AIRCRAFT ACCIDENT REPORT AND EXECUTIVE SUMMARY

				Reference:	CA18/2/3/9505		
Aircraft registration	**ZS-DKS**	**Date of accident**	7 December 2015		**Time of accident**	0857Z	
Type of aircraft	Eclipse EA500 (Aeroplane)		**Type of operation**		Private (Part 91)		
Pilot-in-command licence type		Private	**Age**	57	**Licence valid**	Yes	
Pilot-in-command flying experience		Total hours	2 977.0		Hours on type	506.15	
Last point of departure	Lanseria International Airport (FALA), Gauteng						
Next point of intended landing	Cape Town International Airport (FACT), Western Cape						
Location of the accident site with reference to easily defined geographical points (GPS readings if possible)							
On the farm Spioenkop, Overberg district, (GPS position: 34°10.31' South 020°08.15' East)							
Meteorological information	Surface wind: 160º/5kt, Temperature: 24ºC, CAVOK						
Number of people on board	1 + 0	**No. of people injured**	0	**No. of people killed**	1		

Synopsis

The aircraft had taken off on a private flight with the pilot being the sole occupant on board. The pilot had filed an IFR flight plan and had informed air traffic control (ATC) at FALA that the aircraft had a fuel endurance of 4 hours and his estimated flying time to FACT was approximately 2 hours and 30 minutes.

After take-off the aircraft climbed to its cruising altitude of 36 000 feet (FL360) as was seen on the radar recordings. The pilot maintained communication with ATC until overhead Kimberley. Shortly thereafter the aircraft was observed to change course, turning slightly left before the town of Douglas. The aircraft remained at FL360 and was observed to fly south towards the waypoint OKTED, which was a substantial distance to the east of FACT. FACT could not get communication with the aircraft and the aeronautical rescue co-ordination centre (ARCC) was advised of the situation. The aircraft was kept under constant radar surveillance. The ARCC requested assistance from the South African Air Force (SAAF) and a Gripen (military jet) from Air Force Base Overberg (FAOB) was dispatched to intercept the aircraft. The pilot of the Gripen intercepted the aircraft approximately 3 minutes before it impacted the terrain. The Gripen pilot was unable to get close enough to the aircraft as it was flying very erratically, and he could therefore not see whether the pilot was conscious or not. The aircraft was observed entering a left spiral and continue spiralling down until it impacted the ground. The pilot was fatally injured and the aircraft was destroyed during the impact sequence.

The investigation revealed no anomalies on the part of the aircraft and all damage was attributed to the impact with the ground. The fatal injuries sustained by the pilot made it imposible to determine if the pilot was incapasitated or not.

Probable cause

It was observed that the aircraft performed a series of unexplainable as well as erratic flying maneuvres, which resulted in a loss of control and the aircraft to enter into a spiral dive, which was observed by the Gripen pilot before colliding with the ground.

SRP date	11 September 2018	Release date	27 September 2018

AIRCRAFT ACCIDENT REPORT

Name of Owner : Dixco Transport (Pty) Ltd
Name of Operator : Private (Part 91)
Manufacturer : Eclipse Aerospace
Model : EA500
Nationality : South African
Registration marks : ZS-DKS
Place : On the farm Spioenkop, Overberg district
Date : 7 December 2015
Time : 0857Z

All times given in this report are Coordinated 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) the purpose of investigation of an aircraft accident or incident is to determine, in terms of the provisions of this Part, the facts of an accident or incident in the interest of the promotion of aviation safety and the reduction of the risk of aviation accidents or incidents, and ***not to establish blame or 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 Sunday afternoon, 6 December 2015 at 1345Z, the aircraft ZS-DKS took off from Cape Town International Airport (FACT) on a private flight to Kuruman Airport (FAKU). On board the aircraft was the pilot, who was also the owner of the aircraft, accompanied by three passengers. In an interview, one of the passengers on this flight indicated that it was an uneventful flight. The duration of the flight was approximately 2 hours and they landed at FAKU between 1530Z and 1545Z. The pilot owned a business in Kuruman and the passengers were returning home. The aircraft was parked at the airport overnight. The intention of the pilot, as the

passenger understood it, was to fly back to Cape Town the following day.

1.1.2 On Monday morning, 7 December 2015 the pilot, being the sole occupant on board the aircraft, took off from FAKU and flew to Lanseria International Airport (FALA) in Gauteng. Available evidence indicates that he did not experience any defects or system malfunction with the aircraft during the flight. The flight time to FALA was approximately 45 minutes and the aircraft landed at FALA at 0445Z.

1.1.3 After landing the pilot taxied towards the hangars on the southern side of the aerodrome. After the aircraft was parked, it was refuelled and 750 litres of Jet A1 was uplifted. The pilot then spent some time on the ground, where he met up with an associate. It was also during this period that he handed a suitcase as well as a briefcase to the secretary of the person he visited. He indicated that his wife would come and pick it up at some stage and gave her his wife's name and contact number. He then returned to the aircraft to prepare for the flight to FACT.

1.1.4 An IFR flight plan was filed for the flight, which indicated the route as follows: FALA/N0340F360 LIV DCT XAGEN UZ31 XALVA UQ23 CSV UZ26 ERDAS DCT FACT. George Aerodrome (FAGG) was reflected on the flight plan as his alternate aerodrome. Also, under the supplementary information the estimated departure time from FALA was entered as 0500Z, with an endurance of 3 hours and 30 minutes, and search and rescue was entered as normal (SARNML). The aircraft departed FALA at 0621Z from runway 07, and after becoming airborne the aircraft was observed on radar to turn left on track as per the ATC clearance.

1.1.5 According to available information the pilot maintained radio contact with air traffic control at FALA on the tower frequency 124,0 MHz. The after-departure clearance as issued by the ATC required the pilot to contact Johannesburg radar on 123,7 MHz. when passing through 6500 ft. According to radar information at 06:48:21, with the aircraft positioned overhead Klerksdorp, it reached its cruising altitude of 36 000 feet (FL360). It remained on track and was observed to start changing heading at 07:20:32 just before the town of Douglas in the Northern Cape by turning slightly left while remaining at its cruise altitude of FL360. The pilot complied with ATC instructions, and when he reached the hand-over reporting point established radio communication with Johannesburg flight information region (FIR) Central on 120,3 MHz. He then continued on Upper Airway UZ31 as per the flight plan while maintaining FL360. It was noted that the last communication between the pilot and ATC was when the aircraft was near the city of Kimberley.

1.1.6 The mandatory occurrence report (MOR) with reference number CA-87-2015 indicated that the aircraft entered the FACA FIR (Area Control Centre) airspace without any communication from the pilot. However, throughout Johannesburg Area (FAJA) flight information region FIR continually attempted to re-establish communication with the pilot of ZS-DKS. A decision was then made to notify the aeronautical rescue control centre (ARCC) of the situation. Due to the nature of the situation, an INCERFA was declared. From this point onwards the aircraft was under permanent surveillance while being tracked on radar.

1.1.7 Once the aircraft was observed to change heading it was flying south towards the OKTED waypoint, which was a substantial distance to the east of FACT (heading of 133° and a distance of 50 nm). The aircraft was observed flying overhead the town of Robertson at 08:32:45 and the ESRUK waypoint near the town of McGregor at 08:34:44, maintaining FL360 en route to the OKTED waypoint, which was some distance to the south. At 08:37:04 the aircraft was observed to commence with a right turn, during which the height of the aircraft varied by 2 000 feet, remaining between FL350 and FL370. The aircraft completed a 360° turn to the right and immediately commenced with a second right-hand turn.

1.1.8 After it had completed the second 360° turn, it was observed to fly in an easterly direction for a brief period, during which the aircraft was observed to have climbed to an altitude of FL376, after which it descended and again entered into a right-hand turn at 08:44:38 at an altitude of FL330 and a speed of 456 knots. The aircraft completed the third right-hand turn at 08:47:58 at an altitude of FL305 with the speed captured at 337 knots. After completing the turn, it immediately entered into a fourth right-hand turn at an altitude of FL326 and a speed of 377 knots. The aircraft completed the 360° turn at 08:48:33 at FL317 and a speed of 398 knots. The aircraft was then observed flying in an easterly direction for a period of approximately 4 minutes when again it entered into a right-hand turn at 08:52:22 at FL321 and a speed of 290 knots. From the radar footage this orbit was observed to be very tight, as the aircraft was observed to have completed the 360° turn at 08:53:57 at an altitude of FL335 and a speed of 446 knots. The last time the accident aircraft was observed on radar was at 08:55:42 when it was at an altitude of 12 300 feet, a speed of 396 knots and a heading of 008°.

1.1.9 At 08:55:27 the aircraft ZS-DKS was intercepted by a Gripen supersonic military jet from the South African Air Force (SAAF), which had been dispatched from Air Force Base Overberg (FAOB). In an interview with the Gripen pilot following the accident, he stated that he could not get close enough to the aircraft to observe whether the pilot of ZS-DKS was conscious or not. He remained in a wide orbit and kept the aircraft in sight as it spiralled towards the ground in a left wing low attitude until it impacted the terrain. On his return to base he informed air traffic control at FAOB on the status of the aircraft and gave them the position of the crash site.

1.1.10 The accident occurred during daylight conditions on the farm Spioenkop in the Overberg district. The geographical position of the accident was determined as 34°10.31' South 020°08.15' East at an elevation of 538 feet above mean sea level (AMSL). The pilot was fatally injured and the aircraft was destroyed during the impact sequence.

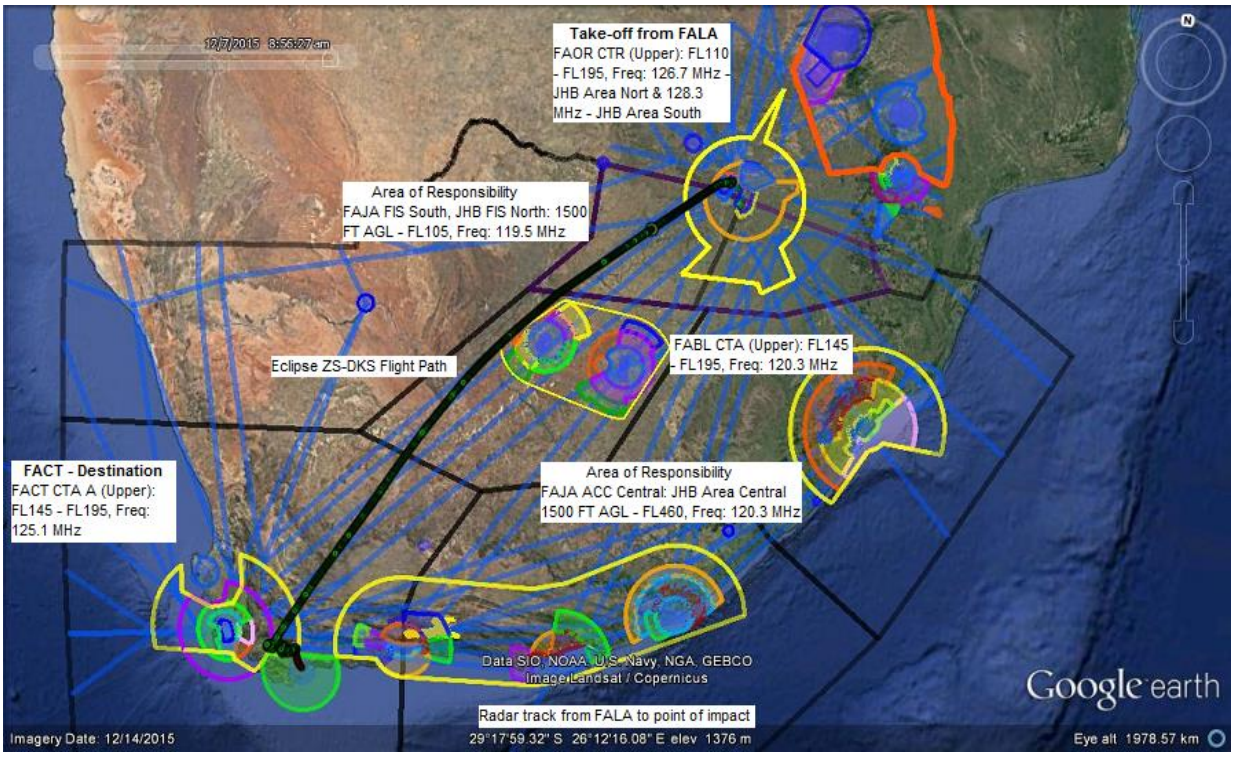


Figure 1: The flight path (visible in black) of the aircraft from FALA to the point of impact

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 during the impact sequence.

Figure 2: The empennage section of the aircraft

1.4 Other damage

1.4.1 Other damage was limited to a barbed wired fence and vegetation.

Figure 3: Damage to the fence

1.5 Personnel information:

1.5.1 Pilot-in-command (PIC)

Nationality	South African	Gender	Male	Age	57
Licence number	0270269327	Licence type	Private pilot		
Licence valid	Yes	Type endorsed	Yes		
Ratings	Instrument, RNP APCH (LNAV/VNAV)				
Medical expiry date	30 May 2016				
Restrictions	Must wear suitable corrective lenses and hearing aids				
Previous accident/incident	ZS-DKS on the take-off roll runway 01 reported having a burst tyre and veered off runway 01. ATC activated the crash alarm to alert fire crew, who responded. ZS-DKS shut down 50 metres or more off Runway 01. Fire crew advised only pilot was on board and was okay.				

Flying experience:

Total hours	2 977.0
Total past 90 days	Unknown
Total on type past 90 days	Unknown
Total on type	506.2

No pilot's logbook could not be located to verify the flying hours.

