# AIRCRAFT ACCIDENT REPORT AND EXECUTIVE SUMMARY

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|---|---|
| Reference: | CA18/2/3/9082 |

| | | | | | |
|---|---|---|---|---|---|
| **Aircraft Registration** | **ZS-TVR** | **Date of Accident** | 13/09/2012 | **Time of Accident** | ±1517Z |
| **Type of Aircraft** | Beech F33A (Aeroplane) | | **Type of Operation** | Private flight | |

| | | | | | |
|---|---|---|---|---|---|
| **Pilot-in-command Licence Type** | Private Pilot | **Age** | 64 | **Licence Valid** | No |
| **Pilot-in-command Flying Experience** | Total Flying Hours | 1 047,4 | | Hours on Type | 984,9 |

| | |
|---|---|
| **Last point of departure** | Pietermaritzburg aerodrome (FAPM), (KwaZulu-Natal province) |
| **Next point of intended landing** | Newcastle aerodrome (FANC), (KwaZulu-Natal province) |

**Location of the accident site with reference to easily defined geographical points (GPS readings if possible)**

Ophatha, near Cato Ridge (GPS position; 29°38.679' South 030°42.236' East, elevation 1 574 feet)

| | | | | | |
|---|---|---|---|---|---|
| **Meteorological Information** | Surface wind 130°/10 kts; Temperature 15°C, Dew poi nt 12°C, Overcast | | | | |
| **Number of people on board** | 1 + 2 | **No. of people injured** | 0 | **No. of people killed** | 1 + 2 |

## Synopsis

The pilot, accompanied by two passengers, took off from Newcastle aerodrome (FANC) early on Thursday morning, 13 September 2012 on a private flight and landed at Pietermaritzburg aerodrome (FAPM) at 0523Z.

The aircraft was then parked at the aerodrome, after which the three occupants attended an agricultural conference in the city. Later the same afternoon they returned to the aerodrome for their intended return flight to FANC. The aircraft was cleared for take-off under special visual flight rules (SVFR) by air traffic control (ATC) at 1507Z, using runway 16. Approximately ten minutes after take-off a witness first heard an aircraft flying above the clouds, and seconds later he saw an aircraft descending through the clouds and spiralling down towards the ground. The aircraft remained in a spiral attitude until it impacted with dense bush and mountainous terrain. Following impact the aircraft was consumed by fire. All three occupants on board the aircraft were fatally injured in the accident.

## Probable cause

The pilot most probably became spatially disorientated after entering an area of adverse weather conditions (thunderstorm activity) which resulted in a loss in control of the aircraft with inadequate height available to recover.

| | | | |
|---|---|---|---|
| IARC Date | | Release Date | |

# AIRCRAFT ACCIDENT REPORT

| | |
|---|---|
| **Name of Owner** | : T.J. Janse van Rensburg |
| **Name of Operator** | : Private flight |
| **Manufacturer** | : Beech Aircraft Corporation |
| **Model** | : F33A |
| **Nationality** | : South African |
| **Registration Marks** | : ZS-TVR |
| **Place** | : Ophatha, near Cato Ridge, KwaZulu-Natal |
| **Date** | : 13 September 2012 |
| **Time** | : ±1517Z |

*All times given in this report are 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 (1997) 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.*

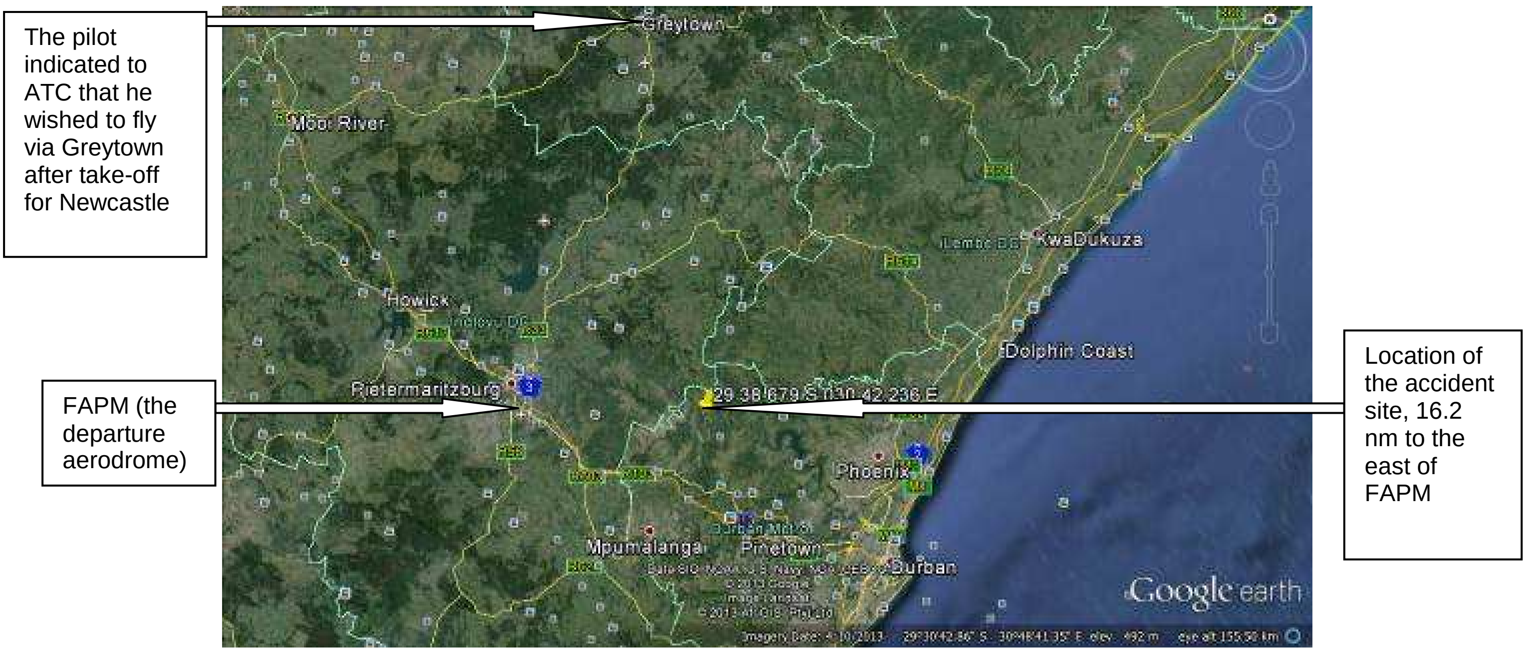
## 1. FACTUAL INFORMATION

### 1.1 History of flight

1.1.1 The pilot, accompanied by two passengers, took off from Newcastle aerodrome (FANC) early on Thursday morning, 13 September 2012 on a private flight and landed at Pietermaritzburg aerodrome (FAPM) at 0523Z.

1.1.2 The aircraft was then parked at the aerodrome, after which the three occupants attended an agricultural conference in the city. Later the same afternoon they returned to the aerodrome for their return flight to FANC. The aircraft was cleared for take-off under special visual flight rules (SVFR) by air traffic control (ATC) at 1507Z. Runway 16 was used. Approximately ten minutes after take-off, a witness first heard an aircraft flying above the clouds (he was unable to see it from the ground) and seconds later saw an aircraft descending through the clouds, spiralling towards the ground. The aircraft remained in a spiral dive attitude until it impacted with dense bush and mountainous terrain, where it was consumed by the post-impact fire. All three occupants on board the aircraft were fatally injured in the accident.

1.1.3 The Google earth map below indicates the aerodrome of departure (FAPM) of the aircraft (ZS-TVR), the intended destination (FANC), which was 114 nm (211 km) towards the north-north-west of FAPM (heading 348°M ) and the accident site, which was 16,2 nm (30 km) to the east of FAPM.

1.1.4 The captain of a scheduled domestic flight, Link 741 (being operated under the provision of Part 121 of the Civil Aviation Regulations) indicated in a statement that they had to enter into a holding pattern for approximately 20 minutes to the north of FAPM where they waited for thunderstorm activity to move east of FAPM before they were able to commence with the approach for landing on runway 16. The scheduled flight was operated between O.R. Tambo International aerodrome (FAJS) and FAPM. The weather at FAPM at the time was instrument meteorological conditions (IMC). Link 741 broke cloud at 2 200 feet above ground level (AGL) in haze with limited forward visibility during the approach. Upon landing at FAPM he saw the aircraft ZS-TVR standing at the holding point of runway 16, waiting to take off. He also followed the conversation on the radio during which the pilot of ZS-TVR requested take-off clearance under special visual flight rules (SVFR) for a flight to Newcastle. After landing, while they were taxiing towards the apron area, he communicated with ATC, informing them that he would not advise a VFR departure. The pilot of ZS-TVR, however, opted to continue with the take-off regardless of the information provided by the captain of Link 741.

1.1.5 The last documented evidence of any fuel uplift into ZS-TVR was dated 10 September 2012 at Newcastle aerodrome, when 124 litres of Avgas 100L was uplifted. According to available information, the aircraft did not uplift any fuel on 13 September 2012 while it was on the ground at FAPM.

1.1.6 The accident occurred during daylight conditions at a geographical position that was determined to be South 29° 38.679' East 030° 4 2.236' at an elevation of 1574 feet above mean sea level (AMSL).

## 1.2 Injuries to persons

| Injuries | Pilot | Crew | Pass. | Other |
|---|---|---|---|---|
| Fatal | 1 | - | 2 | - |
| Serious | - | - | - | - |
| Minor | - | - | - | - |
| None | - | - | - | - |

## 1.3 Damage to aircraft

1.3.1 The aircraft was consumed by the post-impact fire that erupted.

**Figure 1.** View of the wreckage that was consumed by the post-impact fire

## 1.4 Other damage

1.4.1 Minor damage was caused to vegetation in the area of the crash site.

## 1.5 Personnel information

1.5.1 Pilot-in-command

| | | | | | |
|---|---|---|---|---|---|
| Nationality | South African | Gender | Male | Age | 64 |
| Licence number | 0270477185 | Licence type | Private pilot | | |
| Licence valid | No | Type endorsed | Yes | | |
| Ratings | Night rating | | | | |
| Medical expiry date | 30 April 2013 | | | | |
| Restrictions | Must wear suitable corrective lenses and have a spare set of glasses available.<br>Hearing protection.<br>Hypertension protocol. | | | | |

| | |
|---|---|
| Previous accidents | 1. The landing gear collapsed during the landing rollout at FANC on 2 July 2000 when the pilot retracted the landing gear instead of the flaps (ZS-ITL, Beech V35B).<br>2. Pilot performed a wheels-up landing at FANC on 22 July 2010, when he forgot to lower the landing gear prior to touchdown. He was flying the same aircraft (ZS-TVR) at the time. |

The pilot applied for a student pilot's licence on 23 November 1999. On 16 April 2000 he passed his flight test for his private pilot's licence. During his private pilot's training he flew 82,5 hours in total, of which 61,2 was on the Cessna 172, 1,3 hours on a Cessna 175 and 20 hours on a Beech 35. Of the 82,5 hours, 67,2 were dual flying hours and 15,3 solo flying hours. According to available information (CAA pilot file) he flew only the Beech 33/35 type aircraft after he had obtained his private pilot's licence.

During August 2002 the pilot flew 16,3 hours in order to obtain a night rating. According to a logbook entry, 3,1 hours were dual night flying hours and 13,2 hours were flown under instrument flying conditions, which was part of the training for his night rating. His night rating was endorsed on his pilot licence on 27 August 2002. Following the practical flight test for the night rating, the flight instructor who conducted the test made the following entry at the bottom of the test form under the heading Remarks: *"I advised the student to fly without autopilot more regularly in order to improve accuracy".*

The pilot's last skills test or competency check ride for a private pilot's licence (aeroplane) on record (CAA pilot file, form CA61-03.4) was conducted on 31 March 2011. The last pilot logbook entry on record was dated 22 April 2011. The flying hours reflected in the columns below were obtained from the logbook pages attached to the skills test form. According to available information, the pilot's flying logbook was with him in the aircraft at the time of the accident and was destroyed by the post-impact fire.

| **Total hours** | Day Dual hours | Day Solo hours | Night flying | Instrument flying |
|---|---|---|---|---|
| **1 047,4** | 92,1 | 910,7 | 17,8 | 26,8 |

*NOTE: The pilot had a night rating endorsed on his licence. He did not have an instrument rating at any stage.

On 19 April 2011 the pilot completed a language proficiency test for his radiotelephony communication at an approved aviation training organisation (ATO).

The last documented correspondence that was received from the pilot was a copy of his aviation medical certificate, which was signed on 10 April 2012 by a CAA-approved medical practitioner.

1.5.2 Civil Aviation Regulations (CARs) Part 61.01.16

Payment of currency fee

**"***(1) (a) The holder of a pilot licence must pay the annual currency fee as prescribed in part 187 on or before the anniversary date of the licence.*

*(b) The privileges of the licence may not be exercised in the succeeding year unless all outstanding fees are paid in full."*

According to available information (CAA pilot file), the last annual currency fee payment as required by the CARs (listed above) was received from the pilot by the regulating authority on 26 April 2011. No annual currency fee was received thereafter. The pilot had therefore not complied with the provisions as stipulated in the CARs, which rendered his pilot licence invalid at the time of the accident.

