# AIRCRAFT ACCIDENT REPORT AND EXECUTIVE SUMMARY

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | | | | | Reference: | CA18/2/3/9281 | | |
| **Aircraft registration** | **ZU-TZT** | **Date of accident** | 29 January 2014 | | | **Time of accident** | ±1140Z | |
| **Type of aircraft** | Giles G-202 (Aeroplane) | | **Type of operation** | | Private | | | |
| **Pilot-in-command licence type** | | Private pilot | **Age** | 50 | **Licence valid** | Yes | | |
| **Pilot-in-command flying experience** | | Total flying hours | 1 693,0 | | Hours on type | 30,8 | | |
| **Last point of departure** | Port Alfred aerodrome (FAPA), Eastern Cape | | | | | | | |
| **Next point of intended landing** | Mossel Bay aerodrome (FAMO), Western Cape | | | | | | | |
| **Location of the accident site with reference to easily defined geographical points (GPS readings if possible)** | | | | | | | | |
| Addo Elephant National Park (GPS position: 33°36.03 5' South 025°47.229' East, elevation 1010 ft AMSL) | | | | | | | | |
| **Meteorological information** | Temperature: 22 °C; Dew point: 20 °C; Cloud: 8 okta s in light to moderate rain | | | | | | | |
| **Number of people on board** | 1 + 0 | **No. of people injured** | 0 | **No. of people killed** | 1 | | | |

## Synopsis

Three aircraft took off from runway 10 at Port Alfred aerodrome (FAPA), at 1106Z. After take-off they turned out right, joining up in a loose formation and flying over the town in a westerly direction. ZU-WAN, the lead aircraft, broke away from the formation and returned to FAPA as she was not comfortable with the prevailing weather conditions towards the west. The other two aircraft, ZU-TZT and ZU-ZOZ, continued with their intended flight to Mossel Bay aerodrome (FAMO). En route they encountered inclement weather conditions and the two aircraft became separated from one another. The pilot flying ZU-ZOZ made radio contact with Port Elizabeth Approach and informed them that he no longer had radio contact with the aircraft ZU-TZT. He was requested to squawk 6101 and following the activation of mode C on the transponder, the aircraft was identified on radar at 10 500 feet abeam of Uitenhage. The pilot continued with the flight along the coast and landed at FAMO at 1320Z. The aircraft ZU-TZT never arrived at FAMO, did not return to FAPA and did not diverted to an alternate aerodrome. At 1449Z the Aeronautical Rescue Co-ordination Centre (ARCC) based in Johannesburg was activated and an official search for the missing aircraft commenced. The wreckage was located on Saturday, 1 February 2014, at approximately 1300Z by a South African Air Force (SAAF) helicopter crew that participated in the search. The aircraft had crashed in the Addo Elephant National Park near Harvey's Loop. The pilot was fatally injured and the aircraft was destroyed in the accident sequence.

## Probable cause

The pilot most probably became spatially disoriented after he entered conditions associated with instrument metrological conditions (IMC) flight, and lost control of the aircraft.

| | | | |
|---|---|---|---|
| ASP Date | | Release Date | |

# AIRCRAFT ACCIDENT REPORT

| | |
|---|---|
| **Name of Owner** | **:** C.R. Pike |
| **Name of Operator** | **:** Private flight |
| **Manufacturer** | **:** Summer Noel B |
| **Model** | **:** Giles G202 |
| **Nationality** | **:** South African |
| **Registration Marks** | **:** ZU-TZT |
| **Place** | **:** Addo Elephant National Park, Eastern Cape |
| **Date** | **:** 29 January 2014 |
| **Time** | **:** ± 1140Z |

*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 Two aircraft, ZU-TZT and ZU-ZOZ, both Giles G202, departed from Springs aerodrome (FASI) and Vereeniging aerodrome (FAVV) respectively on Sunday, 26 January 2014. En route, they met up in the air and flew together to Margate aerodrome (FAMG) where they spent the next few days practising aerobatics with the intention to participate in the Western Cape Aerobatic Championships between 31 January and 2 February 2014 in Mossel Bay. On Wednesday morning, 29 January 2014, the two aircraft departed from FAMG and flew to Port Alfred aerodrome (FAPA). On their inbound leg to FAPA they met up with another pilot in the air flying a Yak 52, registration ZU-WAN. The three aircraft landed at FAPA at 0815Z. After landing, the two aircraft inbound from FAMG uplifted 70 litres and 100 litres of Avgas respectively. The pilot of ZU-ZOZ then went to the operational room of the local flight school and paid for the fuel. He also made a phone call to the aviation weather office in Port Elizabeth to enquire about the weather along their intended route to Mossel Bay. He was advised by the weather forecaster to delay their departure and phone him back in approximately 90 minutes for an update. Following the phone call, he spoke to a flight instructor at the school who showed him the prevailing weather conditions at the aerodrome, which were displayed on a flat-screen television via a live electronic feed. He also showed the pilot the new routing into the Port Elizabeth control zone (CTR) on an aeronautical map.

1.1.2 The three pilots then had lunch in the town and returned to the aerodrome. According to available information, the pilot of ZU-ZOZ purchased two aeronautical maps, a ruler and a fine liner at the pilot shop at FAPA. They also enquired about batteries but the pilot shop did not sell any batteries. A family member of the pilot of ZU-WAN, a local resident of the town, then purchased batteries in town and delivered it to the aerodrome. The batteries were believed to be for a portable global positioning system (GPS) that was utilised by the pilot flying ZU-TZT. At approximately 1045Z the pilot of ZU-ZOZ again phoned the aviation weather office in Port Elizabeth for a weather update. This was approximately two hours after he made the first call. This time he spoke to a different forecaster, who indicated that there were still some scattered showers moving through the area, as well as some fog along the coast with the cloud base varying between 300 and 500 feet above ground level (AGL). To the west of Uitenhage, weather conditions were starting to improve, with a 2 000 feet ceiling at George aerodrome (FAGG), which was 227 nautical miles (nm) (420 kilometres) from FAPA.

1.1.3 At 1106Z, the three aircraft (ZU-WAN, ZU-ZOZ and ZU-TZT) took off from runway 10 at FAPA. After take-off they turned out right and joined up in formation, and flew over the town in a westerly direction. The pilot flying ZU-WAN, the lead aircraft, was not comfortable with the prevailing weather conditions towards the west, as it appeared to be raining: “I very quickly realised that this was not for me, I didn’t need to fly any further to see the conditions. I removed myself from the formation, and turned back to the airfield to land. I suggested that they do the same, and asked them if they realised the weather they were flying towards.” The other two aircraft continued with their planned flight towards their intended final destination being Mossel Bay aerodrome (FAMO). The pilot of ZU-WAN stated that her aircraft did not have the range to fly non-stop to FAMO and it was never her intention to fly with the other two aircraft. She landed back at FAPA at 1112Z, six minutes after they took off.

1.1.4 The pilot flying ZU-TZT was leading the two-ship formation from FAPA to FAMO, a distance of 244 nm (straight-line distance), as he had a portable GPS on board his aircraft as well as an iPad loaded with aviation software (EasyPlan). The pilot flying ZU-ZOZ indicated that he did not have any electronic navigational aids on board his aircraft and had to navigate via aeronautical maps (scale 1:1 000 000) and a magnetic compass. He did spend substantial time planning his intended route on the aeronautical maps prior to their departure from FAPA. Instrumentation on board these aircraft is very limited and the two aircraft were therefore required to comply with visual flight rules (VFR) at all times (the instrumentation on board these two aircraft is listed in paragraphs 1.6.3 and 1.6.4 of this report along with a photo of the instrument panel of the aircraft ZU-ZOZ).

1.1.5 According to a statement by the pilot flying ZU-ZOZ, his first checkpoint after take-off from FAPA was at 10 minutes or 25 nm into the flight, which should have been overhead the town of Alexandria. He indicated that he never saw the town as they had already started steering north of track to avoid some rain showers. After turning onto a new track to Uitenhage, they continued for a few minutes but the weather conditions deteriorated further. They then spotted a large break in the clouds approximately five kilometres to their right. The pilot of ZU-ZOZ told the pilot of ZU-TZT to turn 90° to the right and climb throug h the gap in order to see ahead. They both turned and climbed to about 1 500 feet above mean sea level (AMSL), where they were above a layer of cloud. ZU-TZT then turned left again to the west and confirmed that they were on a new track. The pilot of ZU-ZOZ remained in the 5 o'clock position of the lead aircraft, approximately 100 feet above him. He then noticed the lead aircraft skimming in an out of the flattish layer of cloud beneath them; he radioed the pilot and told him that he should climb to stay clear of cloud. The next moment ZU-TZT disappeared into the layer of cloud beneath them. The pilot of ZU-ZOZ then radioed him and asked him if he was "OK". A few seconds later ZU-TZT radioed back and said he had visual reference with the ground and told the pilot of ZU-ZOZ to come down as well as it looked "OK". The pilot of ZU-ZOZ declined.

1.1.6 The pilot of ZU-ZOZ noticed that on his present track the horizon ahead was very dark, but further right, towards the north there were some yellow/gold-coloured clouds, which indicated to him that the clouds were perhaps thinning and that sunshine was probably breaking through. He turned north towards the 'golden clouds'. He indicated that he glanced to his right, towards Port Alfred, but the weather that way did not look good enough for him to find FAPA without a GPS. The pilot of ZU-TZT then called him and said he could not safely remain clear of cloud and requested his position. ZU-ZOZ responded, saying that “I was still on top of the layer now heading north to some golden clouds, hoping for a break in the clouds, but I was not sure of my position.” That was the last communication he had with the pilot flying ZU-TZT.

1.1.7 He saw a long ridge of mountains to the northwest with clouds running over the peaks. He knew that the mountain peaks rise to over 5 000 feet in the ranges to the west of FAPE and further north even higher, up to 8 000 feet. He descended in order to see if he could get through underneath the overcast conditions in a southwesterly direction, crossing a tar road in a valley. In the distance to his right he noticed a small town approximately five nm away that he could not identify. He managed to cross a further two ridges while he remained clear of cloud, hoping to get to the coast near Humansdorp. After a few minutes, he got trapped in a large valley with low clouds and power lines on the ridge he intended to cross. He then decided to do a level 360° turn in order to decide his next course of action as dark clouds ahead were lowering quickly. At that stage the pilot could not see any level ground below where he could try to do a precautionary landing. The rain also came down so heavily that he could not see ahead of him, apart from about 45° left and right of the nose. At this stage, the pilot realised that his only alternative was to level the wings and pull up into a climb-straight-ahead and hope to break out on top of these clouds quickly. The pilot further stated that he was fully aware of the dangers of spatial disorientation in flying in instrument metrological conditions (IMC) on a very limited panel in an aerobatic aircraft with a high roll and pitch rate. He further stated that he applied his full concentration to ensure the ball in the slip gauge was centred, that he kept the compass steady, and maintained a steady climb speed of 80 miles an hour.

1.1.8 The pilot indicated that he broke cloud at approximately 10 500 feet (with the barometric pressure setting on the altimeter in his aircraft still set at his departure aerodrome, that being FAPA, which was 1007 hectopascal). He indicated that this was the first time he was able to relax somewhat. He selected the approach frequency for FAPE and made radio contact with air traffic control (ATC). During this conversation, he informed them that he was uncertain of his position. He further stated that he dared not lose focus beforehand as the radio and transponder for his aircraft were mounted on the floor, between his knees. He indicated that if ATC had then given him a frequency change or a squawk code, he would most probably have ended up in a life-threatening spiral dive, as he would have had to transfer stick control to his left hand, look down and change the frequency with his right hand while trying to keep wings level and heading steady. Once on top of cloud after he had established radio contact with FAPE approach control, he was given a squawk code of 6101 and was identified on radar at 10 500 feet, five nm abeam southeast of Uitenhage at 11:57:03Z following the activation of mode C on the transponder (see radar data as displayed in Figure 2).

1.1.9 It can be seen from the radar track (Figure 1) that the flight path did not display a straight line from FAPA to Uitenhage, and that the pilots also did not opt to fly along the coast as coastal fog was forecast at the time. It was further established that the transponder of the aircraft ZU-ZOZ had been switched on after take-off from FAPA and that mode C was activated. When the aircraft was approximately 20 nm outbound of FAPA (time 11:19:47Z), mode C was switched off (mode C reflects the height at which the aircraft is flying and this information is accordingly encrypted on radar. However, the pilot can manipulate this function from inside the cockpit should he or she wish to do so). It was only after the pilot had established communication with approach control at FAPE (time 11:56:42Z) that the mode C function was switched on after ATC requested the pilot to activate it. During the thirty-eight minutes the mode C function was switched off, the aircraft was still being tracked on radar as the transponder remained on (the squawk code that was being interrogated by secondary surveillance radar was 5003). At certain areas along the route, radar contact was lost with the aircraft for brief periods, most probably due to terrain (high ground/mountainous terrain) or the aircraft's flying at a very low altitude.

