Air Accident Investigation Unit Ireland

ACCIDENT TO
Pegasus Quantum 15-912, G-BZOD
Near Ballyduggan, Co. Tipperary
9 August 2011

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

FINAL REPORT

AAIU Report No: 2013-003
State File No: IRL00911075
Report Format: Synoptic Report
Published: 21/02/2013

In accordance with Annex 13 to the Convention on International Civil Aviation, Regulation (EU) No. 996/2010 and the provisions of S.I. 460 of 2009, the Chief Inspector of Air Accidents, on 9 August 2011, appointed Mr. Paul Farrell as the Investigator-in-Charge to carry out an Investigation into this Accident and prepare a Report. The sole purpose of this Investigation is the prevention of aviation Accidents and Incidents. It is not the purpose of the Investigation to apportion blame or liability.

Aircraft Type and Registration:	Pegasus Quantum 15-912, G-BZOD
No. and Type of Engines:	1 x Rotax 912
Aircraft Serial Number:	7763
Year of Manufacture:	2000
Date and Time (UTC[1]):	9 August 2011 @ 10.30 hrs
Location:	Near Ballyduggan, Co. Tipperary
Type of Operation:	Refresher Training Flight
Persons on Board:	Crew - 2 Passengers - 0
Injuries:	Crew - 2 Passengers - 0
Nature of Damage:	Aircraft destroyed
Instructor's Licence:	Private Pilot Licence (Aeroplane) with an Instructor Rating (Microlight) issued by the IAA
Instructor's Details:	Male, aged 48 years
Instructor's Flying Experience:	2,918 hours, of which 173 were on type
Notification Source:	ATC Supervisor, Shannon Airport (EINN)
Information Source:	ATC Supervisor EINN, AAIU Field Investigation, AAIU Report Forms submitted by the Instructor and the handling Pilot

[1] UTC: Universal Time Co-ordinated. All timings in this report are quoted in UTC; to obtain the local time add one hour.

SYNOPSIS

During an exercise entitled “stall as a result of an engine failure after take-off”, the aircraft entered a partial tumble manoeuver which caused the outboard section of the starboard wing spar to fracture. Due to the resulting asymmetry of lift, the aircraft entered an autorotation in yaw. The aircraft spiralled to the ground and impacted heavily. Both occupants suffered serious injuries.

1. FACTUAL INFORMATION

1.1 History of the Flight

The aircraft crew comprised an Instructor and a licenced Pilot who had previously been an instructor. The flight was a Refresher Training Flight carried out at the request of the Pilot to revalidate his Weight-Shift Flex-wing Microlight rating which was due to expire on 12 August 2011, 3 days after the Accident. The Pilot’s logbook showed that he had last flown on 19 September 2010. The Pilot held a Private Pilot Licence (Aeroplane) with Aeroplane Class (National Rating) for Weight-Shift Flex-Wing Microlight issued by the Irish Aviation Authority (IAA). The Pilot had a total amassed flight time of 482 hrs, 133 hrs as Pilot undergoing training and the balance (349 hrs) as Pilot in Command. The Pilot’s logbook only records one previous flight on the accident type; that flight was of 1.05 hours duration and took place on 3 June 2003.

The Pilot informed the Investigation that due to the nature and severity of the injuries he suffered in the accident his only memory of the day of the accident was a hazy recollection of driving to the airfield. However, the Instructor had a vivid recall of the day’s events, the accident flight, the accident itself and the events thereafter. Consequently the report draws heavily on the Instructor’s recollection to develop the history of flight.

The Pilot had contacted the Instructor by phone in June 2011 to discuss arranging a Refresher Training Flight. It was agreed to wait for suitable weather and to arrange a time and date by telephone. Eventually an arrangement was made to meet at Kilkenny aerodrome at 9.30 hrs on 9 August 2011. Upon arrival at Kilkenny aerodrome the Pilot enrolled as a flying club member.

The Instructor gave the Investigation a detailed description of the accident flight. The flight followed a structured pattern with the Pilot undertaking exercises of increasing complexity and only progressing to more advanced exercises when the Instructor was satisfied with the Pilot’s demonstrated skill level. The Instructor described how he offered advice on handling issues as they arose and said that the Pilot was at all times open to advice and suggestions. The exercises progressed through climbing and levelling off, descending and levelling off, medium level turns, slow speed flight followed by acceleration back to cruise, recognition of stall onset and stall recovery without power.