Flying experience

| | |
|---|---|
| Total hours | 1 047,4 |
| Total past 90 days | Unknown |
| Total on type past 90 days | Unknown |
| Total on type | 984,9 |

## 1.6 Aircraft information

1.6.1 The accident aircraft, ZS-TVR, was a Beech Bonanza F33A, an all-metal, low-wing aircraft equipped with a single six cylinder, horizontally opposed, fuel injection engine and retractable tricycle landing gear. The aircraft was certified for day and night VFR and IFR operations as per POH, Section 2 - Limitations, pg 2-8. The aircraft was imported into South Africa from the United States of America (USA) in September 2004. The pilot, who was fatally injured in the accident, was the sole owner of the aircraft following its import into South Africa.


**Figure 2.** Photo of the aircraft ZS-TVR

**Airframe**

| | | |
|---|---|---|
| Type | Beech F33A | |
| Serial number | CE-1617 | |
| Manufacturer | Beech Aircraft Corporation | |
| Year of manufacture | 1991 | |
| Total airframe hours (At time of accident) | Unknown | |
| Last MPI (hours & date) | 1 582,5 | 24 January 2012 |
| Hours since last MPI | Unknown | |
| C of A (1st issue date) | 10 November 2004 | |
| C of A (expiry date) | 6 February 2013 | |
| C of R (issue date) (present owner) | 21 October 2004 | |
| Operating categories | Standard Part 91 | |

*NOTE: According to available records the aircraft was involved in a wheels-up landing on 22 July 2010 at Newcastle aerodrome, when the pilot, who was also the owner of the aircraft, forgot to lower the landing gear prior to touchdown. The aircraft was recovered to an aircraft maintenance facility at Wonderboom aerodrome, where it was repaired. The engine was removed and was forwarded to

an approved engine maintenance facility for a shock load inspection. The propeller was substantially damaged during the serious incident and a new propeller was fitted.
On 14 January 2011 the aircraft was subjected to a SACAA inspection for the reissue of the certificate of airworthiness after repair work had been completed. On 3 February 2011 the aircraft was subjected to a flight test. On 7 February 2011 the aircraft was reissued with a certificate of airworthiness that was valid for a period of one year under the provisions of Part 91.

It was not possible to determine the airframe hours at the time of the accident, as both the flight folio as well as the tacho and Hobbs meters were destroyed during the post-impact fire.

**Engine**

| | |
|---|---|
| Type | Teledyne Continental IO-520-BB |
| Serial number | 578776 |
| Hours since new | 1 582,5 (hours at the last MPI) |
| Hours since overhaul | *See note below. |

*NOTE: The engine was subjected to a shock load inspection at 1 514,9 engine hours following the wheels-up landing incident on 22 July 2010.

**Propeller**

| | |
|---|---|
| Type | Hartzell PHC-C3YF-1RF/F8468A-6R |
| Serial number | EE 6869B |
| Hours since new | 67,7 (hours at the last MPI) |
| Hours since overhaul | T.B.O. not yet reached. |

1.6.2 Weight and balance

No official weight and balance calculation could be performed for the accident flight, as most of the essential information required for such a calculation was destroyed during the post-impact fire.

According to the Pilot's Operating Handbook (POH), Section 2, Limitations, pg. 2-7, the maximum certified take-off weight for the Beech F33A was 3 400 pounds (1 542 kg).

The pilot flew from FANC to FAPM earlier that morning, which was a flight of approximately one hour, and had not uplifted any fuel at FAPM prior to departure from FAPM on the return flight to FANC.

1.6.3 Autopilot operation

The aircraft was equipped with a Bendix/King KFC-150 series Automatic Flight Control System (AFCS), which was approved for use in the Beech Bonanza F33A aircraft. The AFCS provided two-axis control for pitch and roll. It also had an electric pitch trim system, which provided auto-trim during autopilot operation and manual electric trim for the pilot during manual operation.

The AFCS installed on the accident aircraft had an altitude hold mode that, when selected, allowed the aircraft to maintain the altitude that it had when the altitude hold was selected. The AFCS did not have the option of allowing the pilot to preselect an altitude so that the autopilot could fly to and maintain the preselected altitude as it climbed or descended from another altitude. The AFCS had a vertical trim rocker switch installed so that the pilot could change the aircraft's pitch up or down without disconnecting the autopilot. The rocker switch allowed the pilot to make small corrections in the selected altitude while in the altitude hold mode or allowed the pitch attitude to be adjusted at a rate of about 0,9 degree per second when not in altitude hold mode.

The AFCS incorporated a flight director, which had to be activated before the autopilot would engage. Once activated, the flight director could provide commands to the flight command indicator to maintain wing level and the pitch attitude. To satisfy the command, the pilot could manually fly the aircraft by referencing the guidance received in the flight command indicator, or the pilot could engage the autopilot and let it satisfy the commands by manoeuvring the aircraft in a similar manner via the autopilot servos.

The AFCS incorporated a navigation mode that could provide guidance to the pilot or the autopilot about intercepting and tracking VOR and GPS courses. While engaged in this mode, the AFCS could receive input signals from either the selected VOR frequency course or from GPS course data selected for presentation on the pictorial navigation indicator. The flight command indicator could then command the bank required to maintain the selected VOR or GPS course with automatic crosswind compensation, and the autopilot, if engaged, would satisfy those commands.

The AFCS incorporated a heading select mode that allowed the pilot to select a heading by moving a ‘bug’ on the outer ring of the pictorial navigation indicator. Once the bug was moved to the desired heading and the heading select button engaged, the autopilot could command the airplane to that heading at a bank angle of about 22°.

The AFCS had a control wheel steering (CWS) button mounted on the control yoke that allowed the pilot to manoeuvre the aircraft in pitch and roll without disengaging the autopilot. According to Allied Signals, when the CWS button was released, the autopilot would resume control of the aircraft at the heading and altitude that had been selected at the time the CWS button was released.

According to Bendix/King, the trim system was designed to withstand any single in-flight malfunction. Trim faults were visually and aurally announced in the cockpit. Through the use of monitor circuits, aircraft control would automatically be returned to the pilot when a fault was detected.

After the AFCS had been pre-flight tested, it could be engaged and disengaged either manually or automatically. The following conditions would cause the autopilot to automatically disengage: power failure, internal flight control system failure, loss of valid compass signal, roll rates greater than 14° per second and pitch rates greater than 8° per second.

Due to the post-impact fire it was not possible to conduct a follow-up examination on the navigation and communication transceivers or the autopilot servos.

## 1.7 Meteorological information

1.7.1 An official weather report was obtained from the South African Weather Services (SAWS).

Weather conditions around the time of the accident were determined from satellite image, radar image and significant weather chart information.

The satellite and radar image consecutively indicated broken to overcast low-level cloud and cumulonimbus (CB) clouds with thunderstorms in and around the area of the accident. The 1517Z SIGWX chart forecast bad weather (i.e. low-level cloud, poor visibility and isolated embedded CB clouds).

METAR (Meteorological Aeronautical Report) for FAPM on 13 September 2013

*FAPM 131400Z 15014KT 7000 HZ BKN010 16/14 Q1017*

| | | |
|---|---|---|
| Date | - | 13 September 2012 |
| Time | - | 1400Z |
| Wind | - | 150° at 14 knots |
| Visibility | - | 7000 m in haze |
| Cloud | - | Broken low-level cloud at 1000 feet |
| Temperature | - | 16℃ |
| Dew point | - | 14℃ |
| Pressure altitude | - | 1017 hPa (hectopascal) |

The METAR that was issued for 1500Z indicated a change in wind direction and strength to 130°/10 knots, a decrease in temperature to 15℃ and a dew point of 12℃.

Freezing levels

The 1200Z vertical profile for FALE indicated the freezing level as just below 13 000 feet and expected it to drop gradually in the course of the day due to cold air advection. Both severe icing and turbulence are associated with and expected to occur within convective clouds (especially CB), but would have occurred above the freezing level.

Summary

The satellite and radar data indicates broken to overcast low-level clouds in the FAPM area. In the area of the accident site thundershowers associated with poor visibility prevailed.

No evidence could be obtained that the pilot obtained a weather briefing prior to the intended return flight to FANC.