1.1.10 After landing at FAMO the pilot of ZU-ZOZ made several telephone calls to the pilot of ZU-TZT but there was no response. The appropriate authorities were informed of the situation. ZU-ZOZ's pilot also made a statement at one of the local police stations in Mossel Bay with reference to a missing person. The Aeronautical Rescue Coordination Centre (ARCC) based in Johannesburg was informed that the aircraft ZU-TZT had not arrived at its intended destination and that the position of the pilot and aircraft was unknown, probably missing. At 1449Z the ARCC was activated and an official search commenced for the missing aircraft. The Accident and Incident Investigation Division (AIID) was informed by the ARCC on Saturday, 1 February 2014 at 1327Z that the wreckage of the missing aircraft had been located by a South African Air Force (SAAF) helicopter crew that participated in the aerial search. The wreckage of the aircraft was found where it had crashed in the Addo Elephant National Park. The pilot was fatally injured and the aircraft destroyed during the impact sequence.

1.1.11 The accident occurred during daylight conditions at a geographical position that was determined to be 33°36.035' South 025°47.229' East at an elevation of 1010 ft AMSL. The yellow thumbnail accompanied by the GPS co-ordinates on the Google earth map (Figure 1) indicates the location of the accident site. The aircraft crashed approximately 55 nm from FAPA (straight-line distance in a westerly direction) and 25 nm from FAPE on a heading of 020° magnetic.

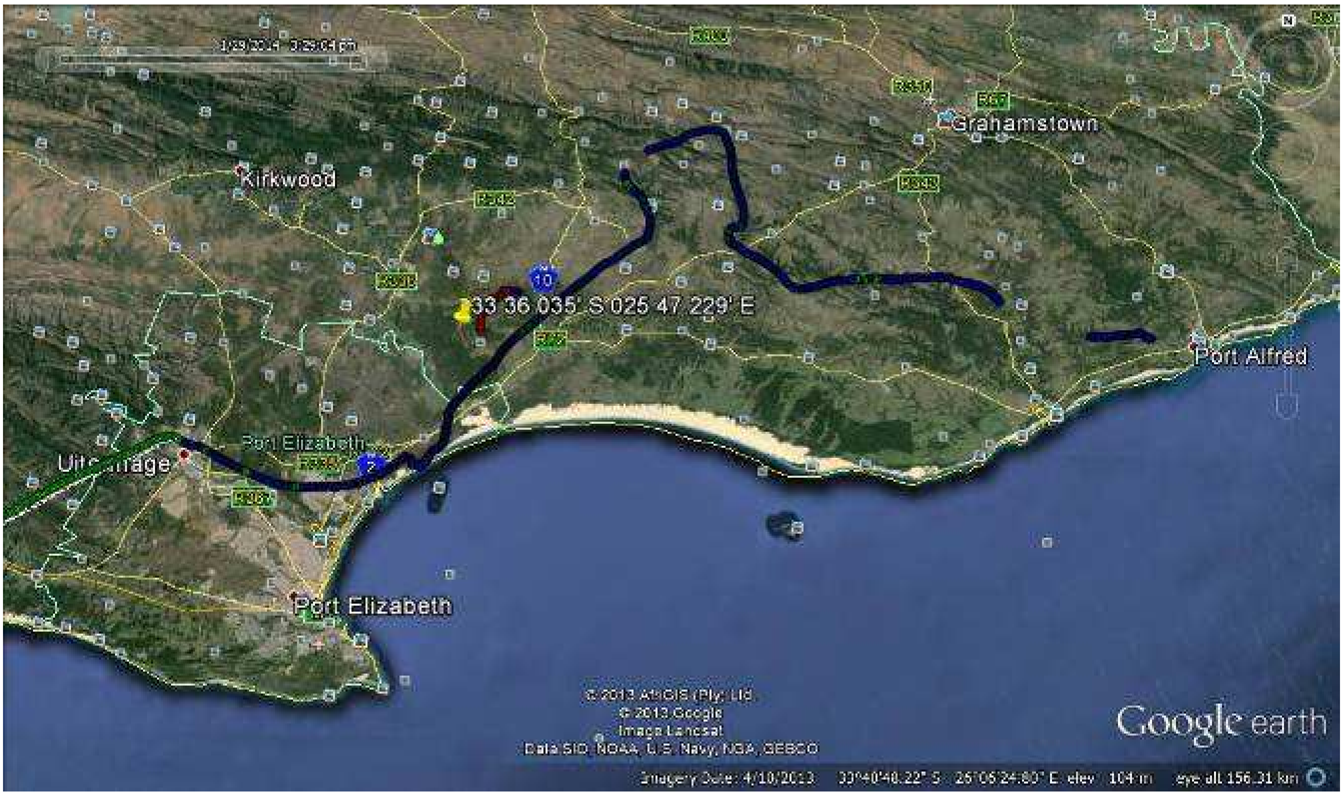



**Figure 1:** The dark blue line indicates the track ZU-ZOZ was flying from FAPA until abeam of Uitenhage

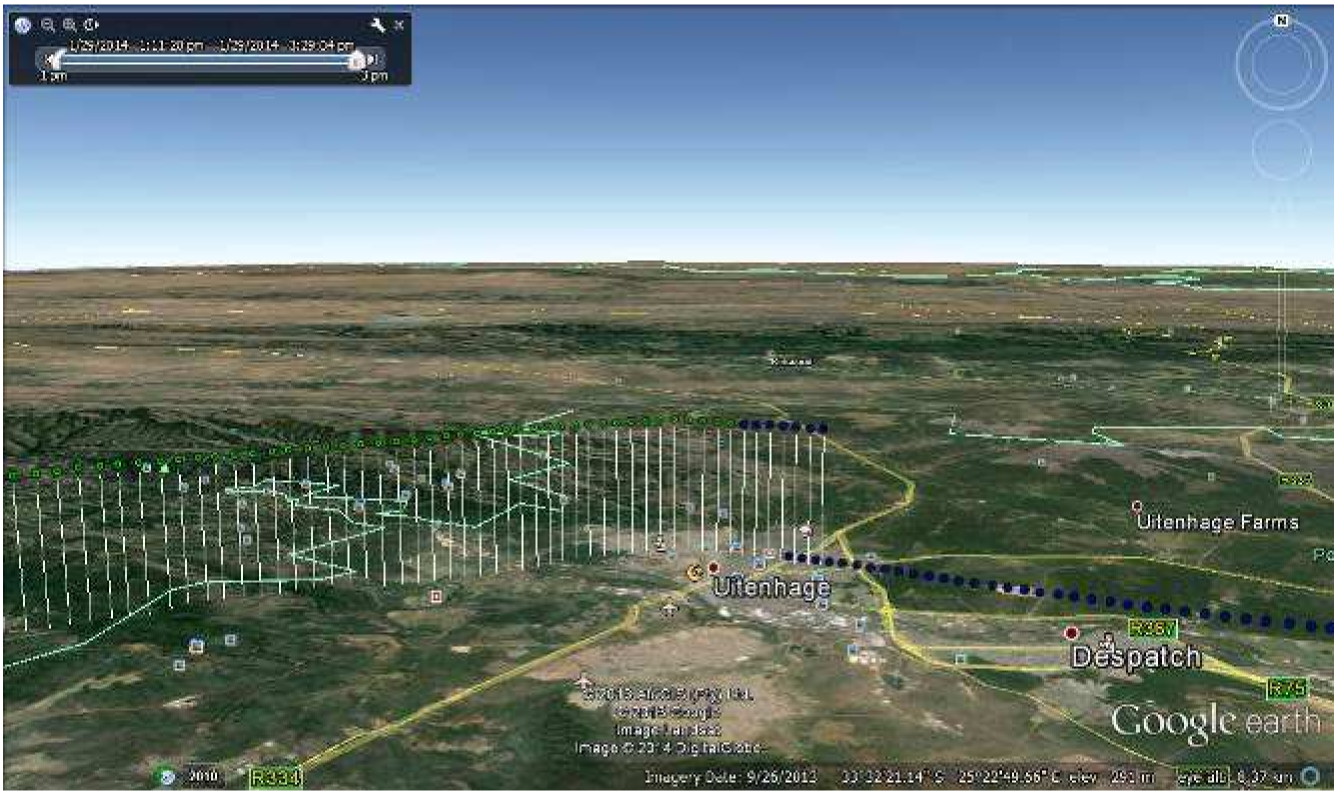



**Figure 2:** Following activation of mode C on transponder, aircraft ZU-ZOZ was identified on radar at 10 500 ft

## 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 3:** Photo of wreckage

## 1.4 Other damage

1.4.1 Minor environmental damage was caused. However, because the accident took place within the boundaries of a national park, the scene was subjected to a detailed clean-up afterwards.

## 1.5 Personnel information

1.5.1 Pilot-in-command (ZU-TZT)

| | | | | | |
|---|---|---|---|---|---|
| Nationality | South African | Gender | Male | Age | 50 |
| Licence number | 0270151582 | Licence type | Private pilot | | |
| Licence valid | Yes | Type endorsed | Yes | | |
| Ratings | Night rating | | | | |
| Medical expiry date | 31 March 2014 | | | | |
| Restrictions | Should keep suitable reading glasses readily available when exercising the privileges of pilot's licence. | | | | |
| Previous accidents | None | | | | |

According to available evidence (CAA pilot file), the pilot had conducted his practical flight test for his night rating on 16 August 2006 through an approved aviation training organisation (ATO).

On 29 March 2008 the pilot completed a language proficiency test for his radiotelephony communication at an approved ATO.

The pilot underwent his conversion onto the Giles G202 type aircraft in the United States of America. Following compliance with certain requirements as set out by the Regulator (Testing Standards division), the aircraft type was endorsed onto his South African pilot's licence on 12 July 2011.

The pilot's last skill check/competency check ride for his private pilot licence (aeroplane) on record (CAA pilot file, form CA61-03.4) was conducted on 28 March 2013. The last pilot logbook entry on record was also dated 28 March 2013. The flying hours reflected in the columns below were obtained from the logbook pages attached to the skills test form. Following the accident, his next of kin was contacted in order to obtain the pilot's logbook but they were unable to locate it. No evidence of such a document could be found on the scene of the accident, nor was it available in electronic format. There is therefore a ten-month period for which no flying history was available in an official logbook as called for in Part 61.01.8 of the Civil Aviation Regulations (CAR).

| **Total hours** | Day Dual hours | Day Solo hours | Night Dual hours | Night Solo hours | Instrument |
|---|---|---|---|---|---|
| **1 693,0** | 143,4 | 1 439,2 | 12,0 | 84,4 | 14,0 |

*NOTE: The pilot had a night rating endorsed on his pilot licence. He did not hold an instrument rating at any stage, but had completed some instrument flying (14 hours) towards his night rating.

Flying experience (as on 28 March 2013):

| | |
|---|---|
| Total hours | 1 693,0 |
| Total past 90 days | unknown |
| Total on type past 90 days | unknown |
| Total on type | 30,8 |

1.5.2 Pilot-in-command (ZU-ZOZ)

| | | | | | |
|---|---|---|---|---|---|
| Nationality | South African | Gender | Male | Age | 67 |
| Licence number | 0270055486 | Licence type | Airline transport | | |
| Licence valid | Yes | Type endorsed | Yes | | |
| Ratings | Instrument rating | | | | |
| Medical expiry date | 30 June 2014 | | | | |
| Restrictions | Should keep suitable reading glasses readily available when exercising the privileges of pilot licence. | | | | |
| Previous accidents | None | | | | |

Flying experience:

| | |
|---|---|
| Total hours | 23 400,0 |
| Total past 90 days | 25,6 |
| Total on type past 90 days | 18,4 |
| Total on type | 95,0 |

## 1.6 Aircraft Information

1.6.1 Aircraft

The Giles G-202 is a tandem two-seat aircraft suitable for aerobatics. The airframe structure makes extensive use of pre-impregnated graphite fibre materials. The aircraft is powered by a Lycoming AEIO-360-AIE engine. All aircraft skins are constructed from a sandwich of resin-impregnated carbon fibre cloth, with layers of honeycomb or foam material on each side. This combination provides an exceptional power to weight ratio. The rear cockpit is instrumented for the pilot-in-command, but most of the flight instruments are repeated at the front panel. The cockpit has been designed to offer the best ergonomics to support high Gs during competition or long cross-country flights.

