AIRCRAFT ACCIDENT REPORT AND EXECUTIVE SUMMARY

				Reference:	CA18/2/3/9268		
Aircraft Registration	ZU-DVM	**Date of Accident**	4 January 2014		**Time of Accident**	1510Z	
Type of Aircraft	Rans S-6ES Coyote II		**Type of Operation**		Private		
Pilot-in-command Licence Type	Private Pilot License		**Age**	46	**Licence Valid**	Yes	
Pilot-in-command Flying Experience	**Total Flying Hours**		223.6		**Hours on Type**	51.4	
Last point of departure	Khunskraal Farm in Cape Infanta, Western Cape						
Next point of intended landing	Swellendam Airfield (FASX), Western Cape						
Location of the accident site with reference to easily defined geographical points (GPS readings if possible)							
Khunskraal Farm in Cape Infanta (GPS position: 33°01'47" South 18°54'40" East, elevation 276 ft. AMSL)							
Meteorological Information	**Temperature:** 27°C; **Surface wind:** 225°/10kts; **Visibility:** <1000m **Cloud cover:** Broken; **Cloud base:** 1000ft; **Dew point:** 4˚C						
Number of people on board	1 + 0	**No. of people injured**	0	**No. of people killed**	1		

Synopsis

The pilot departed in his aircraft with the intention to return to Swellendam Airfield (FASX) after he had dropped off a passenger at Khunskraal Farm.

The aircraft was seen taking off normally, but the aircraft "crabbed" to the right. The aircraft stalled then banked sharply to the left; followed by a left wing drop and the aircraft went into a vertical spiral dive. The aircraft descended and impacted the ground.

The pilot was fatally injured and the aircraft was substantially damaged during the impact sequence.

Probable Cause

Loss of control of aircraft after take-off resulting from a sudden stall, followed by a vertical spiral dive.

Contributory factor

Failure of right rudder pedal cable.

IARC Date		Release Date	

AIRCRAFT ACCIDENT REPORT

Name of Owner	**:**	Bontebok Aviation
Name of Operator	**:**	Not Applicable
Manufacturer	**:**	Rans Aircraft Corp / Geers P
Model	**:**	Rans S-6ES Coyote II
Nationality	**:**	Dutch
Registration Marks	**:**	ZU-DVM
Place	**:**	Khunskraal Farm in Cape Infanta, Western Cape
Date	**:**	4 January 2014
Time	**:**	1510Z

All times given in this report is Co-ordinated Universal Time (UTC) and will be denoted by (Z). South African Standard Time is UTC plus 2 hours.

Purpose of the Investigation:

In terms of Regulation 12.03.1 of the Civil Aviation Regulations (2011) this report was compiled in the interest of the promotion of aviation safety and the reduction of the risk of aviation accidents or incidents and ***not to establish legal liability****.*

Disclaimer:

This report is produced without prejudice to the rights of the CAA, which are reserved.

1. FACTUAL INFORMATION

1.1 History of Flight

1.1.1 On 4 January 2014, the pilot completed his safety checks and then took off from Swellendam and then down the Breede River and over to De Hoop Nature reserve.

1.1.2 On arrival at Cape Infanta, the pilot and passenger flew up the river to Khunskraal farm where the airstrip is located. The pilot landed the aircraft without incident. After a brief conversation with the passenger and another pilot, the pilot of the aircraft decided to depart at approximately 1308Z for Swellendam as bad weather conditions were approaching.

1.1.3 After initially flooding the engine, the aircraft started and was ran for a few minutes to clear and then the aircraft took off. As the aircraft cleared the bushes it was seen crabbing to the right. Shortly after that the aircraft was seen turning to the left, followed by the left wing dropping and aircraft entered into a vertical spiral dive. The aircraft impacted the ground killing the pilot on impact.

1.1.4 The accident occurred during daylight conditions at 1510Z at a GPS position 33°01’47” South 18°54’40” East, elevation 276 ft. AMSL.

1.2 Injuries to Persons

Injuries	Pilot	Crew	Pass.	Other
Fatal	1	-	-	-
Serious	-	-	-	-
Minor	-	-	-	-
None	-	-	-	-

1.3 Damage to Aircraft

1.3.1 The aircraft was destroyed in the accident sequence.

1.4 Other Damage

1.4.1 Other damage was limited to vegetation.

1.5 Personnel Information

Nationality	Dutch	Gender	Male	Age	46
Licence Number	0270463719	Licence Type	Private Pilot Licence		
Licence valid	Yes	Type Endorsed	Yes		
Ratings	Type rated				
Medical Expiry Date	31 January 2014				
Restrictions	None				
Previous Accidents	None				

Flying Experience:

Total Hours	223.6
Total Past 90 Days	5.9
Total on Type Past 90 Days	5.9
Total on Type	51.4

NOTE 1: The pilot's logbook was last updated in January 2013.
NOTE 2: The above hours were calculated based on information obtained from one of the aircraft owners of the aircraft and entries in the aircraft flight folio.

1.6 Aircraft Information

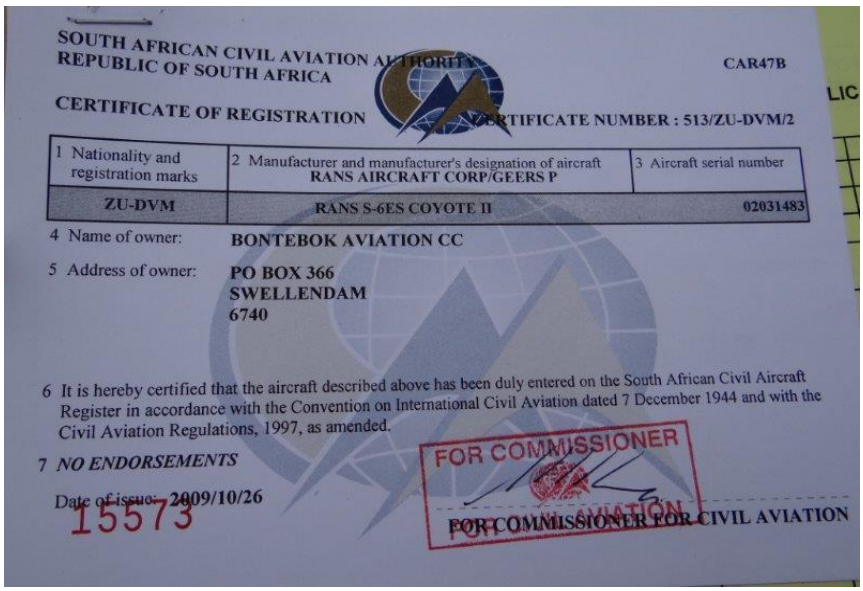
1.6.1 Airframe:

Type	Rans S-6ES Coyote II
Serial Number	02031483 – C of R 0201483 – Data Plate
Manufacturer	Rans Aircraft Corp / Geers P
Date of Manufacture	2005

Total Airframe Hours (At time of Accident)	592.9 hours	
Last Annual (Date & Hours)	26 September 2013	578.1
Hours since Last Annual	14	
Authority to Fly (Issue Date)	1 October 2013	
Authority to Fly (Expiry Date)	25 September 2014	
C of R (Issue Date) (Present owner)	26 October 2009	
Maximum take-off weight	500kg	
Empty weight	296kg	
Operating Categories	Part 91	
Recommended fuel used	91 Octane	

NOTE 1: The serial number on the data plate did not correspond with the serial number on the Certificate of Registration.

