



## Safety Investigation Report

# ACCIDENT TO THE ULM – RAINBOW AIRCRAFT REGISTERED OO-G29 IN HOEVENEN ON 11 DECEMBER 2011

**TABLE OF CONTENT**

<b>FOREWORD</b> .....	<b>3</b>
<b>SYNOPSIS</b> .....	<b>4</b>
<b>1. FACTUAL INFORMATION</b> .....	<b>5</b>
1.1. HISTORY OF THE FLIGHT .....	5
1.2. INJURIES TO PERSONS .....	6
1.3. DAMAGE TO AIRCRAFT .....	6
1.4. OTHER DAMAGE .....	7
1.5. PERSONNEL INFORMATION .....	7
1.6. AIRCRAFT INFORMATION .....	8
1.7. METEOROLOGICAL INFORMATION .....	11
1.8. AIDS TO NAVIGATION .....	11
1.9. COMMUNICATION .....	11
1.10. AERODROME INFORMATION .....	11
1.11. FLIGHT RECORDERS .....	12
1.12. WRECKAGE AND IMPACT INFORMATION .....	13
1.13. MEDICAL AND PATHOLOGICAL INFORMATION .....	17
1.14. FIRE .....	17
1.15. SURVIVAL ASPECTS .....	17
1.16. TEST AND RESEARCH .....	17
<b>2. ANALYSIS</b> .....	<b>18</b>
<b>3. CAUSES</b> .....	<b>20</b>
<b>4. SAFETY RECOMMENDATIONS</b> .....	<b>20</b>
 <b>APPENDIX: RECORDED FLIGHT DATA</b> .....	 <b>21</b>

## FOREWORD

This report is a technical document that reflects the views of the investigation team on the circumstances that led to the accident.

In accordance with Annex 13 of the Convention on International Civil Aviation, it is not the purpose of aircraft accident investigation to apportion blame or liability. The sole objective of the investigation and the Final Report is the determination of the causes, and define recommendations in order to prevent future accidents and incidents.

In particular, Art. 17.3 of EU Regulation 996/2010 stipulates that a safety recommendation shall in no case create a presumption of blame or liability for an accident, serious incident or incident.

EU Regulation 996/2010 does not require accidents with aircraft specified in Annex II to Regulation (EC) No 216/2008 to be investigated. In this particular case, the Chief Investigator has determined that this investigation had a potential for drawing safety lessons.

Unless otherwise indicated, recommendations in this report are addressed to the Regulatory Authorities of the State having responsibility for the matters with which the recommendation is concerned. It is for those Authorities to decide what action is taken.

The investigation was conducted by L. Blendeman, H. Metillon and S. Laureys.  
The report was compiled by L. Blendeman

### NOTE:

For the purpose of this report, time will be indicated in UTC, unless otherwise specified.

## **Synopsis.**

### **Date and hour of the accident**

11 December 2011 at 12:25 UTC

### **Aircraft**

Rainbow Aircraft "Cheetah", msn CH-104, registered OO-G29

### **Accident location**

In a field in Hoevenen near EBHN airfield  
N 51° 18' 00.2" E004° 22' 39.0"

### **Aircraft owner**

SE@FLY B.V.B.A.

### **Type of flight**

Training flight

### **Persons on board**

2

## 1. Factual Information

### 1.1. History of flight.

The pilot took off from EBHN with OO-G29 and a passenger on-board at 12:20 UTC. The purpose was to perform an initiation flight for the passenger.

The airplane took off from Runway 15, climbed to 600ft and turned to the right to join the circuit.

When turning in downwind, the windscreen broke off. The passenger thought it was hit by something.

The airplane started to descend; the pilot reported being unable to avoid the airplane to go down; the elevator controls having no effect.

The pilot turned the airplane towards the airfield, to the right, with the ailerons, but the rate of descend was too high; he realized he would never be able to reach the field. The pilot pushed full throttle, without effect.

He selected a suitable place to perform an emergency landing. For the last 100m, the pilot lowered the flaps. The airplane crash landed on a reed field.

The occupants were taken out of the airplane by the emergency services.

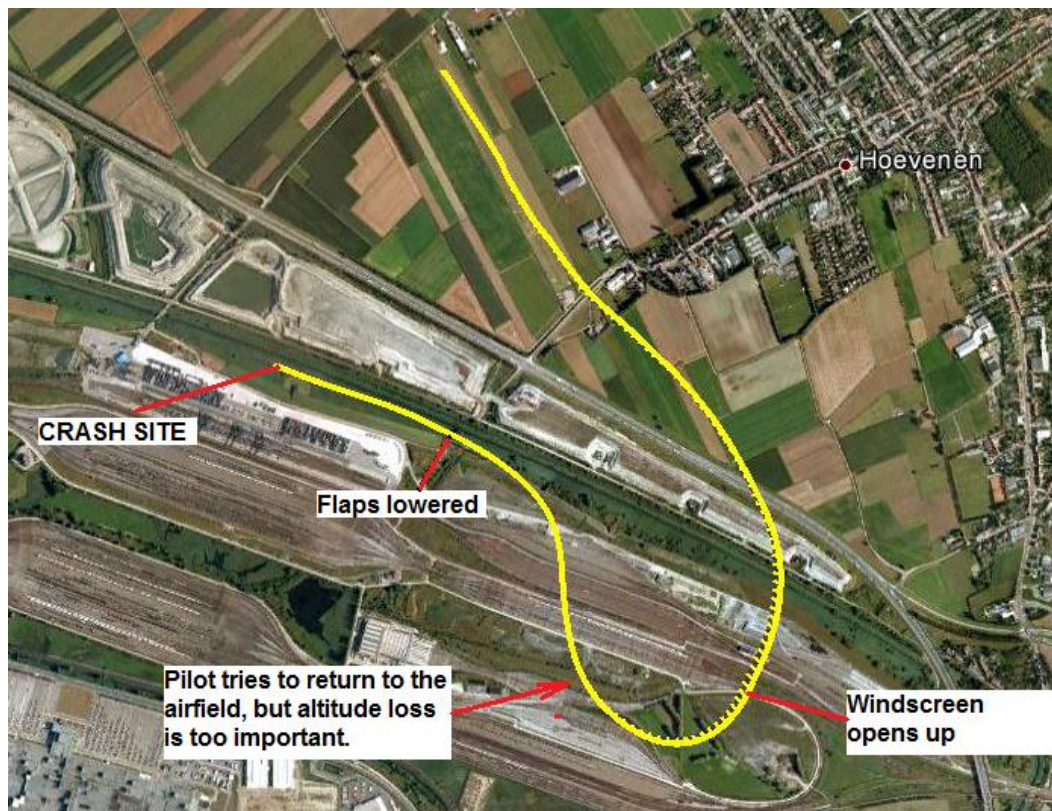


Fig.1 Flight track

## 1.2. Injuries to persons.

Injuries	Pilot	Passenger	Others	Total
Fatal	0	0	0	0
Serious	1	0	0	1
Minor	0	1	0	1
None	0	0	0	0
Total	1	1	0	2