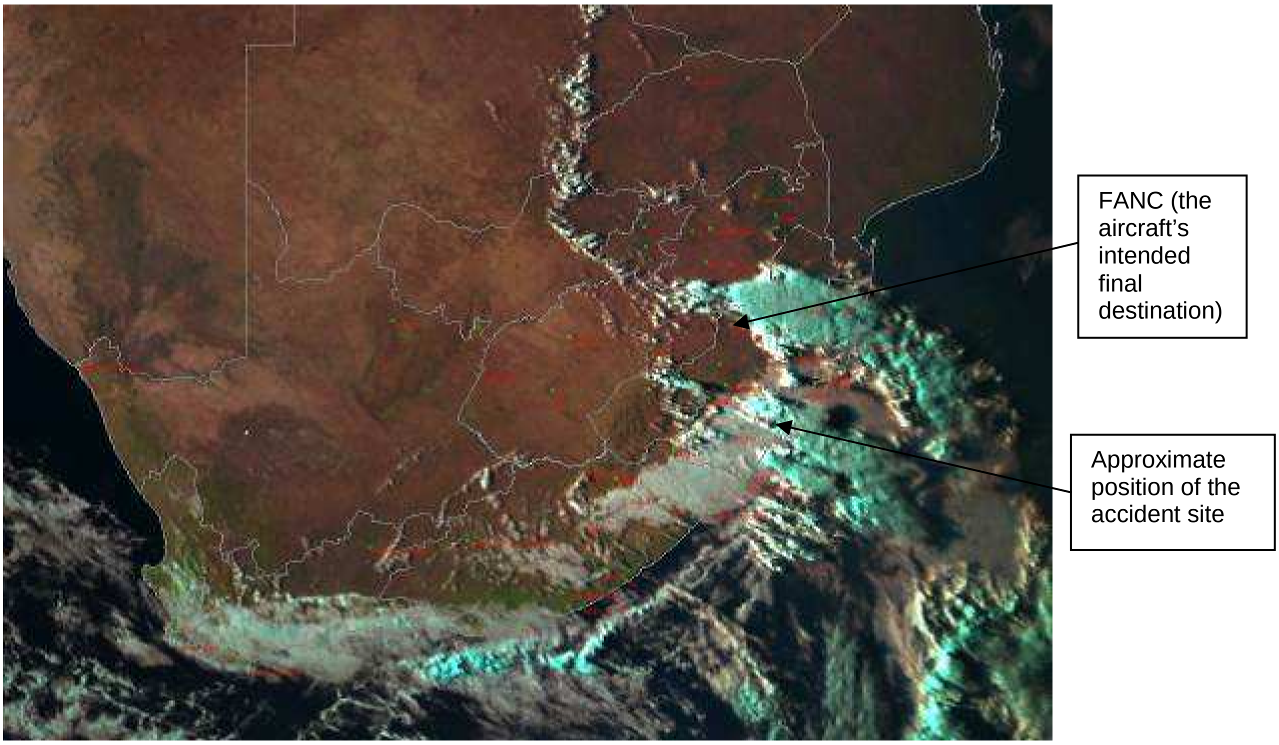



**Figure 3.** Satellite image of the country taken on 13 September 2012 at 1515Z

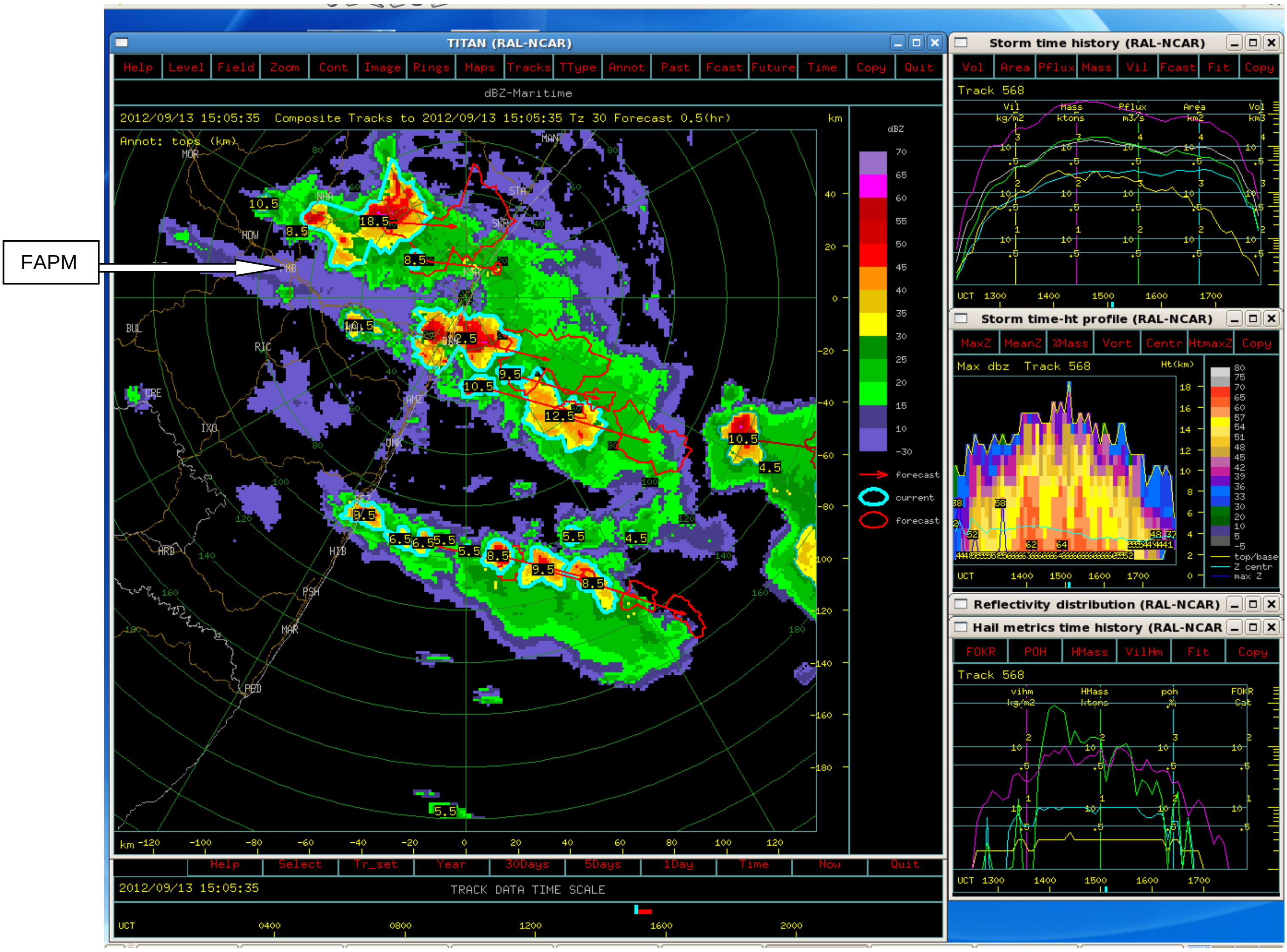



**Figure 4.** Radar image of the KwaZulu-Natal area taken on 13 September 2012 at 1505Z

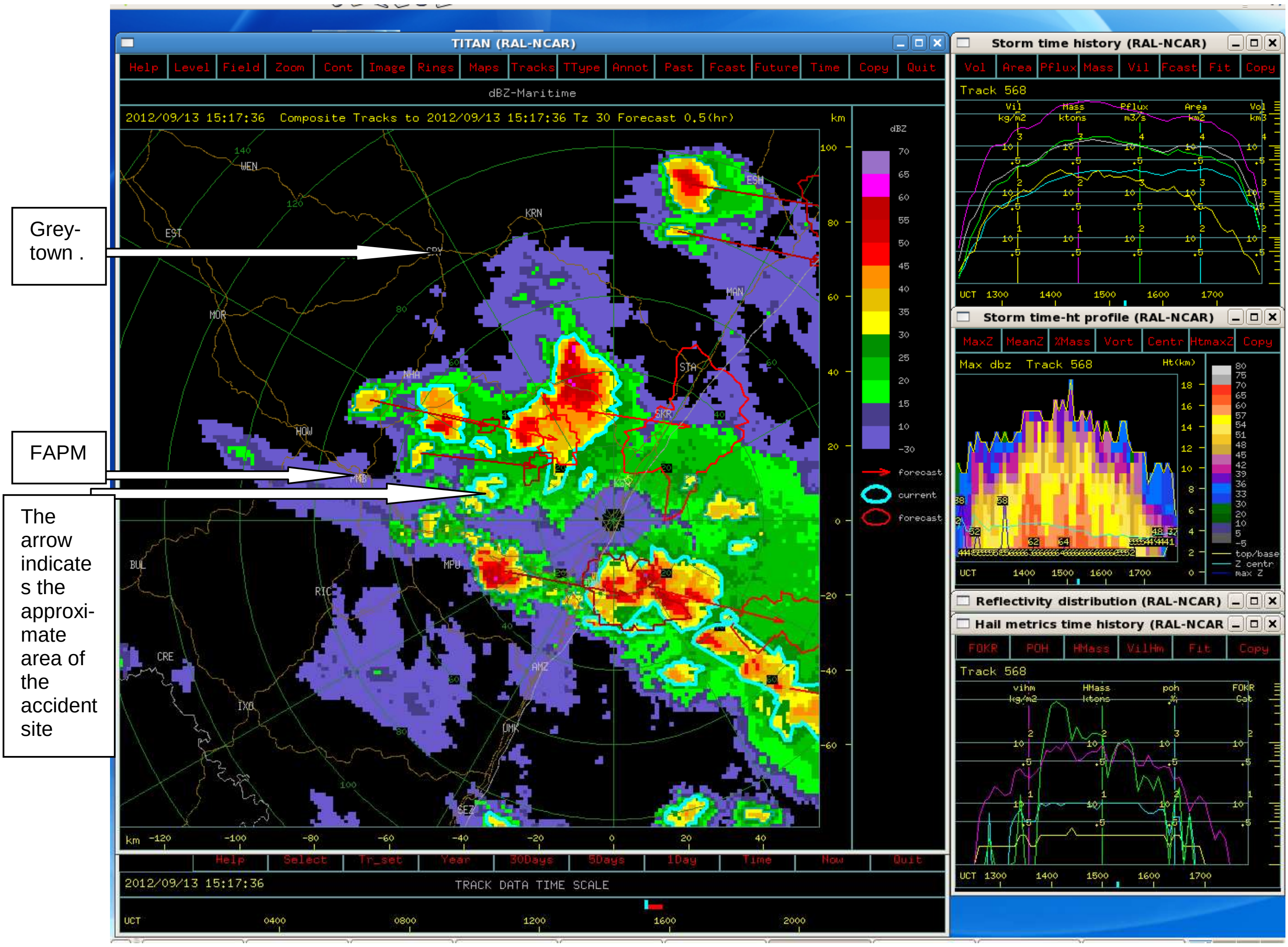



**Figure 5.** Radar image of the KwaZulu-Natal area taken on 13 September 2012 at 1517Z

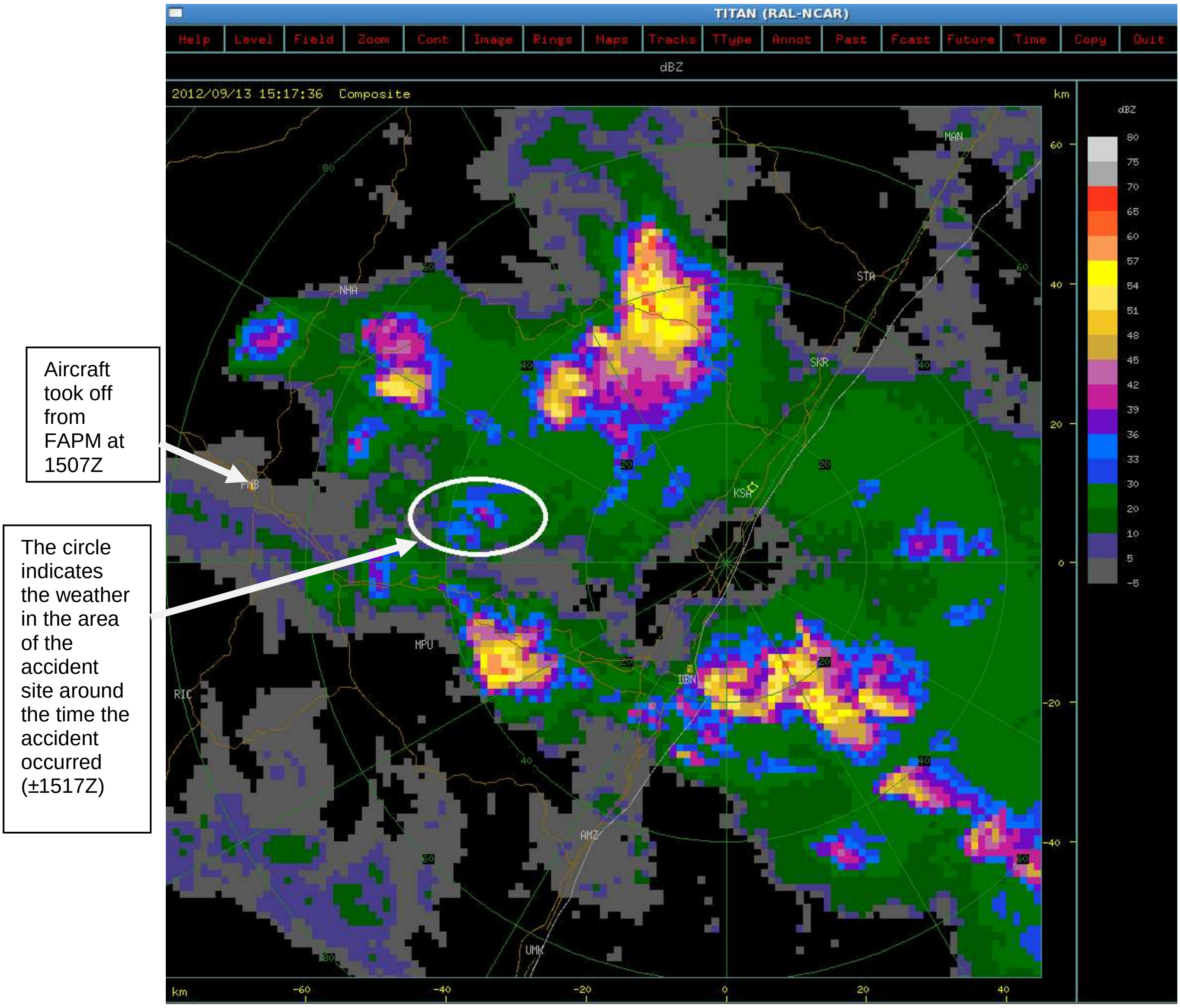



**Figure 6.** Radar image of the KwaZulu-Natal area taken on 13 September 2012 at 1517Z

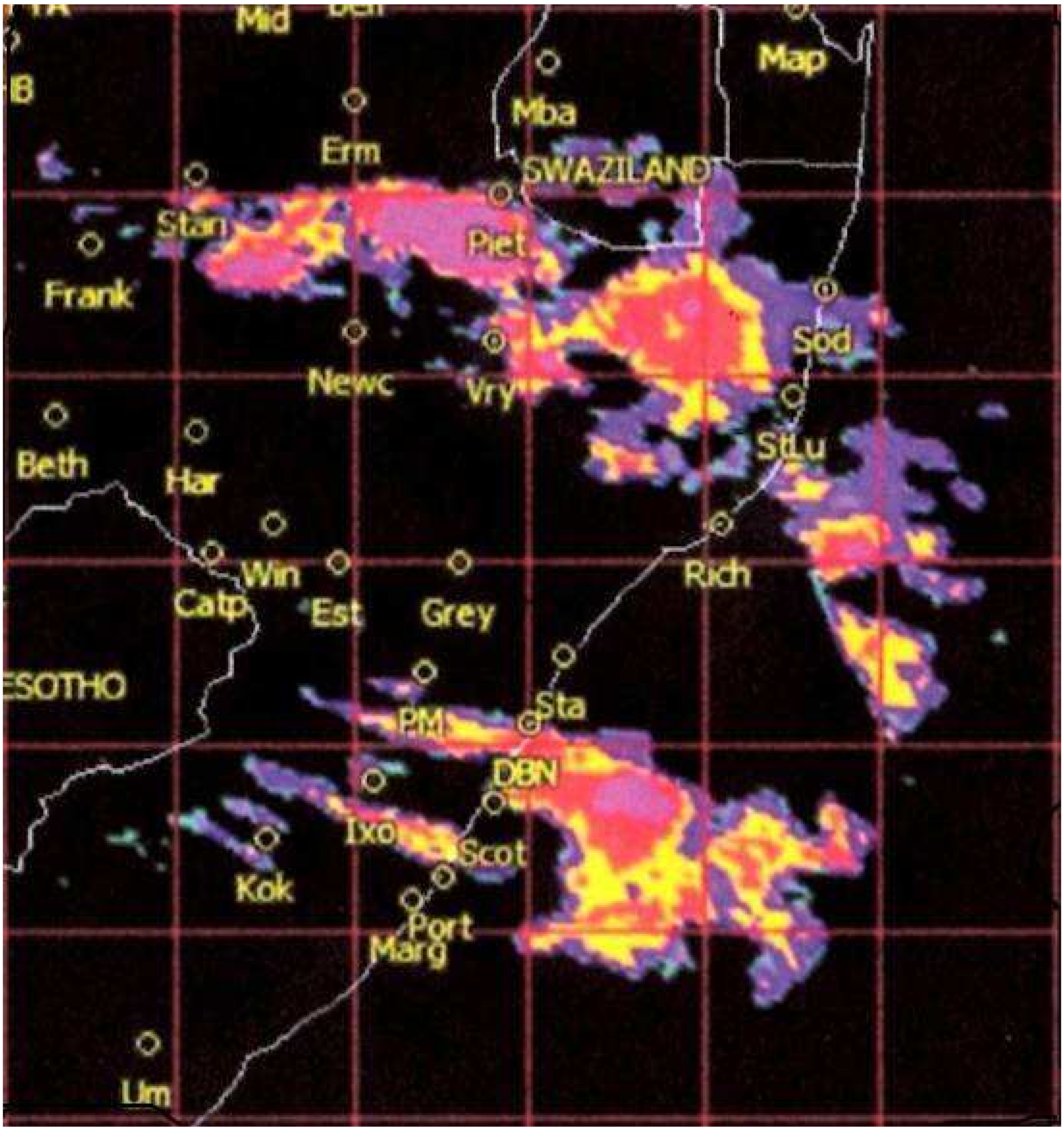



**Figure 7.** Infrared image taken on 13 September 2012 at 1515Z

This infrared image indicates that there was a high possibility of rain and thundershowers at the time in the areas indicated in colour on the photo.