Figure 2: Aircraft fireproof data plate reflecting Serial Number **0201483**


SOUTH AFRICAN CIVIL AVIATION AUTHORITY
REPUBLIC OF SOUTH AFRICA

CAR47B

CERTIFICATE OF REGISTRATION

CERTIFICATE NUMBER : 513/ZU-DVM/2

1 Nationality and registration marks	2 Manufacturer and manufacturer's designation of aircraft	3 Aircraft serial number
ZU-DVM	RANS AIRCRAFT CORP/GEERS P RANS S-6ES COYOTE II	02031483

4 Name of owner: BONTEBOK AVIATION CC

5 Address of owner: PO BOX 366
SWELLENDAM
6740

6 It is hereby certified that the aircraft described above has been duly entered on the South African Civil Aircraft Register in accordance with the Convention on International Civil Aviation dated 7 December 1944 and with the Civil Aviation Regulations, 1997, as amended.

7 *NO ENDORSEMENTS*

Date of issue: 2009/10/26

15573

FOR COMMISSIONER

FOR COMMISSIONER FOR CIVIL AVIATION

Figure 3: Certificate of Registration reflecting Serial Number **02031483**

NOTE 2: The owner confirmed in writing that he made a typing error when he sent the information to the engraver to have fire proof data plates manufactured for the aircraft.

1.6.2 Engine:

Type	Rotax 912UL
Serial Number	5643219
Hours since New	3274
Hours since Overhaul	837

1.6.3 Propeller:

Type	3 blade
Serial Number	C17858
Hours since New	374.3
Hours since Overhaul	TBO not yet reached

1.7 Meteorological Information

1.7.1 The surface weather information below has been obtained from the South African Weather Services (SAWS).

Wind direction	SW	Wind speed	10kt	Visibility	Overcast
Temperature	27˚C	Cloud cover	Broken	Cloud base	1000ft
Dew point	4˚C				

1.7.2 Fine weather with light surface wind was observed over Porterville at the time of the accident. Pronounced vertical wind shear was forecasted between 3000ft and 5000ft above ground level (AGL) with stronger wind above 5000ft.

1.7.3 The density altitude at the time of the accident was 1226ft.

1.8 Aids to Navigation

1.8.1 The aircraft was equipped with the standard factory fitted navigational equipment approved by the Regulator. There were no recorded defects to navigational equipment prior to flight.

1.9 Communications

1.9.1 The aircraft was equipped with one VHF (Very High Frequency) radio approved by the Regulator. There were no recorded defects regarding the communication equipment prior to flight.

1.10 Aerodrome Information

1.10.1 The accident did not occur on or near an aerodrome. The accident occurred on a farm at the GPS co-ordinates determined as S33˚01’47” E18˚54’40”.

Figure 4: Google earth image indicating the crash site

Figure 5: Khunskraal Farm

1.11 Flight Recorders

1.11.1 The aircraft was not fitted with a cockpit voice recorder (CVR) or a flight data recorder (FDR), and neither were they required by the regulations to be fitted to this type of aircraft.

1.12 Wreckage and Impact Information

1.12.1 The aircraft impacted the ground in a nose down attitude and came to rest in a westerly direction in an open field surrounded by vegetation.

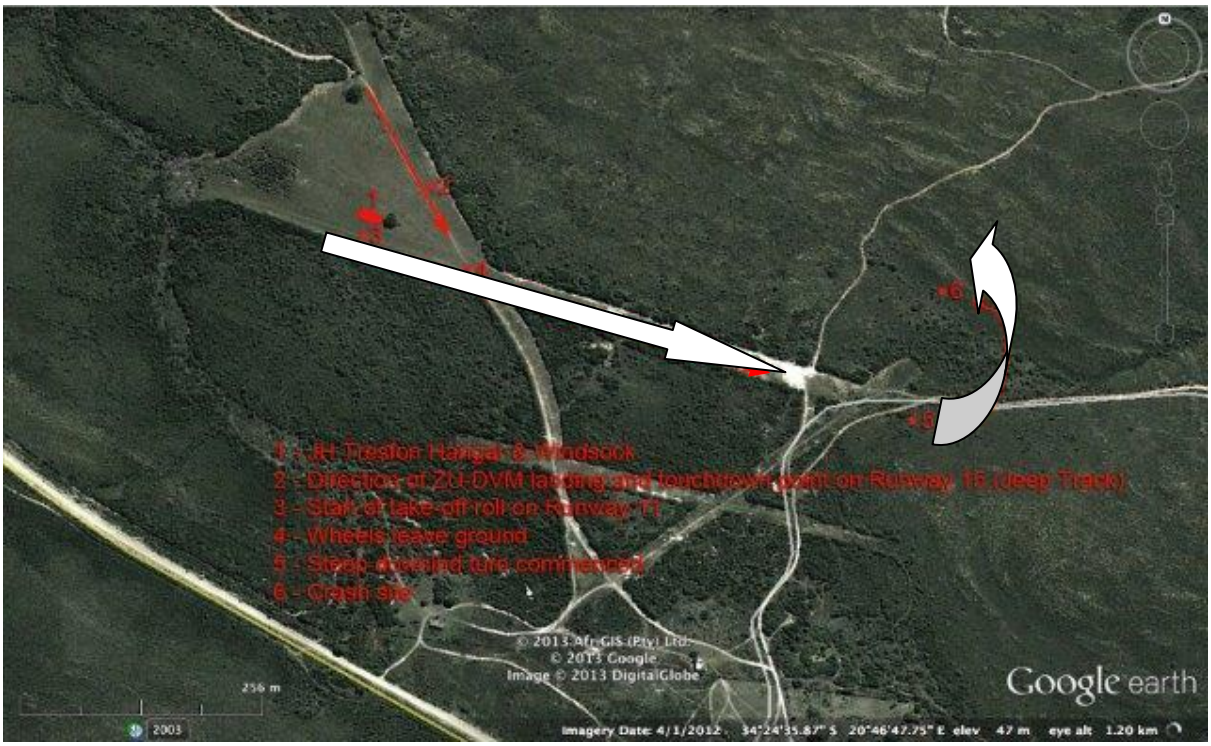


Figure 6: Depicts flight path of the aircraft

1.12.2 The aircraft sustained substantial damage to the forward engine section of the fuselage, propeller, wings, tail plane and undercarriage.

1.12.3 Witness marks on the propeller indicate the engine was producing power prior to impact.

1.12.4 The aircraft had a 15 degree flap configuration following post-crash inspection.

Figure 7: The destroyed forward section of the aircraft

Figure 8: View from the back

1.13 Medical and Pathological Information

1.13.1 A post-mortem examination of the pilot showed that the cause of the death was consistent with multiple injuries (predominantly to the chest).

1.13.4 The results of the toxicology tests were not available at the time the report was compiled. Should any of the results, once received indicate that medical aspects may have affected the performance of the pilot, this will be considered as new evidence and the investigation re-opened

1.14 Fire

1.14.1 There was no evidence of a pre or post impact fire.

1.15 Survival Aspects

1.5.1 The accident was not considered survivable due to the high impact forces associated with the impact.

1.5.2 The pilot was however restrained by the aircraft equipped safety harness.

1.16 Tests and Research

1.16.1 An engine teardown inspection was done after the accident at a SACAA approved maintenance organisation in the presence of the accident investigator. All damages sustained by the engine were attributed to the impact made with the ground. According to the technical report received the engine was in running condition prior to the impact. Refer to Appendix C16.2. The last oil sample analysis that was carried out did not reflect any anomalies that would have contributed to the accident. All findings were normal and within specified limitations. Refer to Appendix D.

