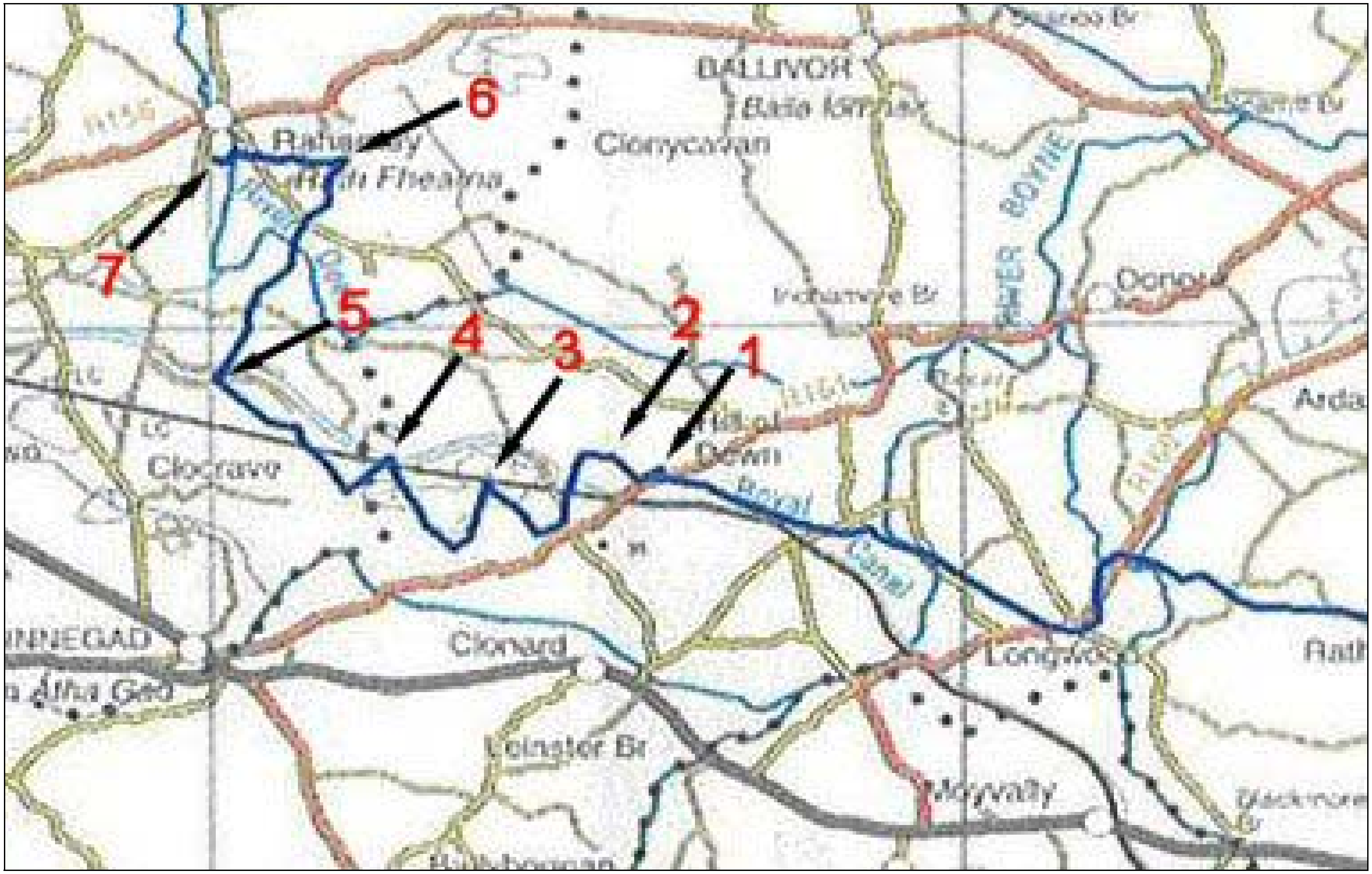
When last seen by witnesses, the aircraft came from the east and was seen flying at low level in a westerly direction. (Scale 1:50,000)