On-site investigation

The investigating team commenced with the on-site investigation the following morning (14 September 2012). At that time overcast conditions with rain prevailed in the area. It remained overcast with rain for the duration of the day as well as the following day.

The photo in figure 8 on the next page was taken of the prevailing weather conditions while the investigating team was hiking towards the crash site. The photo shows that it was raining to the south at the time.

**Figure 8.** Photo of the prevailing weather conditions in the area the next day

## 1.8 Aids to navigation

1.8.1 The aircraft was equipped with the following navigational aids:

(i) Bendix/King KX 155-35 COM/NAV/GPS
(ii) Bendix/King KX-155-34 COMM/NAV
(iii) Bendix/King KN-63 DME
(iv) Bendix/King KMA 24-04 Marker Beacon
(v) Bendix/King KR-87 ADF
(vi) Bendix/King KT-76A Transponder
(vii) 3M WX-1000 Stormscope
(viii) Bendix/King KFC-150 Automatic Flight Control System (2-axis)
(ix) Bendix/King KRA-10 Radar Altimeter
(x) Emergency Locator Transmitter (ELT)

## 1.9 Communications

1.9.1 The pilot of the accident aircraft ZS-TVR communicated with Pietermaritzburg air traffic control (ATC) on the VHF frequency 122,0 MHz. The pilot requested take-off clearance, but ATC advised him that the FAPM control zone (CTR) was in instrument meteorological conditions (IMC). The communication between the pilot and ATC spanned a period of approximately 20 minutes. At 15.07:55Z ATC cleared the aircraft for take-off under special visual flight rules (SVFR). From the transcript of the communication it became evident that the pilot was getting agitated, with the ATC asking him what his intention was several times.

1.9.2 During communication between ATC and the captain of Link 741, a Part 121 scheduled domestic flight from FAJS to FAPM which landed approximately 15 minutes prior to the departure of ZS-TVR at FAPM, the captain of Link 741 advised ATC that he would not recommend a VFR departure at that stage due to weather conditions. A transcript of the communication between ATC and the pilot of ZS-TVR and Link 741 can be found attached to this report as Annexure A.

1.9.3 According to available information, the pilot had not filed a flight plan for the flight.

1.9.4 As far as it could be established, no distress or mayday call was picked up by any station/tower or any other aircraft in the area at any stage during the flight.

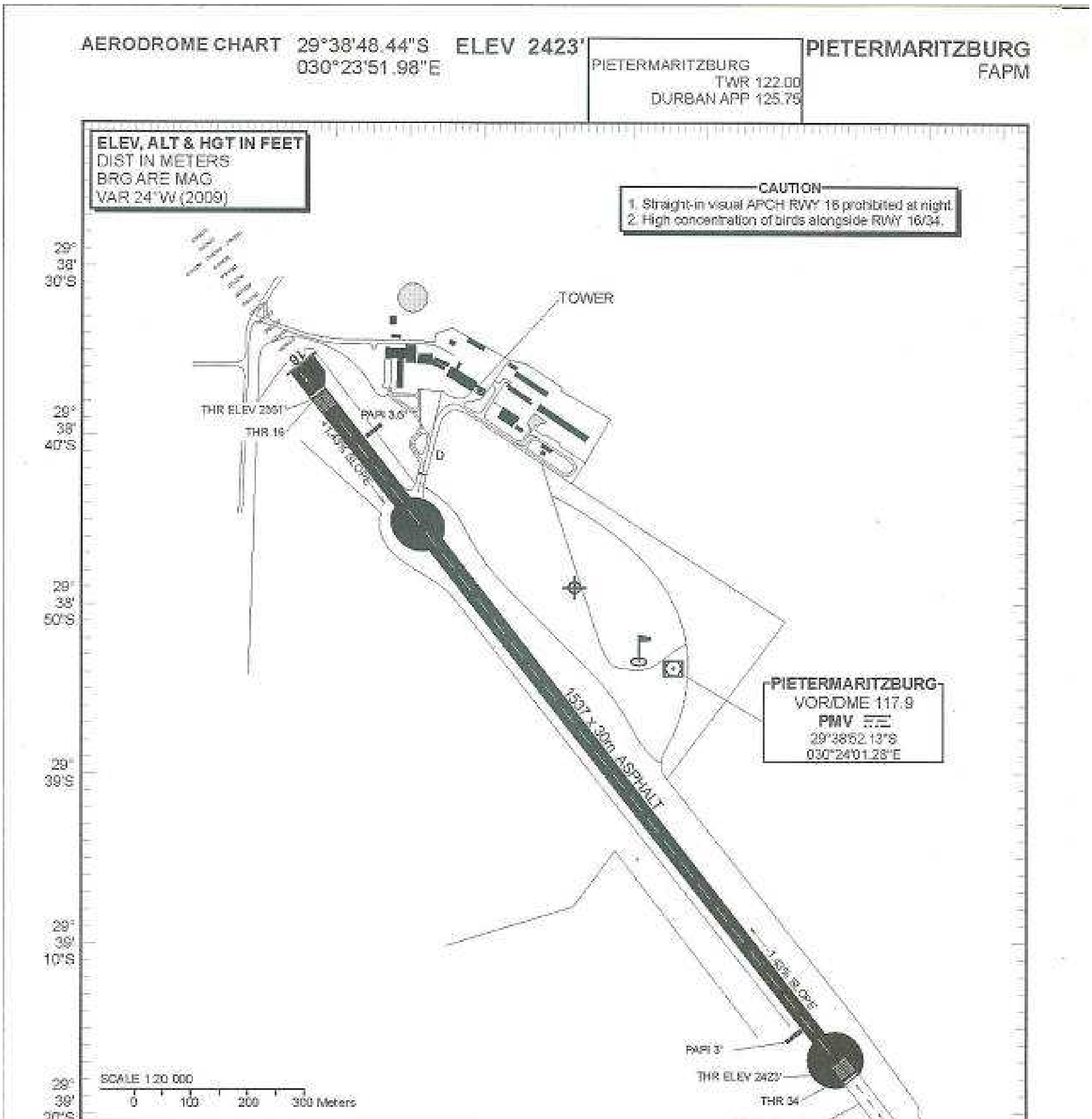
1.9.5 If the aircraft has been identified on secondary surveillance radar, it would have been tracked from take-off until the point where it disappeared from radar (the accident). This would have enabled the investigating team to follow its flight profile, height and speed for the period it was identified on radar.

## 1.10 Aerodrome information

| | | |
|---|---|---|
| Aerodrome location | 2 nm south of the city of Pietermaritzburg | |
| Aerodrome co-ordinates | South 29°38 48,44 East 030° 23 51,98 | |
| Aerodrome elevation | 2 423 ft | |
| Runway designations | 16/34 | |
| Runway dimensions | 1 537 x 30 m | |
| Runway used | 16 | |
| Runway surface | Asphalt | |

| | |
|---|---|
| Approach facilities | Runway lights, PAPI, NDB, RNAV (GNSS) |
| Aerodrome status | Licensed |

The Pietermaritzburg aerodrome layout chart




| RWY LIGHTING | | | | | |
|---|---|---|---|---|---|
| RWY | ALS | PAPI | RTHL | REDL | RENL |
| 16 | SALS | 3.5° L | GREEN | WHITE | RED |
| 34 | NIL | 3.0° L | GREEN | WHITE | RED |
| OTHER: Remote switching after ATC HOD | | | | | |

030°23'30"E 030°24'E 030°24'30"E

PHYSICAL CHARACTERISTICS

| RWY | DIRECTION (T) | THR COORDINATES | THR ELEVATION | TORA (m) | TODA (m) | ASDA (m) | LDA (m) | SWY (m) | CWY (m) | SLOPE | SURFACE | BEARING STRENGTH | CIRCUIT |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 16 | 142° | 29°38'36.35"S 030°23'37.76"E | 2361' | 1537 | 1537 | 1677 | 1537 | 140 | NIL | 0.0143U | ASPH | LCN 43 | UNK |
| 34 | 322° | 29°38'15.73"S 030°24'12.94"E | 2423' | 1537 | 1537 | 1537 | 1537 | NIL | NIL | 0.0143D | ASPH | LCN 43 | UNK |

CHANGE: Physical Characteristics

EFF: 28 JUL 11 AD-01

## 1.11 Flight recorders

1.11.1 The aircraft was not equipped with a flight data recorder (FDR) or a cockpit voice recorder (CVR), nor was it required to be fitted to this type of aircraft by regulation.

## 1.12 Wreckage and impact information

1.12.1 The aircraft crashed in dense bush in mountainous terrain. The impact sequence damaged several trees, which were approximately 10 m in height, followed by ground impact. The damage sustained by vegetation indicates that the aircraft was in a vertical trajectory during the impact sequence. The nose section of the aircraft was orientated along a magnetic bearing of ± 060°M. The impact location was 16,2 nautical miles (nm) towards the east of FAPM (their departure aerodrome).


**Figure 9**. Aerial photo depicting the general terrain where the accident occurred.

**Figure 10**. Damage sustained by trees. The photo was taken on the accident site looking up towards the skyline


**Figure 11**. Aerial photo of the accident site/terrain.

1.12.2 The propeller was found to have separated from the engine during the impact sequence, with one propeller blade being completely embedded in the sand and a second blade partially embedded. The crankshaft failed as a result of the impact, with the crankshaft flange still being attached to the propeller hub assembly. The propeller was lying approximately 2 to 3 m in front of the engine, which was still secured to the main wreckage. The propeller did not sustain any fire damage. The engine and propeller were recovered from the accident scene for examination purposes. The crankshaft failure mode was associated with an overload/ductile failure (45° edges around the circumference of the shaft).

**Figure 12**. Photo of the propeller, which was partially embedded in the ground

1.12.3 The wreckage was contained at one location, without any debris field. It was determined that the landing gear was in the up position. The empennage section had remained intact and both elevators and the rudder control surfaces were still attached at the respective hinging points. The fuselage, including the cockpit and cabin area as well as both wings, was consumed by the post-impact fire. The manifold pressure and fuel flow indicator was the only gauge from the instrument panel that presented a readable display. The manifold pressure indication was ±28,5 inches of mercury (needle on the left-hand side of gauge) and the fuel flow indication was ± 11 to 12 US gallons per hour (needle on the right-hand side of the gauge) this indicate that the engine was functioning during flight and fuel supply was within the expected range.

**Figure 13.** A photo of the manifold pressure and fuel flow gauge that was recovered on site.

## 1.13 Medical and pathological information

1.13.1 A state forensic pathologist visited the scene of the accident. A post mortem was conducted on all three occupants. The cause of death of all the occupants was concluded to be multiple blunt trauma.

1.13.2 The pilot was the holder of a valid aviation medical certificate at the time of the accident. The certificate was issued on 10 April 2012 by a CAA approved medical examiner with an expiry date of 30 April 2013.

## 1.14 Fire

1.14.1 Apart from the propeller, basically the entire aircraft was consumed by the post-impact fire.

## 1.15 Survival aspects

1.15.1 The accident was not considered to be survivable. The impact sequence was associated with high kinetic forces outside the range of human tolerance. Further to that the aircraft was consumed by the post-impact fire.

1.15.2 The accident occurred on mountainous terrain. Due to rain and nightfall, it took the emergency services several hours to reach the scene.

## 1.16 Tests and research

1.16.1 Engine examination

The engine, a Teledyne Continental IO-520-BB, serial number 578776, was recovered from the accident site with the assistance of a helicopter (cargo slingfrom the site). It was transported to an approved engine maintenance facility, where a teardown inspection was performed on Monday, 17 September 2012. The examination of the engine did not reveal evidence of any pre-existing failure or conditions that would have prevented engine operation. The engine teardown report can be found attached to this report as Annexure B.