1.16.3 Metallurgy inspection of the right rudder cable was carried out and it was found that the right rudder cable fractured at the position of the able guide (right hand) due to extensive abrasion induced mechanical wear. Over an undetermined period of operational time the mechanical abrasion wear between the Teflon guide and cable resulted in the failure of the outer strands while the inner core fractured during operation under 'normal' tensile conditions. The left hand rudder cable revealed similar damages at the same guide position; however it was to a lesser degree. This may be an indication that both cables have been exposed to comparable operational hours. Both cables revealed wear damages at other locations suggesting extended operational exposure to the assembly under adverse conditions. Refer to Appendix E

1.16.4 The GPS download in Appendix E clearly shows that the aircraft entered into a vertical spiral dive before impacting the ground.

1.17 Organizational and Management Information

1.17.1 The pilot was one of three owners of the aircraft.

1.17.2 The aircraft was being used in a private capacity at the time of the accident.

1.17.3 Some maintenance has been carried out by the owners who are also pilots.

1.17.4 The last annual inspection was performed by an Approved Persons (AP) who works under a SACAA Approved Aircraft Maintenance Organisation (AMO) and was in possession of a valid approval certificate.

1.18 Additional Information

1.18.1 The aircraft was previously involved in two accidents. The first accident was 15 November 2005 and was not recorded in the aircraft logbooks. The second accident was in December 2008 and was recorded in the aircraft logbook. Only the first accident could be traced by the AIID ECCAIRS system.

1.18.2 ZU-DVM did not have a data plate when the current owners purchased the aircraft. The owner had data plates manufactured and fitted to the aircraft. During the process of requesting the manufacture of the data plates a typing error was made and the incorrect serial number was submitted. The correct serial number of the aircraft is 02031483 as per the Certificate of Registration.

1.18.3 A memorandum was sent to the Director of Civil Aviation on 19 February 2014 strongly recommending that the SACAA issue an Emergency Safety Directive with reference to all Rans Aircraft regarding a full inspection on both rudder cable control cables.

1.19 Useful or Effective Investigation Techniques

1.19.1 None.

2. ANALYSIS

2.1 Pilot (Man):

The pilot was he holder of Private Pilot license. He had a total of 223.6 hours of which 51.4 hours were on type.

The pilot landed at Khunskraal airstrip to drop off a passenger. He got out and chatted to another pilot who was at the airstrip working on his own aircraft. The pilot assessed the surface wind conditions prior to departure and deemed it safe to continue with the flight. As per witness statements, the pilot wanted to leave from Khunskraal airstrip as soon as possible to avoid the approaching bad weather.

2.2 Aircraft (Machine):

The Rans S-6ES Coyote II is an American constructed two-seat single engine ultra-light airplane featuring a tractor configuration and a high-wing monoplane. It is a Non Type Certificated Aircraft. The aircraft had a valid Authority to Fly and had been maintained in compliance with the regulations. The exact number of aircraft still operational in South Africa could not be determined at the time this report was compiled.

The aircraft took-off normally, however was observed “crabbing” to the right due to the strong winds. The aircraft then made a sharp turn to the left thereafter the left wing dropped and the aircraft entered a vertical spiral dive and crashed. During the recovery of the aircraft it was noted that the right hand rudder control cable had failed. The cable was removed and submitted to a Metallurgist for analysis to determine the most probable reason/s for the failure. Metallurgical analysis confirmed that the failure of the right hand rudder control cable and similar (to a lesser degree) damages at the same guide position on the left hand rudder cable raised cause for concern. The fact that the control cables brackets are concealed did not allow the pilot access to conduct a visual inspect prior to flight. Both rudder control cables displayed evidence of wear damages and that the right rudder control cable failed, resulting in limited control authority to the pilot.

2.3 Environment:

Mid-level clouds were observed in the Khunskraal farm and surrounding areas. Moderate (10 knots) south westerly on the lower levels becoming stronger west to north westerly above FL050. Moderate to strong (25 knots) south westerly winds observed west of the area of incident but light to moderate (8-1 knots) to the east and model data estimated moderate surface wind for Khunskraal area. Despite the low level clouds and wind conditions that prevailed at the time of the accident, weather conditions were ruled out as a contributory factor.

3. CONCLUSION

3.1 Findings

3.1.1 The pilot did not hold a valid pilot’s license at the time of the accident.

3.1.2 The aircraft had a valid Authority to Fly and had been maintained in compliance with the regulations.

3.1.3 All control surfaces were accounted for, and all damage to the aircraft was attributed to

the impact forces.

3.1.4 Witnesses saw the aircraft experience a wing drop, followed by a vertical spiral dive.

3.1.5 The pilot succumbed to the injuries sustained in the accident sequence.

3.1.6 The aircraft was destroyed during the impact sequence.

3.1.7 No abnormalities with the aircraft's engine were found following the accident.

3.1.8 The SACAA's monitoring system had been ineffective in identifying the difference in aircraft serial number reflected on the Certificate of Registration and aircraft data place.

3.2.1 Probable Cause/s

3.2.1.1Loss of control of aircraft after take-off resulting from a sudden stall, followed by a vertical spiral dive.

3.2.2 Contributory Factor/s

3.2.2.1Right rudder cable failure.

4. SAFETY RECOMMENDATIONS

4.1.1 The following safety recommendation was submitted to the Acting Director of Civil Aviation a month after the fatal accident. Strong recommendation was made that the Director of Civil Aviation with the assistance of the Airworthiness and Certification Divisions, issue an Emergency Service Bulletin (ESB) for all Rans 56 aircraft on the SA Register. The ESB should be with reference to an immediate detailed inspection of both rudder cables.

5. APPENDICES

5.1 Appendix A - Witness statement #1

ZU_DVM Crash at Khunskraal on 4/1/2013 – Eyewitness Statement
JH Tresfon.

I arrived at my hangar on the airfield at Khunskraal Farm at 11h30 to clean and do some basic maintenance on my gyrocopter. The weather forecast was for fresh westerly winds and I decided that flying was probably best left for another day. Khunskraal is privately owned by siblings Di Mackenzie, Gavin Douglas-Hamilton and Debbie (surname unknown). It may once have been a magnificent airfield with plenty of runways to choose from but since the original owner and pilot passed on the runways have been allowed to decay and have become very overgrown. Only a short section of the main runway 11/29 is still serviceable. With permission from the current owners I use the field for my holiday flying and have a small hangar there. It's perfect for my purposes but can be tricky under certain conditions. The farm sits right up against the eastern side of the Potberg and when the wind is fresh from the west there is a significant rotor that can make things challenging. The westerlies are not consistent and tend to gust strongly here.