The Instructor noted that during the stall recovery without power exercise, the Pilot pitched the aircraft up more rapidly than required and when the stall was reached the control bar was moved rearwards more rapidly than necessary, placing the aircraft in a steep nose down attitude and resulting in a height loss of approximately 600 feet during recovery.

The Instructor took control and with the Pilot "following through" demonstrated the correct technique. After further practice and coaching the Instructor was satisfied with the standard displayed by the Pilot. They then moved on to practise stall recovery with power where the Pilot again exhibited a tendency to lower the nose more rapidly than was necessary, though again this improved to a satisfactory standard with practice and coaching.

The next exercise was to simulate a stall occurring as a result of an engine failure after take-off i.e. where the aircraft may be climbing steeply after take-off (for obstacle clearance) and suffers an engine failure. The Instructor outlined the scenario to the Pilot and the Pilot indicated that he understood the briefing. The Pilot had control of both throttle and control bar. The Instructor asked the Pilot to simulate the scenario by setting the aircraft into a maximum angle climb in accordance with normal procedure and when the Pilot was ready, to simulate an engine failure by closing the throttle at his (the Pilot's) discretion.

With the aircraft set in level cruising flight, the Pilot set the throttle to full power and moved the control bar forward to set the aircraft to the maximum angle climb attitude. The Instructor recalled that the Pilot then closed the throttle and lowered the nose aggressively causing the aircraft to adopt a steep nose down attitude, resulting in a rapid increase in airspeed. The Instructor called to the Pilot to 'Recover-bar forward' which the Instructor intended to be an instant cue for the Pilot to recover from the dive to level flight.

1

It was unclear to the Instructor whether the Pilot initiated the recovery, or whether the natural stability of the aircraft wing caused the aircraft to rapidly pitch upwards. The Instructor's recollection is that the control bar moved rapidly forwards, breaking through the front strut allowing the wing to continue pitching upwards and thus due to centrifugal force causing the 'trike unit' (cockpit) to follow through in a circular motion resulting in the aircraft becoming inverted. The Instructor noted that although under normal circumstances full access to the aircraft controls is available from the rear seat (passenger seat) in this case, due to the extreme violence and G forces involved, he was unable to reach the controls to affect any form of recovery.

The Instructor's helmet, which was properly strapped and secure, was whipped from his head. The Instructor recalled the sound of the airflow and the aircraft descending rapidly in a circular or spinning motion. The Instructor heard no engine noise, and was unable to see the Pilot. The Instructor recalled the only view he had was of the aircraft's wing tips where he had glimpses of some clouds, clear sky and occasional views of the horizon.

The Instructor was firmly convinced that the impending impact would be fatal. To his surprise both he and the Pilot survived the impact. At that point he could see the Pilot in the front seat. The Pilot was breathing but not moving. Both the Instructor and the Pilot were trapped in the wreckage.

1.2 Post Accident

The Instructor's immediate fear was fire as he could smell fuel and his flying clothing was soaked in it. He was also concerned that there may have been no witnesses to the crash and consequently assistance might not be available.

The Instructor freed his arms, retrieved his mobile phone from his flight suit pocket and called the emergency services. Using his phone's GPS App he was able to give the emergency operator the accident location. The emergency operator was able to confirm his location using the phone signal. This location was in a field, surrounded by trees and rough terrain some 300 metres off the Ballyduggan road.

The Pilot, though not obviously conscious, became agitated and attempted to move about. The Instructor tried to comfort him by talking to him in an effort to have him stay still.

The Instructor was in "*unbearable*" pain from his injuries. A young boy appeared through the bushes and confirmed the general location and that the terrain in from the road was rough. The Instructor passed this information to the emergency controller and then asked the boy to go back to the road to direct the emergency services, which he did. Presently, the boy returned with a man who offered words of comfort to both the Pilot and the Instructor. Members of the Gardaí arrived soon afterwards, as did ambulance and fire brigade personnel as well as the Coast Guard helicopter.

Both casualties were removed from the wreckage and taken to hospital.