## 1.17 Organisational and management information

1.17.1 This was a private flight. The pilot was also the owner of the aircraft.

1.17.1 The last maintenance inspection that was carried out on the aircraft prior to the accident flight was certified on 24 January 2012 at 1 582,5 airframe hours. The maintenance inspection was certified by an aircraft maintenance organisation (AMO) that was in possession of a valid AMO approval certificate.

## 1.18 Additional information

1.18.1 Civil Aviation Regulations

Part 61.03.5 Privileges and limitations of a Private Pilot Licence (Aeroplane)

*"(1) The holder of a Private Pilot Licence (Aeroplane) may not exercise the privileges of that licence unless he or she –*

*(a) is in possession of a valid Class 1 or Class 2 medical certificate, issued to him or her in terms of Part 67;*

(b) *has submitted a copy of the medical certificate to the licensing authority, as required in sub-regulation 61.01.6(6) in the event that the aviation medical examiner is unable to submit electronic data to the Director; and*

(c) *complies with the Maintenance of Competency requirements.*

(2) *The holder of a valid Private Pilot Licence (Aeroplane) may, in VMC, act as PIC or co-pilot in any aeroplane for which he or she holds the appropriate valid class rating or type rating.*

(3) *To provide for special VFR, the holder of a Private Pilot Licence (Aeroplane) may fly in IMC, in sight of the surface and clear of cloud, fog or mist within a control zone, after being authorised to do so by the responsible air traffic services controller.*

(4) *If the holder of a Private Pilot Licence (Aeroplane) has the appropriate valid rating, he or she may furthermore exercise the privileges of the licence for any of the special purposes referred to in regulation 61.03.8.*

(5) *The holder of a Private Pilot Licence (Aeroplane) may –*

(a) *act as co-pilot of any aeroplane on which a co-pilot is not a requirement;*

(b) *may not act as pilot-in-command of an aeroplane that is carrying passengers or freight for reward or hire.*

(c) *may not be remunerated for acting in any pilot capacity in an aeroplane.*

(d) *act as a pilot-in command of an aeroplane in the course of his or her own or employer's business, provided that –*

(i) *the flight is only incidental to that business or employment; and*

(ii) *the aeroplane does not carry passengers or freight for reward or hire."*

Part 91.03.4 Air traffic service flight plan

*"(1) The owner or operator of an aircraft shall ensure that an air traffic service (ATS) flight plan is completed if required in terms of sub-regulation (4).*

*(2) The items to be contained in the air traffic service flight plan referred to in sub-regulation (1) shall be as prescribed Document SA-CATS 91.*

*(3) The ATS flight plan shall be filed with the appropriate ATSU and such unit shall be responsible for transmitting such air traffic service flight plan to all air traffic service units concerned with the flight.*

*(4) The air traffic service flight plan shall be filed in respect of –*

*(a) all flights to be conducted in controlled or advisory airspace: Provided that this requirement shall not apply in respect of –*

*(i) a local flight;*

*(ii) a flight crossing an airway or advisory routes at right angles; or*

*(iii) a VFR flight entering or departing from an aerodrome traffic zone or control zone, from or to an unmanned aerodrome and where no other controlled or advisory airspace will be entered during the flight;*

Part 91.06.22, Special VFR weather minima

*"(1) A pilot in command may conduct special VFR operations in weather conditions below the conditions prescribed in regulation 91.06.21 within a control zone (CTR) –*

*(a) under the terms of an air traffic control clearance;*

*(b) by day only;*

*(c) with a cloud ceiling of at least 600 feet and visibility of at least 1 500m, measured from the aerodrome reference point;*

*(d) when the Special VFR flight will not unduly delay an IFR flight;*

*(e) if the aeroplane is equipped with two way radio equipment capable of communicating with an ATSU (air traffic service unit) on the appropriate frequency; and*

*(e) if leaving the control zone, in accordance with instructions issued by an ATSU prior to departure."*

Part 91.06.23, VFR flight determination and weather deterioration

*(1) The PIC of an aircraft operating outside a control zone or an aerodrome traffic zone is responsible to ascertain whether or not weather conditions permit flight in accordance with VFR.*

*(2) Whenever weather conditions do not permit a pilot to maintain the minimum distance from cloud and the minimum visibility required by VFR, the pilot shall -*

*(a) if in controlled airspace, request an amended clearance enabling the aircraft to continue in VMC to the nearest suitable aerodrome, or to leave the airspace within which an ATC clearance is required;*

*(b) if no clearance in accordance with paragraph (a) can be obtained, continue to operate in VMC and land at the nearest suitable aerodrome, notifying the appropriate ATC unit of the action taken;*

*(c) if operating within a control zone, request authorisation to operate as a special VFR flight; or*

*(d) request clearance to operate in accordance with the IFR*

Part 91.02.8, Duties of pilot-in-command regarding flight operations

*"(1) The PIC (pilot-in-command) of an aircraft shall, whether manipulating the controls or not, be responsible for –*

*(a) the operation, safety and security of the aircraft, crew members, passengers and cargo in accordance with these regulations while he or she is in command;*

*(b) operational control of the aircraft unless otherwise provided for in terms of part 93, 121, 127 or 135 under an approved operational control system;*

*(c) the conduct of crew members and passengers carried; and*

*(d) the maintenance of discipline by all persons on board."*

1.18.2 Pilot's Operating Handbook (Beech Bonanza F33A/F33C)

Section X, Safety Information, VFR – Low ceilings

*"If you are not instrument rated, do not attempt "VFR on Top" or "Special VFR" flight clearances. Being caught above a solid cloud layer when an emergency descent is required (or at destination) is an extremely hazardous position for the VFR pilot. Accepting a clearance out of an airport control zones with no minimum ceiling and one-mile visibility as permitted with "Special VFR" is a foolish practice for the VFR pilot.*

*Avoid area of low ceilings and restricted visibility unless you are instrument rated and proficient and have an instrument equipped airplane. Then proceed with caution and planned alternates."*

Section X, Safety Information, Vertigo – Disorientation

*"Disorientation can occur in a variety of ways. During flight, inner ear balancing mechanisms are subjected to varied forces not normally experienced on the ground. This, combined with loss of outside visual reference, can cause vertigo. False interpretations (illusions) result, and may confuse the pilot's conception of the altitude and position of his airplane.*

*Under VFR conditions, the visual sense, using the horizon as a reference, can override the illusions. Under low visibility conditions (night, fog, clouds, haze, etc.) the illusion predominates. Only through awareness of these illusions, and proficiency in instrument flight procedures, can an airplane be operated safely in a low visibility environment.*

*Flying in fog, dense or dust, cloud banks, or very low visibility, with strobe lights or rotating beacons turned on can contribute to vertigo. They should be turned off in* *these conditions, particularly at night.*

*All pilots should check the weather and use good judgement in planning flights. The VFR pilot should use extra caution in avoiding low visibility conditions.*

*Motion sickness often precedes or accompanies disorientation and may further jeopardize the flight.*

*Disorientation in low visibility conditions is not limited to VFR pilots. Although IFR pilots are trained to look at their instruments to gain an artificial visual reference as a replacement for the loss of a visual horizon, they do not always do so. This can happen when the pilot's physical condition will not permit him to concentrate on his instruments; when the pilot is not proficient in flying instrument conditions in the airplane he is flying; or, when the pilot's work load of flying by reference to his instruments is augmented by such factors as turbulence. Even an instrument rated pilot encountering instrument conditions, intentional or unintentional, should ask himself whether or not he is sufficiently alert and proficient in the airplane he is flying, to fly under low visibility conditions and in the turbulence anticipated or encountered.*

*If any doubt exists, the flight should not be made or it should be discontinued as soon as possible.*

*The result of vertigo is loss of control of the airplane. It the loss of control is sustained, it will result in an excessive speed accident. Excessive speed accidents occur in one of two manners, either as an in flight airframe separation or as a high speed ground impact; and they are fatal accidents in either case. All airplanes are subject to this form of accident.*

*For years, Beech Pilot's Operating Handbooks and FAA Approved Airplane Flight Manuals have contained instructions that the landing gear should be extended in any circumstance in which the pilot encounters IFR conditions which approach the limits of his capability or his ratings. Lowering the gear in IFR conditions or flight into heavy or severe turbulence, tends to stabilize the airplane, assists in maintaining proper airspeed, and will substantially reduce the possibility of reaching excessive airspeeds with catastrophic consequences, even where loss of control is experienced.*

*Excessive speed accidents occur at airspeeds greatly in excess of two operating limitations which are specified in the manuals: Maximum manoeuvring speed and the "red line" or "never exceed" speed. Such speed limits are set to protect the structure of an airplane. For example, flight controls are designed to be used to their fullest extent only below the airplane's maximum manoeuvring speed. As a result, the control surfaces should never be suddenly or fully deflected above the maximum manoeuvring speed. Turbulence penetration should not be performed above that speed. The accidents we are discussing here occur at airspeeds greatly in excess of these limitations. No airplane should ever be flown beyond its FAA approved operating limitations."*

### 1.19 Useful or effective investigation techniques

1.19.1 None.

## 2. ANALYSIS

2.1 Pilot (Man)

The pilot obtained his private pilot's licence in April 2000, and in August 2002 he completed his training for his night rating, which was then endorsed on his licence. The pilot was also the owner of the aircraft ZS-TVR since October 2004 and was therefore very familiar with the aircraft and its flying characteristics.

In the available information no evidence could be obtained that the pilot had obtained a weather briefing prior to the return flight to FANC. It was evident from the communication between him and ATC at FAPM that he wanted to proceed with the flight and did not consider the fact that FAPM was declared IMC at the time as significant. Air traffic control emphasised this point several times during the communication with the pilot while he was on the ground, but he remained adamant to proceed with the take-off. From the communication between the pilot and ATC it could be determined that the pilot was getting agitated with the ATC as he waited for his take-off clearance, which was granted only after approximately 20 minutes following his first communication with ATC. The aircraft ZS-TVR was cleared for take-off under special VFR flight rules by ATC with a clear instruction to the pilot; *"to remain clear of cloud and in sight of the ground at all times".*

It became apparent during the investigation that the pilot was very reliant/dependant on flying with the assistance of automation (i.e. with the autopilot engaged). It is believed that the flight in question was not in any way different. However, due to the turbulence they encountered as a result of thunderstorm activity the auto-pilot most probably disengaged, whereupon the pilot had to fly the aircraft manually. The attitude the aircraft was in at the time could not be determined, and the detection by the pilot of such an event might not have been immediate. By the time the pilot became aware of the situation, the aircraft had most probably entered an unusual flight attitude from which he needed to recover without having any well-defined horizon/reference to the ground. With the aircraft being in a spiral dive, the instrumentation might have became blurred; in such a case additional altitude would be required to recover as well as a well-defined horizon. The first time the pilot became aware of the ground was most probably when the aircraft penetrated the clouds in a nose down-spiral, as was observed by the witness and indicated by the wreckage impact sequence. The rate of descent was considered to be high, with the pilot unable to initiate recovery action prior to ground impact. Several factors affect a pilot's ability to successfully recover from an unusual attitude; these include immediate detection of an in-flight upset and the pilots flying experience, skills and knowledge. The possibility of the pilot being spatially disorientated following the in-flight upset and subsequent loss of control cannot be ruled out. For reference to the reader the phenomena with reference to a spiral dive as well spatial disorientation had been included in the report as Annexure C and D respectively.

**Figure 14.** Illustration of blurred instrumentation with the aircraft in a spiral attitude

According to available evidence, the pilot had logged 26,8 hours of instrument flying in his pilot logbook. According to his CAA pilot file, he never held an instrument rating, only a night rating. His limited exposure to instrument flying might have given him a false sense of security. The pilot made a conscious decision to enter into instrument meteorological flight conditions, as he requested to fly via Greytown, which was located towards the north-east of FAPM; however, the aircraft crashed 16,2 nm to the east of FAPM; this indicates a deviation from the intended routing, most probably due to weather avoidance.

The information that was made available by the captain of Link 741 to ATC should have been a very good indication to the pilot that weather conditions were not favourable for VFR flight at the time, hence the special VFR clearance from ATC. The information was, however, not considered as significant by the pilot, as he had already made up his mind to proceed with the flight in order to get home.

The pilot's licence was not valid at the time of the accident flight, as he had not met the requirements stipulated in Part 61.01.16 of the CARs.

## 2.2 Aircraft (Machine)

The aircraft was certified for day and night VFR as well as IFR operations. The aircraft was well equipped and had a 2-axis auto-pilot, storm scope and adequate navigational equipment. There is no evidence of any reported defects with the aircraft prior to take-off from FAPM.

The fuselage was consumed by the post-impact fire, and it was not possible to ensure control continuity of the control surfaces. The empennage area remained fairly intact, although scored. Both the left and right elevators as well as the rudder control surface were still attached to the empennage structure.

The engine was exposed to a substantial amount of heat from the post-impact fire. It was recovered from the accident site and subjected to a teardown inspection at an approved engine overhaul facility. No evidence of mechanical failure was observed. The manifold pressure and fuel flow gauge that was recovered at the accident site indicated a fuel flow rate of approximately 11 to 12 US gallons and hour, which was within the normal engine operating range. The propeller was found to be partially embedded in the ground as it separated from the engine in overload mode.