The pilot suffered a broken vertebra (L3)

## 1.3. Damage to aircraft.

The airplane sustained heavy damage:

- Landing gear torn off (NLG and Main)
- Deformation on side braces
- Windscreen broken
- One propeller blade broken.



Fig. 4 crashed airplane

#### **1.4. Other damage.**

None

#### **1.5. Personnel information.**

##### **Pilot**

Sex: male

Age: 52 years old

Nationality: Belgian

Holder of a Private Pilot Licence, first issued on 17 July 2000, valid until 01 April 2016. Rating: SEP.

Holder of a ULM Authorization, first issued on 10 October 2006, valid until 1<sup>st</sup> March 2012.

Rating: ULM Instructor, first issued in July 2004, valid until 31 August 2013.

Medical certificate: Class 2, valid until 01 March 2012.

Total experience amounts to over 1200FH, among which 1000FH on ULM.

The pilot had flown 24FH on OO-G29 from October 2011 to-date.

## 1.6. Aircraft information.

The Cheetah is a two place, side-by-side Ultra Light airplane, with a Dacron covered, high wing, aluminum tube monoplane with fixed undercarriage and a conventional horizontal and vertical stabilizer.

The engine cowling, cockpit and wing fairing are made of fiberglass.

Specifications (typical)

Empty weight: 283.32 kg

Maximum Take Off Weight: 450kg

VNE: 200 km/h

VNO: 145 km/h

VS: 56 km/h

Landing approach (flaps down 18 deg): 80 km/h

Fuel capacity: 94 Liters

Wing span: 9.72m

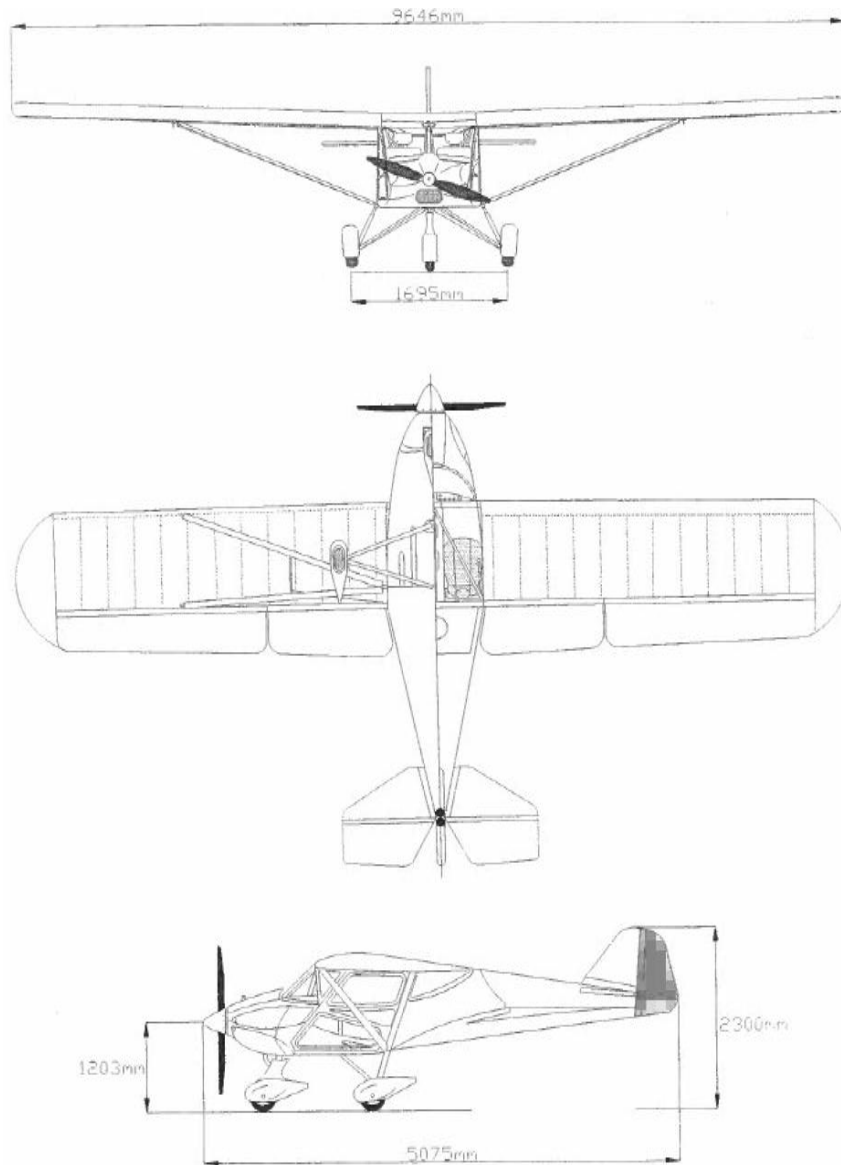
Length: 5.7m

Height: 2.14m



Fig 2. The airplane





**Fig 3. 3-view drawing**

**Airframe:**

- Manufacturer: Rainbow Aircraft (PTY) Ltd.
- Type: Cheetah
  
- Serial number: CH-104
- Assembly /Built year: 2009
- Certificate of Conformity: Form 1 issued on 31/3/2009.
  