**Figure 4:** Giles G-202 type aircraft

1.6.2 Airframe:

| | | |
|---|---|---|
| Type | Giles G-202 | |
| Serial number | KYLE 7 | |
| Manufacturer | Summer Noel B | |
| Year of manufacture | 2002 | |
| Total airframe hours (As on 25/01/2014) | 647,0 | |
| Last Annual inspection (hours & date) | 625,2 | 26 September 2013 |
| Hours since last Annual inspection | 21,8 | |
| Authority to Fly (issue date) | 27 September 2013 | |
| Authority to Fly (expiry date) | 25 September 2014 | |
| C of R (issue date) (present owner) | 21 August 2012 | |
| Operating categories | Private | |

NOTE: The airframe hours of the aircraft at the time of the accident could not be determined with accuracy as no official flight folio was recovered from the accident scene, nor any tachometer or Hobbs meter readings due to the destruction of the aircraft during the impact sequence. The hours entered in the table above were obtained from a certified true copy of the aircraft flight folio, which was obtained from the next of kin, with the last entry on page 5 of the document dated 25 January 2014 and the airframe hours entered being 647,0. This entry was made four days prior to the accident flight.

The aircraft was built in 2002 and imported into South Africa from the USA in 2012 (See Certificate of Registration {C of R} date in table above). The pilot was the sole owner of the aircraft following importation into South Africa.

Engine:

| | |
|---|---|
| Type | Lycoming AEIO-360-AIE |
| Serial number | L-27711-51A |
| Hours since new | 625,2 (at last annual inspection) |
| Hours since overhaul | TBO not yet reached |

Propeller:

| | |
|---|---|
| Type | MT Propeller MTV-9-B-C/C190-18B |
| Serial number | 98282 |
| Hours since new | 625,2 (at last annual inspection) |
| Hours since overhaul | TBO not yet reached |

### 1.6.3 Aircraft instrumentation fitted to ZU-TZT

According to the CAA aircraft file, the aircraft was equipped with the following instrumentation:

Airspeed indicator
Compass
Turn and slip indicator
Altitude meter
Acceleration G unit
Trim elevator indicator
VM1000 Engine monitor
Quartz chronometer and watch
Fuel gauges:
- (i) Left and right combination wing tank gauges
- (ii) Main tank gauge

### 1.6.4 Aircraft instrumentation fitted to ZU-ZOZ

According to the CAA aircraft file the aircraft was equipped with the following instrumentation, shown on a photo of the cockpit taken on 23 February 2014 for illustration purposes (Figure 5):

Airspeed indicator
Acceleration G unit
Turn indicator
Compass
Altitude meter
Micro-vision 1000 digital engine parameters
King KY-97A VHF radio (floor-mounted)
King KT-76 Transponder with Mode C (floor-mounted)
Fuel gauges (floor-mounted):

(i) Left and right combination wing tank gauge


**Figure 5:** Front and rear cockpit of aircraft ZU-ZOZ

## 1.7 Meteorological information

1.7.1 An official weather report was obtained from the South African Weather Services for 29 January 2014 along the intended route.

1.7.2 Dew point spread analysis

The dew point spread value, which is the difference between air temperature and dew point temperature, was determined for four automatic weather stations located between Port Alfred and Port Elizabeth on the day. A dew point spread value of 2℃ is seen as a good indication for the presence o f cloud with a base of 1 000 feet or lower.

The data analysed in Figure 6 shows a deterioration of the dew point spread and possible lowering of the cloud base in the Port Alfred area between 1000Z and 1100Z (yellow curve). The blue curve shows an increase in the spread towards Port Elizabeth consistent with the trend of increased dew point spread as shown in the METAR summary below. However, between 1115Z and 1130Z a rapid decrease in spread and possible drop in cloud base overhead Addo (red curve) and Grahamstown (green curve) occurs. It appears that the inland cloud base rapidly deteriorated during this period, especially overhead Addo.

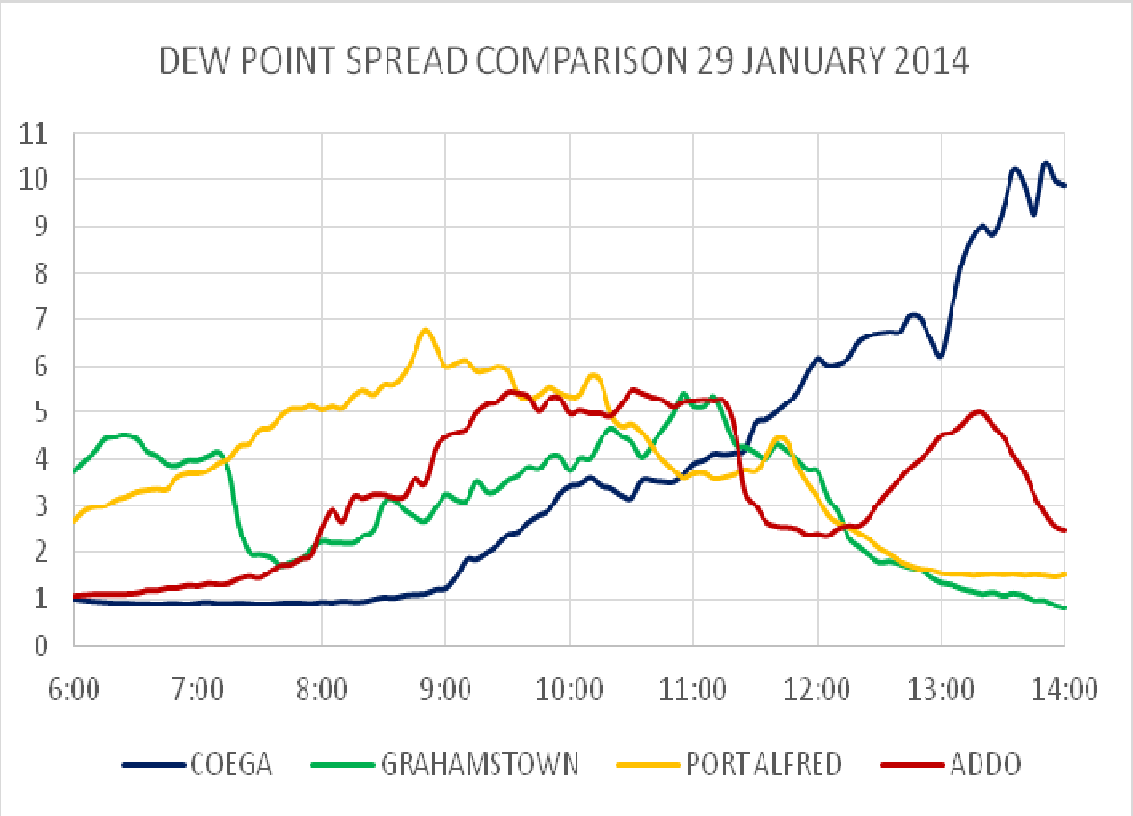



**Figure 6:** Dew point spread comparison for four automatic weather stations

1.7.3 Aviation routine weather report (METAR) summary for FAPE on 29 January 2014:

FAPE 291000Z 23014KT 9999 SCT008 BKN015 23/20 Q1009 NOSIG=
FAPE 291100Z 24016KT 9999 FEW009 BKN018 23/19 Q1009 NOSIG=
FAPE 291130Z 24018KT 9999 BKN021 23/19 Q1009 NOSIG=
FAPE 291200Z 24020KT 9999 BKN026 24/19 Q1009 NOSIG=
FAPE 291230Z 24015KT 9999 BKN034 25/19 Q1009 NOSIG=

Special meteorological aerodrome report(s)

SPECI FAPE 290631Z 24006KT 210V270 4800 -RA BKN006 23/22 Q1008 NOSIG
SPECI FAPE 290731Z 23011KT 5000 -RA BKN003 22/20 Q1008 NOSIG=