It was evident from the severity of the post-impact fire that there was a substantial amount of fuel on board the aircraft on impact, and fuel was not considered to have had any bearing on the accident.

It is believed that aircraft performance was not impaired in any way by the loading of the aircraft. The same three occupants who arrived earlier the morning at FAPM boarded the aircraft for the return flight to FANC. No fuel was uplifted at FAPM.

## 2.3 Environment

At the time the pilot of ZS-TVR requested a take-off clearance, the FAPM CTR was IMC. The aircraft was cleared for take-off from runway 16 by ATC under special VFR flight rules. Inclement weather conditions, associated with low-level cloud, rain and thunderstorm activity, prevailed in the area. According to satellite, radar and infrared data, the rain and thunderstorm activity was located in a broad band to the north as well as to the east of FAPM all the way to the east coast.

During communication with ATC the pilot requested to fly via Greytown and then from there onwards to his intended final destination (Newcastle). Greytown is located 36 nm north-east of FAPM (heading 016°M). The aircraft crashed 16,2 nm to the east of FAPM. The pilot's decision to take this route took him into thunderstorm activity. This is a clear indication that the pilot had not conducted any flight planning prior to departure from FAPM; had he done proper flight planning, he would have known that he would be flying directly into adverse weather conditions.

When it issued the pilot with a special VFR take-off clearance, ATC was very clear that he should remain clear of cloud and in sight of ground at all times. According to a witness, he heard an aircraft flying overhead the area but was unable to see it, as overcast conditions with rain prevailed at the time. A few seconds later he saw an aircraft emerging through the clouds in a spiral dive attitude towards the ground. This evidence shows clearly that the pilot did not maintain visual reference to the ground as he had been instructed to do by ATC.

The possibility of the aircraft encountering icing conditions was considered, but available data indicated that this was highly unlikely. Due to the destruction of the wreckage by the post-impact fire, the possibility that the aircraft might have encountered hail could not be determined either.

## 2.4 Conclusion

It was evident from the information that was gathered that inclement weather conditions prevailed in the area at the time the pilot requested take-off clearance for a flight to Newcastle. Link 741, which was a scheduled domestic flight operated under the provisions of Part 121 (airline operation - aircraft above 5 700 kg), had to enter into a holding pattern for an extended period due to inclement weather conditions en route to FAPM from FAJS. Following landing at FAPM, the captain of Link 741 communicated with ATC and indicated that he would not recommend a VFR departure at that stage. The pilot of ZS-TVR, who was listening on the tower frequency at the time, was therefore able to follow the conversation, yet he opted to proceed with the take-off.

Following a special VFR take-off clearance from ATC, the pilot of the accident aircraft did not adhere to the clearance provisions and entered IFR flight. The aircraft crashed after a spiral dive approximately 10 minutes after take-off.

Improper flight planning by the pilot played a major role in this accident. The pilot had all the resources available that he required to gather the necessary information, especially the weather data, prior to the flight, but he did not familiarise himself with this data. Despite being ultimately responsible for the safety of the flight and its passengers, he made the decision to proceed with the flight in conditions which were not conducive to VFR flight at the time and entered IFR conditions, which resulted in a loss of control and inability to recover control of the aircraft prior to ground impact.

# 3. CONCLUSION

## 3.1 Findings

3.1.1 The pilot was the holder of a private pilot's licence and had the aircraft type endorsed on his licence and in his pilot logbook. His licence was, however, not valid at the time of the accident, as he had not complied with Part 61.01.16 of the CARs (payment of annual currency fee).

3.1.2 The pilot was in possession of a valid aviation medical certificate that was issued by a CAA-accredited medical examiner.

3.1.3 The pilot's last skills test/competency check ride for his private pilot's licence was conducted on 31 March 2011.

3.1.4 The pilot had a night rating endorsed on his pilot's licence.

3.1.5 The aircraft was in possession of a valid certificate of airworthiness at the time of the accident.

3.1.6 The last MPI that was carried out on the aircraft prior to the accident flight was certified on 24 January 2012 at 1 582,5 airframe hours.

3.1.7 The aircraft was not identified on secondary surveillance radar at any stage during the flight.

3.1.8 No flight plan was filed by the pilot for the intended flight from FAPM to FANC, nor was it required in accordance with Part 91.03.4 of the Civil Aviation Regulations as amended.

3.1.9 Air traffic control at FAPM had advised the pilot of ZS-TVR that the FAPM CTR was IMC at the time he requested a clearance for take-off.

3.1.10 The pilot was cleared for take-off under special VFR rules. ATC advised him to *remain clear of cloud and in sight of ground at all times*. A witness observed the aircraft descending through the clouds (overcast, in rain) to the ground prior to impact.

3.1.11 The captain of Link 741 advised ATC that he did not recommend a VFR departure from FAPM at the time due to inclement weather conditions in the area. (Link 741 landed at FAPM approximately 15 minutes prior to the departure of the accident aircraft after it had to enter into a holding pattern to avoid adverse weather conditions.)

3.1.12 According to available weather data that was obtained from satellite, radar and infrared information, it was overcast with low-level clouds, and thunderstorms prevailed in and around the area of the accident at the time.

3.1.13 According to a witness who observed the aircraft descending through the clouds, overcast conditions with light rain prevailed at the time in the area of the accident.

3.1.14 The aircraft crashed 16,2 nm (30 km) to the east of FAPM. Its intended final destination was Newcastle, which was located to the north-west of Pietermaritzburg.

**3.2 Probable cause/s**

3.2.1 The pilot most probably became spatially disorientated after entering an area of adverse weather conditions (thunderstorm activity) which resulted in a loss in control of the aircraft with inadequate height available to recover.

**3.3 Contributory factor/s**

3.3.1 Improper VFR into IMC. (The pilot did not adhere to the special VFR clearance instructions from ATC at FAPM.)

3.3.2 Improper flight planning.

(i) No evidence could be obtained to indicate that the pilot had obtained an official weather forecast prior to take-off from FAPM. This should be regarded as a significant factor resulting in this accident.

(ii) The pilot disregarded essential information with reference to the weather conditions at the time that was communicated by the captain of Link 741 with ATC at FAPM (*"VFR flight not recommended at the time"*).

3.3.3 Weather conditions associated with low cloud, rain and thunderstorm activity were present along the flight route.

3.3.4 Overdependence on automation by the pilot. The aircraft was equipped with a 2-axis autopilot with a flight director as well as a storm scope.

3.3.5 The pilot had made a conscious decision to proceed with the flight even though ATC had informed him that the FAPM CTR was IMC.

3.3.6 Disregard for standard safe operating procedures and instructions (pilot did not adhere to the special VFR clearance issued by ATC).

3.3.7 The pilot displayed an over eagerness to get home.

## 4. SAFETY RECOMMENDATIONS

4.1 None

## 5. APPENDICES

5.1 Annexure A (Communication between ATC, the pilot of ZS-TVR and Link 741)
5.2 Annexure B (Engine teardown report)
5.3 Annexure C (Graveyard spiral)
5.4 Annexure D (Disorientation)

## ANNEXURE A

A transcript of the communication between ATC at FAPM, the pilot of ZS-TVR as well as the captain of flight Link 741 on the VHF frequency 122.00 MHz.

| Time | Station | Text of conversation |
|---|---|---|
| 14.47:23 | ZS-TVR | Maritzburg, Tango Victor Romeo (TVR). |
| | ATC | TVR tower. |
| | ZS-TVR | TVR a Bravo Echo three three (33), three onboard request taxi instruction for a flight to Newcastle. |
| 14.47:39 | ATC | TVR the QNH 1018 the CTR is in IMC, your intentions? |
| 14.47:46 | ZS-TVR | QNH 1018, and just say the rest? |
| | ATC | Maritzburg CTR is in IMC, report your intentions? |
| 14.47:56 | ZS-TVR | Copy that TVR. |
| | ATC | TVR just confirm your intentions? |
| | ZS-TVR | To climb through and and and be well above the clouds, destination Newcastle. |
| 14.48:36 | ATC | TVR standby, say again your intentions to go to Newcastle Sir? |
| 14.48:41 | ZS-TVR | TVR Bravo Echo three three, three onboard, request request taxi instructions for flight to Newcastle, intending to climb to 085, TVR. |
| | ATC | TVR are you requesting special VFR to Newcastle Sir? |
| | ZS-TVR | I am in a wide state down because I can see the mountain and everything. |
| 14.49:13 | ATC | TVR, Sir we are in IMC we only route VFR via special rules. Standby. Break break Link 741 you are clear to land runway 16 and backtrack, wind 150° at 10 knots . |
| | Link 741 | Clear to land, backtrack, Link 741. |
| 14.49:37 | ATC | TVR say again Sir, the CTR can only accommodate special VFR routings below cloud and in sight of ground. |
| | ZS-TVR | I follow that, will you allow me too, will you allow me to fly visual below the clouds? |
| 14.50:03 | ATC | TVR, affirm that is the special VFR I was talking about sir, standby the official start from approach. |
| | ZS-TVR | Okay copy that, so I can proceed? |
| 14.50:26 | ATC | TVR taxi to the holding point alpha, in the loop. |
| | ZS-TVR | Copy that, taxi to holding point alpha in the loop. TVR. |

| | | |
|---|---|---|
| 14.52:12 | ATC | TVR your start has been approved but expect departure after about 10 minutes due IFR traffic inbound. |
| 14.52:29 | ZS-TVR | Okay just have to wait. |
| | ATC | TVR |
| 14.52:36 | Link 741 | Maritzburg tower from Link 741 Sir we won't recommend a VFR departure out of her towards Newcastle at this stage, we broke cloud at 2 200 feet there coming over the ridge. |
| 14.52:49 | ATC | Link 741 thanks for your information. TVR did you copy sir? |
| | ZS-TVR | Okay I copy that, then I will definitely intend going the Greytown way in that case. |
| 14.53:04 | ATC | TVR confirm your requested destination now Greytown or do you want to route via Greytown - Albert Falls area? |
| | ZS-TVR | I would like to route via Greytown - Albert Falls area. TVR or even more to the east of Albert Falls. |
| | ATC | TVR copied, standby. |
| | ZS-TVR | TVR. |
| 15.05:44 | ATC | TVR behind the landing PA34 to taxi and backtrack lined up and wait runway 16 behind. |
| | ZS-TVR | Copy that, TVR behind the PA34 enter and backtrack and wait. |
| 15.06:39 | ZS-TVR | Maritzburg TVR entering and backtracking runway 16. |
| | ATC | TVR. |
| 15.07:55 | ATC | TVR, runway 16, you are clear take off, surface wind 180° at 15 knots, left turn, route special VFR clea r of cloud insight of ground at all times, report CTR outbound, not above CTR, outbound. |
| | ZS-TVR | TVR copy that, next report outbound. |
| 15.13:26 | ZS-TVR | Tower TVR is out. |
| | ATC | TVR report pass, frequency 124 decimal 2. |
| | ZS-TVR | 124 decimal 2. TVR |

There was no further communication between the aircraft ZS-TVR and air traffic control.