- Type Authorization: ARCA 2008/143 – 1/28-08-2008
- Registration: OO-G29, issued on 16 Apr 2009
- ULM Authorization: N-1999-621 issued by BCAA on 11 June 2009.
- Total Time: 140.1 FH
  
- Empty weight: 250.5kg
- MTOW: 450kg

**Engine:**

- Manufacturer: Rotax.
- Model: 912UL
- Serial: 4.408.425

**Propeller:**

- Manufacturer: DUC
- Model: SWIRL Inconel
- Serials: PA10SD51111190209116 / PA10SD51211190209116 / PA10SD51131190209116.

### **1.7. Meteorological conditions at EBAW**

Wind:

Direction: 210 degrees variable between 180 and 240 degrees

Speed: 10 kts

Clouds: scattered 4500ft

Temperature: 7°C

QNH: 1013 hPa

### **1.8. Aids to navigation.**

Not applicable.

### **1.9. Communication.**

Not applicable

### **1.10. Aerodrome information**

Not applicable

## 1.11. Flight Recorder

The aircraft was not equipped with a dedicated Flight recorder, but was fitted with an integrated instruments system Stratomaster Enigma of MGL Avionics.



The Enigma collects data from various sources; GPS and probes in the aircraft and engine.

According to the version and interface installed, the Enigma can provide the following functionalities:

- Engine monitoring System (EMS)
- Attitude/Heading Reference System (AHRS)
- Collision avoidance
- Auto-pilot

Data were extracted from the memory, and the following recorded flight data were used :

- GPS position
- Airspeed
- Altitude
- Ground speed
- Vertical airspeed
- Engine rpm

The graphs are in appendix.

## 1.12. Wreckage and impact information:

### The windscreen

The windscreen is made of 1 piece of polycarbonate (2mm thick) attached to the roof structure of the airplane, bent downward and attached by 9 rivet nuts to the forward fairing of the cockpit, and bent sideward and attached to the side structure of the cockpit.

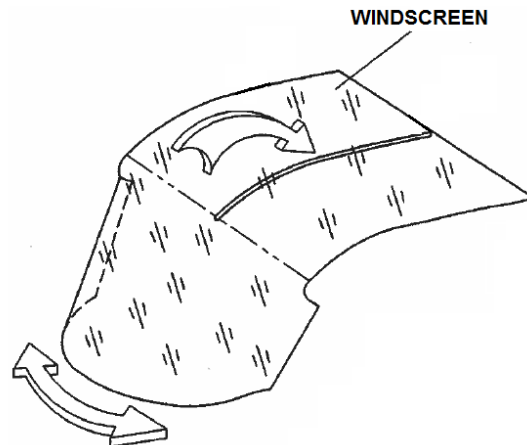


Fig. 5. Windscreen configuration

The windscreen was broken in 4 parts. All parts were found on the wreckage.



Fig. 6 Damaged Windscreen

The central cracks were initiated from the attachment point 4 and a point between attachment 5 and 6.

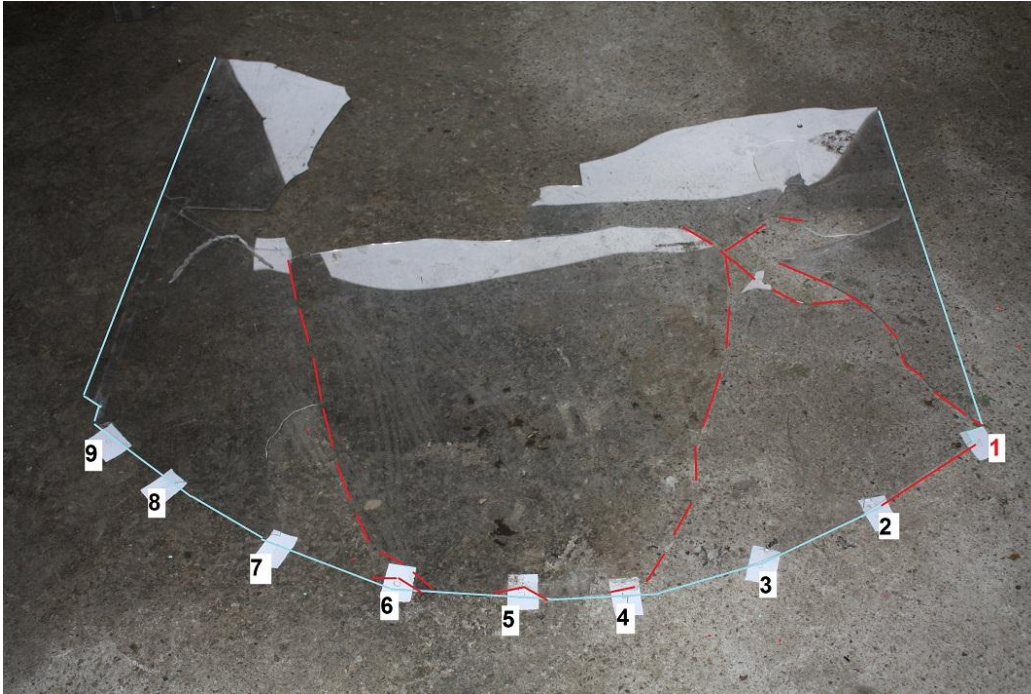


Fig. 7 windscreen fractures

Attachment 4:

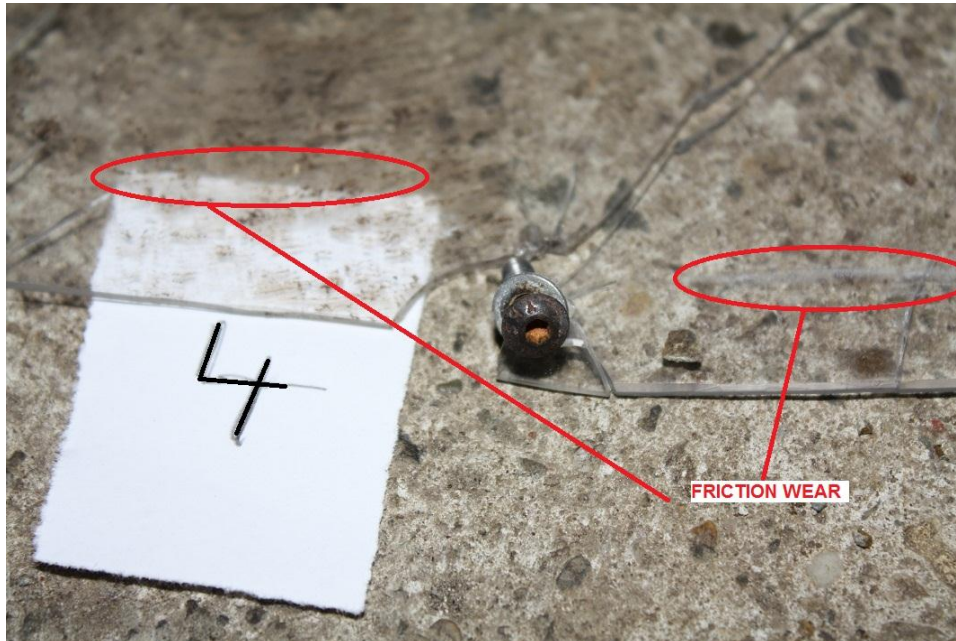


Fig 8. Attachment point 4

The area shows friction wear from both sides of the attachment.

Attachment point 6

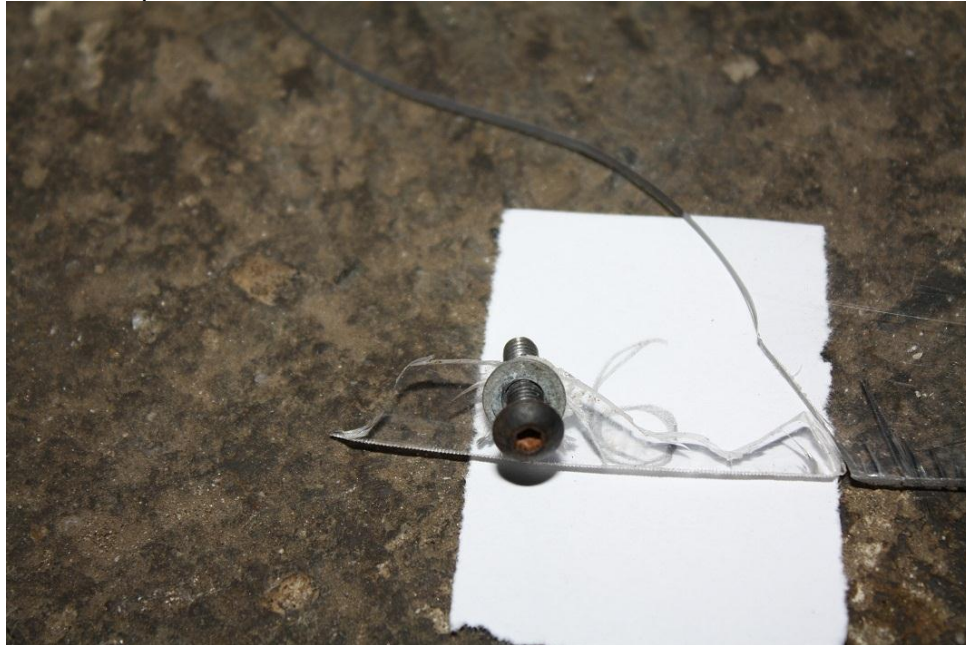


Fig. 9 Second fracture point

Crack initiations are visible left and right of the fracture.



Fig 10 cracks in the windscreen

### Windscreen installation.

The installation of the windscreen is identified in pages 127-129 of the Rainbow assembly manual:

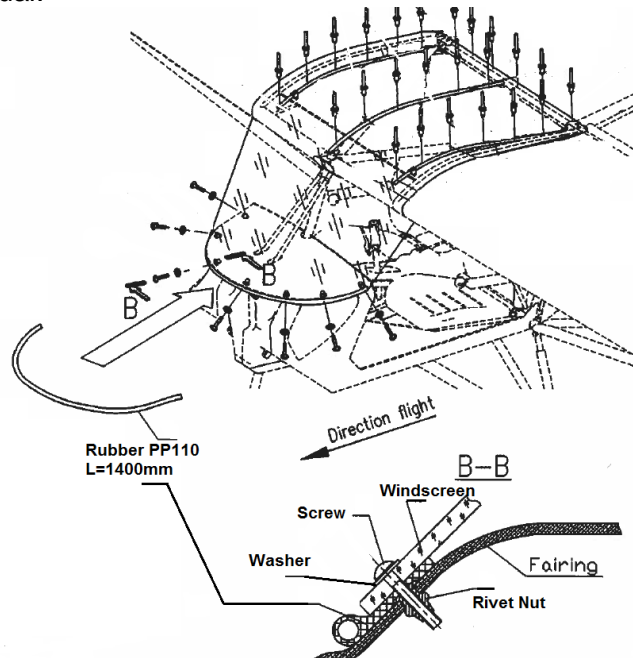


Fig. 11 Manufacturing details

The windscreen is attached to the airplane forward fairing by rivet nuts and separated from the fairing by a rubber seal (see fig 11 hereabove)  
On OO-G29, the inspection of the windscreen revealed that the Rubber seal PP110 was not installed. A silicone sealing was added.





## **Maintenance**

The airplane was leased to the Hoevenen aeroclub for flight training on 30 September 2011. The airplane counter showed 60.45 FH at the time.

The airplane was maintained in accordance with manufacturer's requirements by the Hoevenen aeroclub's mechanics.

The last maintenance involved a replacement of the engine exhaust pipe.

Reportedly, the windscreen showed on 30 September 2011 already some light cracks around the windscreen attachment point. The cracks did not evolve from that time.

### **1.13. Medical and pathological information.**

Not relevant

### **1.14. Fire.**

There was no fire.

### **1.15. Survival aspects**

The pilot suffered from a broken L3 vertebra, due to the vertical shock during the crash. The passenger was unhurt.  
Both pilot and passengers had their safety belt on.

There are no standard or regulation issued pertaining to the resistance of the seats to vertical loads, and the seats of the Cheetah were not designed to withstand a vertical load of the magnitude encountered during a crash.