1.7.4 Satellite image taken at 1100Z on 29 January 2014 (Figure 7 and 8).

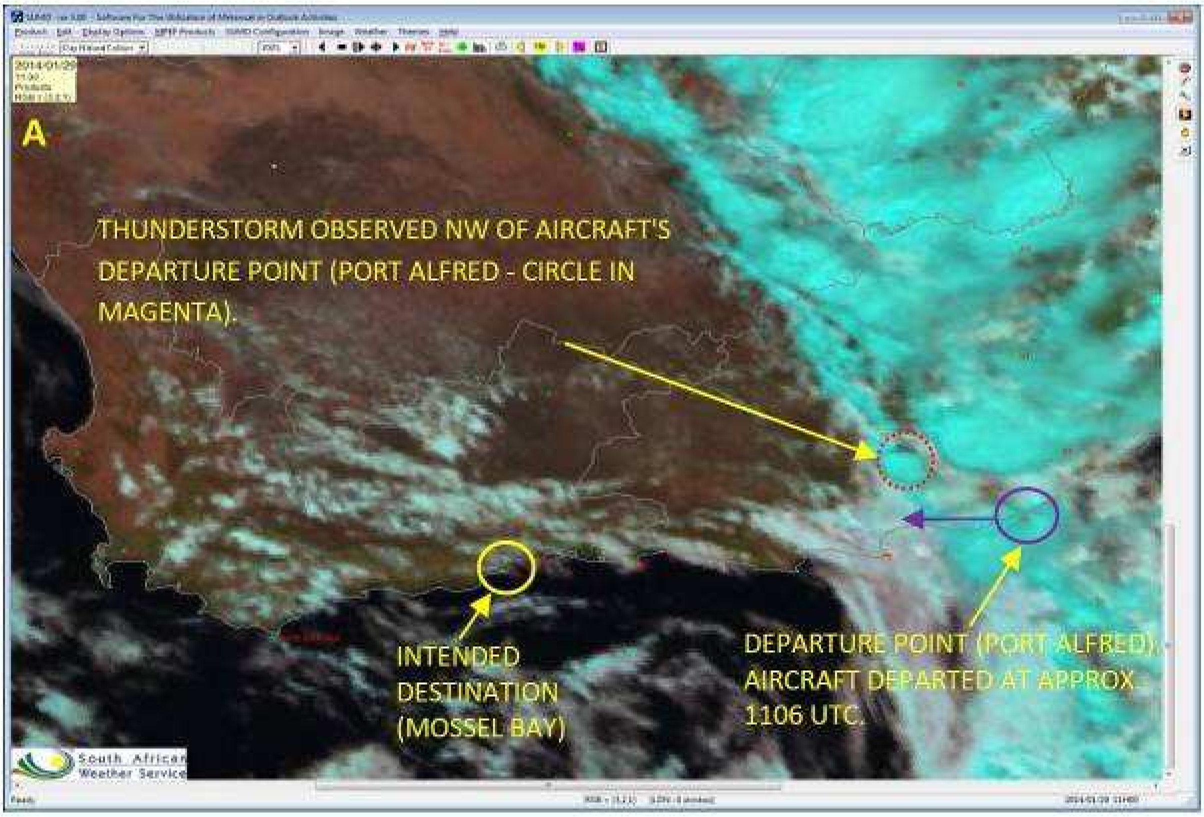



**Figure 7:** Satellite image taken on 29 January 2014 at 1100Z

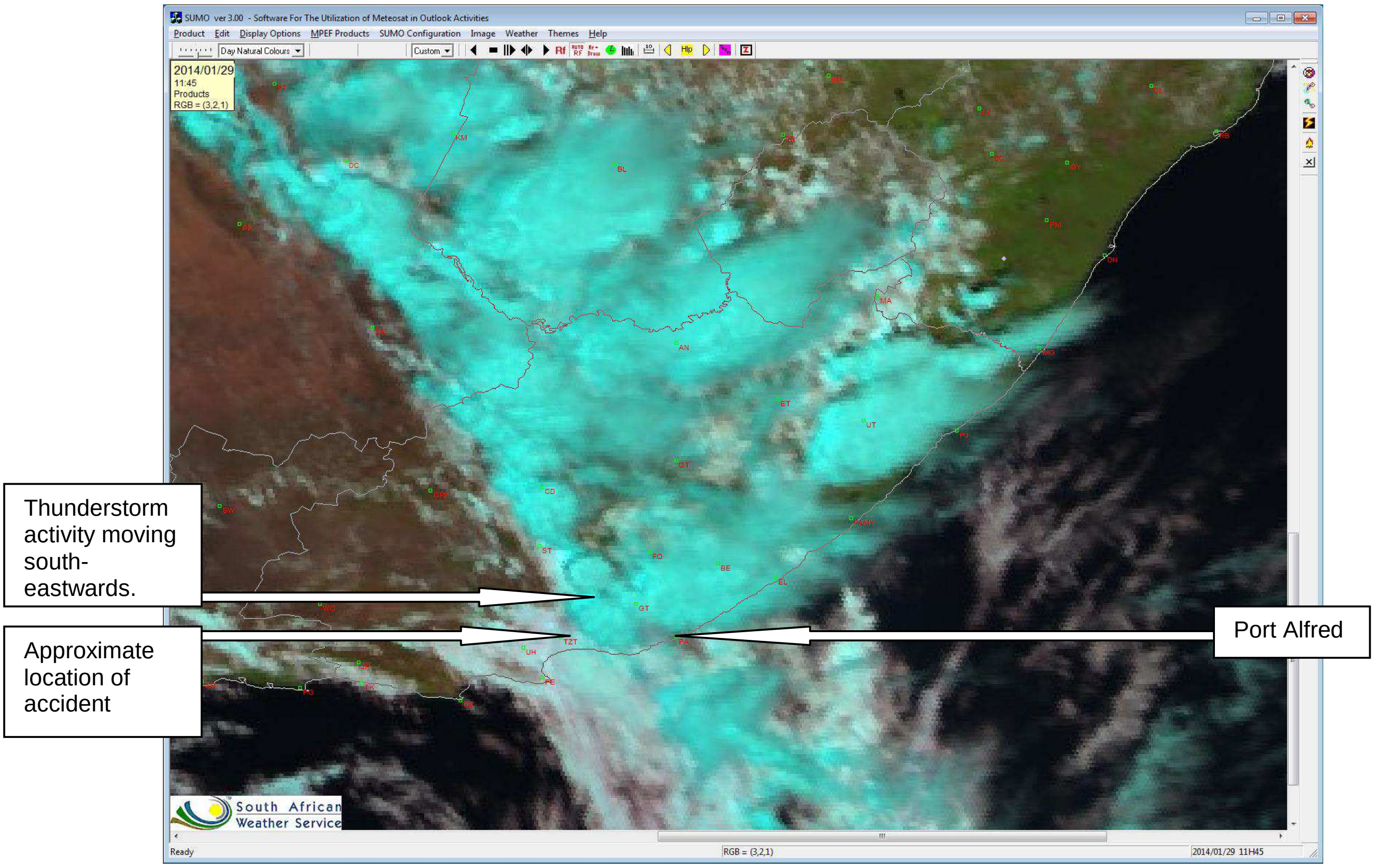



**Figure 8:** Satellite image taken on 29 January 2014 at 1145Z

### 1.7.5 Radar images taken of the Eastern Cape region on 29 January 2014

The image in Figure 9 was taken four (4) minutes after the aircraft took off from FAPA.