1.3 Aircraft

The aircraft was a standard Pegasus Quantum 912 with a current British Microlight Aircraft Association (BMAA) Permit to Fly. Around August 2010 the sail was replaced with a new one incorporating BMAA approved modification M236 (Technora trailing edge). The rest of the sail was standard construction with a Trilam leading edge and Dacron main body. The aircraft was check flown by a BMAA check pilot and found to fly satisfactorily although the trim speed was somewhat high (74 mph) due to the new sail causing reduced washout. The wing was tuned later by relaxing the rib bungee tensions so that the Instructor said it flew normally with a trim speed around 62 mph. This tuning is normal practice. The aircraft was check flown again by the same BMAA check pilot and found to be satisfactory shortly before the accident flight. There were no reported problems with the serviceability of the aircraft before or during the accident flight.

The aircraft had a tandem seating arrangement with the Pilot in the front seat and the Instructor behind him. Communications between Pilot and Instructor, which the Instructor informed the Investigation were very good at all times, were via intercom/headsets.

The Instructor informed the Investigation that the aircraft weight for the accident flight was calculated as follows:

- Aircraft empty weight, 199 kg
- Maximum take-off weight 409 kg
- Total fuel 28 litres, 20.16 kg
- Occupant weights were 80 kg and 82 kg respectively

Based on these figures, the Instructor deemed the aircraft to be within maximum take-off weight and centre of gravity limits.

1.4 Weather

The Instructor informed the Investigation that weather conditions for flying were good with:

- Wind velocity; 280 degrees / 10kts
- Temperature; 14 degrees Celsius
- Thermic activity; Nil
- Clouds; 4 oktas at 4000'
- Visibility; 10km or better

1.5 Stall Characteristics and the Tumble Mode

The Quantum is normally control-limited against stalling in that a slow reduction in airspeed of 1 kt per second requires a continuous increasing push force by the pilot until the control bar contacts the trike front strut, when the aircraft will continue to fly at a slow airspeed (around 35 mph) with sluggish roll control. There is no wing dropping tendency even when stalled in turns. It is only necessary to relax the push force and allow the bar to come back a few inches to resume normal flight.

For a flex-wing aircraft such as the Pegasus Quantum 912, as the approach to the stall is made progressively nose-up and the speed allowed to decay, there comes a point where the nose-down pitch motion at the stall break becomes violent enough to drive the aircraft into a tumble. If the pilot pulls the control bar in as the nose drops at the stall break then the nose down pitching motion will be increased. The wing inverts and then tends to pitch nose-up while the inertia of the trike unit continues nose-down. The opposing forces between wing and trike are very high and typically the wing control bar or trike front strut will fail, allowing the propeller to hit the wing keel and the trike to fall into the back of the sail. If the tumble motion is strong enough, the cycle repeats, typically causing both the wing leading edges to fail.

Gratton & Newman[2] produced a paper entitled "*TOWARDS THE TUMBLE RESISTANT MICROLIGHT*".

The paper describes "*The tumble mode is a pitching departure from controlled flight which leads to a pitch autorotation that is generally unrecoverable" It goes on to explain that "The tumble mode is a departure from controlled flight which was first studied rigorously by the British Microlight Aircraft Association (BMAA) following a fatal accident to a Gemini Flash IIa aircraft, G-MVEP. Conclusions were reached concerning this mode, which may be summarised by:*

- *The mode is a nose-down pitching departure from controlled flight, leading to a pitch autorotation at rates up to 400°/s.*

[2] Dr. Guy Gratton, MSETP School of Engineering and Design, Brunel University, UK (also Test Pilot, British Microlight Aircraft Association) and Dr. Simon Newman School of Engineering Sciences, University of Southampton, UK.

- *No pre-breakup 'escape route' from an established tumble mode has been identified.*
- *The tumble invariably leads to loss of the aircraft, and in a large proportion of cases [usually those where the monopole failed during in-flight breakup] loss of the crew also.*

Four potential entry routes were identified, which were:

- *The whip-stall;*
- *Spiral instability combined with loss of visual horizon;*
- *Failed loop (or other aerobatic) manoeuvre;*
- *Flight through (own) wake vortex.*

The report goes on to describe "*The whip-stall is an aggressive entry to the aerodynamic stall (pushing the bar out aggressively to achieve a high deceleration rate, well in excess of the 1kn/s normally recommended), followed by an equally aggressive recovery initiation by the pilot (pulling in the control bar rapidly).*"

1.6 Wreckage Examination

The trike front strut failed in bending and tension with marks on the front strut protection sleeve indicating it struck the control frame at the right hand corner, i.e the trike unit fell into the right hand side of the sail. There were two characteristic blade strike marks on the starboard side of the wing keel above the propeller **(Photo No. 1)** and blue Dacron keel pocket fibres embedded in one damaged propeller blade **(Photo No. 2)**. This indicates that the front strut had failed and the trike unit continued to swing back into the sail while the engine was running at low power.