The pilot, looking at his own experience, suggested the use of lightweight paratroop seats or rotorcraft utility seats featuring a (limited) crashworthiness instead of the seats usually found on ultra-light airplane.

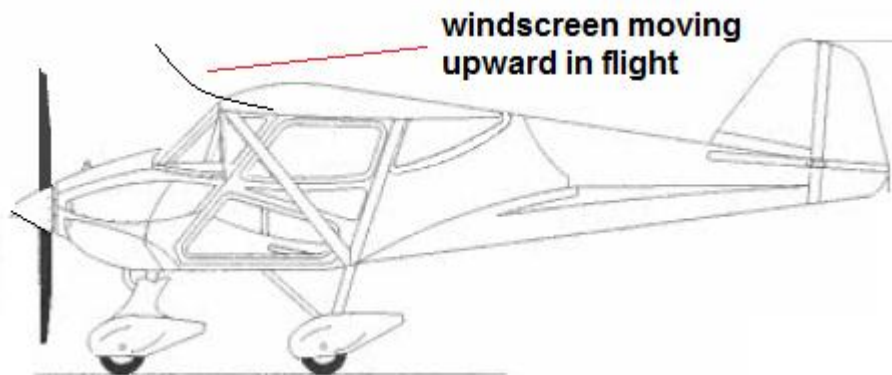
### **1.16. Test and Research**

Not Applicable

## 2. Analysis.

The pilot reported hearing a bang; the occupants thought something hit the windscreen, however there are no trace of impact visible on the windscreen itself (such as blood, feathers, that would be expected in the case of a bird strike). The pilot further reported seeing a gap at the place of the windscreen, and the roof being torn out.

The windscreen forward portion was found in the wreckage, indicating it was not liberated in flight, and remained attached to the roof. The forward portion of the windscreen went up, pushed by the air flow (engine and airplane displacement) causing a very important aerodynamic drag, making that the airplane went irresistibly down.



The windscreen failed in flight from cracks originating from attachment point 4 and cracks between attachment point 5 and 6.

The cracks at the attachment point and at the border of the windscreen were caused by a mechanical stress coming from the relative movements of the airplane structure and the windscreen (a visible sign of this movement is given by wear traces around attachment point 4). The installation of the windscreen was not complying with the manufacturer's requirements, as it omitted to place a rubber seal between the windscreen and the forward fairing, that would normally act as a stress dampener.

The manufacturer was contacted, and gave the following comment:

Firstly, Rainbow Aircraft management and staff were extremely sad to hear of the accident involving Cheetah CH – 104. The Cheetah XLS has an impeccable safety record and this event is a major cause for concern for all involved in Rainbow aircraft.

This is however the only case we have on record of a windshield failure.

Technical management have reviewed the preliminary report findings with interest. It is important to note that the our technical team are only working with info received in the report and as they have not been able to view the Cheetah. Our findings are therefore not to be taken as an official report but purely an opinion based on the info we have on hand. Their thoughts on the windshield failure are as follows:

When the windshield is installed without the rubber seal between the shield and fairing structure, there are various factors to be considered that could in all likelihood be a major contributor to the failure thereof. Starting with the actual installation, with the rubber in place, this would act as a visual aid to judge the degree of how tight the screws are being turned to as the rubber would start to compress with the tightness. Without the rubber seal present, it would be extremely easy to over tighten the screws that could cause hairline cracks in the windshield around the screw holes and with no rubber seal, the shield will take all of the force of the tightened screw.

The rubber strip would also act as a buffer from vibration. Vibration could of course also contribute to the forming of cracks and make any existing cracks worse over time.

Over time, the hairline cracks **will** grow exponentially and will reach a point that the strength of the shield is jeopardised.

We have made comparisons with other Cheetah XLS aircraft. A Cheetah (Serial number CH 073. manufactured in 2008 and with approximately 300 hours on airframe) that came in for general maintenance and a windshield replacement as over time, the top cowling had been allowed to scratch the windshield when removed/replaced. There are no visible cracks around the lower screw holes and the windscreen does not seem to have hardened over time and is therefore not overly brittle. This aircraft obviously did have the rubber seal in place as per design specification.

Temperature:

The South African climate dictates that we cannot personally test the effects of how the shield will fair up to extreme atmospheric temperature variations over time. However, there are Cheetahs being operated in the northern regions of USA (Wisconsin) that experience extremely hot summers and extremely cold winters. We have been in contact with the operators and they have inspected their windscreens without finding. (In all cases, the rubber seal was present).

Having said this, our technical management have considered that temperature variations could have played a part in the failure as expanding and contracting of the shield could very well have adversely affected any small cracks that might have been present from installation as mentioned above. This would have been made worse by the omission of the rubber seal.

We are of the extremely strong opinion that not installing the rubber seal has played a significant role in this failure. Also, as cracks had been present (noticed in September 2011) it would obviously have been prudent to have taken more notice of this.

Once again, we are extremely sad to hear that persons were injured in this Cheetah XLS accident and we wish them all the best for a quick and full recovery. We are however sure that the cause of the problem relates to the assembly of the Cheetah varying from the factory approved method.

### **3. Causes.**

The accident was caused by the in-flight failure of the windscreen caused by an inadequate attachment of the windscreen to the airplane structure.