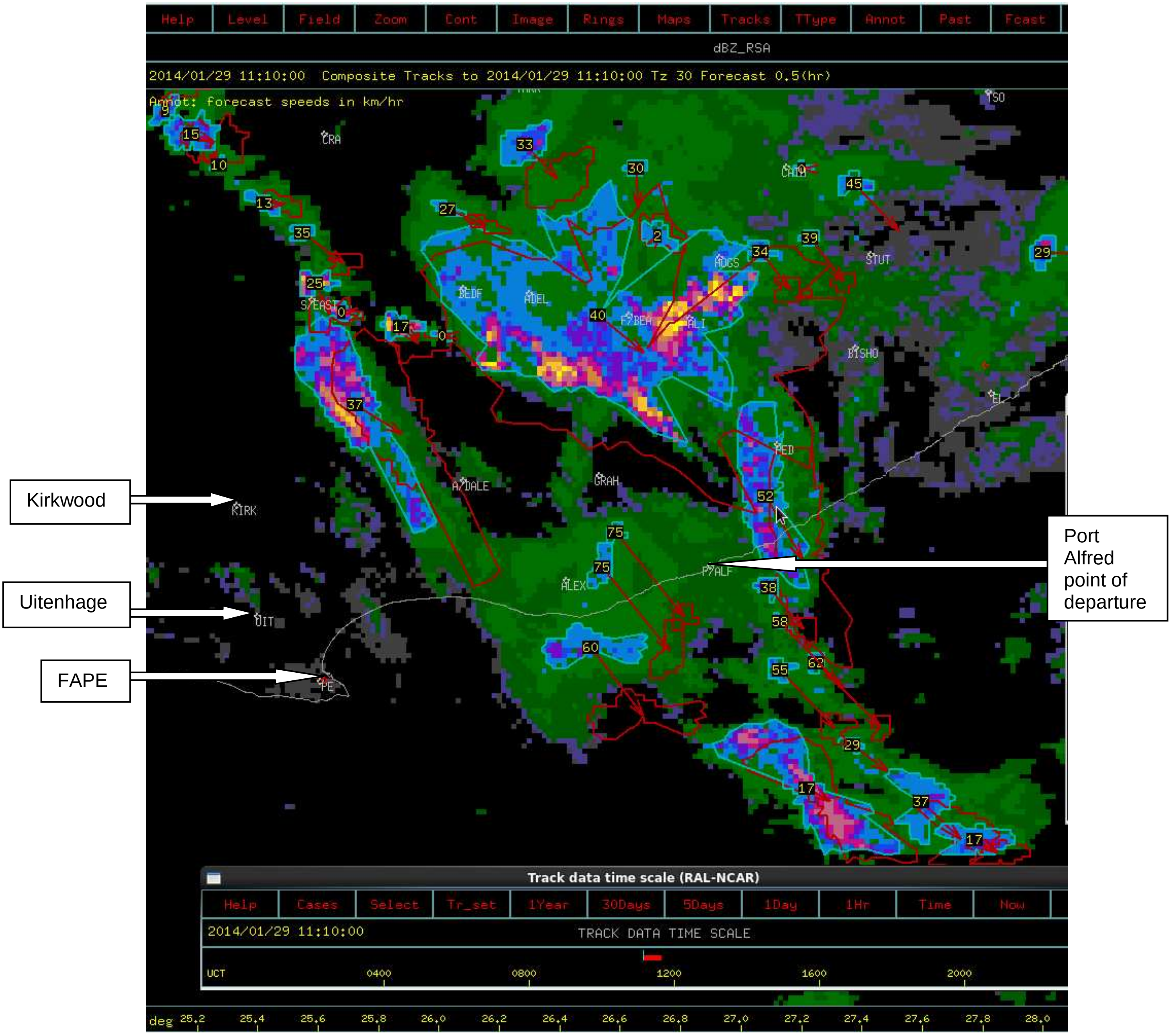



**Figure 9:** Radar image of Eastern Cape region taken on 29 January 2014 at 1110Z

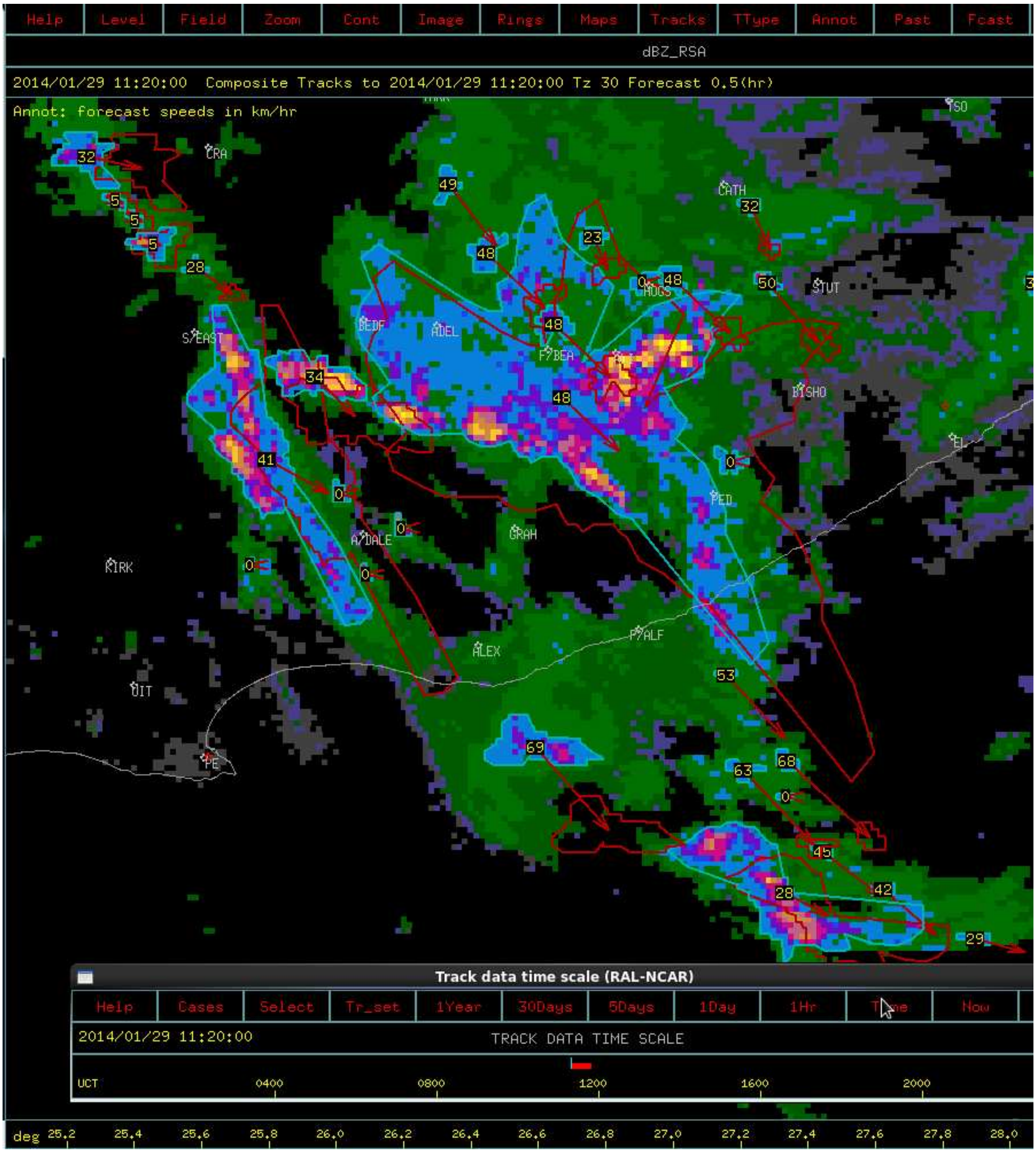



**Figure 10:** Radar image of Eastern Cape region taken on 29 January 2014 at 1120Z

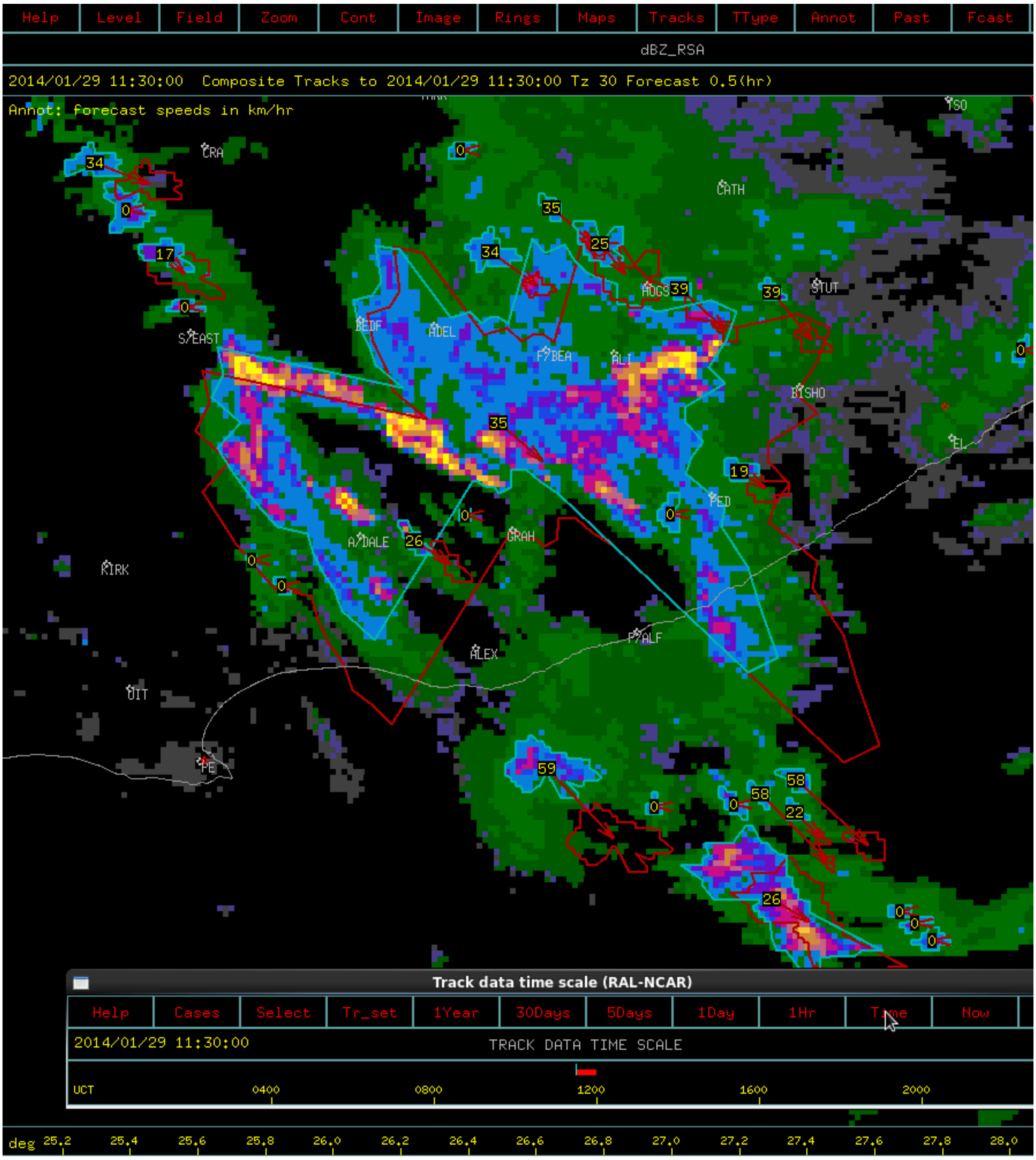



**Figure 11:** Radar image of Eastern Cape region taken on 29 January 2014 at 1130Z

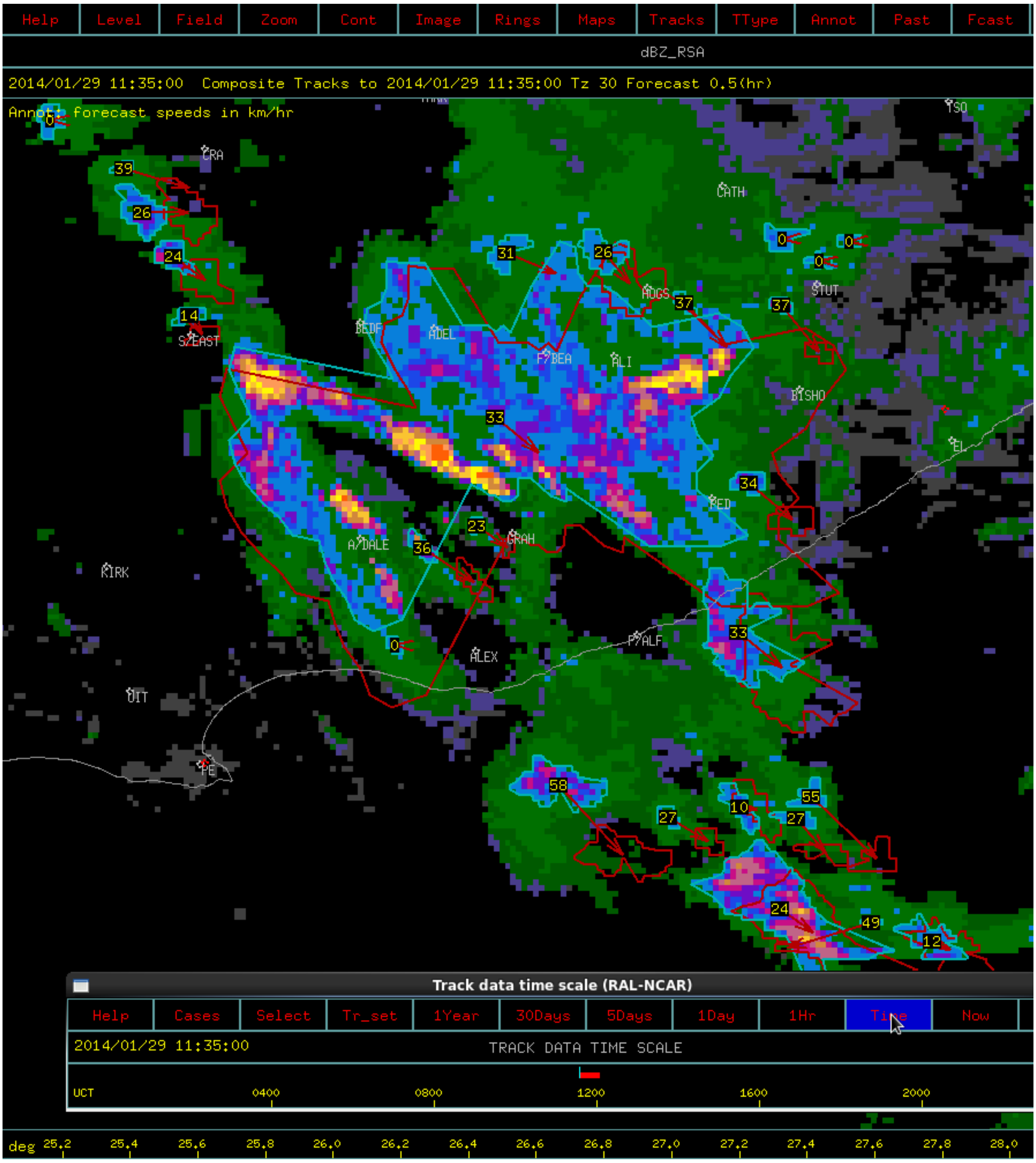



**Figure 12:** Radar image of Eastern Cape region taken on 29 January 2014 at 1135Z

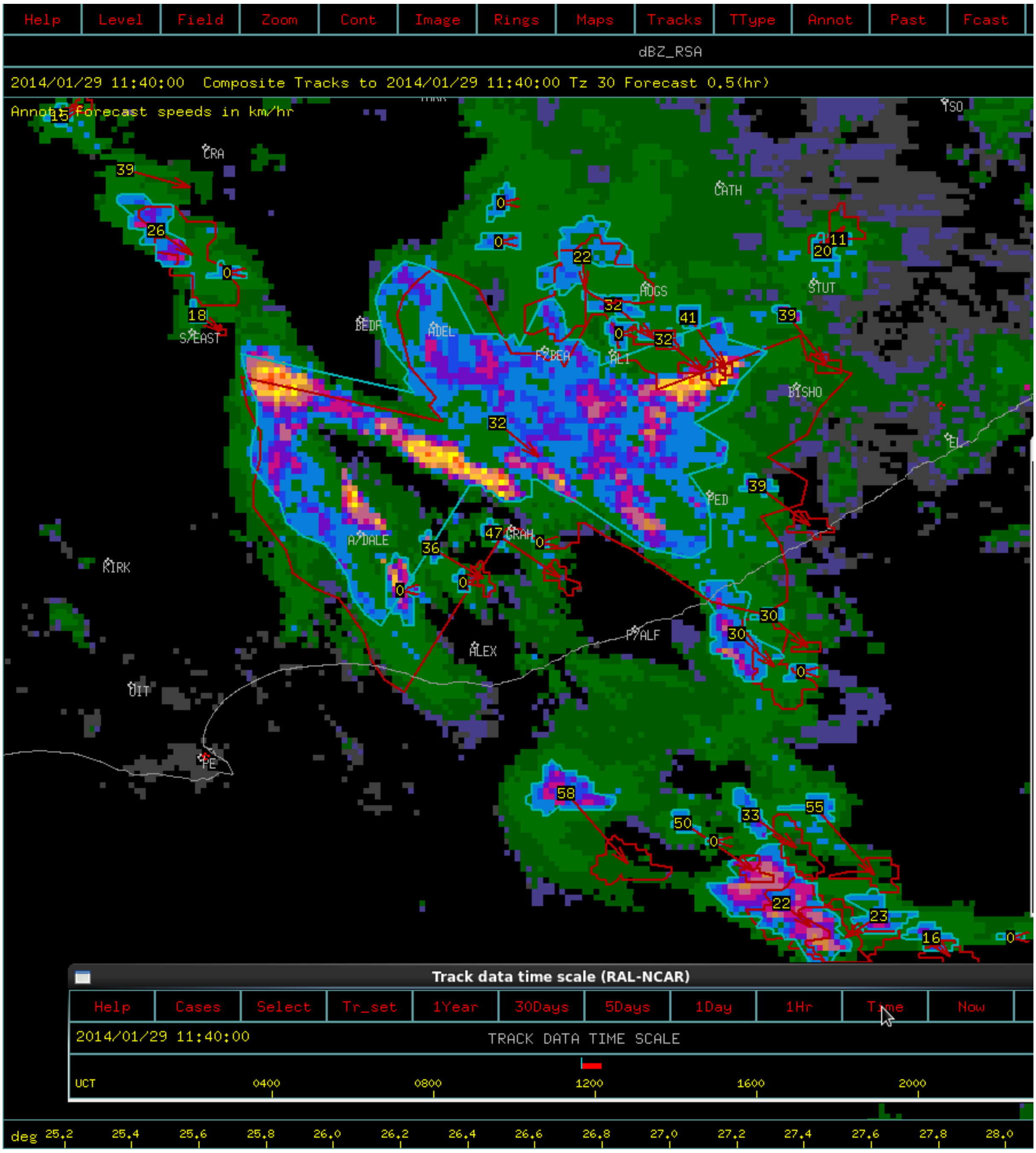



**Figure 13:** Radar image of Eastern Cape region taken on 29 January 2014 at 1140Z

1.7.6 The data tabled in Figure 14 was obtained from the automatic weather station at Addo (GPS position: 33°26 01.5 South 025°44 54.7 Ea st), which was located 11 nm (20 kilometres) towards the north of the accident site. The highlighted times are South African Standard Time (SAST) and give the time frame between the departure of the two aircraft from FAPA (1106Z) and the subsequent period during which the accident occurred.