On arrival my windsock was already dancing around on the flagpole, indicating rising wind of approximately 10-15 knots varying between SW and W. I spent an hour in the hangar and then stepped outside for a look when I heard a plane nearby. I recognized the bright green Rans ZU-DVM flying low level over the river (from the north towards the river mouth in a southerly direction) straight away and assumed it must be Gerhard Hoek flying (at the time I did not realize the plane had two other owners). I called Gerhard on the radio and asked him to "kom maak 'n draai hier by my" and a voice I did not recognize said he was about to land anyway. The windsock was now quite lively and I watched the landing with interest. The pilot wisely decided to land into wind on a westerly direction on a jeep track (alternate runway 15) rather than land crosswind on the runway. The landing was a little messy with a big balloon and a hard touchdown. He taxied to my hangar and both he and passenger Stuart Meiklejohn disembarked. At the same time Stuart's wife arrived to collect him. I introduced myself and met Joos for the first time. He was clearly embarrassed at the landing and although I had made no comment he volunteered that the landing was tricky with strong wind and lift one second and nothing the next. He and Stuart had a look inside my hangar and we had a brief discussion about gyrocopters. Joos seemed a little anxious about the strengthening wind and cut short the pleasantries in order to get going. He said that he did not want to waste time backtracking down the jeep track for an into wind takeoff on runway 15 and decided to rather use the main runway 11 for a crosswind takeoff. We turned the plane by hand onto runway 11 abeam my hangar. The main runway is lined with thick rooikrans bushes and is slightly protected from the westerly wind. He tried four or five times but struggled to start the Rans and it appeared to be flooded. He gave it a minute and then tried again and this time the engine swung into life with a healthy roar. Wasting no time he gunned down the runway in a southerly direction (towards Infanta) and was airborne in an impressively short distance. Stuart, his wife and I stood a little way behind the plane to watch the takeoff. As Joos rose above the rooikrans he was hit by the full effect of the westerly and the plane yawed into the wind fairly severely. He continued with a steep climb while crabbing in a southerly direction with the nose of the plane facing to the SW. At about 300ft AGL he did a sudden steep downwind bank towards the Breede River on the left. I became fairly concerned as it seemed an overly aggressive maneuver. He continued the turn until he had swung through 180 degrees and now faced us head on (facing north towards Swellendam). The nose pitched up slightly and then without warning the plane stalled, the left wing dropped and he did a nose down spiral dive in an anti-clockwise direction into the ground. Time of impact was 13h15. I ran to my jeep and raced down the runway trying to find the crash site in the bushes. At the same time I phoned Gerhard Hoek and told him his plane was down and that he should get an ambulance and emergency services to the site. Stuart was also in his own vehicle and we arrived nearby the site at the same time. We ran the last 100m through the bushes to the plane and I arrived slightly ahead, probably about two or three minutes after the impact. The crash was very hard and the cockpit had been crushed. The plane landed on it's belly with a slight nose down angle and the cockpit had been folded forward while the engine and instrument panel had been pushed back. The extent of Joos' injuries was severe and it was pretty clear that he was gone but I checked for a pulse on his carotid artery nonetheless. His skin was still warm to the touch but there was no pulse. He was still in the left seat, both legs on the pedals but lying slumped sideways onto the passenger seat with his face on and partially under the panel. His legs had been broken with open wounds and visible bone above the ankles, his right leg was shattered by the joystick at the knee and thigh, his neck was broken and his face was smashed into the control panel with extensive lacerations. The engine was dead but the fuel pumps were still running and fuel was spraying into the cockpit. There was just mangled wreckage where the fuel pump switches were supposed to have been and I also could not find the master switch. I turned both ignition switches off for good measure. Stuart and I made the call to remove Joos from the plane as there seemed to be an imminent fire risk. At this point some farm labourers including Jimmy (the farm caretaker) arrived and we asked them to help. I undid the seatbelt with some difficulty as Joos was doubled over. The laborers lifted the wings on either side of the cockpit and then Stuart and I had to bend the cockpit open to get him out. His leg was stuck behind the joystick and we tried to bend it (the stick) to recover the body. Eventually we managed to clear the body from the cockpit. At this point the full extent of his injuries was clear and there was no chance he was still alive. We moved him a little way from the plane and then waited for help to arrive. Around twenty minutes later two doctors, Ian Siggy and Barry Penn from the nearby village of Infanta arrived and certified Joos dead. I left the site to close up my hangar and returned as the Working On Fire Huey landed at the site. I spoke to pilot Gert Uys and Overberg Disaster Management's Reinardt Geldenhuys before I left about an hour later. I returned that same evening and the following day with the CAA Accident Investigator Natasha Apollis.

5.2 Appendix B - Witness Statement #2

Summary of events leading up to plane crash involving Joost Bonekamp at the Breede River on the 4th of Jan 1014

I arrived in Swellendam at about 1030 from Capetown having arranged with Joost to fly down to Cape Infanta where my wife would pick me up.
We had breakfast and then proceeded to collect fuel for the aircraft.
On arrival at the flying club Joost proceeded with the safety checks and as I had never flown in a light plane before explained to me what he was doing which I appreciated.
We took off at about 1215hrs and flew over Swellendam and then down the Breede River and over to De Hoop Nature reserve.
We flew low over the coast as I wanted to take pictures of the dolphins and sharks.
On arrival at Infanta we flew over my house and then up the river to Kuens Kraal farm where the airstrip is located.
We landed without incident and spoke to Juaan, another pilot who was on the airstrip.
My wife arrived and after chatting for a few minutes Joost got back in the plane (1308 hrs)for the flight back to Swellendam.
After initially flooding the engine he got it started and ran it for a few minutes to clear and then took off. As he cleared the bush the plane seemed to have been hit with a gust of wind which pushed the tail to the left. He carried on for a few moments and then seemed to turn to the left when the left wing dropped and the plane crashed to the ground. I estimate he was about 120 ft when this happened.(1314hrs) As we rushed to the scene my wife called a friend at Infanta to get a doctor to come to Kuens Kraal asap.
Juaan and myself got Joost out of the plane but we could see that he had already passed away but as there was petrol leaking we thought it better to remove him.
Doctor Barry Penn arrived and certified that Joost had passed on.
I waited at the scene until emergency services arrived before I left.
After the body had been removed I retrieved Joosts cell phone and wallet which I handed to his wife .

Stuart Meiklejohn

5.3 Appendix C - Engine Report

AEROSPORT
CAPE TOWN
WWW.AEROSPORT.CO.ZA
TRAINING@AEROSPORT.CO.ZA | +27 21 975 3891

25 FEB 2014

Aerosport
P.O Box 805
Brackenfell
7561

Engine Report ZU-DVM Rotax 912 ULS Sn / 5643219
Louis v Wyk AP no 39

To whom it my concern

1) General overview of engine: It can be determined that the engine was running at a fairly high RPM on impact, as all three propeller blades are damaged near the root at the hub of the propeller.

2) One of the pickups on the mag side is damaged and possibly from being caught on the magnet on impact

3) Engine in general seems to appear without major damage.

4) Crank could be turned freely, without any problem.

5) The run out check on gearbox prop flange showed no problem and is within spec's.

6) Removal of the sparkplugs carried out and did a cold blow-by test. All found to be within limits 78/80 on all cylinders.