### **4. Safety Recommendation.**

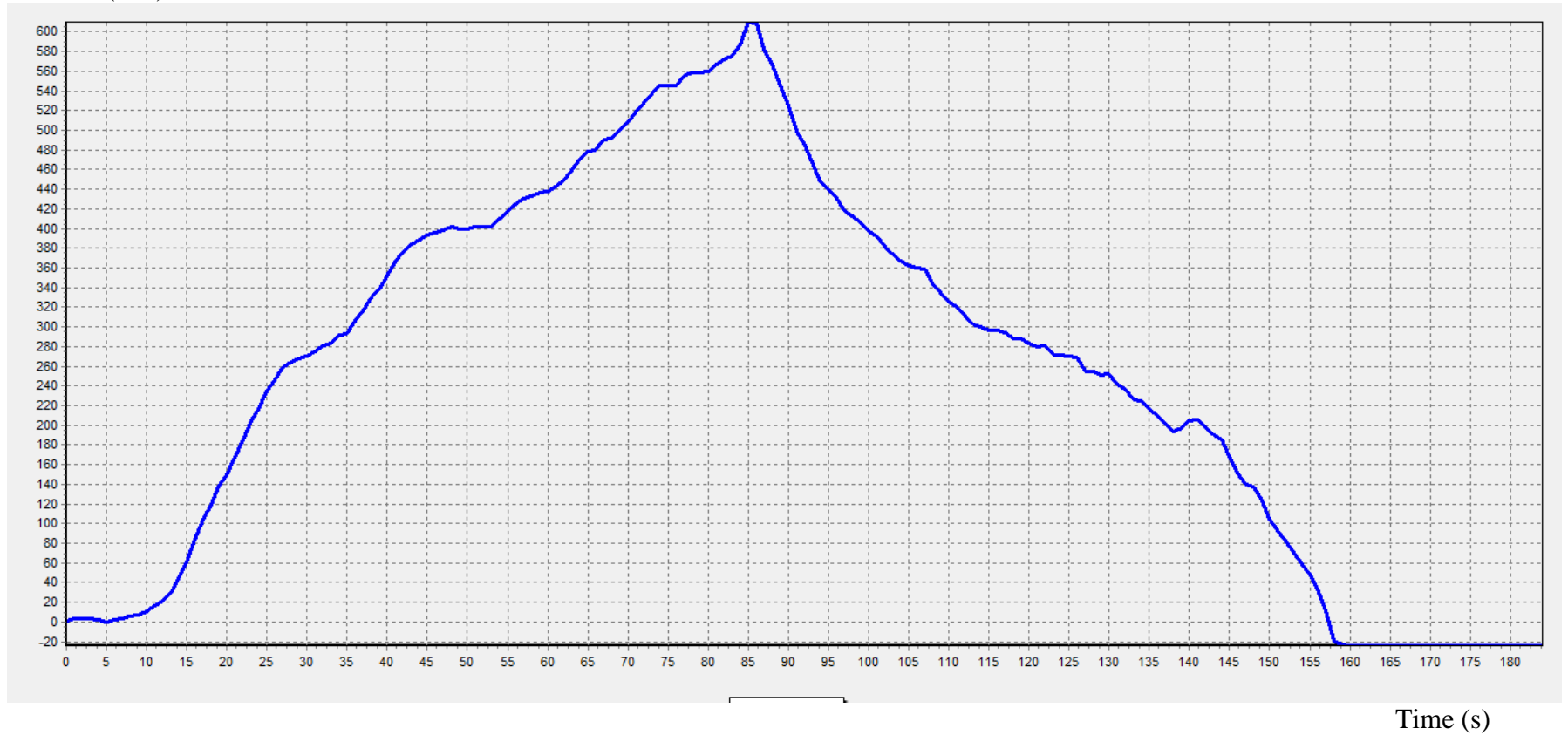
#### **Recommendation 2011-U-2 to Rainbow Aircraft South Africa**

AAIU(Be) recommends Rainbow aircraft to amend the current assembly manual of the Cheetah to incorporate a caution note about the importance to install the rubber seal when installing the windscreen.

The General Manager of Rainbow Aircraft agreed to comply with the recommendation in an e-mail dated 01 March 2012.

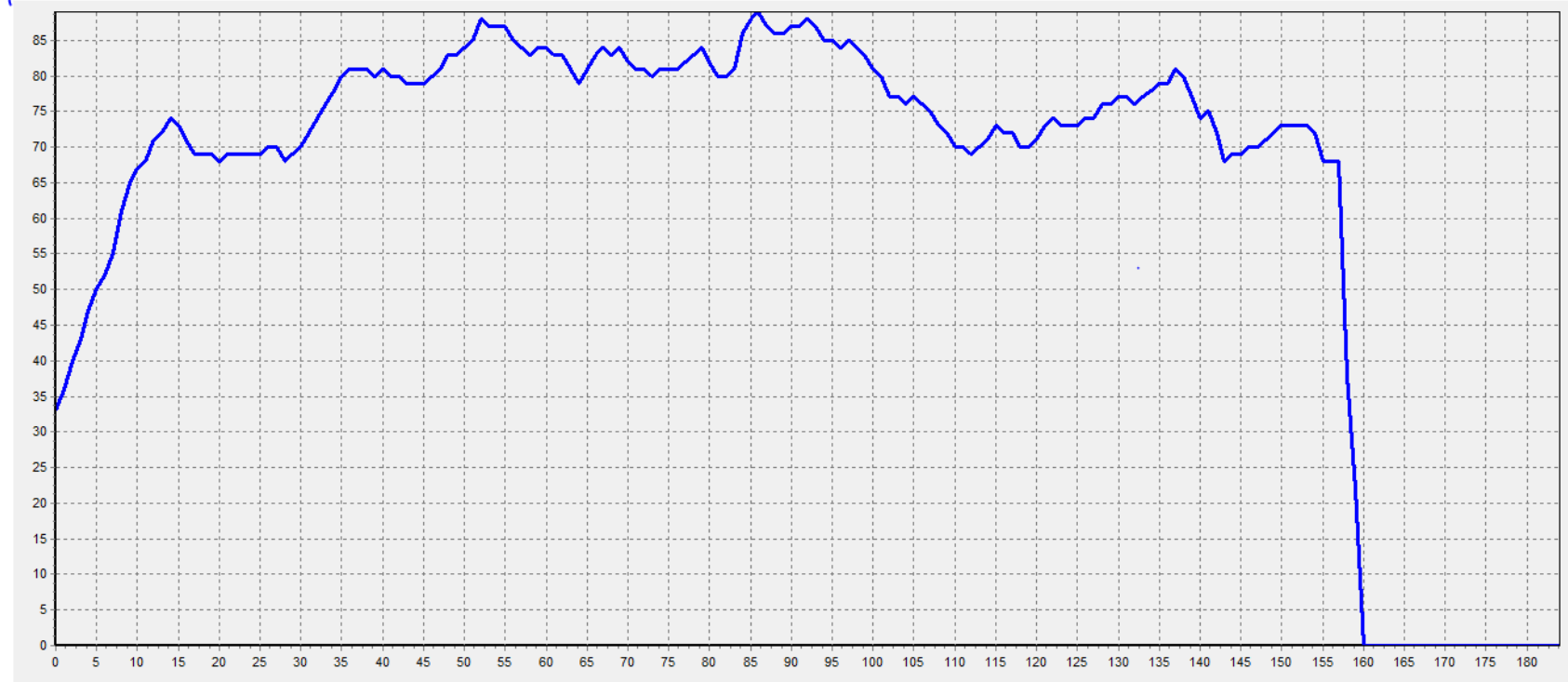
## **Appendix. Recorded Flight Data download (extract)**