1.5.2 The pilot was issued with a student pilot licence (SPL) when he started flying training. He received training on fixed-wing aircraft from an approved aviation training organisation (ATO). After he successfully completed his training he was issued with a private pilot licence (PPL) on aeroplanes.

1.5.3 The pilot completed an aircraft type differences and familiarisation training on the Eclipse EA500 aircraft. The aircraft manufacturer in the United States of America (USA) presented the first phase of the training. The pilot travelled to the USA where he attended the Eclipse 500/550 (EA50) ground and flight training course. A letter dated 30 April 2013 from Eclipse Aerospace was available on the CAA pilot file,

which confirmed the pilot's attendance. On his return to South Africa he commenced with his flying training phase until he was found to be proficient and met the type endorsement requirements. According to available records the pilot completed his training in South Africa on 29 April 2013 on the aircraft type and the required paperwork (form CA 61-09.06) was submitted to the CAA on 2 May 2013, after which the aircraft type was endorsed on his pilot licence.

1.5.4 On 29 May 2013 the pilot conducted his initial skills test for an instrument rating successfully and form CA 61-11.4 was completed and submitted to the CAA on 31 May 2013. The instrument rating was endorsed on the pilot licence and was valid until 30 June 2014.

1.5.5 On 26 May 2014 the pilot again conducted his initial skills test for an instrument rating successfully and form CA 61-11.4 was completed and was submitted to the CAA on 27 May 2014. The instrument rating was endorsed on the pilot licence and was valid until 30 June 2015.

1.6 Aircraft information

1.6.1 The Eclipse EA500

The Eclipse 500 is a marketing name for the Eclipse Aerospace EA500, a small six-seat business aircraft originally manufactured by Eclipse Aviation and later produced by Eclipse Aerospace.

The Eclipse 500 became the first of a new class of Very Light Jets when it was first delivered in 2006. The aircraft was powered by two lightweight Pratt & Whitney PW610F-A turbofan engines in aft fuselage-mounted nacelles.

Figure 4: An Eclipse EA500 aircraft (photograph was obtained from the internet)

Airframe:

Type	Eclipse EA500	
Serial number	500-000142	
Manufacturer	Eclipse Aerospace	
Year of manufacture	2008	
Total airframe hours (at time of accident)	714.7 hours (27 November 2015)	
Last phase inspection (hours & date)	582.60	18 March 2015
Hours since last phase inspection	145.95	
C of A (issue date)	5 July 2013	
C of A (expiry date)	4 July 2016	
C of R (issue date) (Present owner)	24 June 2013	
Operating categories	Standard - Part 91	

Engine No. 1 (left-hand side)

Type	Pratt & Whitney PW610F-A (Turbofan)
Serial number	PCE - LA0284
Hours since new	714,7 hours (27/11/2015)
Hours since overhaul	T.B.O. not yet reached

Engine No. 2 (right-hand side)

Type	Pratt & Whitney PW610F-A (Turbofan)
Serial number	PCE - LA0290
Hours since new	714.7 hours (27/11/2015)
Hours since overhaul	T.B.O. not yet reached

1.6.2 All the aircraft documentation required to be carried on board was inspected during the investigation to determine validity and was found to be in order.

1.6.3 The aircraft maintenance documentation, which includes the airframe logbook, both engine logbooks, the flight folio and the last phase inspection and work packs, was inspected. The following observations were made:

1.6.3.1 According to the maintenance documentation the aircraft was maintained

according to the manufacturer's requirements and in accordance with applicable regulations.

1.6.3.2 The aircraft was maintained in accordance with the approved aircraft maintenance schedule (AMS).

1.6.3.3 All the maintenance documentation was inspected during the investigation to determine validity and was found to be in order. There was no evidence of any defects and/or system malfunctions that were unresolved. All the maintenance carried out was properly certified. The aircraft was considered to be serviceable and airworthy after the last maintenance inspection was certified.

1.6.4 The investigation determined that after the last maintenance inspection was certified on the aircraft, it was flown from FACT (its home base) on several private flights to different destinations around the country. The evidence was that during take-off on one of the flights at FACT, the aircraft veered to the side of the runway and collided with several runway lights. Damage to the aircraft was limited to the right-hand main wheel assembly. The aircraft was repaired and released to service.

Note: It should be noted that the incident was not subjected to a formal investigation by the authority, hence the cause and contributory factor(s) were not determined.

1.6.5 According to the pilot's operating handbook (POH) the aircraft was certified to use Jet-A/A1 fuel. The fuel delivery receipt when the aircraft was refuelled at FALA prior to the accident flight indicates that the right type and grade of fuel was uplifted. The POH indicates that the fuel capacity was distributed between the two main fuel tanks, which were located inside the wings. The total fuel capacity of the aircraft was 254.4 US gallons, of which 250.9 US gallons or 770 kg (948 litres) were usable fuel. The pilot reported to ATC that the aircraft had an endurance of 4 hours with the fuel that was on board prior to take-off from FALA.

1.6.5.1 Available information indicated that the take-off time from FALA was 0621Z and the time of the accident was captured at 0857Z. The aircraft was therefore airborne for 2 hours and 36 minutes. This validates the earlier statement that the aircraft had sufficient fuel on board for the intended flight to FACT.

1.7 Meteorological information

1.7.1 The meteorological information in the table below was obtained from the South African Weather Service (SAWS)

Wind direction	160˚	Wind speed	5 kts	Visibility	9999 m
Temperature	24 ˚C	Cloud cover	BKN012	Cloud base	<1000 ft
Dew point	18 ˚C				

1.7.2 The SAWS report stated that *"The meteorological information was recorded at AFB Overberg Airport (FAOB) station, located close to the coast and 40 km south of the accident site".*

1.8 Aids to navigation

1.8.1 The flight was conducted under instrument flight rules (IFR) in daylight conditions. According to the South African Aeronautical Information Publication (AIP), the following ground-based navigational aids were available to the pilot for landing at FACT:

(i) Non-directional radio beacon (NDB) - CB: frequency 462,5 kHz.
(ii) VHF Omni-directional radio range (VOR) - CTV: frequency 115,7 MHz.
(iii) Distance measuring equipment (DME) – CTV/CTI/KSI: frequencies 119,1 MHz, 110,3 MHz and 109,1 MHz.
(iv) Instrument landing system (ILS) LOC: frequency 109,1 MHz.
(v) Instrument landing system (ILS) GP CATII: frequency 331,4 MHz.
(vi) Runway lights and identification marks.

1.8.3 During the flight to FACT, secondary surveillance radar (SSR) was used to monitor the flight path of the aircraft. According to FACT SSI, SSR Operation states that *"all flights with mode A and C transponder for which a flight plan is filed, will be allocated a squawk code by the Eurocat X FDP, which will be displayed on the FPS. All aircraft in South African airspace shall operate their transponders on Code A2000 until a code is allocated by ATC".*

1.8.4 According to the Eclipse EA500 type-certificate data sheet (TCDS), the aircraft was fitted with AVIO next generation (NG) type glass cockpit flight instrumentation displays. The AVIO NG displays consist of two 768 x 1024 resolutions primary flight displays (PFDs) and one 1440 x 900 resolution multi-function display (MFD). The

AVIO NG incorporates integrated avionics systems using software-based line replaceable units (LRUs), which share a digital signal transmission bus. The avionics configuration was critical to the proper operation of the cockpit instrumentation system.

Figure 5: The AVIO NG glass cockpit fitted on the Eclipse aircraft

1.8.4.1 According to the radio station licence issued to the aircraft, other additional equipment installed and used for navigation purposes comprised an ADF, DME, GPS and a weather radar.

1.9 Communication

1.9.1 The Air Traffic Services Unit (ATSU) at FALA is manned 24 hours and communication facilities were available that provide ground as well tower control. There was no proof of any anomaly experienced with the communication facilities at the airport.

1.9.1.1 There was communication between the pilot and air traffic control at FALA while the aircraft was operating in their area of responsibility.

1.9.1.2 The investigation determined that there was communication between the pilot and the radar controller after the aircraft was handed over from FALA to FAJA FIR airspace.

1.9.2 According to the FACT aerodrome chart, the Air Traffic Services Unit (ATSU)

communication facilities available are automatic terminal information service (127.00 MHz), tower (118.1 MHz) and surface movements on 121.9 MHz. The communication facilities are available 24 hours. There was no proof of any anomaly experienced with the communication facilities at the airport.

1.9.3 The investigation determined that there was no radio communication between the pilot and FACT ATSU during the flight after the aircraft entered into FACT FIR airspace. No communication could be re-established by any means.

1.9.4 According to the radio station licence, the aircraft was equipped with two VHF Honeywell KTR 2280 radio communication units. The investigation determined that the pilot was able to communicate with ATC using the headset microphone or the hand-held microphone. The aircraft maintenance documentation shows that during the last maintenance inspection, the radio communication equipment was certified serviceable. The pilot did not report any anomaly with the radio communication equipment.

1.10 Aerodrome information

1.10.1 Not applicable

1.11 Flight recorders

1.11.1 The aircraft was not fitted with a flight data recorder (FDR) or a cockpit voice recorder (CVR), nor was it required to be installed on this aircraft according to the regulations.

1.12 Wreckage and impact information

1.12.1 The pilot flying the Gripen that intercepted the aircraft ZS-DKS reported that the accident aircraft was observed to have a very erratic flight profile followed an oscillating flight profile before it entered into a spiral dive and impacted with terrain. The Gripen pilot remained at a safe distance from the aircraft, as it was observed to have entered into a spiral dive at substantial rate of descent (ROD).

1.12.2 The aircraft impacted the ground at a geographical position 34°10.670' South 020°08.280' East at an elevation of 538 feet AMSL. During the impact sequence the Gripen pilot observed no explosion or post-impact fire. He did observe a cloud of dust when the aircraft impacted the ground. The aircraft then broke up, with the wreckage being distributed on a relatively straight line.

1.12.3 During the on-site investigation, the accident site and wreckage were examined to determine if there was any evidence of failure that could have contributed to the accident. There was no evidence that suggest that there was damage to any aircraft system inflight and all damage was attributed to impact with the ground. From the wreckage and ground impact marks, it was evident that the aircraft impacted the ground while in a left wing low attitude, which corresponds to the observation made by the pilot that was flying the Gripen. Break-up and destruction of the wreckage were associated with a high-speed impact with the ground. During the ground impact sequence, the aircraft somehow bounced a couple of times along the wreckage impact path, and a large number of fragmented parts and components were located along the impact path.

1.12.4 Information from the accident site was used to draw an impact sequence diagram. The ground marks indicate that the wing of the aircraft impacted the ground first, and the wing structure displayed evidence of severe deformation. The impact sequence was found to follow a relatively straight line.

1.12.5 Following the left wing impact mark, the subsequent ground marks indicate that the nose section of the aircraft then impacted the ground. Due to the high impact forces the fuselage structure then started to break up.

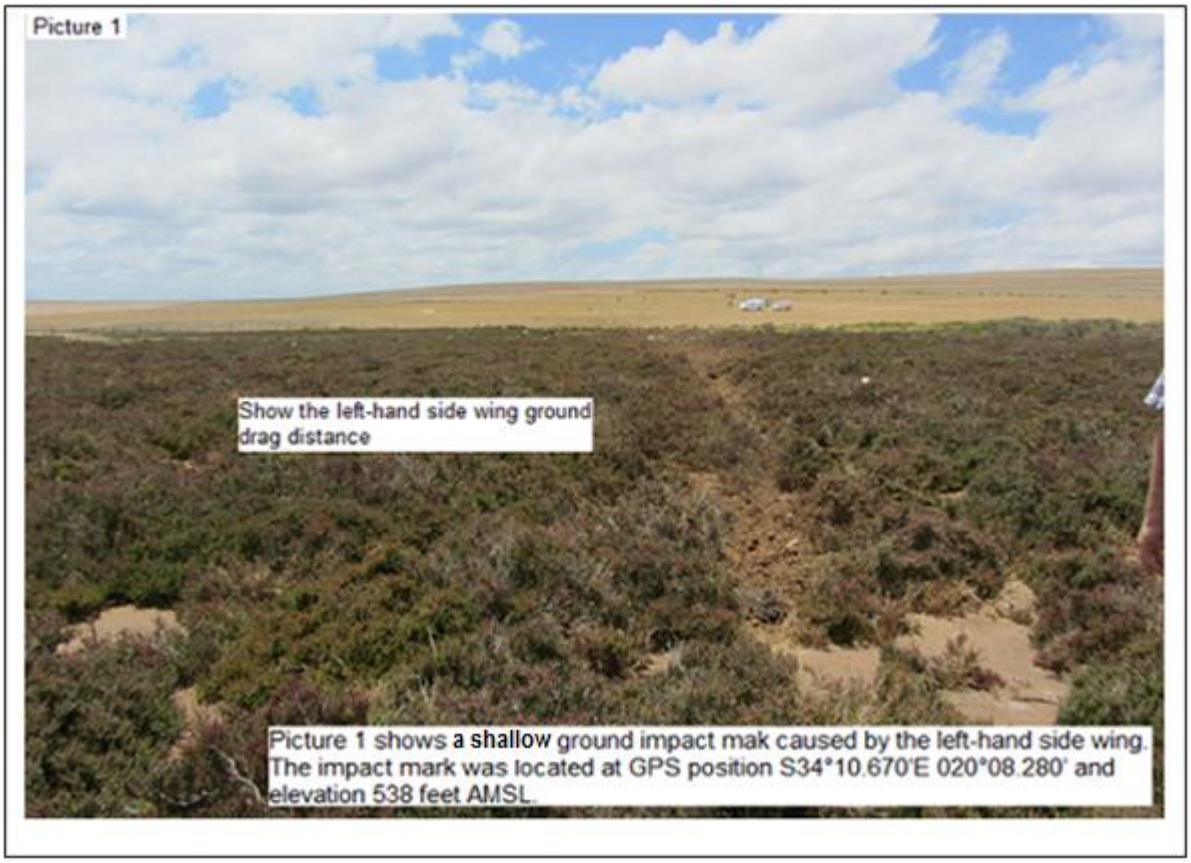


Figure 6: The first ground impact mark

Figure 7: The ground impact mark of the nose and fuselage

1.12.6 After the nose impacted the ground it disintegrated; as a result, the cockpit debris (i.e. navigation aids, radio communication equipment, furnishings and loose pages of documentation that was on board the aircraft were found scattered over

a large area, as can be seen in Figure 8.