Appendix B



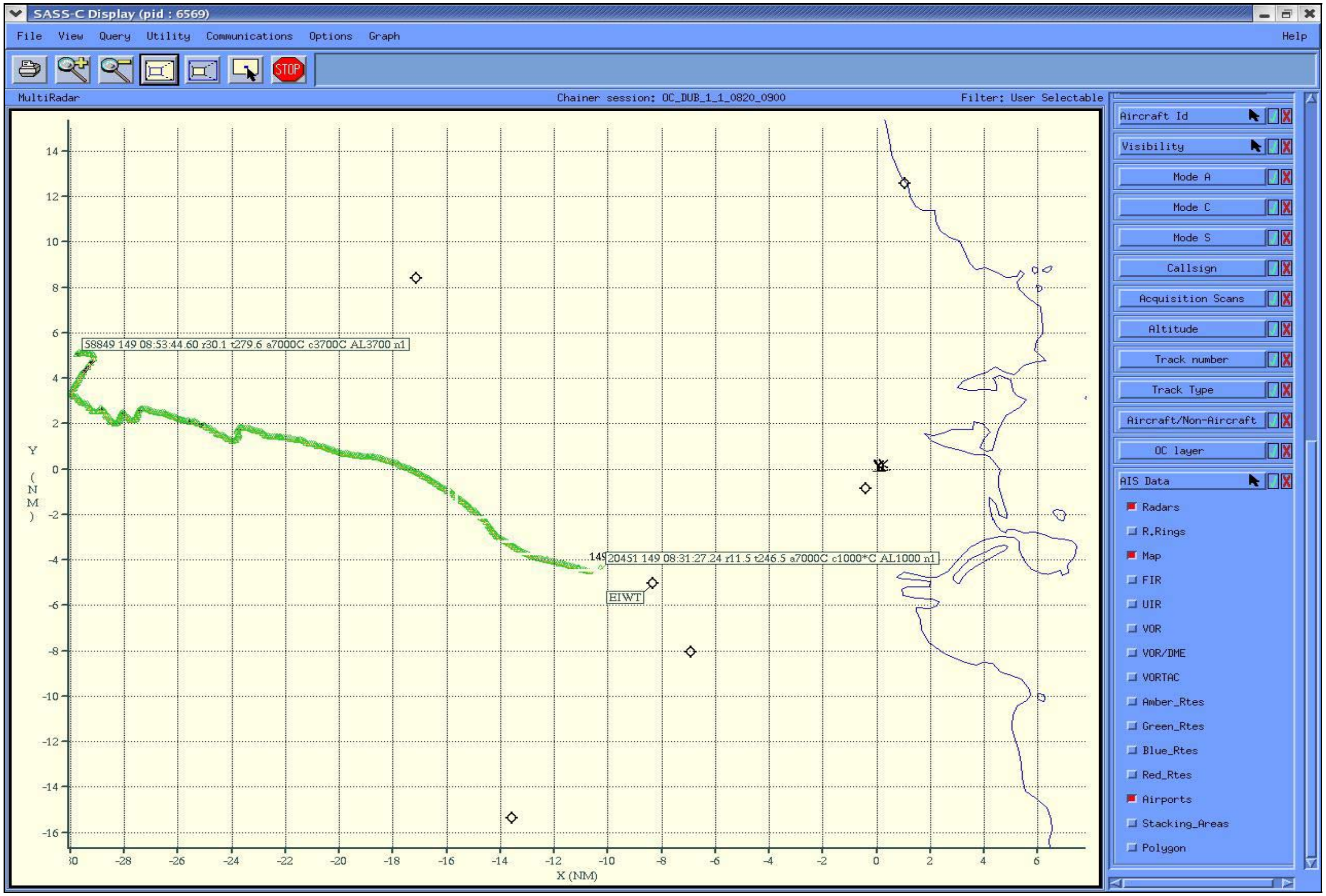
Bar Chart recording heading, groundspeed and altitude prior to loss of radar contact