The right hand leading edge failed in negative bending outboard of the crossboom to leading edge junction sleeving **(Photo No. 3**). There were clods of soil embedded in the inboard part of this fracture whereas the outboard part of the leading edge was clean.

Other failures found were consistent with ground impact of the wing on the RH side causing buckling/bending of the cross boom and inboard leading edge. The kingpost remained straight, with grass embedded in the end. The LH control frame upright failed in outward bending/buckling indicating that the trike had at some stage been thrown to the left side and /or that positive loading was applied to the wing (tight lower flying cables). The main wing keel was bent and broken behind the hang point and the RH control frame top had been pulled out of the fitting in overload.

The trike unit remained attached to the wing by the main pylon and had hit the ground in a sideways attitude. Except where cut by emergency services, the harnesses were intact and marks on the harness webbings showed that lap and shoulder restraints were in use by both occupants. The seat frame had been squashed sideways but the seat moulding remained intact. The fuel tank was still intact although fuel had leaked from the filler neck. Fuel was found in the carburettor float bowls and the engine turned freely. Damage to one propeller blade leading edge indicates it had been turning at low power when it hit the wing keel. One propeller blade was relatively undamaged and the other had been damaged by heavy ground impact bending loads.

In general, the condition of the aircraft was good and it was properly maintained.

There was no corrosion of any significance and all failures were consistent with overload. No sign of fatigue was discovered.