Figure 8: Scattered debris from the cockpit and cabin area ahead of the nose impact mark

1.12.7 The two engines were located more than 1 km from the point of impact, which was at the end of the wreckage path. The number 1 engine (left side) displayed substantially more impact damage than the number 2 engine (right side).

Figure 8: The wreckage distribution beyond the first point of impact

Figure 9: Front view of No. 1 engine

Figure 10: Front view of No. 2 engine

Figure 11: The inner section of the left wing and the left main gear

Figure 12: The right wing

Figure 13: The right wing with the main gear still in the retracted position

Figure 14: The vertical stabiliser with both elevators attached

Figure 15: The rudder

1.13 Medical and pathological information

1.13.1 The Department of Health, Provincial Government of the Western Cape Forensic Pathology Services, Report No: WC/18/0476/2015 states that the medico-legal post-mortem examination of the pilot was conducted on 9 December 2015. The report concluded that the cause of death could *"not be determined by autopsy alone",* as the body was extremely fragmented.

1.13.2 No toxicological information was provided in the post-mortem report, which stated *"no specimens were retained as a result of the fragments being devoid of blood".*

1.13.3 According to the aviation medical certificate that was issued by a designated medical examiner on 22 April 2014, the pilot was found medically fit to hold a Class 2 aviation certificate, which expired on 30 April 2015 and was issued subject to the restriction/limitation *"that the pilot must wear suitable corrective lenses".*

1.13.3.1 However, according to his aviation medical certificate that was issued on 1 April 2011, the following restrictions/limitations were imposed: *"the pilot to fly with hearing aids, must wear suitable corrective lenses and annual Lipogram".* This medical certificate was confirmed by the Institute for Aviation Medicine on 14 July 2011.

Note: A letter on record from an audiologist dated 17 March 2010 states the following: *"The pilot was seen for a routine hearing assessment. The assessment was due to the pilot having a long history of bilateral hearing loss that required him to use binaural amplification. During the assessment it was determined that the pilot had a moderate to severe conductive hearing loss in the right ear and mild to moderate conductive hearing loss in the left ear. As a result, his speech was tested and found that his speech thresholds correlated well with the pure-tone averages. The speech discrimination scores were found to be excellent."* In conclusion, the audiologist recommended that the pilot's hearing should be monitored on an annual basis and he must continue to make use of his hearing aids*".*

1.13.3.2 The aviation medical certificate that was issued on 29 April 2013, stated that the pilot had to fly with hearing aids, must wear suitable corrective lenses, have spare spectacles on hand when flying and, most importantly, was required to submit to repeated blood pressure readings. This medical certificate was confirmed by the Institute for Aviation Medicine on 15 November 2013.

Note: The requirement in the first medical certificate – submission of an annual lipogram – somehow fell away. There was no information on the CAA pilot file as to why the lipogram was no longer a requirement. (A lipogram measures the exact amount of different types of cholesterol (and not just the total amount). It measures the total cholesterol, high-density lipoprotein (HDL), low-density lipoprotein (LDL) and triglyceride levels.)

1.13.3.3 The aviation medical certificate that was issued on 22 April 2014 contained the following restriction/limitation: *"must wear suitable corrective lenses".* This medical certificate was confirmed by the Institute for Aviation Medicine on 16 June 2015.

1.13.4 The SACAA Aviation Medicine Department (AVMED) was requested to provide information as to the renewal of the pilot aviation medical examination after 4 March 2015. The SACAA consulted with the Institute of Aviation Medicine on this matter. According to available information, the Institute for Aviation Medicine had not received any documentation to indicate that the pilot had renewed his aviation medical after it had expired on 30 April 2015. During consulation with the next-of-kin they presented the investigating team with a aviation medical certificate that indicate the pilot was examined by a designated medical examiner on 11 May 2015. According to the aviation medical certificate he was found fit for flight until 31 May 2016.

1.13.5 During a consultation with the pilot's next-of-kin (his wife and son), they advised the investigation team that the pilot had been diagnosed with skin cancer. They advised that he had undergone several sessions of radiation treatment at a medical facility in Durban during the first quarter of 2015. The CAA pilot file contained no information that the pilot suffered from any type of cancer and was receiving treatment for the condition.

1.14 Fire

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

1.15 Survival aspects

1.15.1 The pilot was fatally injured in the accident. The accident was not considered survivable, the impact forces was well above those of human tolerance. Available evidence indicates that the aircraft impacted the ground at a speed that exceeded 300 knots.

1.15.2 The South African Aeronautical Rescue and Coordination Centre (ARCC) co-ordinated the search and rescue (SAR) operation of the aircraft while it was still in-flight. According to the ARCC SAR activity report, FAJA ACC notified them that communication was lost with the pilot/aircraft while it was enroute to FACT flying at its cruise altitude of FL360. Due to the severity of the situation an INCERFA was declared. The ATC continued to try to re-establish communication with the pilot, but was unsuccessful. The pilot did not respond at all. The ATC observed on radar that the aircraft veered off track slightly to the left. At this time ATC upgraded the emergency to a DETRESFA.

1.15.3 Due to the severity of the situation, the SASAR/ARCC decided to task a Gripen military jet to intercept the aircraft. According to the SASAR/ARCC report, this step was taken when it became clear that there had to be something seriously wrong on board the aircraft and that the only way to assess the situation was to rely on the observations made by the Gripen pilot.

1.15.3.1 As indicated above, the Gripen was airborne at about 0850Z from AFB Overberg (FAOB). According to the Gripen pilot, the aircraft was approximately 30 nm north of AFB Overberg at the time he took off. The aircraft was intercepted, but it was not possible for him to get close enough to the aircraft, as its flight profile was erratic. The aircraft disappeared from radar as it descended towards the ground while in a spiral dive.

According to the SASAR/ARCC activity report, other resources such as the Maritime Rescue Coordination Centre (MRCC), SA Navy, National Sea Rescue Institute (NSRI) and the Metro were placed on standby should the aircraft fly out to sea. However, when the exact location of the accident scene was known, all relevant authorities were immediately notified to stand down.

Note: When the ground emergency and rescue services arrived on the accident scene, they found the wreckage of the aircraft, which was severely broken up

and spread over a large area.

1.15.4 The pilot filed a flight plan for the flight to FACT. The flight plan indicated search and rescue as NORMAL (SARNML), which means that search and rescue assistance was required when an emergency situation arose enroute to FACT. Also a search and rescue operation would be activated automatically.

1.15.5 All aircraft are required to carry on board a specified list of emergency equipment, which the pilot can use when the need arises. Available evidence indicates that the aircraft did carry on board all the required emergency equipment.

1.15.6 It should be noted that the aircraft was equipped with a pressurisation system. Both systems were inspected during the last maintenance inspection prior to the accident flight and were found to be serviceable. As the aircraft was flown at high altitude, both systems were required to be operative.

1.15.7 According to Eclipse Aerospace, EA500 Quick Reference Handbook (QRH), Section 5, *"the aircraft cabin is pressurised on the ground and for the duration of the flight until landing"*. Due to the fact that the aircraft was destroyed during the impact sequence, it was not possible to determine whether or not the aircraft experienced a pressurisation problem/malfunction during flight prior to the accident or not. The debris of the pressurisation system was inspected during the wreckage investigation process and no evidence was found that could be associated with a pre-accident failure.

1.15.8 There was a 406 MHz emergency locator transmitter (ELT) on board the aircraft, which was found to be in the ARMED position. With the aircraft being intercepted by a military jet, the relevant authorities immediately knew the location of the accident site. The ELT was located on the accident site.

1.16 Tests and research

1.16.1 Radar data of the flight was made available to the investigation team. The radar track of the flight was from the point of departure (FALA) to the point where radar coverage was lost when the aircraft was in a spiral dive towards the ground. The radar track data analysis showed the following:

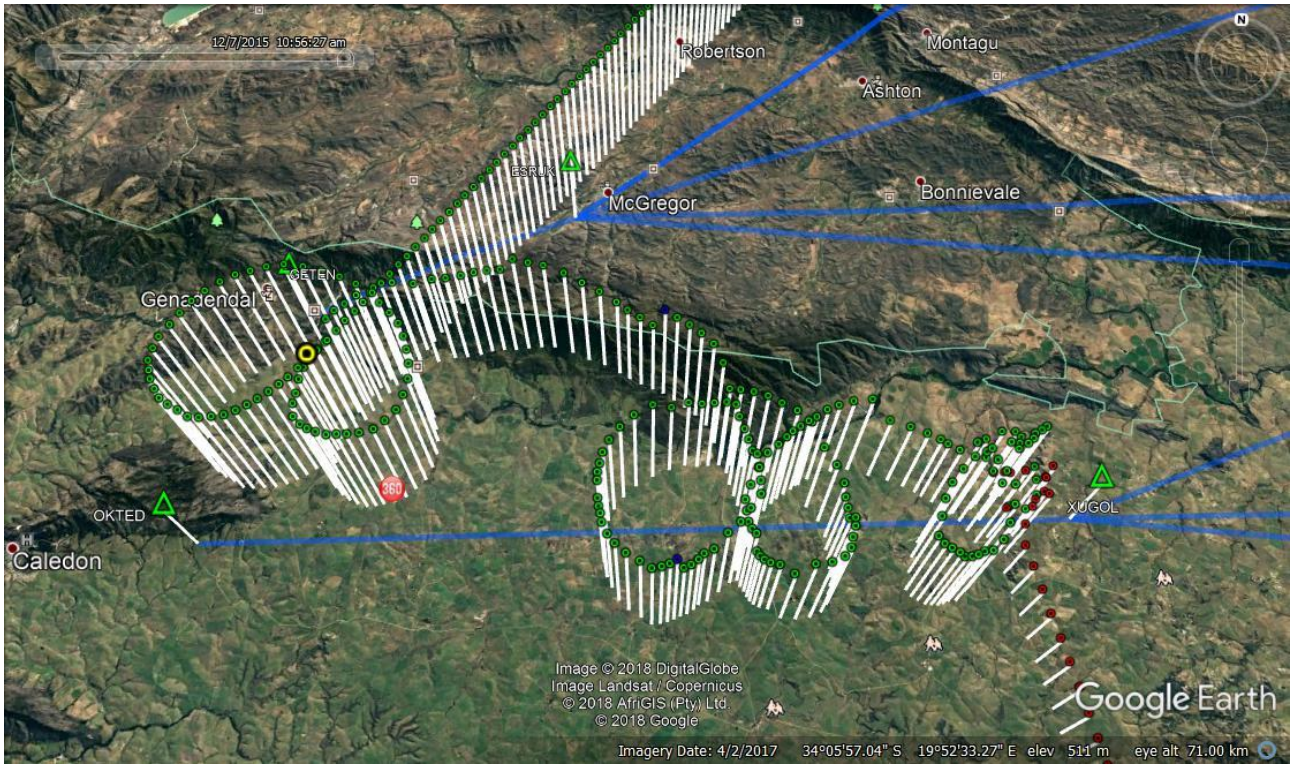


Figure 16: The radar data showing the five orbits the aircraft made before ground impact

(i) According to the radar track log, at about 0629Z, FL160, speed 231 knots, true heading 232 degrees, the aircraft entered JHB Area North and South. At this point the aircraft was under the jurisdiction of JHB Area North available on broadcasting frequency 126.7 MHz.

(ii) At about 0638Z, FL261, speed 229 knots, the aircraft entered JHB FIS North, available on broadcasting frequency 119.5 MHz. It continued straight on and crossed the Z/ZU6 airway heading to “EXANO”, which it reached at about 0643Z, FL322 and speed 235 kts.

(iii) The flight continued on this heading to position “IMSIR” near Kimberley with VOR KYV. The position “IMSIR” is found on the Z/UZ31 airway originating from “XAGEN” and was reached at about 0710Z, FL360 and speed 304 kts.

(iv) At position “IMSIR” (which is the entry point into JHB Area Control, available on broadcasting frequency 120.3 MHz) there was a slight left bank turn (-8 degrees) onto a new heading (224 degrees). The aircraft then followed Z/UZ31 airway for about 15 minutes, FL360 and speed 306 kts - 312 kts;

(v) The next position was “NESUS”. However, at about 0725Z, FL360 and speed 306 knots, the aircraft started to deviate in a left bank turn (-10 degrees), leaving the Z/UZ31 airway and gradually changing direction to heading 214 degrees until it got to the entry point of Cape Town FIS West (available on broadcasting frequency 131.125 MHz) between “APLEN” and “EGNOM”. The entry point was crossed at about 0753Z, FL360 and speed 315 knots.