South African Weather Service

Hugh van Niekerk
Regional Manager
0822338404
041 5811476

Weather Office
Private Bag X5991
Walmer
6065

ADDO ELEPHANT PARK - Climate Number: 0055447A7 Lat: -33.4420 Lon: 25.7480 Height: 142 m (Extracted 2014/02/05 07:45)

HOURLY DATA : Temperature (C) - 29 January 2014

| h01 | h02 | h03 | h04 | h05 | h06 | h07 | h08 | h09 | h10 | h11 | h12 | h13 | h14 | h15 | h16 | h17 | h18 | h19 | h20 | h21 | h22 | h23 | h24 | avg | mx | tm | mn | tm |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 22.3 | 22.5 | 22.3 | 22.2 | 22.2 | 22.2 | 22.2 | 22.5 | 23.2 | 24.9 | 25.9 | 26.2 | 26.4 | 22.5 | 22.6 | 22.6 | 22.6 | 23.9 | 23.1 | 22.1 | 21.3 | 20.8 | 20.2 | 20.0 | 23.4 | 26.7 | 1133 | 20.0 | 2354 |

HOURLY DATA : Humidity(%) - 29 January 2014

| h01 | h02 | h03 | h04 | h05 | h06 | h07 | h08 | h09 | h10 | h11 | h12 | h13 | h14 | h15 | h16 | h17 | h18 | h19 | h20 | h21 | h22 | h23 | h24 | avg | mx | tm | mn | tm |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 92 | 92 | 93 | 93 | 93 | 93 | 94 | 94 | 93 | 86 | 76 | 74 | 73 | 86 | 76 | 86 | 81 | 69 | 72 | 77 | 80 | 81 | 84 | 85 | 84.3 | 94 | 0750 | 68 | 1753 |

HOURLY DATA : Pressure hectopascal (hPa) - 29 January 2014

| h01 | h02 | h03 | h04 | h05 | h06 | h07 | h08 | h09 | h10 | h11 | h12 | h13 | h14 | h15 | h16 | h17 | h18 | h19 | h20 | h21 | h22 | h23 | h24 | avg | mx | tm | mn | tm |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 990.9 | 991.5 | 990.7 | 990.6 | 990.3 | 989.5 | 990.3 | 990.4 | 990.7 | 991.2 | 991.2 | 991.3 | 991.2 | 991.8 | 992.6 | 993.5 | 993.6 | 994.1 | 995.2 | 996.3 | 997.4 | 997.7 | 997.9 | 997.7 | 992.8 | 997.9 | 2300 | 989.5 | 0600 |

HOURLY DATA : Rain(mm) - 29 January 2014

| h01 | h02 | h03 | h04 | h05 | h06 | h07 | h08 | h09 | h10 | h11 | h12 | h13 | h14 | h15 | h16 | h17 | h18 | h19 | h20 | h21 | h22 | h23 | h24 | 00-24 | hr'ly |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | 0.2 | | 0.4 | | | 0.4 | | | | | | 0.2 | | 0.2 | | | | | | | | | 1.4 | 0.4 |

HOURLY DATA : Wind (deg m/s) - 29 January 2014

| h01 | h02 | h03 | h04 | h05 | h06 | h07 | h08 | h09 | h10 | h11 | h12 | h13 | h14 | h15 | h16 | h17 | h18 | h19 | h20 | h21 | h22 | h23 | h24 | Ave Spd | Max Gust | Time |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| S 2.9 | NE 1.7 | E 1.9 | ESE 1.2 | E 1.3 | Calm 0.0 | Calm 0.0 | SSW 1.3 | WNW 1.1 | WSW 2.1 | SW 2.7 | WSW 1.5 | Calm 0.0 | S 4.2 | S 5.5 | E 1.8 | E 2.7 | S 3.5 | S 4.2 | S 3.1 | S 1.4 | S 1.8 | SSE 1.2 | Calm 0.0 | 2.0 | SSW 10.5 | 1405 |

hxx = time (SAST)
(SAST ≈ UTC+2hrs)
Wind speed = m/s
(1m/s ≈ 2kts)

**Figure 14:** Temperature, humidity, pressure, rainfall and wind for Addo Elephant Park on 29 January 2014

### 1.7.7 Weather conditions

The most probable weather conditions at the time and place of the accident site were:

| | | |
|---|---|---|
| Cloud cover | - | eight oktas (8/8) of low cloud with a base of ± 500 ft AGL |
| Weather | - | light to moderate rain |
| Temperature | - | 22 ℃ |
| Dew point | - | 20 ℃ |

## 1.8 Aids to navigation

1.8.1 The aircraft was equipped with basic navigational aids, which consisted of a magnetic compass. According to available information, the pilot had a portable GPS on board as well as an iPad that was loaded with aviation software. The CAA aircraft file indicates that the aircraft was equipped with a Bendix King transponder, part number 066-1062-10, serial number 121303. No evidence of any aeronautical maps was found on the scene of the accident, nor was the transponder switched on during the flight (no radar tracking data was available).

## 1.9 Communication

1.9.1 The aircraft was equipped with a Bendix King radio, part number 064-1051-70, serial number 30070. The two aircraft flying from FAPA to FAMO were in radio contact with one another on the VHF frequency 123,45 MHz.

1.9.2 The pilot of ZU-ZOZ established radio contact with Port Elizabeth approach on the VHF frequency 120,40 MHz at 11:56:42Z and was identified on radar five nm southeast of Uitenhage after he was requested to squawk 6101. Following the squawk, the pilot was requested to activate his mode C function on the transponder as no height information was displayed on radar. Once the function was activated, the aircraft was identified at 10 500 feet and was instructed to turn left on a heading of 275° with no altitude deviation. The pilot was asked if he was instrument-rated; he confirmed that he was, and an IF flight plan was created. At 12:14:00Z the pilot cancelled his IF flight plan and requested to continue under VFR, whereupon he was requested to contact Cape Town for information.

1.9.3 After the pilot of ZU-ZOZ had landed at FAMO, he made several cell phone calls but could not make contact with the pilot of ZU-TZT, which he thought might have diverted to another aerodrome or might have conducted a precautionary/forced landing somewhere en route. ATC services was accordingly informed, and the pilot also made a statement at a police station in Mossel Bay with reference to a missing person.

1.9.4 No evidence could be obtained that the pilot of the accident aircraft was ever in contact with any ATC station.

## 1.10 Aerodrome information

1.10.1 The accident did not occur at or near an aerodrome.

## 1.11 Flight recorders

1.11.1 The aircraft was not equipped with a flight data recorder or a cockpit voice recorder, nor was it required to be fitted to this type of aircraft according to the regulations.

1.11.2 The aircraft was destroyed when it crashed, and the GPS and the iPad on board as well.

## 1.12 Wreckage and impact information

1.12.1 The aircraft hit the ground on a heading of approximately 010° magnetic. The impact sequence indicates that the aircraft was in a vertical nose-down attitude when it crashed in bushy terrain (Figure 15). The nose section, including the propeller, was embedded in a crater approximately one m in depth (Figure 16). The fuselage, which consists mainly of a composite type of material, shattered in a substantial number of pieces.

**Figure 15:** Crash site

**Figure 16:** Crater caused during the impact sequence

1.12.2 The engine was split diagonally along the crankcase centre with only the propeller hub left attached to the crankshaft flange (Figure 17). The spring steel undercarriage frame was dislodged from the airframe, the two main wheels had separated from the frame assembly and were found some 10 m from the impact crater. The horizontal and the vertical tailplane, including the tail wheel assembly, were entangled in a tree near the impact position. A parachute was found in the same location.

**Figure 17:** The engine which was severely deformed and split open

## 1.13 Medical and pathological information

1.13.1 The post mortem report indicates the cause of death to be multiple injuries.

1.13.2 No samples for blood alcohol, toxicology or carbon monoxide (CO) could be taken.

## 1.14 Fire

1.14.1 There was no pre- or post-impact fire.

## 1.15 Survival aspects

1.15.1 The impact forces associated with this accident were regarded well above that of human tolerance. The accident was therefore not considered survivable.

1.15.2 A parachute was located on the scene of the accident. According to available information, the pilot was wearing the parachute during the flight. The parachute was an emergency device, which the pilot could have utilised to bail out of the aircraft during an emergency phase of the flight where he or she felt it to be unsafe to continue with such a flight.

1.15.3 The bail-out procedure was explained to the investigating team by the pilot that was flying ZU-ZOZ at the time and mainly consisted of the following:

(i) Remove headset or helmet
(ii) Unbuckle your five point safety harness
(iii) Unlatched the canopy which will blow off towards the back
(iv) Position the aircraft in an attitude that would assist with the bail-out.

It is important to note that the pilot must be acquainted with parachute deployment procedures/skydiving, in order to have a successful jump. According to the pilot of ZU-ZOZ, the pilot of ZU-TZT had never received any official training in skydiving nor had he ever performed a jump, including a tandem jump.

1.15.4 There have been a few occurrences in South Africa including a mid-air collision between two gliders where the pilot of one of the aircraft bailed out, deployed his parachute and survived the ordeal. On 13 February 2010, two pilots wearing parachutes bailed out of an aircraft over the sea near Durban after the aircraft entered into a flat spin from which they were unable to recover. Both occupants landed on the beach.

1.15.5 The aircraft was not fitted with an emergency locator transmitter (ELT).

## 1.16 Tests and research

1.16.1 Due to the destruction of the aircraft during the impact sequence no tests or research were conducted on any part/component of the wreckage.

## 1.17 Organizational and management information

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

1.17.2 The last annual Inspection prior to the accident flight was certified on 26 September 2013 at 625,2 airframe hours. The approved person that performed the inspection was accredited by the Aero Club of South Africa.

## 1.18 Additional information

1.18.1 The Civil Aviation Regulations of 2011 as amended state:

Duties of PIC (pilot-in-command) regarding flight preparation

*Part 91.02.7 (1) The PIC of an aircraft shall not commence a flight unless he or she is satisfied that –*

*(a) the aircraft is airworthy;*

*(b) the instruments and navigation, communication and other equipment required for the particular type of operation to be undertaken, are installed and are serviceable and functioning correctly, except as provided for the MEL, if any;*

*(c) the aircraft has been released to service in accordance with Part 43;*

(d) *the mass of the aircraft at any time does not exceed the MCM calculated from the performance information provided in the AFM referred to in regulation 91.03.2, in terms of which the operating limitations referred to in Subpart 9 are complied with;*

(e) *the load carried by the aircraft is properly secured, fit to be conveyed in accordance with Part 92 and is so distributed that the centre of gravity is within the limits prescribed in the AFM referred to in regulations 91.03.2;*

(f) *an ATS flight plan, referred to in regulation 91.03.4, has been properly completed and filed with the appropriate ATSU, is such flight plan is required in terms of regulation 91.03.4;*

(g) *all the documentation and forms required to be carried on board are carried as specified in regulation 91.031;*

(h) *a check has been completed indicating that the operating limitations referred to in Subpart 8 will not be exceeded;*

(i) *the search and rescue information, referred to in regulation 91.01.4, is available on board;*

(j) *the requirements in respect of fuel, oil, oxygen, weather, minimum safe altitudes, aerodrome operating minima and availability of alternate aerodromes for the route being flown and any likely alternatives, whether flown under instrument of VFR, are complied with;*

Visual flight rules – Visibility and distance from cloud

**“***Part 91.06.21 (1) Every VFR flight shall be so conducted that the aircraft is flown with visual reference to the surface by day and to identifiable objects by night and at no time above more than three eighths of cloud within a radius of five nautical miles of such aircraft and –*

*(a) in the case of aircraft excluding helicopters operating under the conditions of visibility and distance from cloud equal to, or greater than, the conditions specified in tables 1 and 2 –*

**Table 1**

| Airspace | Forward flight visibility | Distance from clouds | Ground visibility and ceiling |
|---|---|---|---|
| Control zones | Five km | Horizontally: 600 metres<br><br>Vertically: 500 feet | No aircraft shall take off from, land at, or approach to land at an aerodrome or fly within the control zone when the ground visibility at the aerodrome concerned is less than five km and the ceiling is less than 1 500 feet. |
| Within an aerodrome traffic zone (which does not also comprise a control zone or part of a control zone) | Five km | Horizontally: 600 metres<br><br>Vertically: 500 feet | No aircraft shall take off from, land at, or approach to land at an aerodrome or fly within the aerodrome traffic zone when the ground visibility within such aerodrome traffic zone is less than five km and the ceiling is less than 1 500 feet. |

**Table 2**

| In airspace other than those specified in Table 1**Airspace class** | **Altitude band** | **Forward Flight visibility** | **Distance from cloud** |
|---|---|---|---|
| C F G | At and above 10 000 feet AMSL | 8 km | 1 500 m horizontally<br>1 000 ft vertically |
| C F G | Below 10 000 feet AMSL and above 3 000 feet AMSL, or above 1 000 feet above terrain, whichever is the higher | 5 km | 1 500 m horizontally<br>1 000 ft vertically |
| C | At and below 3 000 feet AMSL, or 1 000 feet above terrain, whichever is the higher | 5 km | 1 500 m horizontally<br>1 000 ft vertically |
| F G | At and below 3 000 feet AMSL, or 1 000 feet above terrain, whichever is the higher | 5 km | Clear of cloud and with the surface in sight |

*Provided that the minima specified in Table 1 are not applicable when:*

*(i) entering or leaving a CTR and the flight has received clearance from an ATSU to operate under Special VFR minima as prescribed in regulation 91.06.22; or*

*(ii) entering or leaving an ATZ on a cross-country flight; and*

*(iii) a pilot in the aircraft maintains two-way radio communication with the aerodrome control tower or aerodrome flight information service unit, in which case the pilot may leave or enter the aerodrome traffic zone when the ground visibility is equal to or greater than five km and the ceiling is equal to or higher than 500 feet.*

VFR flight determination and weather deterioration

*"Part 91.06.23 (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 flying 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 authorization to operate as a special VFR flight; or*

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

1.18.2 Search for missing aircraft

The ARCC in Johannesburg was activated on 29 January 2014 at 1449Z following information from ATC at FAPE that the aircraft ZU-TZT might be missing as it never arrived at its final destination (FAMO), and there was no contact with the pilot via aircraft radio or his personal cell phone. A land search commenced on the same day and an aerial search started the next morning. A joint operation centre was opened by the South African Police Services (SAPS) at Alexandria, which worked in close collaboration with the ARCC and the Disaster Management Office of the Eastern Cape.