Photo No. 1: Propeller blade strike marks on the keel

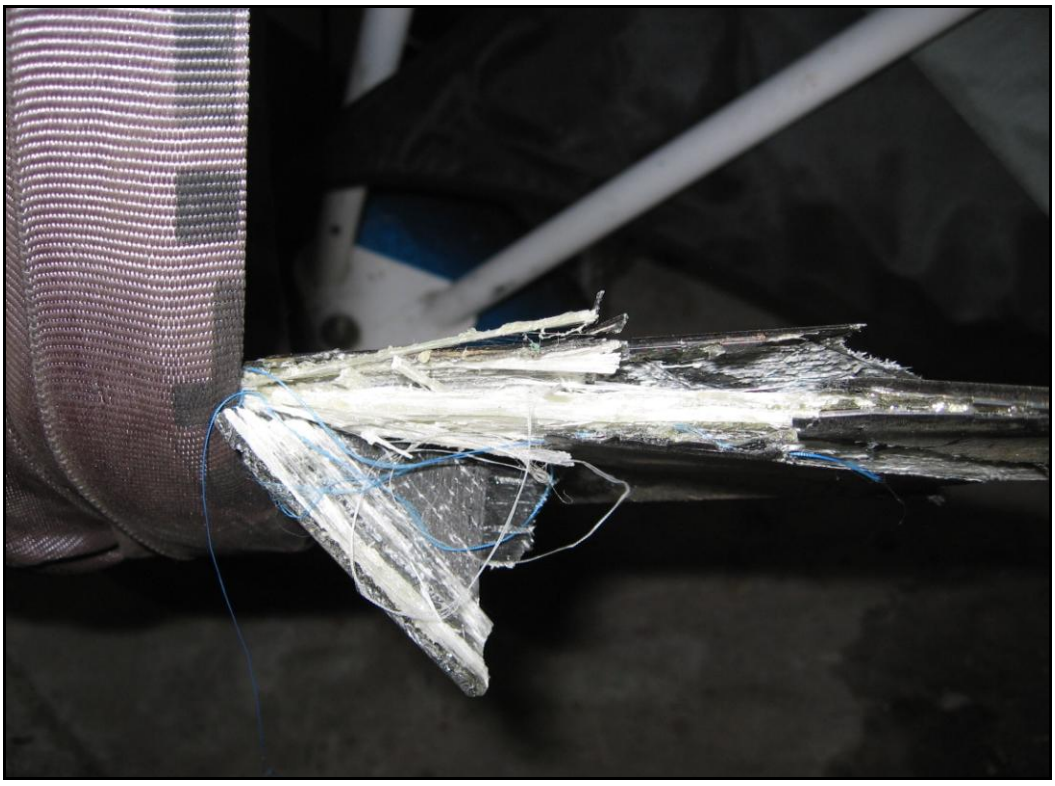

Photo No. 2: Blue Dacron from keel pocket embedded in propeller blade

Photo No. 3: Starboard (RH) wing leading edge failure outboard of crossboom, showing inboard part muddy and outboard part clean

1.7 Regulatory Aspects

On 26 August 2010 the IAA issued Aeronautical Notice (AN) P.17, Issue 2 entitled "*Technical Requirements for the Student Pilot Licence (Microlight Aeroplane) [SPL(M)], Private Pilot Licence (Microlight Aeroplane) [PPL(M)], Flight Instructor Rating (Microlight Aeroplane) [FI(M)], Microlight Aeroplane Ratings and for the Registration of Training Facilities for the PPL(M) and FI(M)*".

The Pilot held a Private Pilot's Licence (Aeroplane) issued by the IAA. He had a Weight-Shift Flex-wing Microlight rating which was due to expire on 12 August 2012. The accident flight was undertaken by the Pilot in partial fulfilment of the requirements for revalidation of ratings.

AN P.17 states:
"*Licence and Rating Privileges …*
6.4 The holder of a valid microlight aeroplane rating is entitled to act as pilot-in-command of the relevant class or type, provided that the holder shall not act as pilot-in-command of a microlight aeroplane carrying a passenger or a student pilot unless within the preceding 90 days such holder has completed three take-offs and landings as the sole manipulator of the controls in a microlight aeroplane of the same class or type."

AN P.17 prescribes the requirements for Revalidation and Renewal of ratings as:

7.1 For revalidation of single-engine piston microlight aeroplane (land or sea, as appropriate) class ratings the applicant shall on single-engine piston microlight aeroplanes (land or sea, as appropriate):-

(a) within the three months preceding the expiry date of the rating, pass a proficiency check with an authorised microlight examiner on a single-engine piston microlight aeroplane (land or sea, as appropriate); or

(b) within 12 months preceding the expiry of the rating :-

(i). complete a total of not less than 12 hours of flight time in aeroplanes or microlight aeroplanes, to include not less than 6 hours of pilot-in-command time in microlight aeroplanes (land or sea, as appropriate) and 12 take-offs and 12 landings in microlight aeroplanes (land or sea, as appropriate); and

(ii). complete a microlight aeroplane (land or sea, as appropriate) refresher training flight of at least 1 hour's duration with a duly authorised FI(M). This flight may be replaced by any other proficiency check or skill test for any other aeroplane class or type rating.

7

The Pilot was pursuing the revalidation option laid down in AN P.17, 7.1 (b) *(ii)*. His logbook showed that he had accumulated the required flight time in August and September of 2010 and the accident flight was to be the prescribed refresher flight.

AN P.17 prescribes the requirements for Microlight Training Facilities as:

Registration of Microlight Aeroplane Training Facilities

8.1 A microlight aeroplane training facility for microlight pilot licences and associated aeroplane or FI(M) ratings shall register with the Authority by submitting a completed Registration Form issued by the Authority pursuant to this Direction.

The Operator held a Certificate of Registration as a Registered Training Facility (RTF) issued by the IAA. The Instructor was listed as the RTF's Chief Flying Instructor (CFI), and was authorised by the IAA as both a Microlight Flight Instructor and a Microlight Flight Examiner. The aircraft was listed on the RTF certificate.

The aircraft was registered in the United Kingdom (UK) and operated on a UK Civil Aviation Authority (CAA) Permit to Fly. Operation of the aircraft in Ireland required permission from the IAA and a certificate of permission was provided to the Investigation.

2. ANALYSIS

The flight was being conducted by a licensed Pilot under the supervision of an authorised Flight Instructor. The Flight Instructor was the CFI of an IAA approved RTF. In accordance with AN P.17 the Pilot was entitled to act as Pilot-in-Command as the aircraft was not carrying a Student Pilot or passenger. The IAA's regulatory requirements governing the flight, the RTF and the aircraft were complied with.