(vi) The aircraft continued heading to the Q/UQ52 airway (FACT to FALA), crossing it at about 0743Z, FL360 and speed 315 to 321 knots. Next it crossed the UZ10 airway (FAOR to FACT) at about 0817Z, FL360 and speed 328 knots. It then continued on to the UZ2 airway “TETAN to NIBEX”, crossing it at about 0817Z, FL360, speed 329 knots. It seemed as if it was heading to 212 degrees in the direction to “OKTED”.

(vii) At approximately 68 nm from “OKTED”, before reaching the entry point of FACT controlled airspace available on broadcasting frequency 125,1 MHz, another Q/UQ47 airway was crossed at about 0826Z, FL360 and speed 331 knots. When inside FACT controlled airspace, the aircraft continued to cross the Q/UQ55 airway “TETAN to UVDEX” and then headed to Z/UZ3 airway “ESRUK to GETEN” (FALE to FACT).

(viii) The aircraft maintained FL360, speed 329 knots and heading 209 degrees until overhead the Swellendam area (GPS reading S34°01’42.57” E020°26’16.10”). At this point the aircraft started to fly erratically and unpredictably, making a total of 10 turns to the right, climbing and descending.

(ix) At 0837Z the aircraft climbed to FL367, speed 316 knots. It entered the first right turn (radius approximately 3,5 nm) reducing speed to 283 knots. Halfway through the turn, the aircraft started to descend to FL358 and its speed increased to 397 knots.

(x) At about 0839Z, FL355 the aircraft entered second turn (radius approximately 2.5 nm) at 452 knots. During this second turn it seems as if the aircraft climbed back to FL362 and descended to FL323 at speeds ranging from 245 knots during the climb to 425 knots when descending. At about 0842Z, when the aircraft completed the second turn, it appeared to be levelling off, but continued to climb and descend in the direction of “XUGOL”.

(xi) At about 0844Z, FL330 and speed 420 knots, the aircraft entered a third turn (radius approximately 3.5 NM). When entering the turn, it started to descend. During the

descent in a turning attitude the speed increased to about 486 knots and again decreased to about 147 knots in a climb.

(xii) Another two turns followed before the aircraft entered into what is believed to have been a spiral dive, during which the radar log recorded speeds of 420 knots and as high as 578 knots. At about 0855Z, FL168 with a speed of 557 knots, the final radar log was recorded prior to the impact. The accident time was reported to be approximately 0857Z.

1.16.2 In order to comply with International Civil Aviation Organisation (ICAO) rules, the State of Occurrence (Republic of South Africa in terms of Annexure 13, Chapter 4) had to notify the States of Design and Manufacture of the aircraft and the engines. Accordingly, the National Transportation Safety Board (NTSB) in the USA, where the aircraft was manufactured, and the Transportation Safety Board (TSB) in Canada, where the engines (Pratt & Whitney Canada) were manufactured, were informed. In terms of Chapter 5, the State of Occurrence consulted with the USA and Canada about participation in the investigation. It was at this time that the States communicated their decision to appoint accredited representatives to assist South Africa.

1.16.3 The following two Honeywell components were retrieved from the accident site: KTR 2280 (P/N 069-01037-0102 with S/N 1594) and EGPWS (PN: 965-1198-005 Mod 1 with SN: 7372). Both these units contained non-volatile memory and were sent to Honeywell in the USA, which had the required expertise, tooling, equipment and highly qualified personnel to carry out the investigation on the equipment. According to Honeywell, when the units arrived at their facilities they were still in their original packaging as dispatched from South Africa.

KTR 2280 (P/N 069-01037-0102 with S/N 1594)

EGPWS (PN: 965-1198-005 Mod 1 with SN: 7372)

Figure 18 and 19: The KTR 2280 and EGPWS units that were sent to the USA for downloading

1.16.4 The KTR2280 unit was a multimedia digital radio (MMDR) and displayed the following information: VHF communication, ADF selection as well as the localiser and glideslope information. It was possible to connect the unit to an engineering bench test harness and power it up. This test was conducted at their facility in Olathe, Kansas City, USA. The unit was found not to contain a time stamp, but a date stamp was captured, which displayed the date of the accident flight.

(i) MMDS NVM data consists of: COM squelch settings, COM side tone level, COM wideband notch calibration data, COM Rx & Tx factory calibration data, ADF QE, antenna location settings, NAV tuning calibration data, GS centring, detector gain data and MMDS serial numbers and mod status data.

(ii) Host NVM data consists of: COM side tone and mic gain offsets, COM emergency frequency and volume, ADF QE, antenna location, COM squelch settings, time and temperature data, ADF, VOR, LOC, & GS damping values and current operating settings (frequencies, volumes, air/ground, etc.)

1.16.5 The EGPWS was forward to the Honeywell facility in Redmond, Seattle in the USA. The unit appeared to be in relatively good condition and contained non-volatile memory (NVM). The EGPWS does not record continuously; it is an event-driven unit. The unit is therefore able to store data from the 20 seconds preceding and 10 seconds following an alert. When an alert is issued, the warning file creates a blank line entry, writes the alert type in the Rec ID field and may capture some information

about the software and database version loaded (this varies by software version; later software captures more data).

1.16.6 Honeywell KTR 2280 examination report (Honeywell, Olathe, Kansas City)

During the examination of the unit the following observations were made:

(i) It could not be determined whether this was the number one or the number two unit that was on board the aircraft.

(ii) The unit captured the date information, but no time stamps were present. No errors were recorded during the accident flight.

(iii) There were no faults recorded during the accident flight leg. Two fan faults were captured during the Honeywell inspection; these were attributed to the impact damage to the fan.

(iv) Functional testing found that the VHF and ADF receivers were both functional and capable of receiving a very weak signal. The VHF transmitter did not function.

(v) Analysis found that the transmitter fault (i.e. fault log downloaded at 09:44:01 central daylight time) was in an area on the transmitter circuit board where impact damage had occurred (cover dented inward). No determination was made as to whether the fault was the result of a damaged circuit board or a component.

(vi) The active/in-use frequencies were as follows: VHF communication frequency 120,005 MHz; VHF Nav/GS 112,00 MHz; ADF frequency 200 KHz.

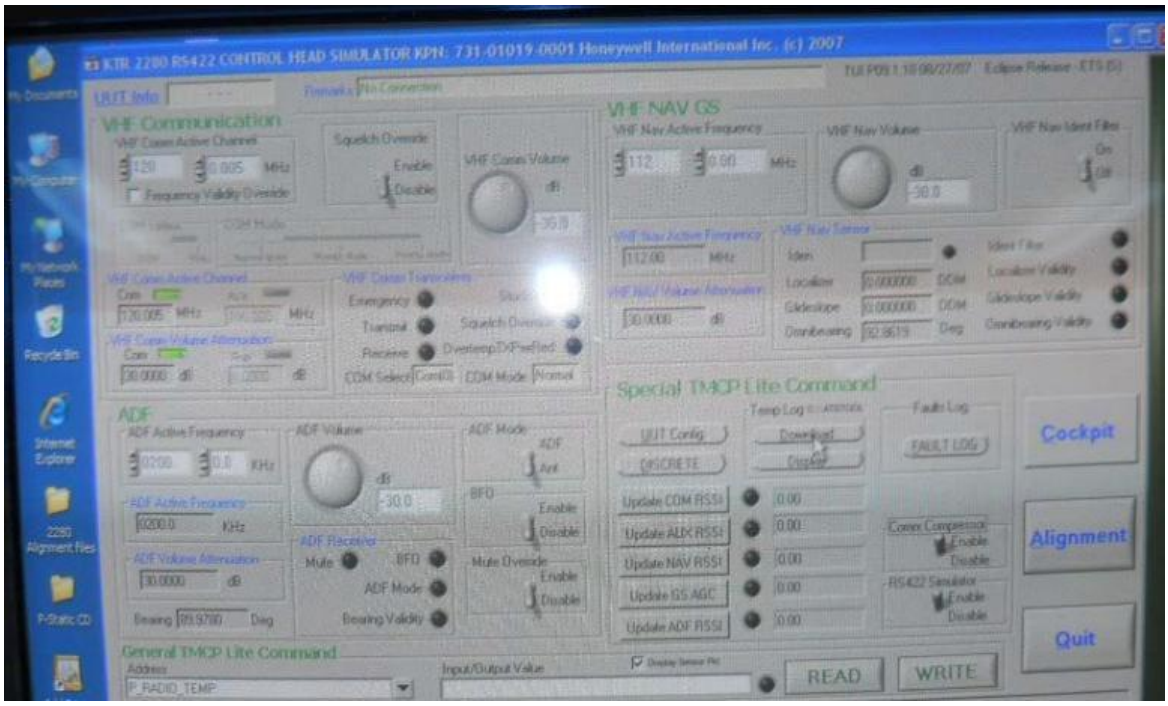


Figure 20: A computer screenshot of the frequencies that were retrieved from the unit

(vii) The error/maintenance data was successfully recovered. No errors were present that would preclude normal operation. No pre-impact faults were observed. The duration of the power-on and power-off cycle from the accident flight could not be determined using the KTR2280 data due to the absence of time stamps (no flight management system output to the KTR 2280). However, it was confirmed that aircraft power was present at the time of impact using the EGPWS data.

1.16.7 The Honeywell EGPWS examination report identified the accident flight leg 535 and made the following findings:

(i) According to Honeywell, no landing data was recorded.

(ii) The warning history data was recorded between 1012:54:29 and 1012:56:42.

(iii) Terrain alerts were recorded between 1012:54:49 and 1012:56:34 due to rapid descent,

(iv) GPS Alt and VFOM and static air temperature are invalid during the recorded alerts; cause unknown.

(v) EGPWS position source shows DR (dead reckoning) briefly during rapid descent due to GPS invalid data.

(vi) The event log shows no events during the accident flight.

(vii) The fault log showing in-air faults for leg 574 are believed to have been caused by lab power-up.

(viii) System time of power-up in Redmond lab was at 1012:56:44.

1.16.7.1 Flight path diagram: The flight data track properties (latitude and longitude, TACAlt, magnetic track & true track, true heading & roll etc. were downloaded from the EGPWS. The flight data was then used to plot the flight path on Google Earth as can be seen in Figure 21 below.

Figure 21: A plan view of the final flight path

1.16.8 The Transportation Safety Board of Canada (TSB) was informed of the accident as per the requirements contained in ICAO Annex 13. The engine manufacturer Pratt & Whitney Canada (P&WC) assisted the South African investigation team with the teardown examination of the engines.

1.16.9 Both engines were crated and sent to Plant 5 at P&WC in St. Hubert, Quebec, Canada. Both engines, although severely damaged by the impact (they came to rest more than 1 km from the point of first impact) displayed evidence that the engines were delivering power on impact. In what range the engines were producing power could not be determined with certainty.

1.16.10 Both engines displayed evidence of foreign object ingestion, which consisted mainly of soil, small stones and vegetation, which were located downstream as far as the hot section of the engines. The aircraft impacted the ground in a left wing low attitude; as a result, much more destruction was observed on engine No. 1 (serial number PCE-LA0284) than on engine No. 2 (serial number PCE-LA0290). However, both engines displayed evidence marks (at more than one location within the engine) associated with the engines delivering power on impact. The figures below illustrate the internal rotational signature marks that were observed during the teardown inspection of both engines.

1.16.11 For illustration purposes, a cross-section of the PW 610F-A engine has been included in Figure 22. The photographs that follow the cross-section diagram show the hardware found on the No. 1 and 2 engines. All the engine components illustrated below displayed evidence associated with rotation during impact.