Appendix C



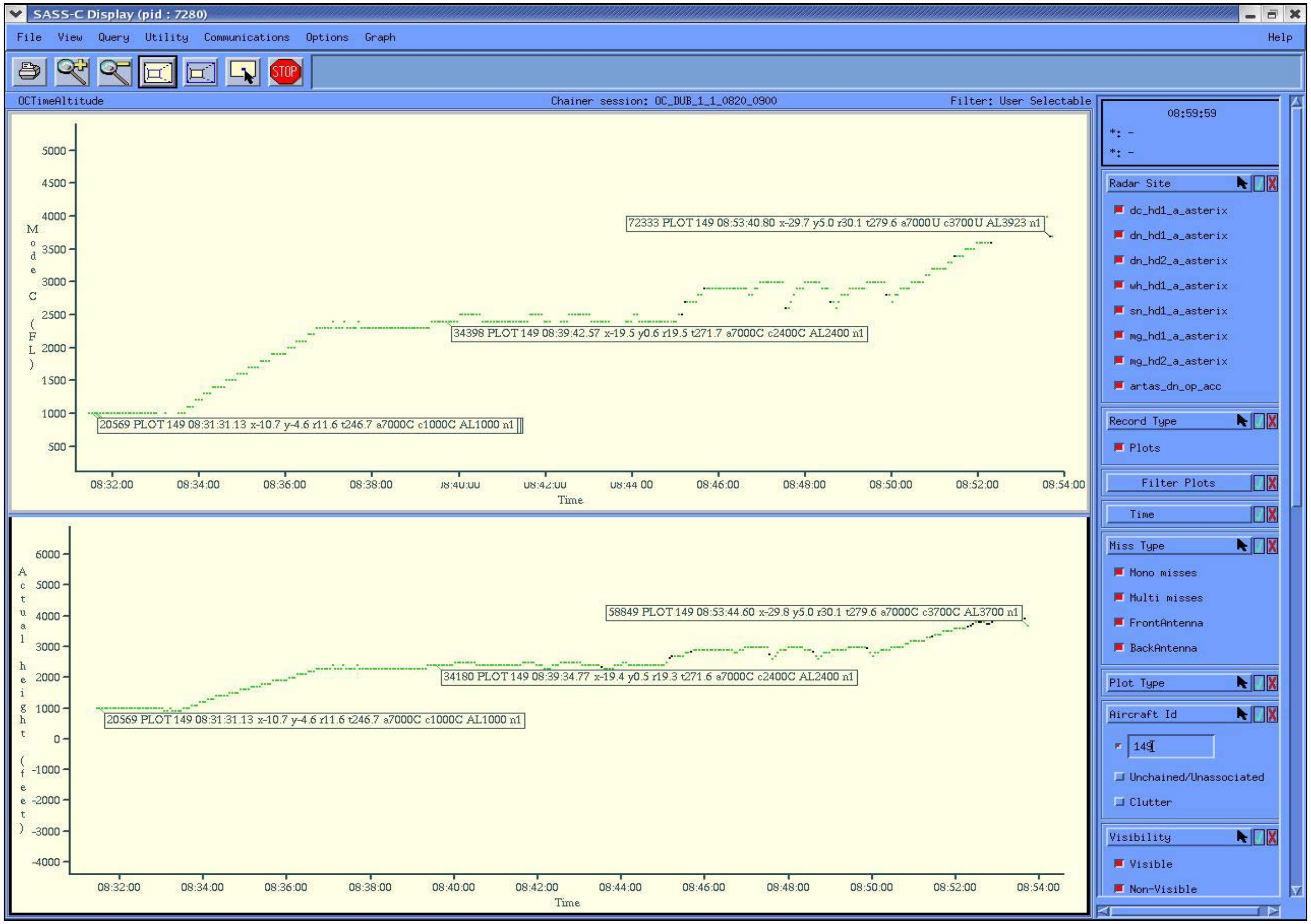
Map overlay of track made good prior to loss of radar contact