7) The only damage on the engine that we could see was the following

   a) One of the stator pickups damaged
   b) Oil pressure sender unit bent
   c) Oil temp probe broken off
   d) Hole in bottom of carburettor
   e) Carburettor rubber mounts broken
   f) Water pipe broken

8) All damaged items seems to be from the impact with the ground

9) To the best of my knowledge it seems that the engine was in a running condition until impact with the ground

This above inspection was done under supervision of SACAA Aircraft Accident & Incident Investigator, Natasha Apollis

Louis v Wyk
Aero Sport CT
CAA 0077
AP No 39

5.4 Appendix D - Oil sample readings

OILWATCH

PO Box 527, Howard Place, 7450
E-mail: support@oilwatch.co.za
Fax: (021)531-7166, Tel: (021)531-7165

LUBE MARKETING
SITE: AERO SPORT
MACH: ROTAX 912S-ZU-DVM
COMP: ENGINE

Manager
PO Box 614 Kuils River
7579
946 3711

Status 0
Normal
Sample #
225279

Analysis Report

Sample Number	Bottle Number	Register Date	Sample Date	SMR	Oil Read	Filter Read	Oil Chng	Filt Chng	Oil Topup	Oil Supplier	Oil Grade
225279	170011	2013-09-30	2013-09-26	578	100	100	Y	Y	N	SHELL	ADVANCE AX7

PQ / Spectrometer / Wear Metals and Additives

Sample Number	PQ	Fe	Al	Cr	Pb	Cu	Sn	Ni	Ag	Si	B	Na	Mg	Ca	P	Zn	Mo	Ba	Ti	V
225279	9	43	9	1	346	8	0	2	0	6	52	13	16	1922	761	750	0	0	0	0

Viscosity / FTIR / Oil Condition

Sample Number	V40	Oxi	Nit	Sul	Soot %	H2O %	Fuel %	TBN
225279	90.6	14	12	23	<0.5	ND	<1	5.8

Particle Count Cleanliness / ISO 4406:99

Sample Number	ISO4	ISO6	ISO14
225279			

Comments / Recommended Action / Feedback

Sample No. 225279 - Status 0

Comments: High Pb (lead) is typical of engines using LRP (lead replacement) fuel. All of the wear rates appear normal for the stated oil period in use. Oil viscosity is within range for the product specified.

Action: Resample at regular intervals to monitor the oil condition and wear trend.

Date Printed: 2013/10/1 (E) Accuracy of recommendations is dependant on representative sample and complete, correct data on both unit and oil. This report is not an endorsement or recommendation of any product or system. Page 1 of 1

5.5 Appendix E - Metallurgical Analysis of Right Rudder Cable

ITEM: **RUDDER CONTROL CABLE, RIGHT HAND ASSEMBLY, RANS 65 AIRCRAFT, NUMBER ZU-DVM**

1. INTRODUCTION

1.1. A failed right hand (pilot's perspective) rudder control cable (Photo 1) from a Rans 65 aircraft, number ZU-DVM, was submitted to determine most probable reason/s for failure during operation resulting in a fatal accident.

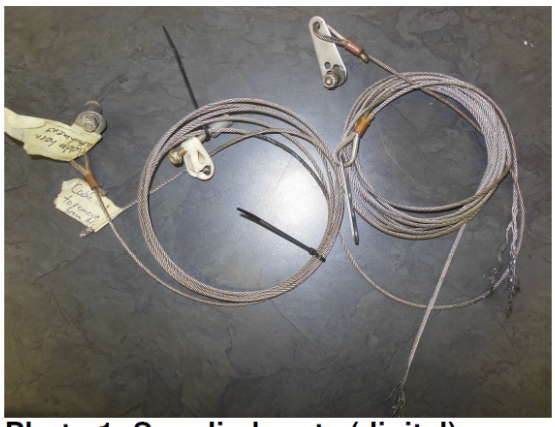


Photo 1: Supplied parts (digital)

1.2. This report is divided into the following sections:

2. APPLICABLE DOCUMENTS

(a) None applicable.

3. DEFINITIONS

(a)	OEM	Original Equipment Manufacturer
(b)	SACAA	South African Civil Aviation Authority
(c)	SEM	Scanning Electron Microscope

(d) EDS Energy Dispersive Analytical System (x-ray)

4. PERSONNEL

(a) The investigative member and compiler of this report is Mr C.J.C. Snyman, ID number 6406105057080. Mr Snyman is a qualified Physical Metallurgist (H.N.Dip Metallurgical Engineering, Tech. PTA), Radiation Protection Officer (RPO) registered with the National Nuclear Regulator (NNR) and Aircraft Accident Investigator (SCSI).

5. APPARATUS AND METHODOLOGY

(a) The apparatus employed for this investigation are Stereo-, Electron Microscopes and Digital Camera.

(b) The methodology included a visual examination of supplied parts, sectioning to remove fracture surface then followed by a Microscope investigation.

6. INVESTIGATION

6.1. **Visual Investigation.** Both the right- and left hand rudder control cables (Figure 1) are from 1+6 design (Figure 2) consisting of a single multi-wire core and 6 outer multi-wire strands in a 'Right Regular Lay' (Figure 4) of the 7x7 aircraft cable type (Figure 3) while the qualitative EDS results correspond with the composition of a Stainless Steel base alloy (Table 1).

The visual inspection revealed a fracture (Photo 2, red arrow) at the position of the Teflon based cable guide (yellow arrow) in the right hand rudder control cable in close proximity to the rudder horn attachment position (blue arrow). Extensive mechanical abrasive wear of the outer strand wire surfaces were evident at the fractured position. The fracture revealed extensive break-up and delamination of the cable core as well outer strands.

The left hand cable revealed a similar darkened area (Photo 3, red arrow) as well as significant wear and indications of fractured wires at the relevant position (Photo 5, red arrow). Significant surface abrasive wear were also noted at other positions on both cables (Photo 6, red arrow).

At higher magnifications the SEM investigation revealed the core wires to have failed under a tensile load (Photo's 7 and 8, yellow arrows) with clear indications of 'necking' (Photo 9) while the fracture surface revealed the typical 'dimple' geometry synonymous with a ductile failure (Photo 10).

The fractographs from the outer strand wires revealed extensive mechanical abrasive wear damages (Photo's 11, 12 and 13, yellow arrows). Selected wires showed failures due to the mechanical wear only (Photo's 13 and 14, yellow arrows) while others revealed small fracture surfaces of a ductile nature (Photo's 15 and 16, red arrow).

Photo 17 depicts the same cable exposed to a mechanical (side-cutter) incise for comparison purposes.

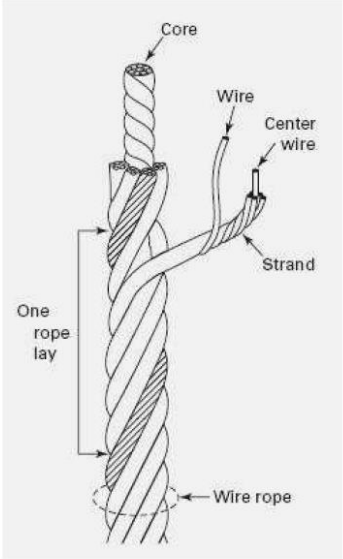


Figure 1: Wire rope nomenclature (courtesy The Cable Connection)

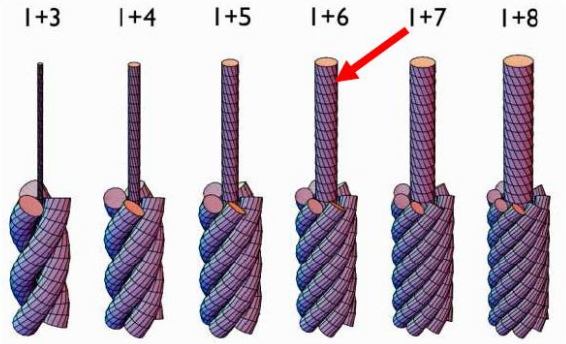


Figure 2: Typical relationship between outer strands and the core size (courtesy R Verreet)