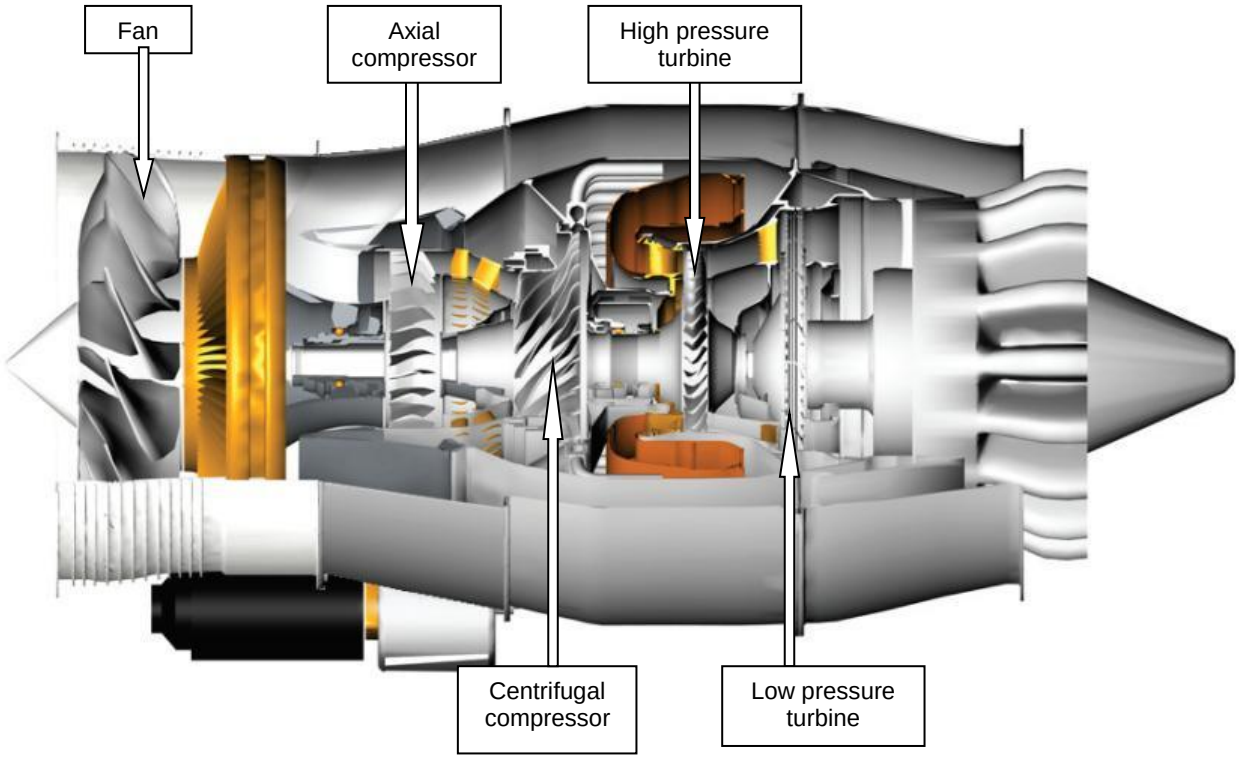


Figure 22: A cross-section of the engine

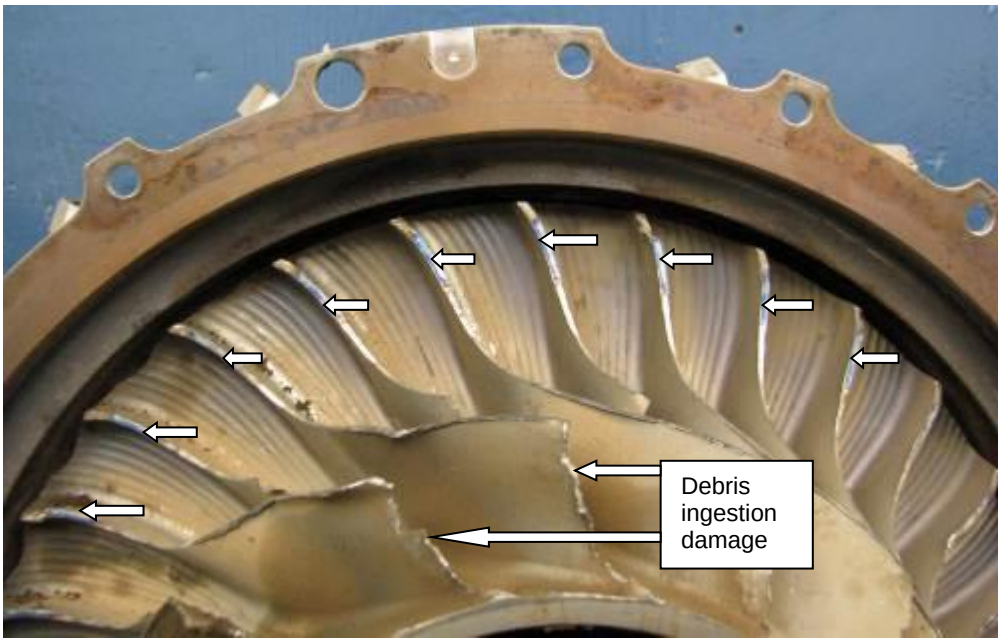


Figure 23: Close-up of the No. 1 engine high-pressure (HP) centrifugal compressor airfoils

Figure 24: Rub marks on the No. 1 engine centrifugal compressor shroud

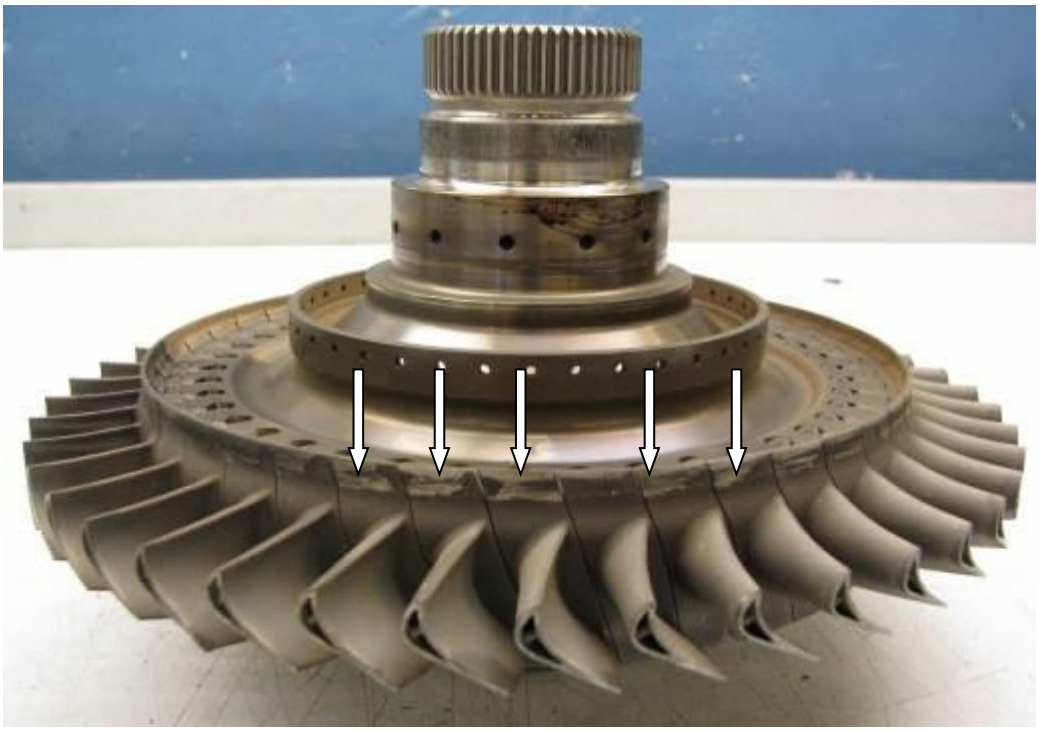


Figure 25: Rub marks on the high-pressure (HP) turbine leading edge, with no distress to the blades

Figure 26: Rub marks on the low-pressure (LP) turbine disk and blades

The photographs following below refer to the No. 2 engine. The engine displays slightly less evidence of rotation than the No. 1 engine, which was attributed to the angle of impact.

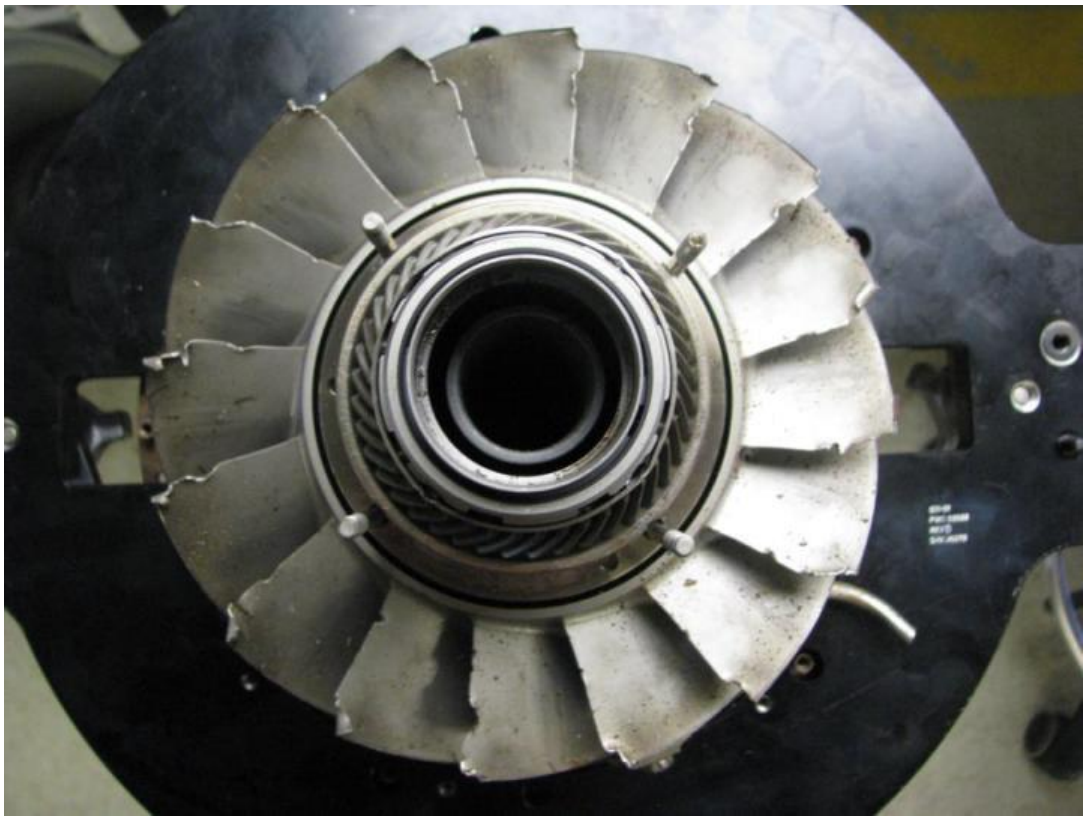


Figure 27: Damage to the axial compressor (No. 2 engine) associated with debris impact during rotation

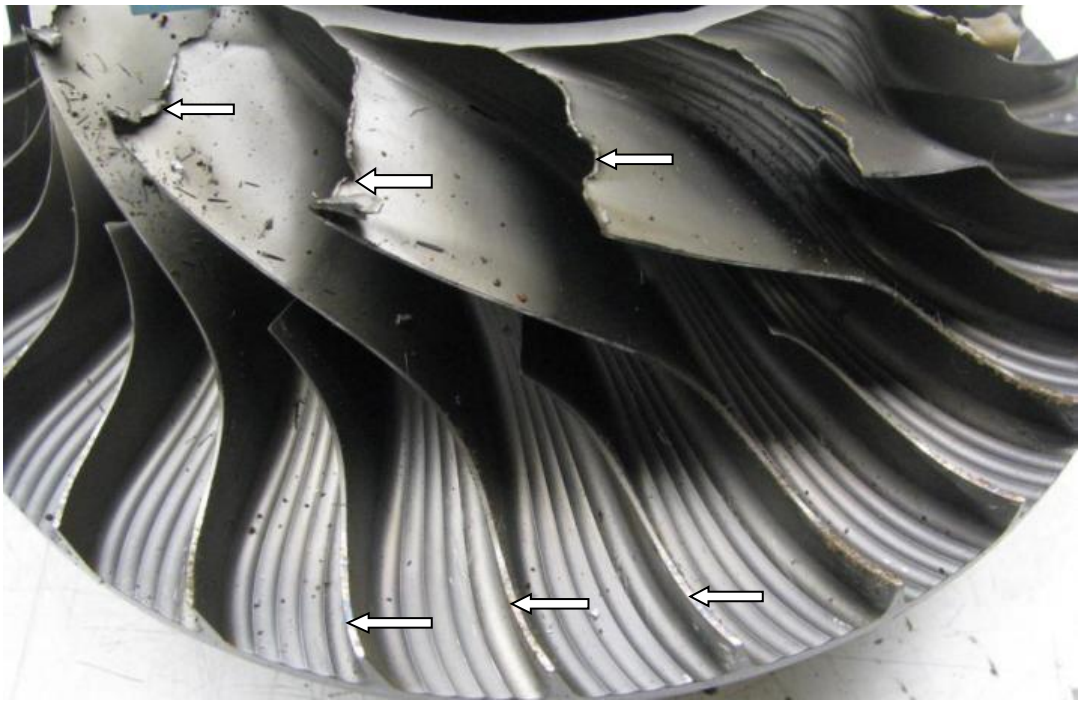


Figure 28: Close-up of the centrifugal compressor with damage visible to the airfoils