During the morning of 30 January 2014, SAPS obtained a subpoena to gain information from the pilot of ZU-TZT's cellular service provider. This information was essential for search coordination, to determine in which vicinity the last signal of his cellular phone could be traced through IMEI (International Mobile Equipment Identity) mapping. It was noted that the signal of the cellular phone was picked up by the cellular phone towers at Hillcrest Farm on 29 January 2014 at 11:23:12Z and 11:26:41Z and at Boslaagte between 11:27:46Z and 11:32:04Z, which was the last signal that was picked up by any cellular phone tower. The search was then concentrated in the area of Boslaagte, being the last tower that indicated phone reception. The cellular service provider indicated that the reception area of a tower had a radius of between 2,5 and up to 25 kilometres. Boslaagte was approximately five kilometres from Nanaga and the search was intensified in that area up to the Sunday's River mouth.

At first light on 31 January 2014 the land as well as the aerial search continued. A team of motorcycle riders also joined the search party and they were asked to patrol the sand dunes from Sunday's River mouth to Woody Cape. Several leads were followed up during the course of the day from people that reported sightings of an aircraft, but none of them was positive.

On Saturday, 1 February 2014, the land as well as the aerial search continued. The wreckage of the aircraft was spotted around 1300Z from the air by the crew of a military helicopter that participated in the search. SAPS and the National Parks authority were accordingly informed, that the wreckage was located near Harvey's Loop in the Addo Elephant National Park. SAPS and Addo game rangers went to the scene. The searchers had to walk some distance over terrain where vehicles could not pass, with the game rangers providing protection against wild animals.

## 1.19 Useful or effective investigation techniques

1.19.1 None.

# 2. ANALYSIS

## 2.1 Pilot (Human)

The pilot of ZU-TZT was the holder of a valid private pilot's licence and had a night rating endorsed on it since August 2006. The aircraft he was flying at the time was equipped with basic instrumentation as listed in paragraph 1.6.3 of this report. The instrumentation was adequate for VFR as well as aerobatic flight. The pilot was leading the two-aircraft formation on their intended VFR flight to FAMO. It was clear from the statement obtained by the pilot of ZU-ZOZ that it was not very long after take-off from FAPA that they started to encounter inclement weather conditions associated with low cloud and rain and they started to deviate from their intended routing. The pilot of ZU-TZT had a serviceable GPS and iPad with various installed flight navigation applications. On arrival at the accident site, the investigators were able to recover the pilot's navigation flight log. The navigation log consisted of three legs: FAMG-FAPA-FAMO. There were no reference points en route on the navigation flight log and no evidence of a map at the accident scene. Once the pilot had entered inclement weather conditions his first task would have been to aviate. Flying in IMC conditions requires intense concentration. Due to the limited instrumentation, the pilot would have not been able to divert his attention to navigation at this stage of the flight. The limited visibility would not have allowed the pilot to reference ground features easily. The pilot opted to route towards an area in the distance with better visibility at a low altitude. Once the aircraft broke cloud, the pilot did indicate to the pilot of ZU-ZOZ via radio communication that he had reference to the ground. The pilot of ZU-ZOZ advised the pilot of ZU-TZT to initiate a climb and route towards the north to steer clear of high ground. To do so, the pilot would have to initiate a climbing turn to the right from his present position. The pilot would have only been able to refer to his airspeed indicator, altimeter and magnetic compass. It must be kept in mind that the pilot had 14 hours of instrument flying, which would have been obtained during his night rating training. The pilot would not have practised this manoeuvre in this particular aircraft under simulated IMC conditions. It is possible that during this manoeuvre the pilot became spatially disorientated and subsequently crashed. Radio contact between the two aircraft was lost and the pilot of ZU-ZOZ opted to initiate a climb and avoid cloud and rain.

The timeline of when and where the two aircraft got separated could not be determined with accuracy, but it is known that the pilot flying ZU-ZOZ opted to turn right towards the north as weather conditions appeared to be better in that direction. From the radar data (track data) on the aircraft ZU-ZOZ, it was apparent that the pilot did indeed turn towards the north and deviated substantially from the straight line track.

It should be kept in mind that two telephone calls were made to the weather office in Port Elizabeth by the pilot flying ZU-ZOZ prior to their departure from FAPA. During the first call, the weather forecaster stated that *flight was not recommended*, and that the pilot should call him back in approximately 90 minutes for an update on the prevailing weather conditions. The pilot did call back two hours later; this time he spoke to a different forecaster, who indicated that there were still some scattered showers moving through the area, and some fog along the coast with the cloud base varying between 300 and 500 feet AGL. To the west of Uitenhage, weather conditions were starting to improve with a 2 000-feet ceiling at George aerodrome (FAGG), which was 227 nm (420 kilometres) from FAPA.

Taking the prevailing weather conditions into consideration, the pilots decided to take off and continue with the flight. The pilot of ZU-ZOZ indicated that at some stage during the flight he considered turning back to FAPA but would not have been able to locate the aerodrome without the aid of an electronic navigational device (i.e., GPS) as weather conditions in that direction had also started to deteriorate. This was after the two aircraft became separated from one another in the air. The above information did not meet the requirement for VFR flight as contained in Part 91.06.21(1) of the CAR, as they were flying in and out of cloud and encountered conditions associated with heavy rain, which reduced visibility even further.

It was evident from the interview as well as the statement obtained from the pilot of ZU-ZOZ that they were continuously flying penetrating cloud without reference to the ground at times.

## 2.2 Aircraft (Machine)

Both the aircraft were equipped with limited instrumentation and certified for VFR flight only. The aircraft was destroyed during the impact sequence and the engine was found to have split open. The propeller hub was still attached to the crankshaft flange. Several fractured pieces of the wooden propeller blades where dug out of the crater, approximately 15 to 30 cm in length. It was evident from these fractured pieces that the engine was delivering power when the aircraft crashed to the ground. Both wingtips where accounted for, including the aerobatic sight gauge that was fitted to the left wing. The empennage and horizontal stabilisers, including the elevators and tail wheel, were found entangled in a tree. Due to the extent of the damage to the aircraft, it was not possible to reconstruct the wreckage. Because the propeller (sections thereof), the empennage (tail section) and both wingtips were located in the same area, an in-flight structural failure of a major part of the aircraft was eliminated.

## 2.3 Environment

Weather conditions along the intended route were not conducive to VFR flight, with coastal fog as well as low cloud and light to moderate rain forecast. In his statement, the pilot flying ZU-ZOZ indicated that he constantly had to alter his route and height in order to avoid cloud and rain. He indicated that at a certain stage during the flight he encountered heavy rain, with very limited to no forward visibility. He further indicated that he at some stage thought he was going to pick up ice, which made him rethink the bailout procedure should the engine fail. Not having an idea of his position that was something that crossed his mind.

Weather conditions at the place of the accident were most probably eight oktas (8/8) of cloud at approximately 500 feet AGL in light to moderate rain.

## 2.4 Mission

The intention of the two aircraft was to fly nonstop from FAPA to FAMO under VFR flight rules over a distance of 244 nm, which was within the range of the aircraft. The pilot leading the formation was using electronic navigational aids (GPS and iPad) as the instrumentation on board the aircraft was limited. The pilot that followed, planned his route on an aeronautical map he had purchased from the pilot shop at FAPA. He had no electronic navigational aids on board his aircraft.

The pilot flying ZU-ZOZ requested assistance from ATC once he had broken cloud near Uitenhage, where he was identified on secondary surveillance radar at 10 500 feet after he had entered the given squawk code and activated the mode C function on the transponder. From there he turned in a southwesterly direction towards the coast and was able to proceed along the coastline and landed at FAMO, two hours and twenty minutes after he took off from FAPA.

He informed ATC that he had lost radio communication with the pilot of ZU-TZT along the route and was therefore uncertain of his whereabouts.

## 2.5 Conclusion

Both pilots made a conscious decision to press on with the flight, knowing that weather conditions did not meet the minimum for VFR flight as stipulated in the regulations. Shortly after take-off from FAPA, they had already started to scud run, trying to remain clear of cloud and rain. Not very long after take-off, the two aircraft became separated from one another as each pilot opted for the routing he felt was going to work out the best for him at that stage. The pilot of ZU-TZT opted to remain low and the pilot of ZU-ZOZ attempted to remain clear of cloud but was unable to do so for the duration of the flight as weather conditions associated with low cloud and rain moved through the area.

The pilot flying ZU-ZOZ was an experienced pilot, who held an Airline Transport pilot's licence with an instrument rating and had accumulated over 23 000 flying hours. Because he did not have any electronic navigational equipment on board his aircraft, he was unable to return to FAPA. Inclement weather conditions had moved in over the area and he indicated that he would not have been able to locate the aerodrome again. He subsequently took a substantial detour from the intended route to climb through the clouds. He knew that he had to ensure the aircraft's wings were level before doing so and once he made the decision to start climbing, he focus his attention straight ahead on the bubble in the turn indicator. He knew that if he turned his head in any direction he would become spatially disorientated and lose control of the aircraft. He therefore also chose to avoid speaking to ATC as they might have requested a squawk or radio frequency change and he knew if he had to move his head he would lose control of the aircraft and most probably end up in a graveyard spiral. He therefore only spoke to approach control once he was on top of the cloud, as he had no idea of his current position.

When the two aircraft became separated from one another, the pilot of ZU-TZT made the decision to fly lower than ZU-ZOZ. It could have been that he decided to remain low in an attempt to stay clear of cloud as far as possible and within visual reference to the ground. With the terrain along the route being mountainous, it might not have been possible to maintain visual contact with the ground at all times. Low clouds that might have been down to the ground, over high ground or very near the ground could have resulted in the pilot having to make a decision to penetrate cloud, not knowing how long he would be required to fly in IMC conditions. With limited instrumentation and no reference to any form of artificial horizon, the pilot most probably became spatially disorientated and lost control of the aircraft after he entered conditions associated with IMC flight. The impact sequence indicated that the aircraft was in a vertical nose-down attitude when it crashed, which was indicative of a loss of control event in flight.

# 3. CONCLUSION

## 3.1 Findings

3.1.1 The pilot was the holder of a valid private pilot's licence and he had the aircraft type endorsed on his licence.

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

3.1.3 The pilot was the holder of a valid aviation medication certificate issued by a CAA-approved medical examiner.

3.1.4 The pilot's last skills test/competency check ride for the revalidation of his private pilot's licence was conducted on 28 March 2013.

3.1.5 The aircraft was in possession of a valid authority to fly at the time of the accident.

3.1.6 The last annual inspection that was carried out on the aircraft prior to the accident flight was certified on 26 September 2013 at 625,2 airframe hours.

3.1.7 After landing at FAPA, ZU-TZT and ZU-ZOZ uplifted 70 and 100 litres of Avgas respectively.

3.1.8 The pilot of ZU-TZT bought batteries for his portable GPS at Port Alfred and the pilot of ZU-ZOZ bought two aeronautical maps, a ruler and a fine liner at the pilot shop at FAPA. He had no electronic navigational aids on board his aircraft.

3.1.9 The pilot flying ZU-WAN returned to FAPA shortly after take-off, as she was not comfortable flying with the prevailing weather visible towards the west. The other two, ZU-TZT and ZU-ZOZ, continued with the flight from FAPA to FAMO. The pilot flying ZU-WAN did not intend to continue with the flight; she landed back at FAPA six minutes after she took off.

3.1.10 During the approximately three hours that the two aircraft were on the ground at FAPA, the pilot of ZU-ZOZ phoned the weather office in Port Elizabeth twice for a weather update. The first weather forecaster did not recommend any flight and requested that he phone back later. The second forecaster provided the pilot with the prevailing weather at the time, which still indicated low cloud 300 to 500 ft AGL.

3.1.11 According to a statement by the pilot of ZU-ZOZ, the pilot of ZU-TZT was flying the lead for the flight to FAMO as he had a portable GPS and an iPad loaded with the appropriate aviation software on board his aircraft.

3.1.12 Both aircraft were equipped with transponders. According to available information, no radar data was obtained for ZU-TZT, which indicates that the transponder was switched off during the flight.