Appendix D



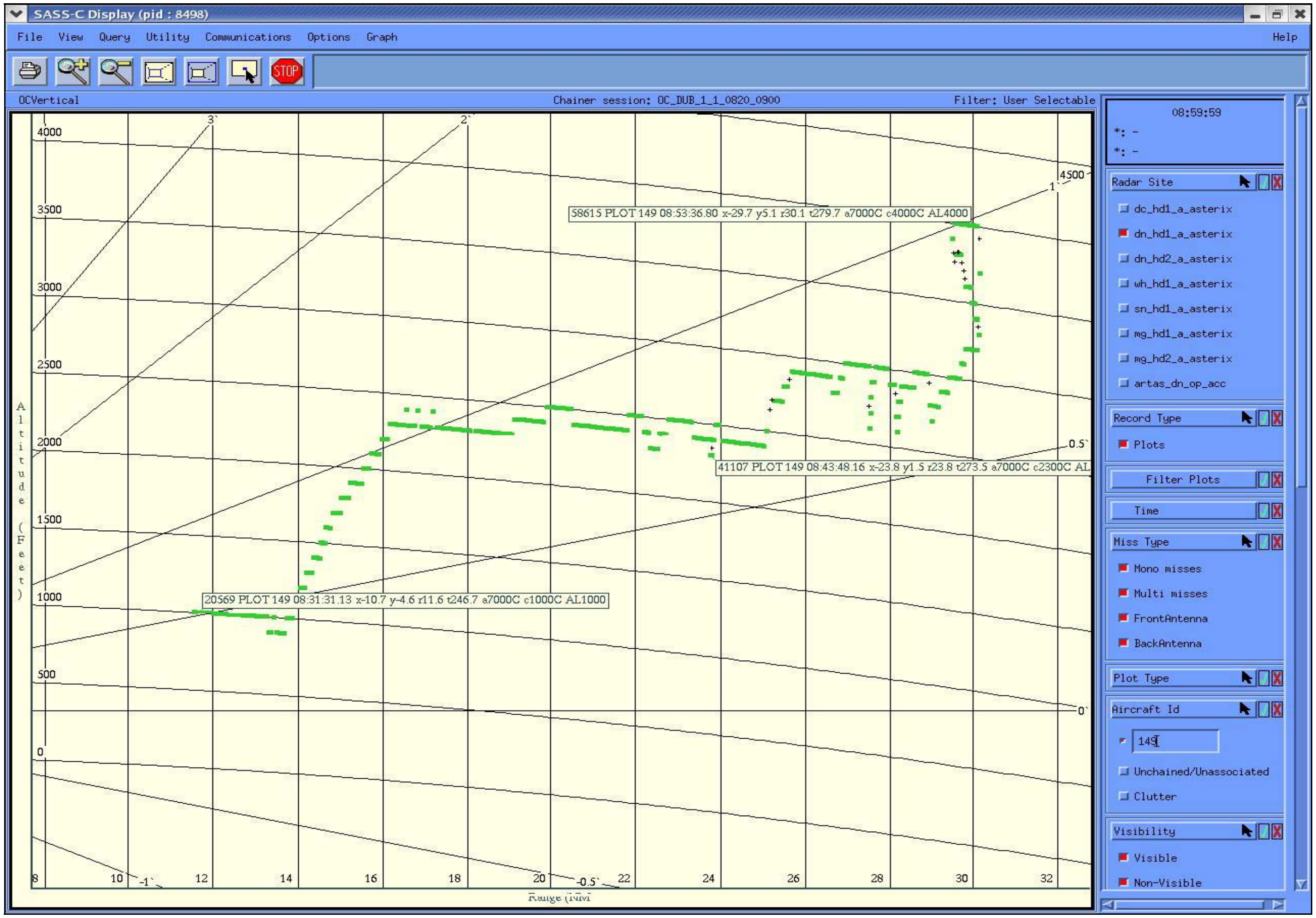
Screen Shot from Dublin Radar 1

Appendix E



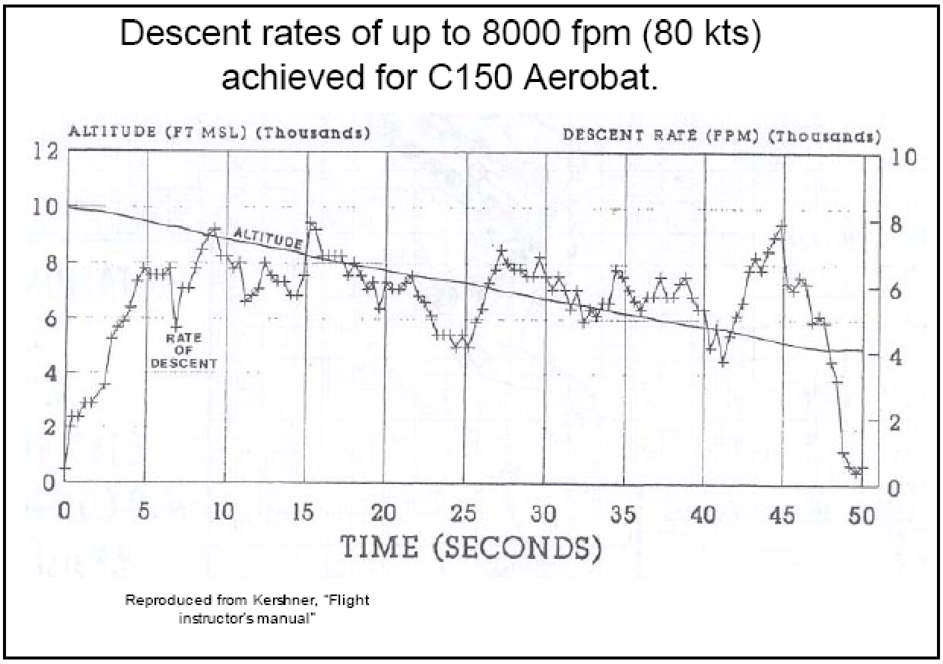
Screen shot showing Mode C Flight Level and Actual Height Vs Time

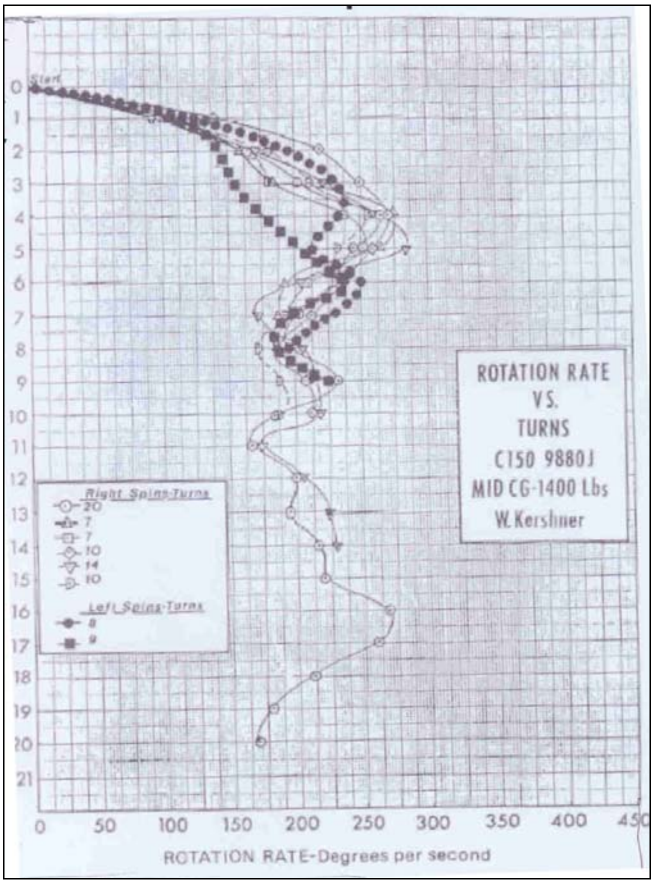
Appendix F



Screen Shot of Altitude (feet) Vs Range (NM)

Appendix G





The above charts of Descent Rate versus Time and Turns versus Turn Rate are reproduced from the published works of W. Kershner, former head of flight testing at Piper Aircraft, and an authority on aircraft spinning, in particular the Cessna 150 series.