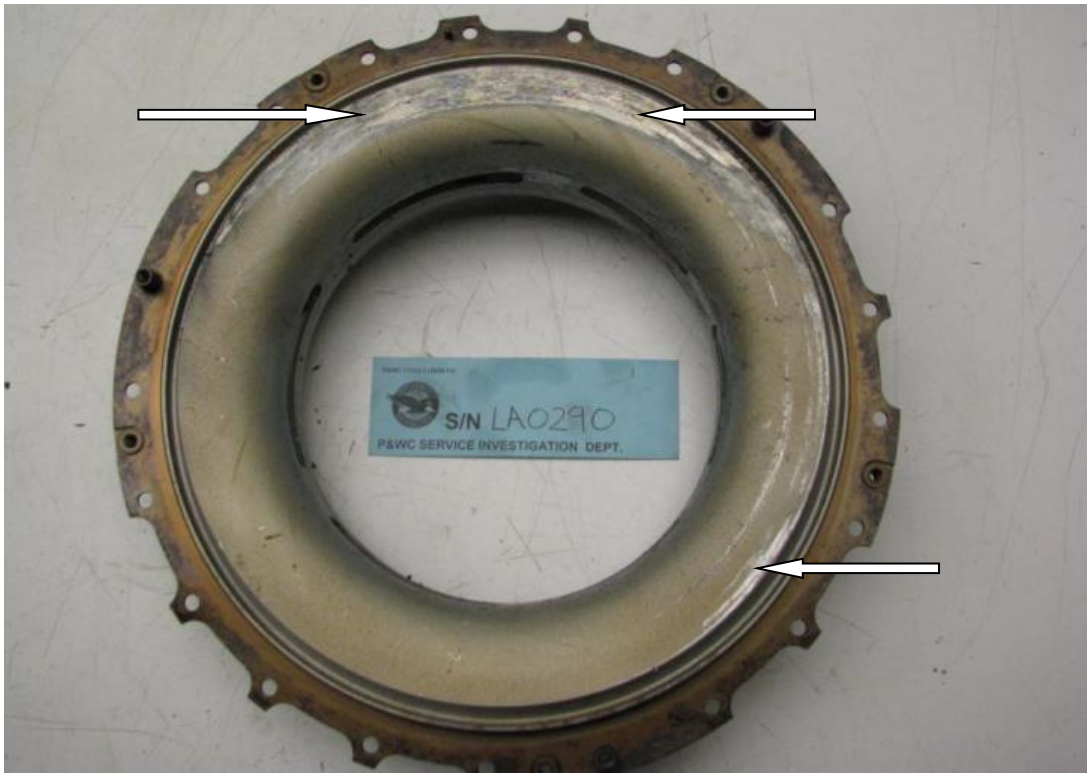


Figure 29: Rub marks visble on the centrifugal compressor shroud

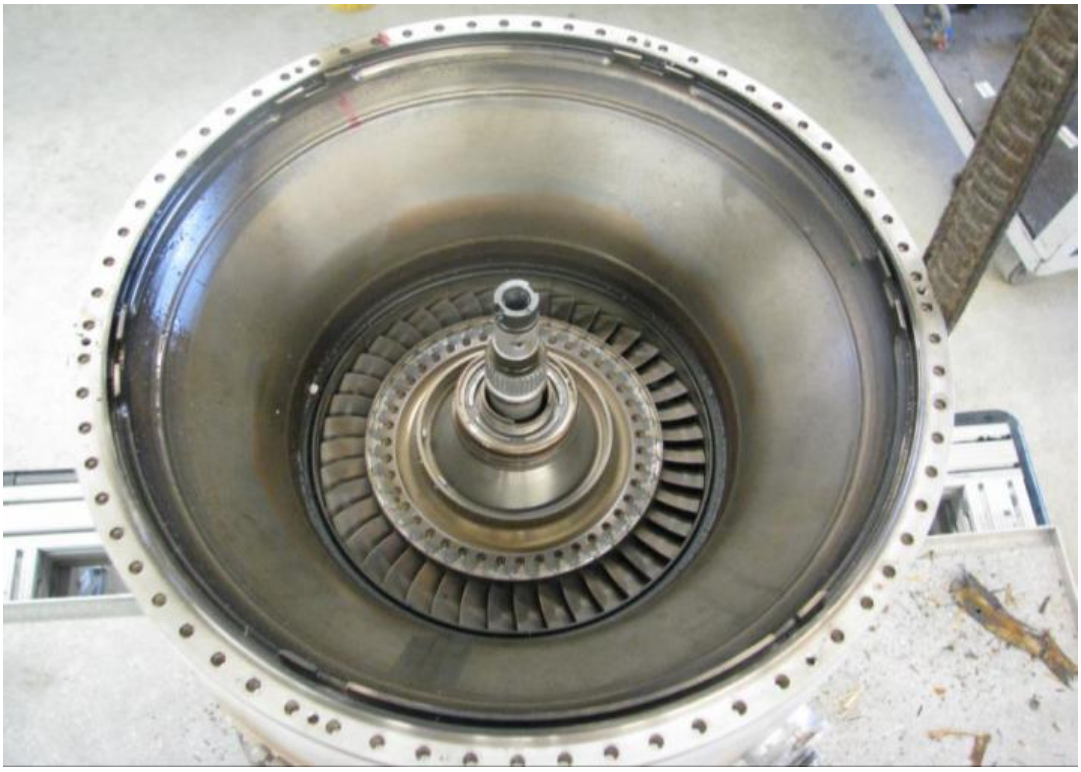


Figure 30: The high-pressure (HP) turbine support case; no damage was visible

Figure 31: The high-pressure turbine disk (trailing edge view), with some rub marks visible

Figure 32: The low-pressure turbine disk with rub marks visible

Figure 33: The ignitor plug faces were not damaged, but they display some carbon accumulation

1.16.12 None of the parts from the accessory gearboxes were recovered, and only one fuel metering unit (No. 2 engine) was recovered. The unit was found on the accident site as it became detached from the engine during the impact sequence. A visual inspection of the unit displayed multiple severe impact damage. The unit, manufactured by Woodward, with part number 35C2496-04 and serial number 15042650, was dismantled in the P&WC accessories department (fuel component shop). The visual inspection of the internal components did not reveal any damage or abnormal conditions that would have prevented normal operation prior to the accident.

Figure 34: The fuel metering unit

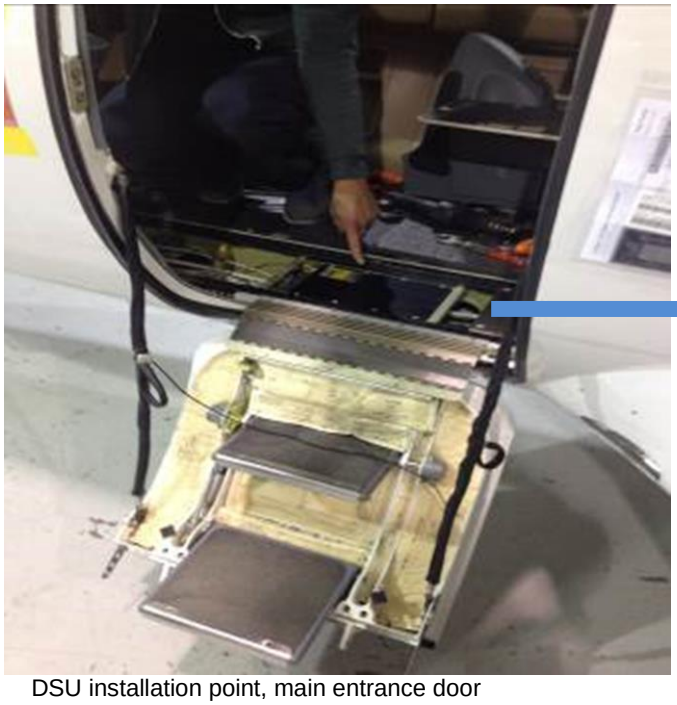
Figure 35: The fuel metering unit after it was dismantled

1.16.13 An NTSB specialist's factual report, no: CHI08IA152, states the following: *"The Eclipse type of aircraft are equipped with a Diagnostic Storage Unit (DSU). The DSU collects aircraft-related data but is not designed to function as a flight data recorder (FDR). It does not meet any crash-survivability requirements and does not record all of the flight parameters as would be required on a flight data recorder. The DSU is also not required to be operational for flight as it is not required equipment under the Eclipse 500 MMEL. However, an operational DSU does collect aircraft-related data in its solid-state memory. Some of the collected data is used as part of Eclipse's FAA-approved flight operational quality assurance (FOQA) program; additionally, the collected data is also used*

to diagnose anomalous behaviour of some individual avionics boxes on the aircraft. Much of the data is collected at 1 second intervals, although some individual parameters are collected more frequently and some are collected less frequently.

The DSU solid-state memory has a large data partition (~2 Gigabytes) dedicated to the collected data. The partition size allows data to be collected by the DSU for the time between service intervals of the aircraft. A very small portion (< 0.1%) of the data is sent in near real time to the ground via SatCom for selected customers while the bulk of the collected data is downloaded from the DSU via Eclipse-controlled ground operations. The data format used by the DSU was defined by Eclipse and does not follow any traditional FDR data formatting standards.

The DSU collected data organized in variable length messages that have an identification header followed by the data payload ending with a cyclic redundancy check (CRC) word. The integrity of the data transmitted is determined by examination of the CRC word by the receiving entity. There is no provision for real-time retransmission of the data in case the CRC identifies an error in the data".



DSU installation point, main entrance door

DSU - Solid state drives motherboard

Figure 36 and 37: Location where the DSU was installed

1.16.14 The investigation team recovered the air data computer (ADC) unit from the accident site and forwarded it to the NTSB engineering division, where the unit was assessed. It was determined that the ADC did contain non-volatile memory, but no flight data was recorded that could be downloaded.

Figure 38 The air data computer that was recovered

1.17 Organisational and management information

1.17.1 Due to the nature of the operation of the aircraft, it was necessary to determine if all the organisational and management requirements relevant to the operations had been complied with by the owner and the relevant organisations in terms of existing regulations. For this purpose, the licences and approvals of all organisations were assessed, especially those that had a direct influence on the operation of the aircraft.

1.17.2 Aircraft maintenance organisation (AMO): The AMO, which was responsible for maintaining the aircraft, was in possession of a valid Part 145 AMO approval certificate. The certificate had all the appropriate category ratings endorsed on it, which allowed the AMO authorisation to conduct maintenance on the aircraft type.

1.17.3 The aircraft was flying from FALA with its intended final destination being FACT as per a flight plan that was filed by the pilot prior to his departure from FALA.

1.17.4 The air traffic services at FALA, FAOR and FACT respectively were duly approved in accordance with Part 172 of the Civil Aviation Regulations (CARs) of 2011 as

amended.

1.18 Additional information

1.18.1 After landing at FALA, the pilot indicated that he would be taxiing to a facility that was located on the southern side of the aerodrome. This was normal practice for the pilot each time he landed at this aerodrome. The practice was also that each time the pilot would pay the company he visited a courtesy call first before his arrival. However, this time the pilot deviated from this arrangement.

1.18.2 After the aircraft had been parked, the pilot arranged for it to be refuelled. Thereafter he went to the offices of the company he always visited and met up with one of the directors, who was a friend of his. The pilot indicated to those he came to see that the aircraft was being refuelled, as he would be flying back to Cape Town. He carried with him a bag (laptop/business type) as well as a small suitcase, as can be seen in Figure 39, and asked if he could leave it at their facility. However, he made a special request that his wife should be contacted at exactly 0830Z and asked to come and collect the bags. The pilot insisted on the time she should be called and wrote his wife's name, her contact number and the time she should be phoned on a piece of paper. Before he returned to the aircraft, he stated that should his wife ask for an explanation, the person should tell her that he said his plans had changed.

Figure 39: The suitcase and the bag the pilot left at FALA

1.18.3 At about 0605Z a short message (SMS) was send to the pilot's wife to inform her of the suitcase and bag, and that her husband's (the pilot's) plans had changed. At about 0618Z, the pilot's wife called the person who had sent the SMS. She indicated to the person that the SMS was confusing to her, because she was at their residence in Stellenbosch and that she had not made plans to travel to Gauteng. She asked the person to tell her what was going on and where the pilot was going to. The person stated that he was flying to Cape Town. The wife then said that she would make arrangements to collect the bags.

1.18.4 Following the telephone conversation, the person at the company based at FALA wrote an SMS to the pilot that was sent at 0726Z. The person was well aware that the pilot was flying at the time and thought he would see the messages after he had landed at FACT. The SMS stated that the arrangement with regard to the bags was confusing to his wife as she was at their residence in Stellenbosch and had no plans to travel to Gauteng. Thereafter several phone calls were made to the pilot's cell phone, leaving voice messages asking him to phone back, but he never did. The bag and the suitcase as depicted in Figure 39 were delivered to the accident site by the director, a friend of the pilot. The suitcase was locked, but the laptop/business bag was not; it contained documentation related to the pilot's businesses as well as a laptop and an iPad. These two bags were then returned to the pilot's wife and son at their residence in Stellenbosch.

1.19 Useful or effective investigation techniques

1.19.1 No new methods were used.

2 ANALYSIS

2.1 At the time when the pilot arrived at the facility at FALA, he parked the aircraft and requested for it to be refuelled. While the aircraft was being refuelled, the pilot went to the offices to meet with some of the employees. This was not the first time he visited this facility. He was familiar with some of the employees. However, this time his visit came as a surprise. A statement from one of the employees indicated that she and another colleague were talking in the kitchen when the pilot walked in to greet them. This was at approximately 0550Z to 0600Z that day. The pilot had two bags with him

and asked if he could leave them with her in her office. The pilot explained to her that his wife was coming to collect the bags. Apparently, his wife was on a flight from FACT to FALA later that morning.

2.2 Before the pilot left her office, he wrote his wife's name, telephone number and the time 0830Z (10h30 - local time) on a piece of paper, which he handed to her. The employee was requested to call his wife at 0830Z exactly and to tell her about the bags she should pick up on her arrival at FALA. The pilot told her that if the wife asked more questions, she should tell her that he had said *"my plans have changed".* The pilot then left the office and returned to the aircraft to embark on his flight to FACT.

2.3 The decision to fly to Cape Town via Lanseria could be seen as a change of plan; so could the decision to leave the bags at the facility and have his wife coming to Lanseria to pick them up.

2.3.1 The decision to fly to Lanseria and the unexpected visit to facility was deemed important when considering the *"change of plans"* issue. According to statements from the employees at the facility at Lanseria, they were clearly surprised by his visit that day. In their view they had a very good relationship with the pilot; however, the understanding was always that he would first contact them to communicate his intentions before his arrival. This way they would be able to make all the necessary arrangements to receive him. The experience was that in the past, whenever he flew to Lanseria it would be for business. Depending on the duration of his stay, employees from the facility would help him with either parking or storage space for the aircraft. However, this time he did not come to Lanseria for business. He had supposedly concluded the business in Kuruman.

Note: In an article "Advertorial – Owner Profile" published in the SA Flyer Magazine, the pilot is quoted saying that *"On a daily basis I need to move between my branches in Kokstad, Vryheid, Bloemfontein and Welkom, often visiting two or three in one day. While I never envisaged getting into the world of flying, my business needs soon dictated this path for me in order to save time, streamline my business and increase my productivity".* With this in mind, a "change of plans" might not really be so unusual in the pilot's busy schedule.