Altitude (feet)



1. Pressure Altitude

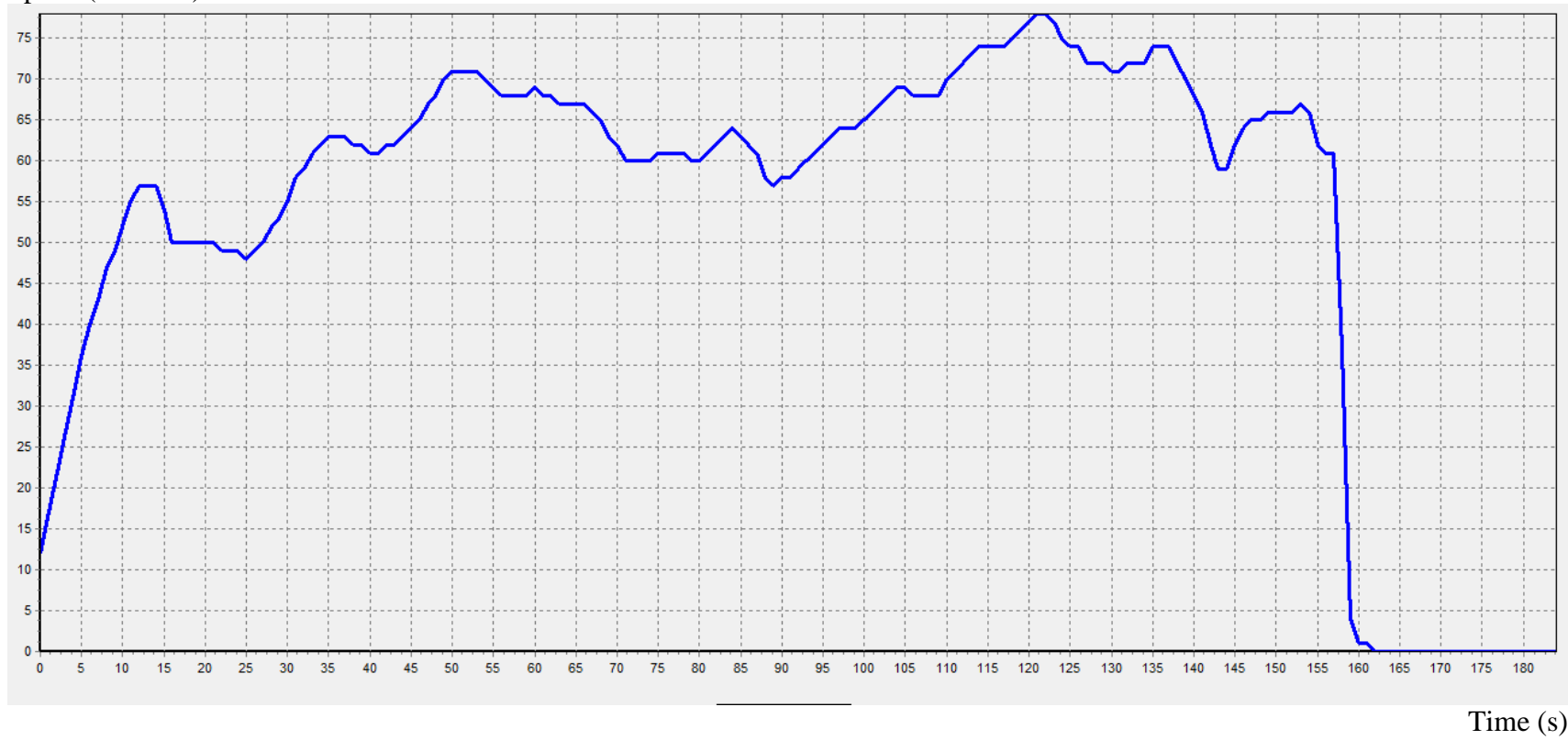
Airspeed (miles/hr)



Time (s)

2. Airspeed

Speed (miles/hr)