## ANNEXURE B

The engine, a Teledyne Continental IO-520-BB, Serial No. 578776 was recovered from the accident site by helicopter (was sling from the site) as well as the propeller, which was found to have separated from the engine following the failure of the crankshaft flange during the impact sequence. The engine was transported to an approved engine maintenance facility where a teardown inspection was performed on Monday, 17 September 2012 as the engine was severely damaged and could not be bench tested. The engine displayed substantial scoring / fire damage as a result of the post impact fire. The purpose of the teardown inspection was to assess the mechanical integrity of the engine. The following observations were made:

A photo of the engine prior to the teardown inspection.

| **Engine Model** | **Teledyne Continental IO-520-BB** |
|---|---|
| **Serial No.** | **578776** |
| Fuel flow divider valve | The unit display scoring / fire damage.<br>The unit was opened and it was found that the diaphragm inside was undamaged. The unit was free of contaminants / obstructions. All the associated fuel lines and connections |

| | |
|---|---|
| | were intact. |
| Fuel pump | The pump sustained substantial fire damage. |
| Fuel filter | It was not possible to make a proper assessment of the fuel filter unit due to fire damage. |
| Spark plugs<br>Champion<br>RHB-32E | The spark plugs sustained some fire damage but it was possible to remove all of them and they were found to be in an overall good condition, displaying a light brownish colour, which was associated with normal engine operation. |
| HT leads | The high tension leads sustained fire damage. |
| Magneto's<br>Slick<br>Model No. 6310 | Both the magnetos were still secured to the engine however, they both sustained impacted damage as well as fire damage. The right-hand unit sustained substantial more fire damage and neither of the units could be subjected to a bench test procedure, nor was it possible to check the magneto timing. |
| Fuel nozzles<br>(GF 148) | All six fuel nozzles were removed from the engine and apart from scoring no damage were noted. |
| Fuel control unit | The unit sustained fire damage. All the cable/control linkages attached to the unit was still secured to the unit on both sides. The butterfly valve was found to be in the fully open (deflected) position. |
| Vacuum pump | The vacuum pump that was fitted to the engine sustained fire damage and could not be turned by hand. The aircraft was |

| | |
|---|---|
| | also equipped with an additional vacuum pump (electrically driven). This unit sustained fire damage as well as impact damage and could not be tested. |
| Oil filter | The filter was still attached to the engine but had sustained substantial fire damage.<br>The unit was removed from the engine and was cut open. No metal particles were observed in the filter. |
| Gear drive train | The gear drive train was undamaged. |
| Cylinders | All six the cylinders display fire damage (scoring). All the cylinders were removed and they showed signs of proper combustion and carbon deposits found to be normal on this type of engine. |
| Pistons & rings | The pistons were in a good condition with very little carbon build-up visible.<br>Not any of the rings were broken on any of the six pistons. |
| Main bearings & Big-end bearings | All the bearings were found to be in an overall good condition and displayed evidence of adequate lubrication. |
| Connecting rods | All six connecting rods were found to be in a overall good condition/undamaged and the bolts properly secured. |
| Camshaft | The camshaft was found to be in an overall good condition including the gear drive assembly. |
| Crankshaft | The crankshaft was found to be in an overall good condition. |
| Cylinder head / valve assembly | All six the rocker covers were removed and the valves with their associated valve springs were found to be intact and in a good condition. |
| Oil pump | The oil pump was found undamaged and in a good condition. There was still a substantial amount of oil in the engine even though the casing was damaged on the right aft side. The |

| | |
|---|---|
| | sump assembly remained intact. |
| Oil cooler | The unit sustained some impact and fire damage. |
| Alternator | The unit was attached to the engine but sustained fire damage. It was removed and the front drive gears could be inspected, with no anomalies noted. |
| Propeller Governor (CSU) | The unit with its control cable linkage was still attached to the engine. It sustained substantial fire damage. The attachment linkage was found to be secured. |
| Alternate observations | The exhaust stacks were removed and inspected, it was found to display a brownish colour on the inside, which could be associated with normal engine operation.<br>The most intense part of the fire was concentrated towards the left aft section of the engine with evidence of coked engine oil visible in that area. Fire damage caused to components in that area was much more severe if compared to the rest of the engine. |
| Conclusion: | The teardown inspection of the engine did not reveal any pre or post impact mechanical failure that would have prevented the engine from normal operation. |

## ANNEXURE C

Graveyard spiral

Source; http//en.wikipedia.org/wiki/Graveyard_spiral

Graveyard spiral

In aviation, a graveyard spiral is a dangerous spiral dive entered into accidentally by a pilot who is not trained or not proficient in instrument flight when flying in instrument meteorological conditions (IMC).

Graveyard spirals are most common in nighttime or poor weather conditions where no horizon exists to provide visual correction for misleading inner-ear cues. Graveyard spirals are the result of several sensory illusions in aviation which may occur in actual or simulated IMC, when the pilot loses awareness of the aircraft's attitude. In other words, the pilot loses the ability to judge the orientation of his aircraft due to the brain's misperception of spatial cues.

The graveyard spiral consists of both physiological and physical components. Mechanical failure is often a result but generally not a causal factor, as it is the pilot's sense of equilibrium which leads to the spiral dive. Flying by "the seat of the pants," and failing to recognize and/or respond to instrument readings is the most common source of controlled flight into terrain where a plane controlled by a pilot impacts ground.

Physics of the Graveyard Spiral

The impression given by the senses in that situation would be level flight, with a descent indicated on the altimeter and vertical speed indicator. This usually leads to the pilot "pulling up" or attempting to climb by pulling back on the control yoke. In a banking turn, however, the aircraft is at an angle and will be describing a large circle in the sky. Pulling back on the control yoke has the effect of tightening that circle and causing the plane to lose altitude at an increasing rate.  An increasing component of the lift being generated by the wings is directed sideways by the bank angle. At that point the aircraft is describing a descending circle or spiral. In the ever-tightening, descending spiral the aircraft eventually exits the base of the clouds and/or impacts the ground.

**Spatial Disorientation**

Source: http://www.skybrary.aero

Importance

Spatial disorientation, if not corrected, can lead to both loss of control *and* controlled flight into terrain. The possibility of becoming spatially disorientated is hard-wired into all humans. In fact, it is the proper functioning of our spatial orientation system, which provides the illusion; and because this is a system we have learnt to trust, it is particularly difficult for some people, in some circumstances, to accept that their orientation isn't what it appears to be! Despite the capability, accuracy, reliability and flexibility of modern flight displays and instrumentation, pilots can still find themselves questioning what the aircraft is telling them, because the "seat of their pants" or "gut feeling" is saying something else. No one is immune.

Therefore, learning, and regularly refreshing one's knowledge, about spatial disorientation, how and why it happens, how to recognize it, and what to do to about it, is essential in improving and maintaining flight safety.

Spatial Orientation

Spatial orientation is the ability to perceive motion and three-dimensional position (for pilots we could include the fourth dimension – time) in relation to the surrounding environment. Humans (and most animals) are able to achieve this by automatic, subconscious, integration of multiple sensory inputs, such as: the key **senses** of sight and hearing provide broad peripheral awareness as well as focused \ attention on details pressure and touch, through the somatosensory system (the whole body) provide **proprioception**, and the **vestibular system** in the inner ear provides three-dimensional movement and acceleration sensation.

There are three aspects to spatial ''position'' orientation:

1. knowing where the extremity of our body and limbs is
2. knowing what is up, down, left and right, and
3. knowing our position in relation to our immediate environment.

This is then complicated by factoring in, for each aspect, awareness of direction of movement, change in direction, speed of movement and change of speed. This automatic system and process has evolved to help us run, walk, sit, stand, hunt, climb, balance etc. and, it even provides for stabilised eyesight (our most convincing sense) whilst doing all these things.  This system even works when one or more sensory inputs are degraded. Such that many blind, deaf, and disabled people are also able to achieve incredible things naturally and effortlessly.  However, the key point is that this adaptation has occurred on the ground, and under the constant force of gravity, and not in-flight!

Spatial Orientation in Flight

Fully functional flight instruments must be the primary source for pilots to ascertain their spatial orientation. This, of course, relies both on good eyesight and good use of that eyesight; provided we use our sight to look at and read, regularly, those flight instruments that will tell us our attitude, altitude, position, heading and speed. Even pilots flying VFR (visual flight rules) will need to consult their flight instruments regularly.

Because in everyday life our vision is mostly correct, we naturally and habitually trust our vision implicitly above all other senses. It can therefore be compelling, when flying visually, to believe what we see, despite what our instruments are telling us. This makes us prone to several visual illusions, especially during landing.

There are many occasions in-flight when we cannot use, or rely on, our vision at all, such as when flying in IMC (instrument meteorological conditions), when there is no visible horizon and at night. Furthermore, there are many situations when flying in VMC when a pilot *should not* rely on his vision, such as when flying an Instrument Approach, Instrument Departure, or in response to an ACAS (airborne collision avoidance system) Advisory alert etc.

When our sense of sight is degraded, then our “natural” sense of spatial orientation becomes dependent on proprioception (pressure on muscles, joints, ligaments and nerves) and the vestibular system.  Without any (or any reliable) external visual references pilots will subconsciously become more sensitive to their proprioception and vestibular systems, and this is where spatial disorientation can manifest itself.

It must be noted that flight instruments will provide the same information regardless of the meteorological conditions!

Spatial Disorientation in Flight

When we take to the sky, we can be subject to motion, speed, forces and variations in gravity (both positive and negative) for which our orientation system was not designed. This can lead to an incorrect ‘’instinctual’’ understanding of where we think we are, what direction we are moving, and how fast. That is, we can feel ourselves to be certain of our orientation and relative movement, but our actual orientation and movement may be different.  The Flight Safety Foundation describes spatial disorientation as occurring ***when a pilot fails to properly sense the aircraft’s motion, position or attitude relative to the***

***horizon and the earth's surface. Spatial disorientation can happen to any pilot at any time, regardless of his or her flying experience, and often is associated with fatigue, distraction, highly demanding cognitive tasks and/or degraded visual conditions.***

Spatial disorientation is more likely to occur at night, in bad weather, in IMC, and when there is no visible horizon. Other hazards are mal-functioning flight instruments, increased workload (especially during approach and departure), and a breakdown in CRM (crew resource management). When these hazards combine with poor visibility, the risk of spatial disorientation is much greater.

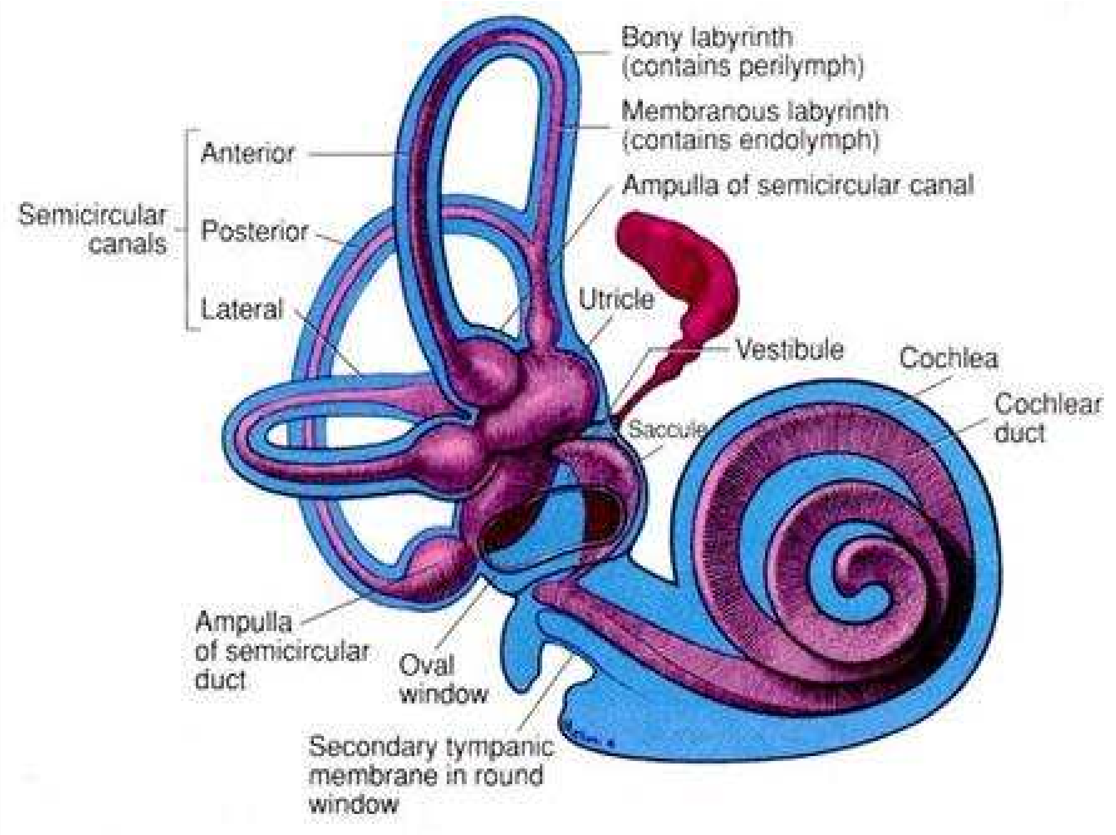
There are two main categories (or types) of common spatial disorientation "illusions" that humans are susceptible to in flight:

> **Somatogravic** – experiencing linear acceleration and deceleration as climbing and descending.
>
> **Somatogyral** – not detecting movement, and experiencing movement in a different (mostly opposite) direction to that actually being flown.

Both categories of spatial disorientation are caused by the normal functioning of the vestibular system, in the relatively unusual environment of flight. The most common somatogravic and somatogyral illusions that occur are explained in more detail below.

Vestibular System

The vestibular system (or apparatus) sits within the inner ear and provides evidence to the brain of angular accelerations of the head in three-dimensions (roll, yaw and pitch) and also linear acceleration/deceleration of the head. It consists of three semi-circular canals and two otolithic detectors.




The inner ear

The semi-circular canals consist of:

> **Anterior** (or Superior) canal – combines with the posterior canal to detect roll.
> **Posterior** canal – combines with the anterior canal to detect detect pitch.
> **Lateral** (or Horizontal) canal – detects yaw.

The two otolithic detectors, **utricle** and **saccule**, provide the brain with a sense of the head's position in relation to gravity, and they combine by detecting accelerations in the horizontal and vertical planes.

Whilst there are some physiological and anatomical differences between the canals and the otoliths, their operation can be described using the same model. Contained within each organ is a free-flowing fluid, such that whenever the head is turned, tilted or accelerated, the fluid (under the influence of gravity, and with its own mass and momentum) will not move with the head immediately, but lag behind somewhat. However, hair-like detectors, attached to the walls of each organ, do move with the head; the resulting force that the deflected hairs are subject to by the lagging fluid is proportional to the angular acceleration.