3.1.13 The transponder on board ZU-ZOZ was switched on and displayed mode C data until the aircraft was approximately 20 nm outbound of FAPA, when the mode C function stopped. Following communication between the pilot and approach control at FAPE, the mode C function was switched on again and the aircraft height was displayed on the secondary surveillance radar at 10 500 feet abeam just north of Uitenhage. For a period of 40 minutes, no mode C data (height) was available on the secondary surveillance radar.

3.1.14 Weather conditions associated with low cloud and rain were encountered by the two aircraft shortly after take-off from FAPA en route to FAMO. Both the pilots failed to adhere to the requirements of Part 91.06.21 of the CAR by entering conditions associated with low cloud and rain, which resulted in a loss of visual reference to the surface.

3.1.15 There was no ELT on board the accident aircraft. An extended search was initiated by the ARCC for the missing aircraft and the wreckage was found three days later where it had crashed in the Addo Elephant National Park.

3.1.16 The aircraft crashed to the ground in a vertical nose-down attitude.

### 3.2 Probable cause/s

3.2.1 The pilot most probably became spatially disoriented after he entered conditions associated with IMC flight, and lost control of the aircraft.

### 3.3 Contributory factor/s:

3.3.1 Neither the pilot nor the aircraft was appropriately rated or certificated to enter conditions associated with IMC flight, which constitutes a contravention of Part 91.06.21(1) of the Civil Aviation Regulations of 2011.

## 4. SAFETY RECOMMENDATIONS

4.1 It is recommended that SACAA publish an article in the *Safety Link* magazine and on their website on pilots involved in accidents, who were required to adhere to VFR flight rules as stipulated in the CAR and then made the decision to enter IMC, with fatal consequences.

This is an ongoing aviation safety violation, which can be avoided if proper flight planning is adhered to and discipline and respect for human life is exercised. It is a known fact that weather conditions do sometimes change quickly, but very few such events have led to fatal accidents in South Africa. It would be accurate to say that in 99% of all the cases where pilots took a conscious decision to enter into IMC,, neither the pilots nor the passengers on board the aircraft ever arrived home. In these days of modern technology at everyone's finger-tips, there is very little excuse for flying into inclement weather conditions if the pilot and aircraft are not appropriately rated or certified to do so.

It is further recommended that the pilot of ZU-ZOZ give something back to aviation since he was able to survive such an ordeal. It is recommended that he participate in the SACAA Summer/Winter Weather campaign, educating aviators on the dangers associated with these types of operations.

4.2 It is recommended that pilots subscribe to the South African Weather Services Aviation Weather website (http://aviation.weathersa.co.za), which provides regular updates on prevailing weather conditions all over South Africa as well as several of our neighbouring states. The website offers several selections, such as viewing satellite images and obtaining regular radar updates that cover most of the big towns and cities over the entire country. The radar are can also be zoomed in to a radius of 50 km.

## 5. APPENDICES

5.1 Annexure A (178 Seconds)

5.2 Annexure B (Spatial disorientation)

## ANNEXURE A

***178 Seconds***

How long can a pilot who has no instrument training expect to live after he flies into bad weather and loses visual contact? Researchers at the University of Illinois found the answer to this question. Twenty students "guinea pigs" flew into simulated instrument weather, and all went into graveyard spirals or rollercoasters. The outcome differed in only one respect; the time required until control was lost. The interval ranged from 480 seconds to 20 seconds. The average time was 178 seconds – two seconds short of three minutes.

***Here's the fatal scenario***

The sky is overcast and the visibility is poor. That reported 5-mile visibility looks more like two, and you can't judge the height of the overcast. Your altimeter says you're at 1500 but your map tells you there's local terrain as high as 1200 feet. There might even be a tower nearby because you're not sure just how far off course you are. But you've flown into worse weather than this, so you press on.

You find yourself unconsciously easing back just a bit on the controls to clear those non-too-imaginary towers. With no warning, you're in the soup. You peer so hard into the milky white mist that your eyes hurt. You fight the feeling in your stomach. You swallow, only to find your mouth dry. Now you realise you should have waited for better weather.

The appointment was important – but not that important. Somewhere, a voice is saying "You've had it – it's all over!"

You now have 178 seconds to live. Your aircraft feels in an even keel but your compass turns slowly. You push a little rudder and add a little pressure on the controls to stop the turn but this feels unnatural and you return the controls to their original position. This feels better but your compass is now turning a little faster and your airspeed is increasing slightly. You scan your instrument panel for help but what you see looks somewhat unfamiliar. You're sure this is just a bad spot. You'll break out in a few minutes. (But you don't have several minutes left…

You now have 100 seconds to live. You glance at your altimeter and are shocked to see it unwinding. You're already down to 1200 feet. Instinctively, you pull back on the controls but the altimeter still unwinds. The engine is into the red – and the airspeed, nearly so.

You have 45 seconds to live. Now you're sweating and shaking. There must be something wrong with the controls; pulling back only moves that airspeed indicator further into the red. You can hear the wind tearing at the aircraft.

You have 10 seconds to live. Suddenly, you see the ground. The trees rush up at you. You can see the horizon if you turn your head far enough but it's at an unusual angle – you're almost inverted. You open your mouth to scream but …

…you have no seconds left.

Source: Transport Canada, Safety Information

## 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 recognise 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.

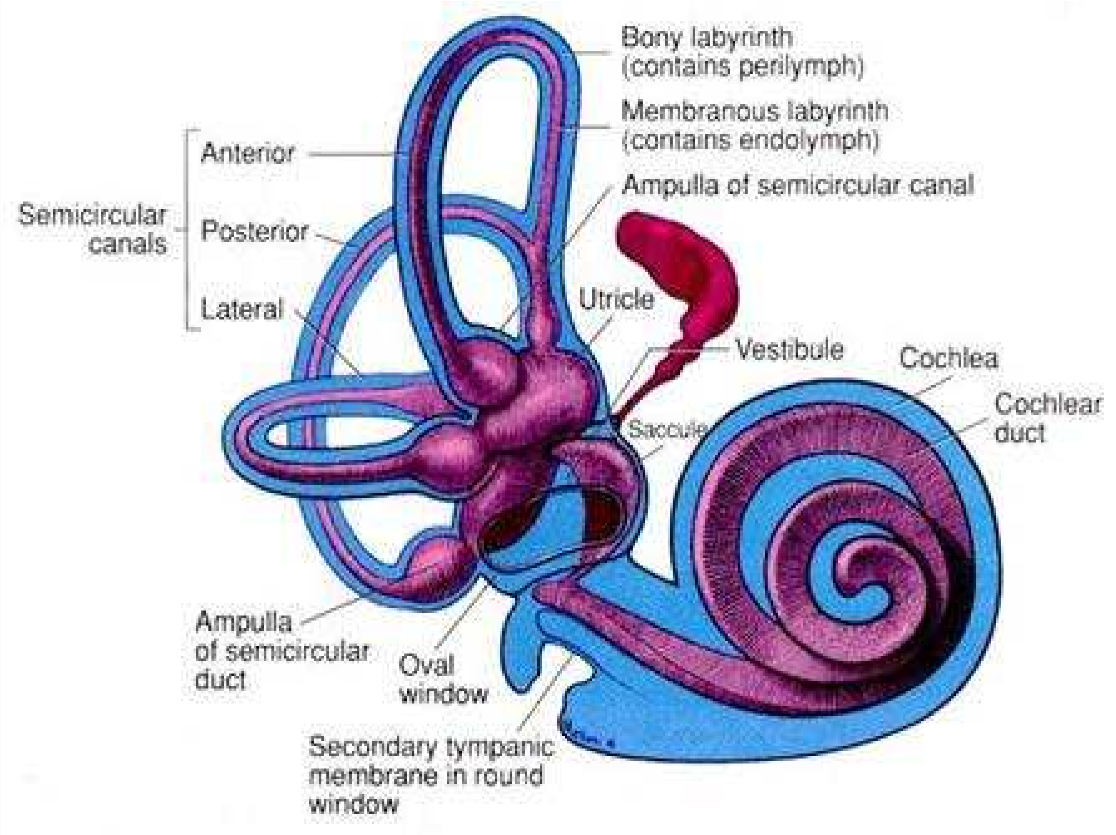
There are two main categories (or types) of common spatial disorientation "illusions" that humans are susceptible to in flight:

> **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.

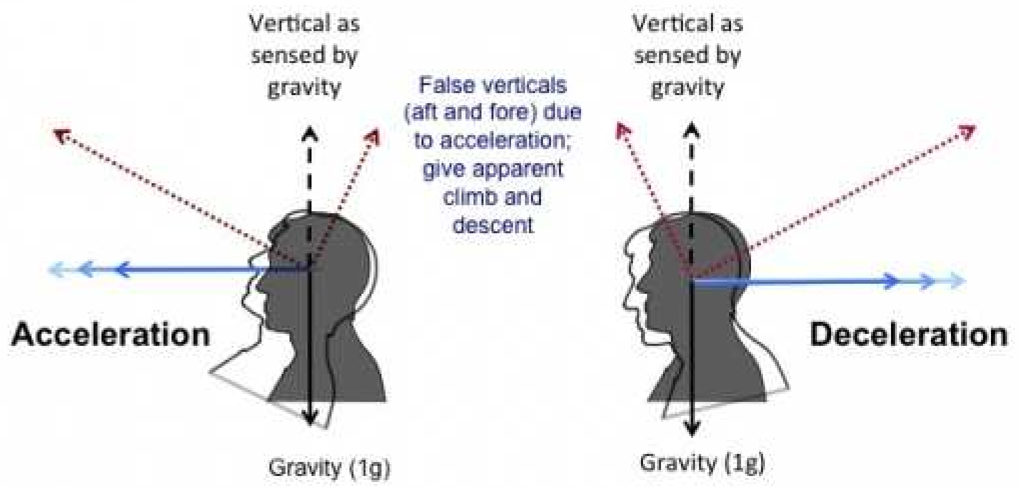
It should be noted, that once the acceleration (or deceleration) ceases, and a constant velocity is reached (including zero velocity), the fluid "catches-up" with the head and becomes still, closely followed by the hair-like detectors. With no force exerted by the fluid on the detectors the “head” experiences 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.

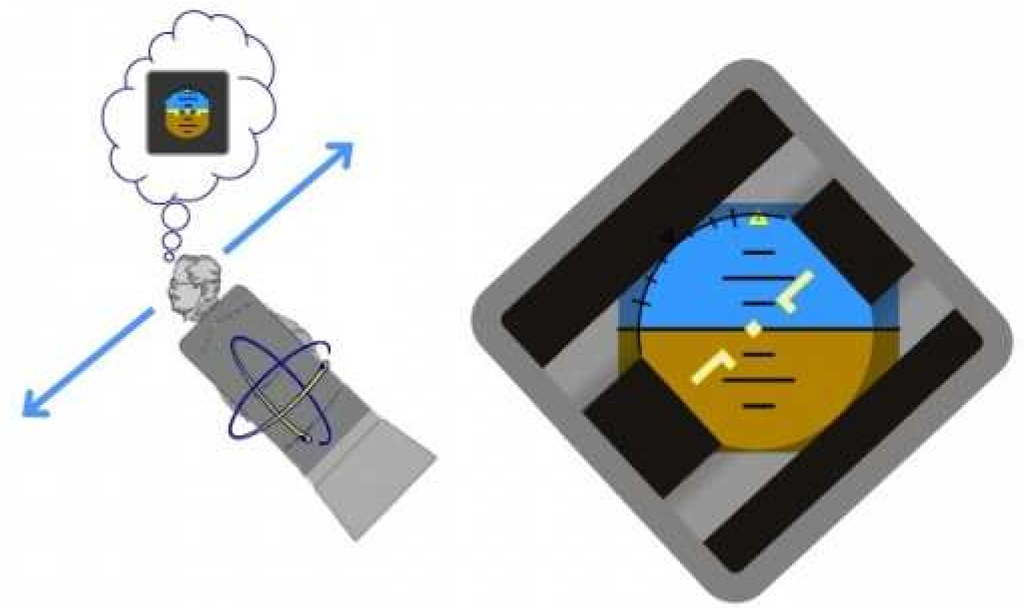
The automatic somatic response to a perceived dive is to increase the aircraft's attitude. If the pilot considers the situation immediately dangerous i.e. when close to the ground, perhaps even over the threshold, then any pull-up response will slow the aircraft further and increase the risk of stalling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

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.