The history of flight as provided to the Investigation by the Instructor indicates a progressive approach with exercises increasing in complexity and handling issues being identified and rectified prior to the next stage of the flight.

The evidence suggests that during the exercise to simulate a stall occurring as a result of an engine failure after take-off, the aggressive lowering of the aircraft nose caused the aircraft to enter a partial tumble manoeuvre. As noted in the research quoted above, the tumble manoeuvre is normally unrecoverable. The Instructor called to the Pilot to 'Recover-bar forward' as he (the Instructor) was unable to reach the controls to affect any form of recovery due to the extreme violence and G forces associated with the aircraft manoeuvre.

On this occasion it is likely that when the aircraft inverted, the front strut failed due to the trike inertia opposing the wing pitching moment. This is supported by the evidence of the propeller strikes on the keel. The tumble entry was only just strong enough to invert the aircraft and allow the trike unit to fall into the right hand sail (failing the leading edge) but not so strong as to start a typical, fully established, tumbling autorotation in pitch. Subsequently, with asymmetric lift due to the failed right leading edge, the aircraft entered an autorotation in yaw which continued until ground impact. This autorotation in yaw reduced the rate of vertical descent sufficiently to make the accident survivable.

3. CONCLUSIONS

(a) Findings

1. The flight was a Refresher Training Flight carried out at the request of the Pilot to revalidate his Weight-Shift Flex-wing Microlight rating.

2. The IAA's regulatory requirements governing the flight, the RTF and the aircraft were complied with.

3. The weather conditions for flying were described as good.

4. A pre-flight inspection was conducted by the Pilot, and observed by the Instructor and the aircraft was found to be in an airworthy condition.

5. There were no reported problems with the serviceability of the aircraft before or during the accident flight.

6. The history of flight as provided to the Investigation by the Instructor indicates a progressive approach with exercises increasing in complexity and handling issues being identified and rectified prior to moving on with the flight.

7. The accident occurred during an exercise simulating a stall occurring as a result of an engine failure after take-off.

8. When the throttle was closed an aggressive lowering of the nose caused the aircraft to adopt a steep nose down attitude, resulting in a rapid increase in airspeed.

9. The Instructor called to the Pilot to 'Recover-bar forward' as he (the Instructor) was unable to reach the controls to affect any form of recovery due to the extreme violence and G forces associated with the aircraft manoeuvre.

10. The aircraft entered a partial tumble manoeuvre.

11. The opposing forces between wing and trike caused the trike front strut to fail.

12. Due to the front strut failure the propeller struck the wing keel.

13. The tumble entry was only just strong enough to invert the aircraft, and allowed the trike unit to fall into the right hand sail (failing the leading edge).

14. The asymmetric lift due to the failed right leading edge caused the aircraft to enter an autorotation in yaw which continued until ground impact.

15. Both Instructor and Pilot suffered serious injuries in the impact.

16. The Instructor, though seriously injured, maintained consciousness and managed to use his mobile phone to alert the emergency services.

(b) Probable Cause

During an exercise to simulate a stall occurring as a result of an engine failure after take-off, an aggressive lowering of the nose caused the aircraft to adopt a steep nose down attitude and the aircraft entered a partial tumble manoeuvre.

(b) Contributory Cause(s)

1. Lack of Pilot currency.

2. The Instructor was unable to reach the controls to affect any form of recovery due to the extreme violence and G forces associated with the aircraft manoeuvre.

4. SAFETY RECOMMENDATIONS

This Investigation does not sustain any Safety Recommendations.

- END -

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

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

Produced by the Air Accident Investigation Unit

AAIU Reports are available on the Unit website at www.aaiu.ie

An Roinn Iompair
Turasóireachta agus Spóirt

Department of Transport,
Tourism and Sport

Air Accident Investigation Unit,
Department of Transport Tourism and Sport,
2nd Floor, Leeson Lane,
Dublin 2, Ireland.
Telephone: +353 1 604 1293 (24x7): or
+353 1 241 1777
Fax: +353 1 604 1514
Email: info@aaiu.ie
Web: www.aaiu.ie