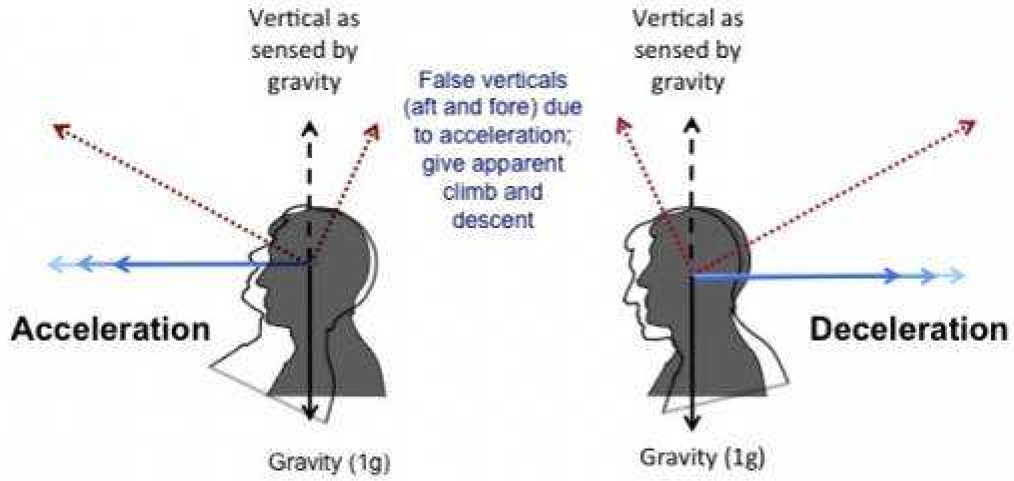
It should be noted, that once the acceleration (or deceleration) ceases, and a constant velocity is reached (including zero velocity), the fluid "catches-up" with the head and becomes still, closely followed by the hair-like detectors. With no force exerted by the fluid on the detectors the “head” experiences no movement until there is a change in speed or direction. Much like the body detecting an accelerating aircraft at take-off, through the pressure on the back of the seat, once a steady speed is reached, there is no longer the extra pressure, only the feel of gravity on the bottom of the seat.

In the same way that our body (proprioception) is unable to detect small accelerations, our vestibular system components also have thresholds of detection, below which we do not “sense” any acceleration. It is therefore possible to be gradually accelerated or decelerated to very high or low speeds respectively without “sensing” any change in speed. Similarly, it is possible to enter a roll, pitch or yaw movement without being able to “sense” any change.

Somatogravic Illusions

Generally the only force experienced in straight and level flight is the vertical force of gravity. If a linear acceleration or deceleration occurs in straight and level flight, then the “sensed” vertical reference of gravity will move back or forward, giving an illusion that the aircraft is climbing or descending respectively. Furthermore, when in a turn the body will be pushed back into the seat, also giving the illusion of climbing. When exiting a turn the opposite can occur, giving the sensation of descending.

If a pilot reacts to any of these sensations without reference to a true visual horizon and/or flight instruments, then the pilot is likely to start an unnecessary descent or a climb depending on whether the aircraft is accelerating or decelerating. Such a reaction can lead to a fatal conclusion.




Somatogravic Illusion

**Illusion of Climbing** – The illusion of climbing is most likely experienced when accelerating at take-off, initiating a go-around with full power, pulling out of a dive, leveling off from a climb and entering (or tightening) a turn.

An automatic somatic reaction to the illusion of climbing is to push the nose forward with the intent of stopping the illusory climb or to initiate a descent. When the pilot considers that the illusory climb is dangerous i.e. possibly leading to a stall, or “busting” a level, then the reaction is liable to be a fast and large “bunt” forward. Another automatic reaction may be to apply more power. Unfortunately, both reactions (bunting forward and applying more power) will increase the sensation of climbing and therefore motivate the pilot to increase the rate that the aircraft nose is lowered; thereby setting up a dangerous positive feedback loop.

A large bunt forward can reduce the experienced vertical force of gravity, which moves the sensed vertical reference backwards, as if climbing. Therefore, in the case where an abrupt change is made from climbing to level flight (note that this is an opposite scenario to those outlined above), the reduced G-force experienced can give the illusion of climbing, causing the pilot to push forward even more, making the situation worse. This particular scenario is often referred to as **illusion of tumbling backwards.**

The application of power and elevator to maintain a level turn can also give the illusion of climbing, or of the nose rising too fast and too much. Any reaction here to lower the nose and/or reduce power can quickly result in a loss of height and an increase in bank angle.

**Illusion of Diving** – The illusion of diving (or descending) is most likely to occur when decelerating the aircraft i.e. when reducing power quickly, deploying air brakes or lowering undercarriage. It can also occur when recovering to level flight following a banked turn.

The automatic somatic response to a perceived dive is to increase the aircraft's attitude. If the pilot considers the situation immediately dangerous i.e. when close to the ground, perhaps even over the threshold, then any pull-up response will slow the aircraft further and increase the risk of stalling or a heavy landing and tail-scrape.

Somatogyral Illusions

There are three common somatogyral illusions, each of which involves the normal functioning of the semi-circular canals in the vestibular system:

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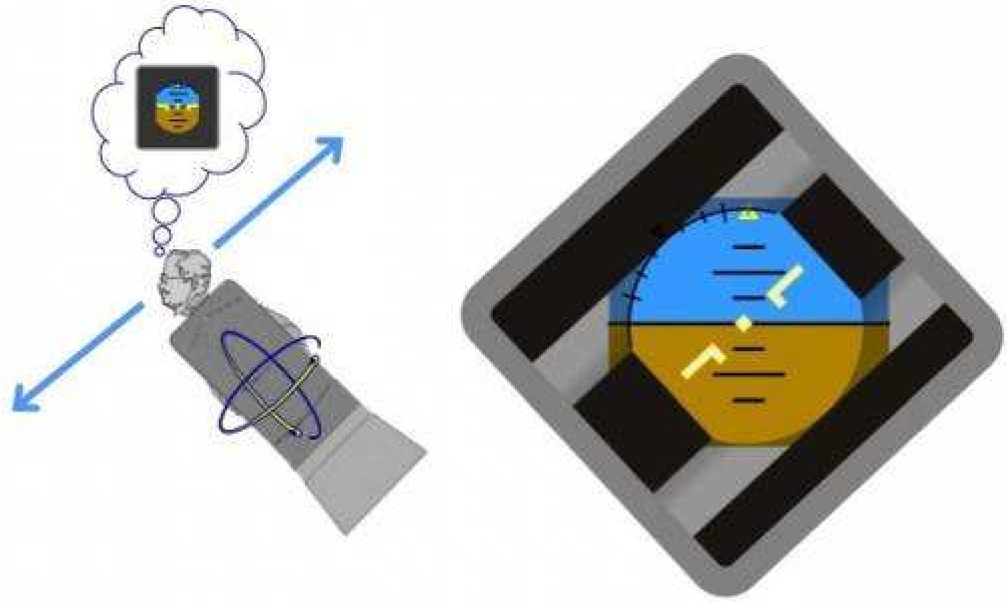
the leans – a false perception of the horizontal
illusion of turning in the opposite direction, and
coriolis – a sensation of tumbling, or turning on a different axis.

Either of the first two illusions above, if not corrected, can lead to what's known as a "graveyard dive" or "graveyard spiral".




The Leans

**The Leans** – When entering a turn the vestibular system will usually pick up the initial rolling and turning movement. However, once stabilised in a steady rate-of-turn and angle of bank (usually around 30 seconds), the vestibular system will "catch-up" with the aircraft (see above) and the pilot will "sense" only that the aircraft is straight and level. The pilot may even adjust his body, and the aircraft, to this new neutral position, hence the term the leans. Only a look at a true horizon and/or the flight instruments will confirm that the pilot is suffering an illusion. The leans can often occur when an aircraft is not trimmed correctly and starts to roll or turn at a rate so slow as to be undetectable (below the detection threshold).

**The illusion of turning in the opposite direction** will often occur when returning to the straight and level from an established turn that was long enough (>30 seconds) to re-set the pilot's internal horizontal reference – as described in "the leans" above. Because the vestibular system is no longer detecting a turn, when the pilot initiates a return to straight and level flight, the vestibular system detects a bank and turn in the same direction of movement. So, when recovering from a left-hand turn to straight and level, the body "senses" a turn from straight and level to the right, and the pilot will be tempted to turn again to the left in order to correct his perception.

**Graveyard Dive** – If, because of the leans or other spatial disorientation, the pilot does not detect a turn, eventually the nose will lower (depending on power management) thereby increasing the speed. The pilot, who senses that the wings are level, but the nose is dropping, will pull back on the elevator to stop the descent and reduce the speed. However, as the aircraft is actually banked, the turn will steepen, which in turn increases the likelihood of the nose dropping further. This positive feedback scenario, if not corrected, will result in an uncontrolled spiral dive.

**Coriolis** – this occurs when the pilot makes an abrupt head movement (such as reaching down and over to collect a chart) whilst the aircraft is in a prolonged turn. Once a turn is established (around 30 seconds) the fluid in all three semi-circular canals will be “neutral” waiting to detect any difference in movement. If the pilot makes a sudden head movement one, two, or all three semi-circular canals will suddenly “sense” the turning aircraft, but because the pilot’s head is at a random angle, the brain will compute an illusory movement. Such an illusion can produce a sensation of tumbling, or merely a turn in a different direction, or at a different rate. The pilot’s instinctive reaction might be to correct any perceived movement.

Other Illusions

Vertigo and dizziness can occur as a result of illness, such as a cold or possibly other long-term health issues.

Usually associated with high altitude flights, and during periods of low stimulation, some pilots have been known to suffer from various “out-of-body” experiences, where they “sense” that they are on the wing looking back in at themselves flying the aircraft. Under similar conditions, some pilots have also reported feeling that the aircraft is precariously balanced on a knife edge and extremely sensitive to small control inputs, or sometimes being “held” or restrained somehow, such that the controls become ineffective.

These events are often one-off, and pilots will benefit from sharing this information in the right forum. However, to rule out any long-term health issues, such as brain tumour, it is recommended that pilots experiencing any inexplicable form of spatial disorientation consult their flight surgeon or doctor as soon as possible.

Other Causes of Spatial Disorientation

This is just a short word about becoming spatially disorientated in relation to an aerodrome or runway when flying an approach; perhaps more commonly called **loss of situational awareness**. Although of a different nature to somatogravic and somatogyral illusions, believing that the aircraft is in a different location (in the air) than it actually is can also be called spatial disorientation. Furthermore, the potential consequences, if not corrected, are the same.

When a pilot "believes" he/she is in a different location than the actual position, then he/she may initiate descent early or late, "turn-in" early or late, configure the aircraft early, or maintain a high speed for too long. All of these actions can result in rushed approaches, high-energy late touchdowns, overruns and runway excursions, heavy landings, balked approaches, excess fuel usage, descent below minimum safety, or vectoring, altitude and even CFIT (control flight into terrain).

The possible causes of this type of spatial disorientation include the following:

insufficient attention and focus on flight and navigational instruments;
incorrect selection of navigation instruments;
inadequate selection of flight displays;
malfunctioning navigation equipment (on the ground or on the aircraft);
errors in arrival and approach charts;
errors in data entry;
inadequate flight crew cross-checking and monitoring;
inadequate or omitted approach briefing;
high workload;
inadequate procedures, omitting to follow procedures, or omitting some elements of a procedure.

There are many more possible contributory factors; however, as with other forms of spatial disorientation, the primary solution is to ascertain one's true position from the best available data (flight and navigation instruments, and in this case ATC) rather than from one's "senses".

Avoiding and Recovering from Spatial Disorientation

Whether avoiding or recovering from all types of spatial disorientation and visual illusions the remedy is the same, and that is ***always scan, read and follow serviceable flight and navigation instruments***.

For an air operator to reduce the risks of pilots reacting inappropriately to spatial disorientation, then a multi-track approach is recommended, to include the following:

aviation medicine training to include understanding of the vestibular system;
human factors training to include understanding of the causes of all forms of spatial (and visual) disorientation;

safety information discussions to include those accidents and incidents attributed to spatial disorientation;

SOP (standard operating procedures) for recovery from any suspected case of spatial disorientation;

SOPs for flight instrument scanning, flight display management, cross-checking and monitoring, for all phases of flight;

SOPs to ensure adequate briefing of critical phases of flight (departure, descent, approach and landing) to also include contingency measures in case of unforeseen event, such as balked landing;

SOPs for flying, managing and monitoring, stabilised approaches;

SOPs always favouring instrument approaches in preference to visual approaches, and perhaps even banning night visual approaches;

SOPs for flying, managing and monitoring go-arounds;

where possible, exposure to disorienting conditions in the flight simulator, and practicing recovery SOP;

safety reporting system that encourages self-reporting of human factors, including spatial disorientation regular refresher training that covers all elements discussed above.

Concerning the issue of self-reporting, there may be some resistance from pilots who fear that they will lose their medical category; hence the need for effective education, and possibly an anonymous reporting system.