Appendix H

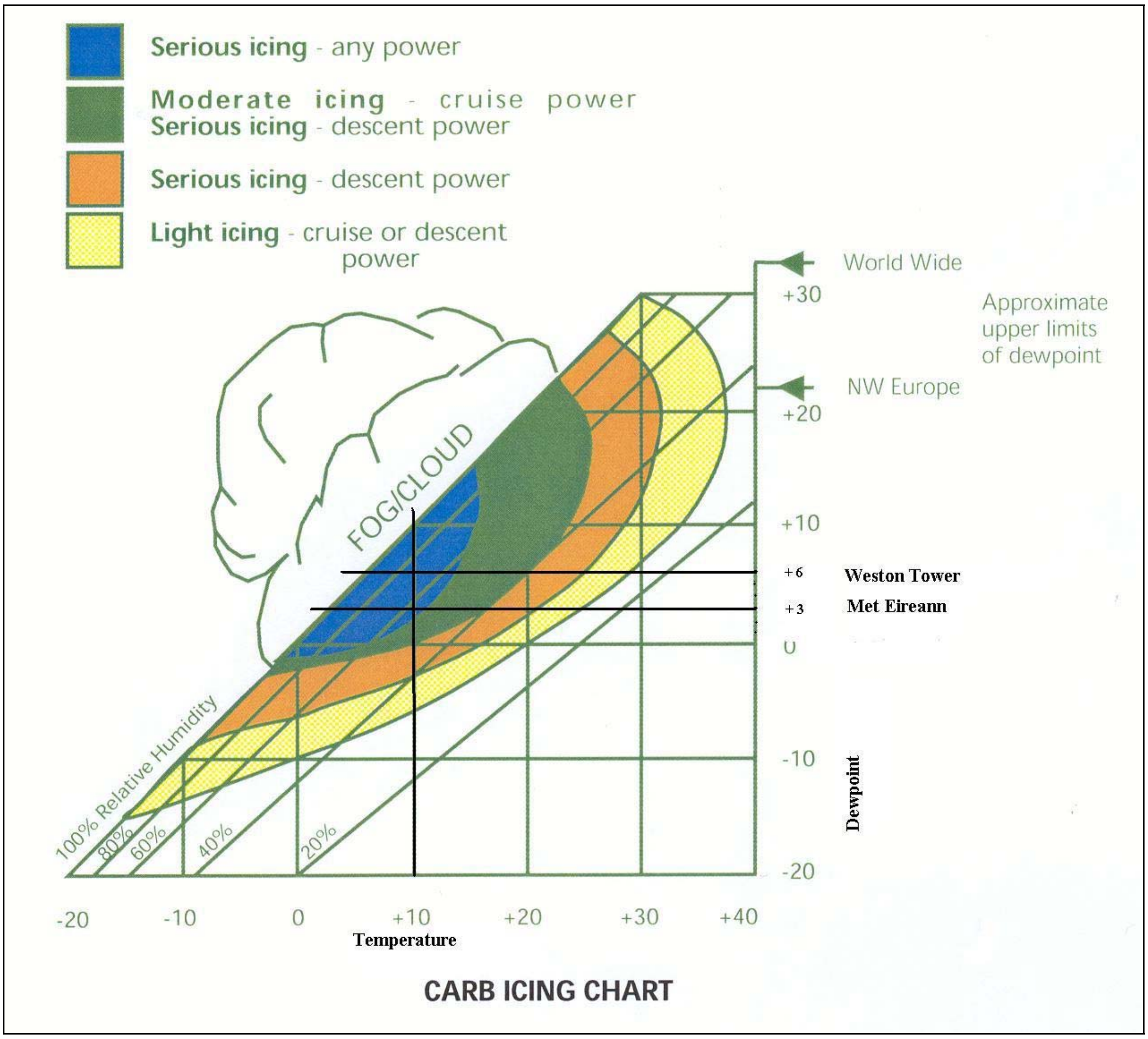


Chart indicates risk of serious icing at +3º and +6º respectively

- END -