2.4 In terms of the decision he made to leave the bags at the facility it is important to reflect on what happened next in the interaction with the pilot's wife. The employee he talked with said that at about 0605Z, after the pilot had left, she decided to send

an SMS to the wife's phone to notify her of the bags, hoping that she would see the message on arrival at FALA and assuming that the wife was flying from FACT to FALA a bit later that morning, as the pilot explained it. Her intention was to ensure that the pilot wife did not leave FALA without first collecting the bags.

2.4.1 Besides the SMS she sent, she also intended to call the wife later at 0830Z, as the pilot had asked her to do. However, while she was waiting she unexpectedly received a call from the pilot's wife at about 0618Z. The wife expressed her concerns about the SMS received. The wife is quoted as saying that she had no idea what the employee was talking about; she was in Cape Town and not on her way to Lanseria. She also asked where the pilot was going. Upon receiving confirmation from another employee the pilot spoke with, the wife was told he was flying to Cape Town. Thereafter the wife said she would ask her brother to collect the bags. This was the end of the phone conversation about this matter.

2.5 Based on the above, the following issues need to be reflected on thoroughly. The first issue relates to the questions from the wife. The fact that the employee could not give answers caused the situation to be much more confusing. Arguably the situation was not making any sense to her, which explains her saying that she had no idea what the employee was talking about. The wife was in Cape Town at the time and the pilot was supposedly flying back to Cape Town anyway. The wife was clearly surprised by the news that the pilot was leaving the bags at Lanseria. Her emphatic response that she was in Cape Town and not on her way to Lanseria shows that the pilot was mistaken in believing that she travelling to Lanseria. Her question about where he was going clearly shows that she was flabbergasted by the news at that point. Worst of all was the message that *"his plans had changed"*. Where was he planning to go if not to Cape Town, where she was probably waiting for him?

Note: It is obvious that when the wife realised she was not getting the correct answers or satisfactorily responses from the employee, she doubtfully agreed to send her bother travelling from Cape Town to collect the bags. She most probably thought that the confusion would be resolved by the time her husband (the pilot) arrived home.

2.6 The employee was completely confused by the situation that unfolded, especially the responses she got from the pilot's wife. She needed clarity urgently from the pilot, which led to the decision to send an SMS to his phone. The SMS was sent at about 0726Z; again assuming that he would get to see it when arriving in Cape

Town. Due to the urgent nature of the situation, the employee decided to also call on the phone. As he was not answering the calls, she left him voice messages.

2.7 The employee realised that the pilot was still en-route to his destination (FACT) and was probably not taking any phone calls until after he had landed. Under normal circumstances the procedure is that in the interest of aviation safety and security the phones must be switched off for the duration of the flight, as their signals could interfere with the aircraft navigation system. Therefore, it is possible that his phone was switched off or he decided not to take calls or respond to messages or was outside of reception range. This could not be established during the investigation. The employee patiently waited until learning of the fatal accident.

2.8 The pilot's wife and son was interviewed hoping that they would provide some clarity on the change of plan. With reference to the conversation between pilot wife and the employee at Lanseria, she did not deny that it had taken place. However, regarding the bags she explained that it was not unusual for the pilot to travel somewhere on business with her or any other family member following. She added that depending on the circumstances they sometimes exchanged data and equipment between places at their branches for the other person to use. The fact that he left the bags at FALA was perfectly normal practice. Nevertheless, when asked about the comments made about "not having any idea what the employee was talking about" and "not on her way to Lanseria" and "where was he going" and "agreeing to send her brother to fetch the bags" her responses were completely vague. It was clear that she was still confused at that time. The unfolding situation left her with more questions than answers.

2.9 After the pilot left the facility at Lanseria, he went straight back to his aircraft. He found that the refuelling had been completed and was given a refuelling slip and an invoice for his records. Nevertheless, in the interest of safety the refuelling information was then used to calculate the following:

2.9.1 The fuel uplift invoice show that the aircraft was refuelled from 0530Z to 0541Z (11 minutes) with Jet A1 fuel. A total of 750 litres (1320 lbs) was uplifted. The ground handling personnel responsible for the refuelling stated that to their knowledge the aircraft was refuelled to capacity (full) at Lanseria. The aircraft documentation shows that full fuel capacity is equal to 1686 lbs/955 litres). Subtraction of the two amounts (full = 1686 lbs/955 litres – refuelled = 1320 lbs/750 litres) indicates that the tanks contained approximately 360 lbs/205 litres at the time of landing at

Lanseria.

Note: The aircraft specification shows that the fuel flow in long-range cruising (KTAS 329 knots at FL410) is estimated to be approximately 335 lbs/190 litres per hour, which accounted for a flight endurance of approximately 5.6 hours'. The fuel flow in high-speed cruising (KTAS 370 knots at FL310) is estimated to be approximately 471 lbs/268 litres per hour, which accounted for a flight endurance of approximately 3.9 hours'.

2.9.2 Based on the fuel information above, the investigation concluded that the aircraft had sufficient fuel on board to successfully fly to and land at FACT . However, in view of the *"*change of plan*"* the decision to refuel at FALA instead of FAKU was questioned. It was found that the pilot owned a refuelling vehicle/bowser with Jet-A1 fuel at FAKU and the bowser had sufficient fuel at the time. He could have refuelled the aircraft at FAKU, but for reasons unknown to the investigation the pilot decided to fly to FALA and refuel there.

Note: A pilot rated on this aircraft type provided very valuable information and stated the following: *"If one simply does a straight line plot, making no airway or routing assumptions, then for the flight direct from FAKU to FACT the flight distance is approximately 461 nm. Assuming the pilot decided to stop for fuel enroute at Upington Airport (FAUP) or Kimberley Airport (FAKM), the total flight distance from FAKU to FAUP and FACT would have been approximately 487 nm; and the total flight distance from FAKU to FAKM and FACT would have been approximately 549 nm, whereas now the total flight distance from FALA to FACT is approximately 682 nm. The conclusion is that the shortest route to fly to do the refuelling is over the flight distance of 487 nm versus the total route distance which the pilot planned to fly from FAKU to FALA to FACT, which equals approximately 942 nm, to achieve the same result and destination"*. This information supports the investigation, namely that it makes no sense to go to Lanseria to refuel.

2.10 The pilot filed a flight plan before embarking on the flight from FALA to FACT. According to the flight plan, the intended route was as follows: N0340F360 LIV DCT XAGEN UZ31 XALVA UQ23 CSV UZ26 ERDAS DCT FACT0230. The information of the endurance was given as 3 hours and 30 minutes. The actual take-off time from FALA was 0621Z and the estimated time of arrival at FACT was at approximately 0851Z (flight time of 2 hours and 30 minutes). In case of any eventualities enroute, the alternative destination was George Airport (FAGG). The flight plan was important because it shows what the pilot was planning to do when

flying to Cape Town. Having the flight plan in hand, FALA ATC was then able to give appropriate flight information to assist him to navigate the aircraft safely to his destination.

2.11 It was deemed necessary to impound FALA tower recordings and listen to the two-way communication between ATC and pilot to confirm if it corresponded to the flight plan. FALA is a manned aerodrome and had appropriate communication facilities available to provide necessary air traffic and navigation services to the pilot. FALA provides tower/approach services on 124.00 MHz and apron/ground services on 121.65 MHz which are available to the aviation industry 24 hours a day. No anomalies were identified in the FALA communication facilities and they were considered to be serviceable.

2.12 The evidence shows that while the aircraft was flying to FALA, at about 0445Z the pilot established contact with FALA ATC and communicated with them on the tower frequency of 124.00 MHz until landing. The pilot correctly reported his position and acted in accordance with applicable regulations. The evidence was that the pilot managed to fly, navigate and communicate effectively with the assistance of FALA ATC to ensure a safe landing. There was no evidence of any anomaly in the radio communication between the pilot and FALA ATC.

2.13 After a safe landing at approximately 0447Z, the pilot continued to communicate with FALA ATC responsible for ground control on 122.85 MHz. The ground controller cleared him to taxi to a facility on the opposite (southern) side of the aerodrome. When the aircraft arrived on the southern side of the aerodrome at ±0450Z, the pilot parked it and no further communication was recorded. Based on different time sources, i.e. landing and refuelling times, the time spent at the facility was approximately one hour. No anomalies in the communication with ATC ground control were reported.

2.14 At about 0600Z the pilot board the aircraft again to embark on the second leg of his flight, which was FACT . He established communication with ground control again on 121.65 MHz. He requested start for FACT as per flight plan, ground control approved the start and cleared him to taxi to Runway 07. As he was approaching the runway he was told to hold short and advised to establish contact with ATC on tower/approach frequency 124.00 MHz. He was then cleared for take off with the following instruction: *"DKS, cleared to Cape Town UZ10 "XAGEN", Runway 07, maintain 8000 ft, through 6500 ft., radial 1237 and squawk 5405".* The pilot read back the instruction correctly.

Note: The objective of ATC at this point in time was to provide proper advice and useful information to the pilot for a safe and efficient conduct of the flight. As he was executing an IFR flight, the ATC's primary role and responsibility was to establish proper two-way communication with the pilot, including that adequate terrain clearances were maintained, and to reduce the risk of collision between the Eclipse aircraft and other aircraft operating within their area of responsibility. In terms of the applicable regulation read together with ATC SSI, the ATC had to provide the pilot with full ATC services according to the airspace classification, as the aircraft was operating in their controlled airspace.

2.15 It should be noted that the aircraft was fitted with VHF Honeywell KTR 2280 radio communication equipment. He was required to tune the radio to the right frequency and to maintain two-way communication throughout the flight. According to FALA ATC, no report was received of any defects or anomalies experienced with the aircraft radio communication system.

2.16 According to the minimum equipment list (MEL), the aircraft was fitted with a Honeywell KTR 2280 multi-mode digital radio (MMDR) communication equipment. The KTR 2280 MMDR integrates the communication and navigation radio equipment. According to the aircraft maintenance records, the radio communication equipment was inspected during the last maintenance and certified serviceable. The pilot operated the aircraft using the radio communication equipment without incident. There was no proof that the pilot reported any defect or malfunction, which he experienced with the radio communication equipment. The radio communication equipment was considered to be in a serviceable condition on the flight.

2.17 The investigation determined that the pilot used the radio communication equipment during the approach to FALA and after landing when he taxied to the facility on the southern side of the aerodrome. When he broadcasted to take-off from FALA, the evidence is that the pilot established two-way radio communication with FALA ATC on VHF tower frequency 124.00 MHz. The pilot broadcasted to FALA ATC at about 0619Z (08:19 local time) after entering the active runway when he requested take-off clearance. FALA ATC cleared him to take off and provided him with appropriate climb information.

2.18 According to the SACAA records, the pilot was the holder a private pilot licence, however his licence was not valid at the time of the accident flight due to the fact that his aviation medical certificate had expired on 30 April 2015. The licence authorised him to act as pilot in command (PIC) on Piper, Cessna, Beech and

Eclipse aircraft. The pilot's CAA file reflect that he flew Piper, Cessna and Beech aircraft regularly over the years until 17 July 2008, when he registered the Eclipse 500 on his company's name as the owner. However, he had to wait until the SACAA issued a certificate of airworthiness authorising the operation of the Eclipse. Since then he flew it regularly, mainly on private business flights within South Africa.

2.19 The aircraft maintenance documentation shows that the Eclipse total time since new (TTSN) was 222.4 hours when it was registered in South Africa. The owner/pilot then flew the aircraft with the last know airframe hours on record being 728.55 hours TTSN. The difference in flight hours of 506.15 hours was most probably flown by the pilot on the Eclipse aircraft.

2.20 En route to FACT abeam the town Douglas the aircraft was observed to deviate from its routing as cleared by air traffic control and commenced with a slight deviation to the left of track. The pilot also did not communicate with air traffic control any further and the ARCC was activated and a DETRESFA was declared. As the aircraft approached waypoint OKTED, which was near the town of Caledon in the Western Cape the aircraft was seen to enter into a right-hand orbit and continue to complete five such orbits which was associated with oscillating and erratic flight profile to such an extend that the Gripen pilot who intercepted the aircraft was unable to get close to it. The Gripen pilot then observed the aircraft to enter into a left spiral dive from which the pilot did not recover.

2.21 The investigation revealed no anomalies on the part of the aircraft and all damage was attributed to the impact with the ground. The fatal injuries sustained by the pilot made it imposible to determine if the pilot was incapacitated at any stage during the flight. In the event of pilot incapacitation the aircraft most probably would have continued on its flight path, flying straight and level until the fuel on board was exhausted, which would have caused both engines to flamed out and the aircraft would have commenced with a decent until impact with terrain or the sea followed. It should be noted that the Gripen pilot could not get close enough to the aircraft to physically look inside the cockpit due to the erratic flight profile of the aircraft prior to and following interception.

3. CONCLUSION

3.1 Findings

The pilot

3.1.1 The pilot was in possession of a valid private pilot licence at the time of the accident and his aviation medical certificate was valid until 31 May 2016.

3.1.2 After landing at FALA the aircraft was taxied to a facility on the southern side of the aerodrome where 750 litres of Jet A1 fuel was uplifted on request of the pilot.

3.1.3 An IFR flight plan was filed by the pilot for the flight from FALA to FACT.

3.1.4 The pilot handed one of the employees at a facility at Lanseria a suitcase and a business bag with a note to call his wife at a given time and to inform her that *"his plans have changed"* and she must collect the bags at Lanseria.

3.1.5 The pilot was in radio communication with FALA ATC on 124.00 MHz prior to and after take-off from FALA en route to FACT.