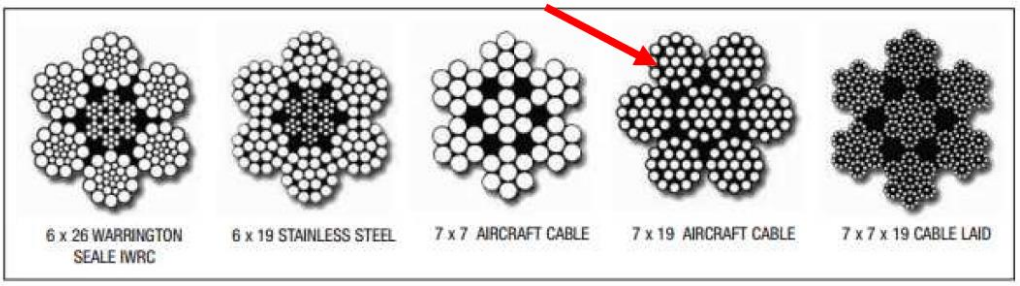


Figure 3: Typical cable layout (courtesy Delta Rigging)

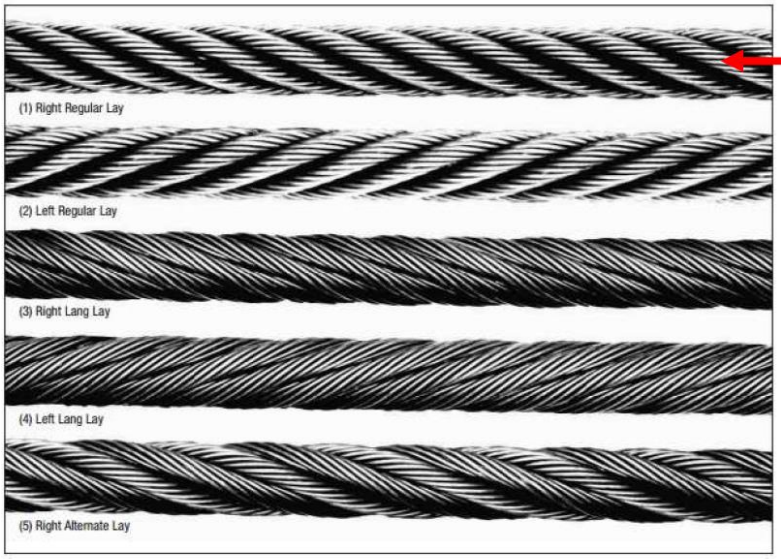


Figure 4: Typical cable layout (courtesy Delta Rigging)

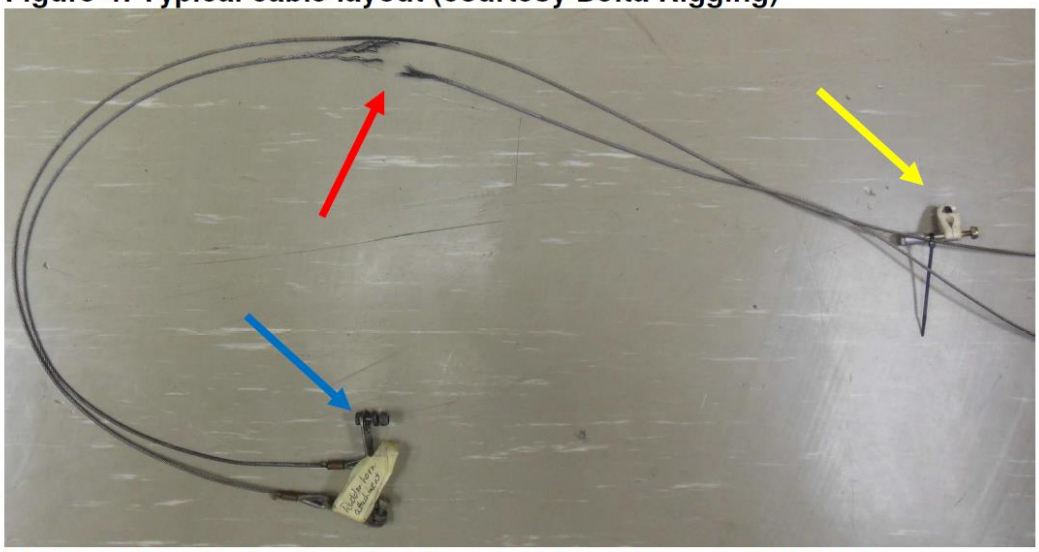


Photo 2: Supplied parts showing position of fracture (digital)

Photo 3: Corresponding positions on left- and right hand cables (digital)

Photo 4: Fractured right hand cable (digital)

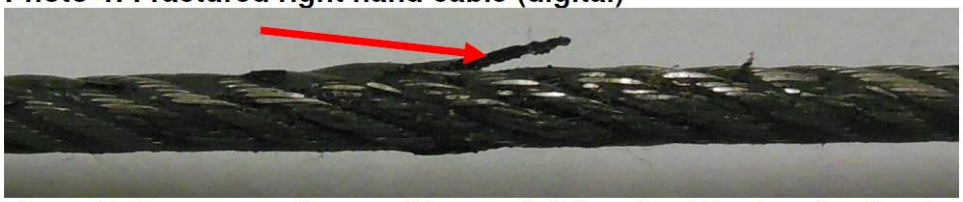


Photo 5: Corresponding position on left hand cable showing fractured wires (digital)

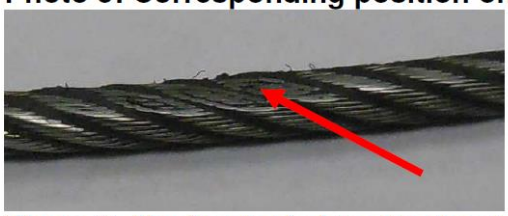


Photo 6: Mechanical abrasive wear evident at other cable positions (digital)

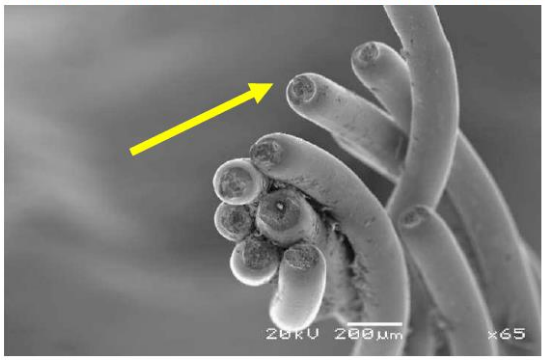


Photo 7: Fractograph showing core wire fractures (x65, SEM)

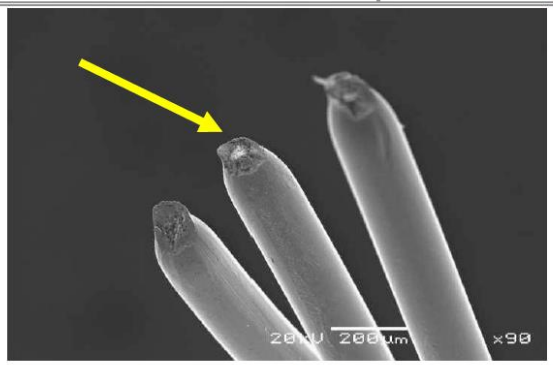


Photo 8: Fractograph showing core wire fractures (x90, SEM)