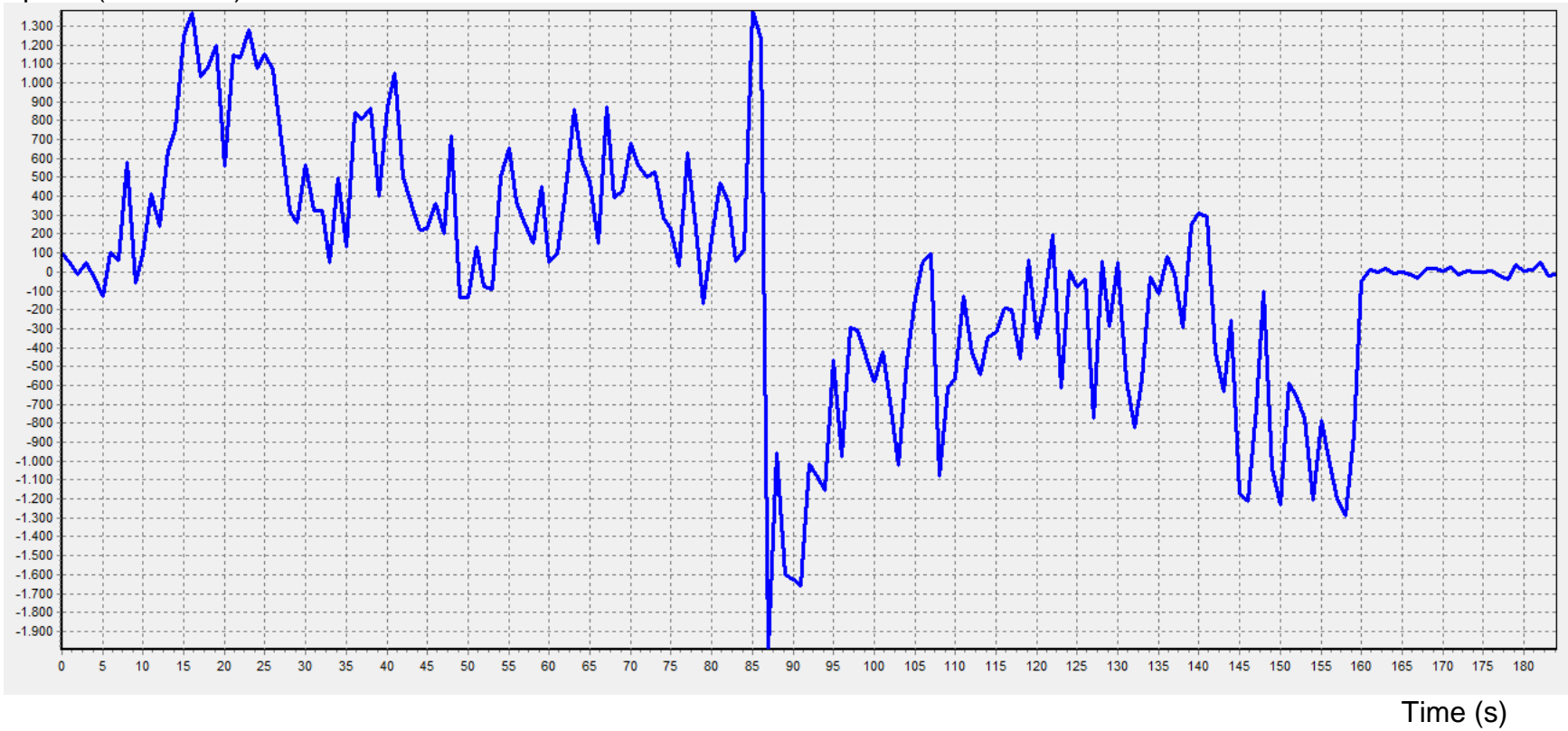


3. Ground speed

Time (s)

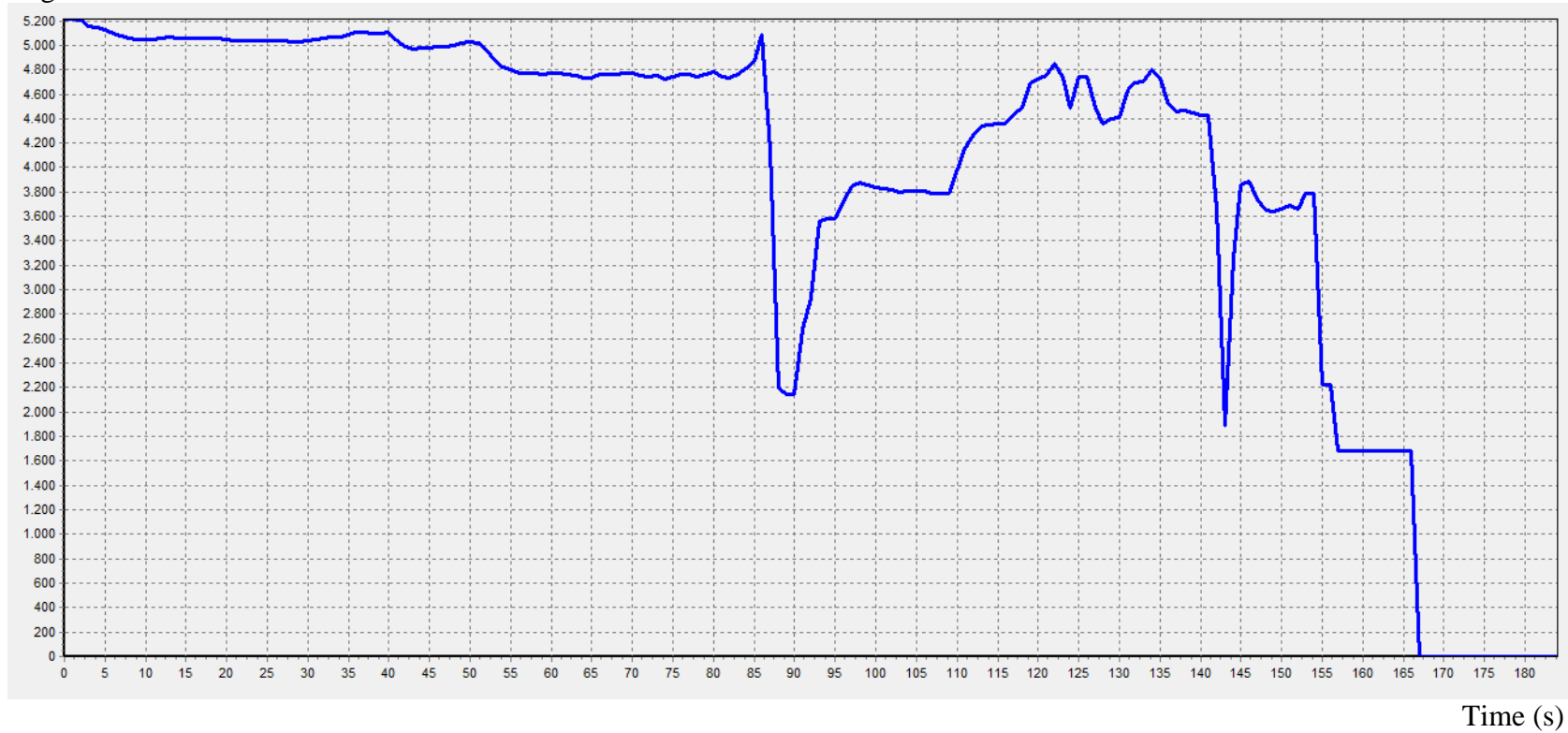


Speed (Feet / min)



4. Vertical Speed

### Engine RPM



5. Engine RPM