3.1.6 There was radio communication between the pilot of the aircraft and FAJA ACC on the frequency 120.30 MHz when the aircraft entered Johannesburg Area Control airspace at 0711Z. The aircraft was cleared to fly to the waypoint NESUS and to maintain FL360. There was no further communication between ATC and the pilot when the aircraft passed abeam Kimberley.

3.1.7 There was no communication between the pilot of the aircraft and ATC for a substantial duration of the flight prior to impact.

3.1.8 At no stage during the flight had the pilot broadcast a distress or Mayday call.

3.1.9 The medico legal post mortem report state that the cause of death of the pilot could not be determined by autopsy alone and that no toxicological specimen was available for examination.

The aircraft

3.1.10 The aircraft was issued with a valid certificate of release to service (CRS), which certified that the aircraft was serviceable and airworthy when the last maintenance inspection was certified on the aircraft prior to the accident flight. The maintenance history of the aircraft showed no evidence of any defects prior to the accident flight.

3.1.11 The aircraft was in possession of a valid certificate of airworthiness (C of A).

3.1.12 The aircraft was approved to be operated under Part 91 of the Civil Aviation Regulations (CARs) of 2011 as amended. In terms of Part 91 operation requirements, the evidence was that the owner/pilot used the aircraft for private operations only.

3.1.13 The engine investigation concluded that both engines, although severely damaged during the impact sequence, showed evidence that the engines were delivering power on impact.

3.1.14 During the investigation process, several pieces of avionic equipment (EGPWS and KTR2280, MS 8GB flash drive card, air data computer (ADC), ELT, MTN SIM card, etc.) were recovered from the accident site and sent to the OEMs for further investigation.

3.1.15 The EGPWS was send to Honeywell (the OEM) for tests. According to Honeywell's technical report, the EGPWS will store data from the 20 seconds preceding and 10 seconds following an alert; warning history data was recorded between 1012:54:29 and 1012:56:42 and terrain alerts were recorded between 1012:54:49 and 1012:56:34 due to rapid descent.

3.1.16 During the examination of the KTR 2280 multimedia digital radio (MMDR) unit, the following frequencies were identified: VHF Communications: 120.005 MHZ; VHF nav/GS.: 112.00 MHz and ADF: 200 KHz.

3.1.17 The NTSB engineering department reviewed the air data computer (ADC) and determined that the unit did not contain any non-volatile memory and therefore did not record any flight data.

3.1.18 Eclipse Aerospace concluded that regrettably the SD 8GB flash drive card was not the 2.5" 4 GB flash drive card found installed in the diagnostic storage unit, but probably an MFD compact memory card. At best it would have flight plan information and navigation and terrain database information on it. If it was the NAV database, it might show the last programmed flight plan.

3.1.19 The 2.5" 4 GB flash drive card was not found during the on-site investigation.

Air traffic and radar control

3.1.20 The aircraft deviated from its intended flight path enroute to FACT and was observed flying towards the OKTED beacon, which was located 50 nm to the southeast of FACT.

3.1.21 FAJA ACC declared an INCERFA when they failed to make radio contact with the pilot.

3.1.22 The aircraft remained at FL360 until after it entered the FACA ACC.

3.1.23 ATC informed the ARCC of the situation and an INCERFA was declared, which was shortly afterwards escalated to a DETRESFA.

Search and rescue operation

3.1.24 The ARCC declared a DESTRESFA when it became reasonably certain that there was an emergency situation on board the aircraft.

3.1.25 With the assistance of the SAAF, a military supersonic jet (Gripen) was dispatched from FAOB. The Gripen pilot intercepted the aircraft ZS-DKS a few minutes before it impacted the ground. He was unable to determine the status of the pilot, as its erratic flight path prevented him from getting close enough.

3.1.26 The aircraft was observed to deviate from straight and level flight by entering an orbit to the right at 08:34:07 near the town of Caledon in the Western Cape. This pattern continued, and the aircraft was observed to complete another four orbits to the right and was heading in an easterly direction towards the town of Swellendam.

3.1.27 A military jet (Gripen) from FAOB was tasked to intercept the aircraft. The pilot of the Gripen could not get close enough to the aircraft ZS-DKS to see whether the pilot was conscious or not, as the aircraft flight profile was very erratic.

3.1.28 The Gripen pilot kept the aircraft in sight until it impacted an open piece of farmland. The aircraft was in a left spiral dive when it impacted the ground.

Weather

3.1.29 Fine weather conditions prevailed in the area where the aircraft crashed and had no relevance to the accident.

Observation

3.1.30 It remains unexplained why the pilot flew from FAKU to FALA, left a suitcase and a business bag there and then flew from FALA to FACT.

3.2 Probable cause

3.2.1 It was observed that the aircraft performed a series of unexplainable as well as erratic flying maneuvres, which resulted in a loss of control and the aircraft to enter into a spiral dive, which was observed by the Gripen pilot before colliding with the ground.

4. SAFETY RECOMMENDATIONS

4.1 None.

5. APPENDICES

5.1 Appendix A (Copy of the communication between ATC and pilot at FALA)

5.2 Appendix B (Copy of the flight plan from FALA to FACT)

5.3 Appendix C (Fuel uplift receipt at Lanseria Aerodrome)

Appendix A

FALA ATC TOWER/APPROACH and PIC TWO-WAY COMMUNICATION RECORDING:

WARNING: The reader of this report is cautioned that the transcription of an ATC recorder audio recording is not a precise science but is the best product possible from the investigation group's investigative effort. The transcript or parts thereof, if taken out of context, could be misleading. The transcript should be viewed as an accident investigation tool to be used in conjunction with other evidence gathered during the investigation. Conclusions or interpretations should not be made using the transcript as the sole source of information.

* - Unintelligible word; TWR – Tower controller; Eclipse – the aircraft involved in the accident; Italic – Afrikaans language; Voice 1 – Male voice (pilot) & Voice 2 – Male voice (ATC).

Communication between ATC and the pilot of ZS-DKS on departure for FACT		
Time	Source	Communication
	Voice 1	Lanseria ground good morning again, this is Delta Kilo Sierra (DKS)
	Voice 2	DKS, good day
	Voice 1	Good day, we request start for Cape Town as per flight plan, one on board, 360 on request
	Voice 2	DKS, standby. As per flight plan regulation, 07, QNH 1022
	Voice 1	1022, can we start on pilot's discretion?
	Voice 2	Affirm - Sir
	Voice 2	DKS, your start is approved
	Voice 1	Thanks a lot, DKS
	Voice 1	Tower DKS, request taxi
	Voice 2	DKS, taxi Alpha to holding point, Runway 07, your ATC is available
	Voice 1	We are ready to, copy
	Voice 2	DKS, cleared to Cape Town, ***10, VAGON, Runway 07, try to maintain 8000 ft through 6500 ft, ***1237, Squawk 5405
	Voice 1	After departure, left hand out, position VAGON, 8000 ft, initially at 6500 ft, ***1237 and the Squawk 5405, and we are parked with NAC on the opposite side
	Voice 2	Commence with taxi, bravo…bravo 3, holding point 07, confirm you like full length for departure
	Voice 1	Affirm, DKS

	Voice 2	******
	Voice 1	DKS, on the bravo 3, holding
	Voice 2	DKS, hold your position
	Voice 2	DKS, cross 07, left alpha holding point ready for departure, frequency 124.0 check
	Voice 1	Uhmmm, cross 07, left alfa to the holding point and when ready you want it ***124.0 check, DKS
	Voice 2	DKS, hold short Runway 07 ******
	Voice 1	Hold short, DKS
	NAC - JP	******talk dear friend
	Voice 1	*Lekker vlieg JP*
	Voice 1	Tower good morning DKS will be ready on the recheck
	Voice 2	DKS, Runway 07, three quarts and 360 degrees at 10 knots, maintain runway heading to 6500 ft before turning left out to XAGEN
	Voice 1	*** lifted to take-off, maintaining runway heading to 6500 ft, before turning left hand out for XAGEN, DKS
	Voice 2	DKS, ready to commence with left hand turn out to XAGEN

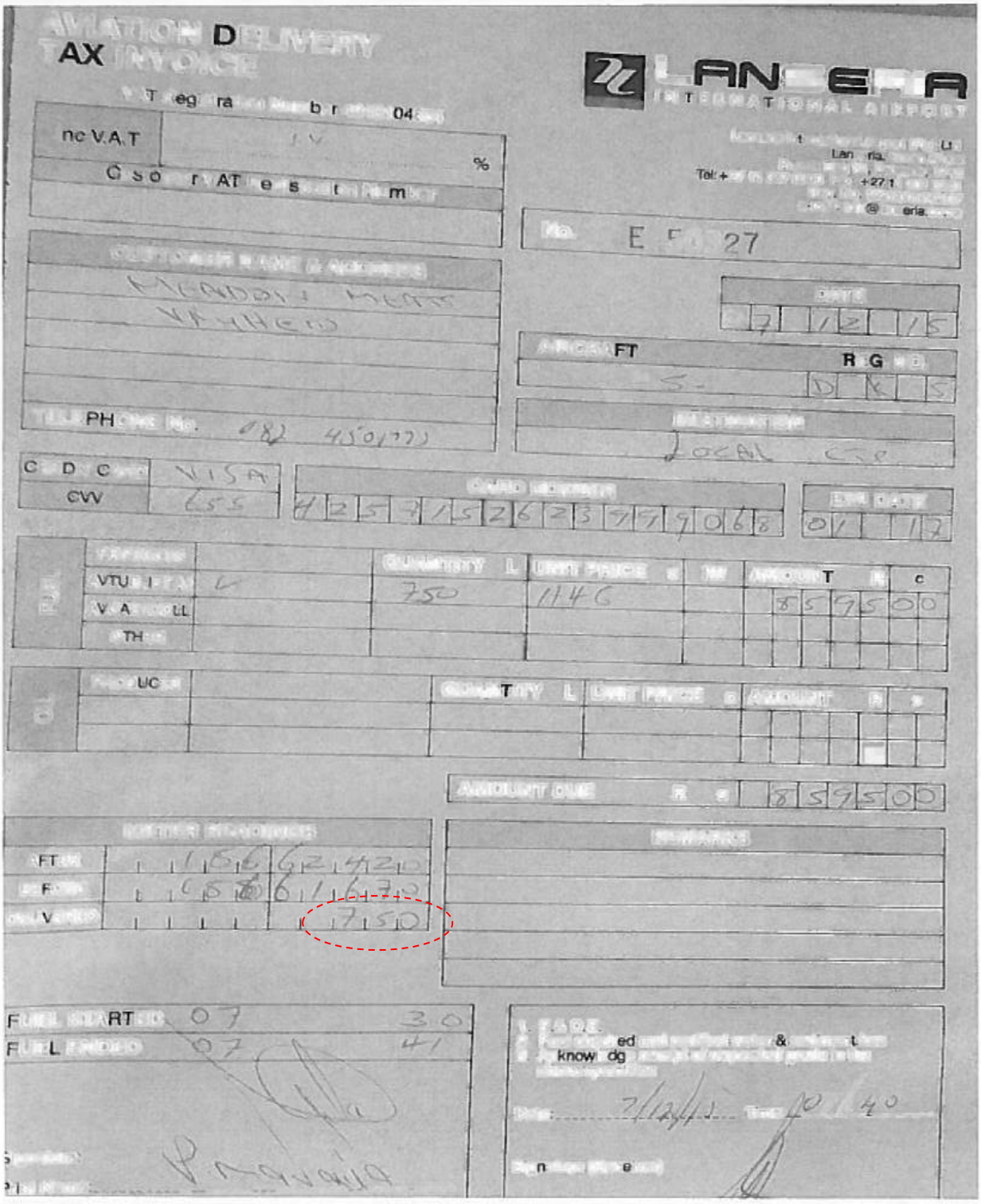
Appendix B

Copy of the flight plan from FALA to FACT

```
Internal Flight plan identifier : 47e4da79Q1
CFMU Flight plan identifier :

Flight plan name : 061201263

Customer identifier :
Customer group identifier :
Customer name :

CFMU Validation : TRUE
Destination Addresses :
Aftn FAJAZQZZ
Aftn FACAZQZZ
Aftn FALAZTZX
Aftn FACTZTZZ
Aftn FAORATFM

Customer Addresses :
None

(FPL-ZSDKS/A5405-IG
-EA50/L-SDFGWZ/C
-FALA0700
-N0340F360 LIV DCT XAGEN UZ31 XALVA UQ23 CSV UZ26 ERDAS DCT
-FACT0230 FAGG
-NAV/GPS DOF/151207 EET/FACA0130 OPR/DIKO TRANSPORT 0824501775
 RMK/SARNML REFID061201263)


Supplementary informations
--------------------------
Endurance                    : 0330
Persons on board             : 001
Emergency radio              : V
Survival equipment           :
Jackets                      :
Dinghies number              :
Dinghies capacity            :
Dinghies cover               : False
Dinghies color               :
Aircraft color and marking   : WHITE BLUE
Remarks                      : FAKS
Pilot in command             :



Additional informations
-----------------------
Slot                         : 0621
Regulation identifier        :
        FACT
Taxitime                     : 0010
Actual time of departure     : 151207 0621
Estimated time of arrival    : 151207 0851
Attention                    :
Phone number                 :
Fax number                   :
E-mail                       :
Second pilot                 :
```

Printed: Dec 11 2015 10:56 1

Appendix C


AVIATION D
AX INVOICE
LANCERIA
INTERNATIONAL AIRPORT
nc V.A.T
%
Tel: +
+27 1
E F 27
PH
C D C
VISA
CVV
VTU
V A LL
TH
UC
T
FT
F
V
RT
L
know dg
n e