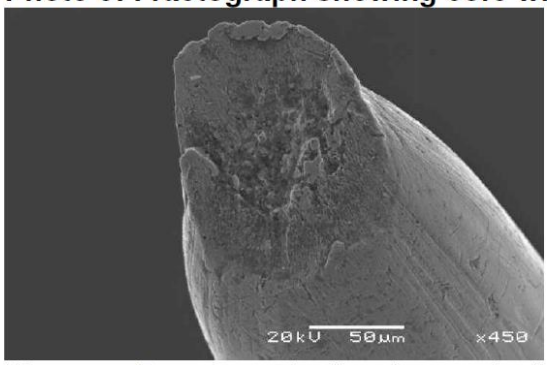


Photo 9: Fractograph showing typical core wire fracture geometry (x450, SEM)

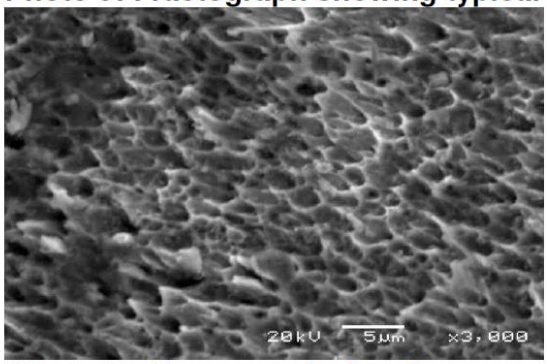


Photo 10: Fractograph showing core wire ductile fracture geometry (x3000, SEM)

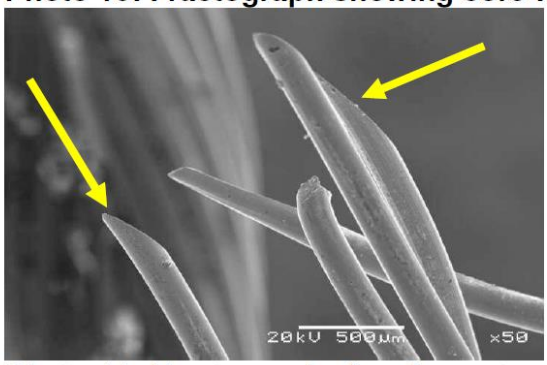


Photo 11: Fractograph showing outer strand wire fractures (x50, SEM)

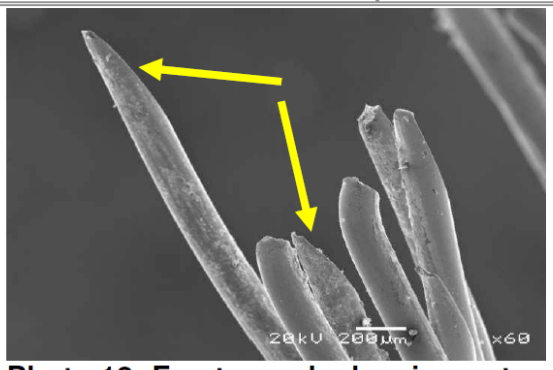


Photo 12: Fractograph showing outer strand wire fractures (x60, SEM)

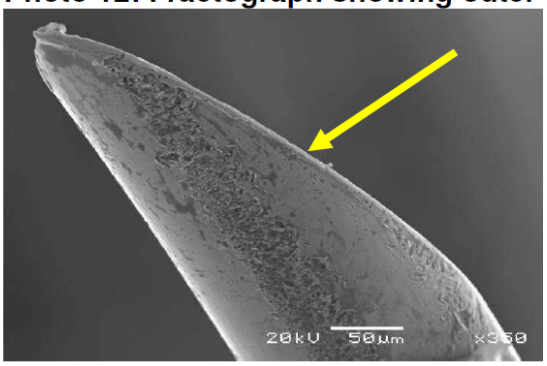


Photo 13: Fractograph showing typical outer strand wire fracture geometry (x550, SEM)

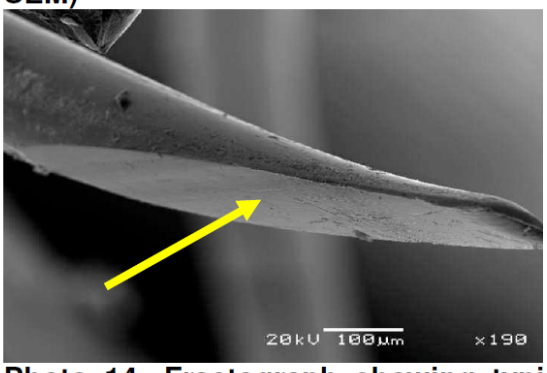


Photo 14: Fractograph showing typical outer strand wire fracture geometry (x190, SEM)

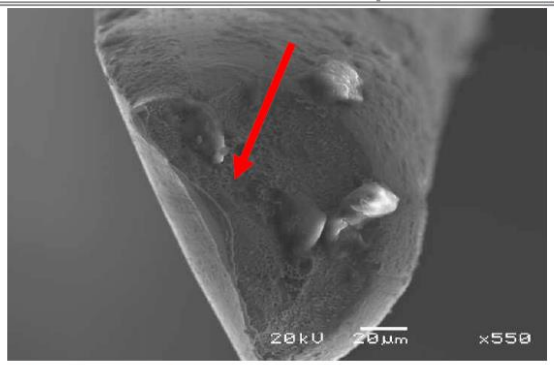


Photo 15: Fractograph showing typical outer strand wire fracture geometry (x550, SEM)

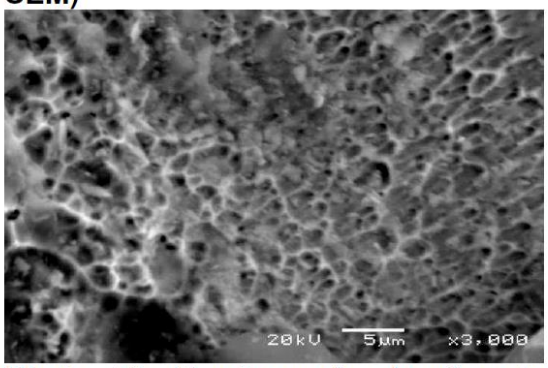


Photo 16: Fractograph showing typical outer strand wire ductile final fracture geometry (x3000, SEM)

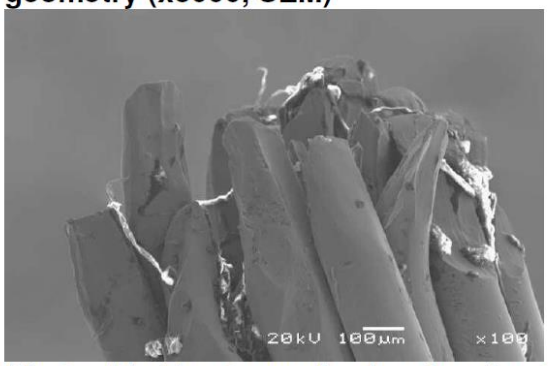


Photo 17: Fractograph showing fracture geometry of a mechanically severed cable (x100, SEM)

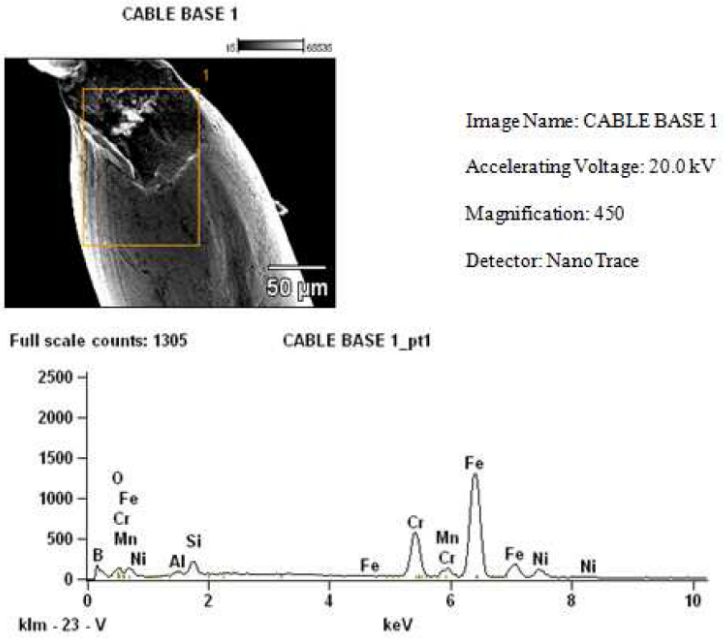


Table 1: EDS results (20keV, 90s, WD 16mm)

7. DISCUSSION AND CONCLUSIONS

The conclusions are based on the investigation results obtained from the supplied parts/components only.

7.1 The investigation results indicate that the right hand rudder control cable fractured at the position of the cable guide (right hand) due to extensive abrasion induced mechanical wear. Over an undetermined period of operational time the mechanical abrasion wear between the Teflon guide and cable resulted in the failure of the outer strands while the inner core fractured during operation under 'normal' tensile conditions.

7.2. Although to a lesser degree, the left-hand cable revealed similar damages at the same guide position. This may be an indication that both cables have been exposed to comparable operational hours.

7.3. Both cables revealed wear damages at other locations suggesting extended operational exposure to the assembly under adverse conditions.

8. RECOMMENDATIONS

8.1. Considering the severe detrimental effect of the failure of such a critical component to Flight Safety, it is strongly recommended that the SACAA urgently alert corresponding

aircraft operators regarding the need of a thorough inspection methodology towards control cable assemblies prior to flight.

8.2. Cable rigging and lubrication practices as depicted by the OEM should be adhered to at all times.

9. DECLARATION

9.1. All digital images has been acquired by the author and displayed in an un-tampered manner.

5.5 Appendix F - GPS Download Results

Name: ACTIVE LOG 006

Index	Time	Elevation	Depth	Temperature	Leg Length	Leg Time	Leg Speed	Leg Course	Position
450	1/4/2014 12:49:51 PM	262 ft			0.2 mi	0:00:09	74 mph	115° true	S34 23.955 E20 46.588
451	1/4/2014 12:50:00 PM	250 ft			0.1 mi	0:00:07	72 mph	119° true	S34 24.021 E20 46.765
452	1/4/2014 12:50:07 PM	256 ft			0.3 mi	0:00:13	74 mph	114° true	S34 24.081 E20 46.895
453	1/4/2014 12:50:20 PM	231 ft			0.2 mi	0:00:12	73 mph	121° true	S34 24.173 E20 47.151
454	1/4/2014 12:50:32 PM	213 ft			414 ft	0:00:04	71 mph	125° true	S34 24.280 E20 47.371
455	1/4/2014 12:50:36 PM	224 ft			427 ft	0:00:05	58 mph	155° true	S34 24.319 E20 47.438
456	1/4/2014 12:50:41 PM	254 ft			84 ft	0:00:01	57 mph	174° true	S34 24.383 E20 47.472
457	1/4/2014 12:50:42 PM	253 ft			0.1 mi	0:00:08	57 mph	167° true	S34 24.397 E20 47.474
458	1/4/2014 12:50:50 PM	262 ft			257 ft	0:00:04	44 mph	196° true	S34 24.504 E20 47.504
459	1/4/2014 12:50:54 PM	278 ft			202 ft	0:00:03	46 mph	256° true	S34 24.544 E20 47.490
460	1/4/2014 12:50:57 PM	265 ft			410 ft	0:00:05	56 mph	267° true	S34 24.552 E20 47.451
461	1/4/2014 12:51:02 PM	240 ft			374 ft	0:00:04	64 mph	318° true	S34 24.533 E20 47.373
462	1/4/2014 12:51:06 PM	232 ft			0.1 mi	0:00:07	67 mph	320° true	S34 24.487 E20 47.323
463	1/4/2014 12:51:13 PM	226 ft			450 ft	0:00:05	61 mph	290° true	S34 24.401 E20 47.235
464	1/4/2014 12:51:18 PM	228 ft			346 ft	0:00:04	59 mph	276° true	S34 24.375 E20 47.151
465	1/4/2014 12:51:22 PM	229 ft			449 ft	0:00:05	61 mph	297° true	S34 24.367 E20 47.083
466	1/4/2014 12:51:27 PM	235 ft			0.2 mi	0:00:08	70 mph	315° true	S34 24.334 E20 47.003
467	1/4/2014 12:51:35 PM	212 ft			0.2 mi	0:00:09	74 mph	316° true	S34 24.239 E20 46.888
468	1/4/2014 12:51:44 PM	235 ft			443 ft	0:00:05	60 mph	289° true	S34 24.124 E20 46.754
469	1/4/2014 12:51:49 PM	246 ft			373 ft	0:00:05	51 mph	257° true	S34 24.100 E20 46.671
470	1/4/2014 12:51:54 PM	251 ft			350 ft	0:00:05	48 mph	241° true	S34 24.114 E20 46.598
471	1/4/2014 12:51:59 PM	235 ft			325 ft	0:00:06	37 mph	213° true	S34 24.141 E20 46.537
472	1/4/2014 12:52:05 PM	224 ft			241 ft	0:00:04	41 mph	152° true	S34 24.186 E20 46.502
473	1/4/2014 12:52:09 PM	185 ft			149 ft	0:00:02	51 mph	135° true	S34 24.221 E20 46.525
474	1/4/2014 12:52:11 PM	187 ft			335 ft	0:00:05	46 mph	155° true	S34 24.238 E20 46.546
475	1/4/2014 12:52:16 PM	190 ft			0.1 mi	0:00:10	43 mph	161° true	S34 24.288 E20 46.574
476	1/4/2014 12:52:26 PM	149 ft			0.1 mi	0:00:10	43 mph	154° true	S34 24.387 E20 46.614
477	1/4/2014 12:52:36 PM	138 ft			309 ft	0:00:07	30 mph	151° true	S34 24.480 E20 46.669
478	1/4/2014 12:52:43 PM	149 ft			337 ft	0:00:35	7 mph	280° true	S34 24.525 E20 46.699
479	1/4/2014 12:53:18 PM	141 ft			8 ft	0:00:01	5 mph	285° true	S34 24.515 E20 46.632
480	1/4/2014 12:53:19 PM	141 ft			17 ft	0:00:04	3 mph	236° true	S34 24.515 E20 46.631
481	1/4/2014 12:53:23 PM	141 ft							S34 24.516 E20 46.628

Center map on selected item(s)

Points	Length	Area	Elapsed Time	Avg. Speed
481	78.0 mi	272 sq mi	1:07:01	70 mph

Compiled by: Natasha Kisten-Skuce

..... Date: ……..……..

For: Director of Civil Aviation

Investigator-in-charge: Kisten-Skuce Date: ……..

Co-Investigator: Not Applicable Date: ……..……