AIRCRAFT ACCIDENT REPORT AND EXECUTIVE SUMMARY

				Reference:	CA18/2/3/9463
Aircraft Registration	V5-NRS	**Date of Accident**	16 August 2015	**Time of Accident**	0429Z
Type of Aircraft	Cessna 441 (Aeroplane)		**Type of Operation**	Commercial (Medical Rescue, Part 138)	

Pilot-in-command Licence Type	Commercial (Namibia)	**Age**	53	**Licence Valid**	Yes
Pilot-in-command Flying Experience	Total Flying Hours	6353.0		Hours on Type	1357.9

Last point of departure	Oranjemund Airport (FYOG) Namibia
Next point of intended landing	Cape Town International Airport (FACT) Western Cape

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

On the farm Maastrecht, approximately 8 nm to the North of FACT. (GPS position S 33°50'56.3“ E 018°34'57.5”) elevation 468ft AMSL.

Meteorological Information	Wind: 160°M/15 Knots; Visibility: 6000m; Temperature: 11°C; Dew point: 11°C; Cloud cover: Broken; Cloud base: 500ft.				
Number of people on board	2+3	**No. of people injured**	0	**No. of people killed**	5

Synopsis

On 15 August 2015 at 2351Z a Cessna 441 aeroplane, with two crew and a paramedic on board took off from Eros Airport (FYWE) on a medical evacuation flight with their intended final destination Cape Town International Airport (FACT).

The aircraft landed at Oranjemund (FYOG) to pick up a male patient and his daughter. At 0206Z the aircraft departed from FYOG on a mercy flight to FACT. At 0343Z the aircraft made the first contact with FACT area and the aircraft was put under radar control. At 0355Z, area control advised the crew that there was a complete radar failure. The aircraft was on a descent to 6500 ft when approach advised them to prepare for a VOR approach for runway 19.

At 0429Z, while on approach for landing at FACT, all contact was lost with the aircraft. At approximately 0556Z the aircraft's wreckage was located approximately 8 nm to the north of FACT. All five occupants on board were fatally injured and the aircraft was destroyed by impact and post impact fire.

The investigation revealed the aircraft collided with terrain during instrument meteorological condition (IMC) conditions while on the VOR approach for Runway 19 at FACT. At the time the ILS was working, however the approach controller offered a VOR approach for separation with an outbound aircraft as the radar was unserviceable.

Probable Cause

The aircraft collided with terrain during instrument meteorological flight conditions while on the VOR approach for Runway 19 at FACT.

SRP Date	12 September 2017	Release Date	20 September 2017

AIRCRAFT ACCIDENT REPORT

Name of Owner	: Namibia Rescue Services PTY (Ltd)
Name of Operator	: Westair Aviation PTY (Ltd)
Manufacturer	: Cessna Aircraft Company
Model	: C441
Nationality	: Namibian
Registration Marks	: V5-NRS
Place	: Cape Town
Date	: 16 August 2015
Time	: 0429Z

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 (2011) this report was compiled in the interest of the promotion of aviation safety and the reduction of the risk of aviation accidents or incidents and ***not to establish blame or liability****.*

Disclaimer:

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

1. FACTUAL INFORMATION

1.1 History of Flight

1.1.1 On Saturday 15 August 2015, at approximately 2351Z, two pilots and a paramedic took off in a Cessna 441, registration V5-NRS, from Eros Airport in Namibia (FYWE) for Oranjemund Airport (FYOG) on the first leg of a medical evacuation flight.

1.1.2 Approximately two hours later, at 0206Z on 16 August 2015, the flight paramedic phoned the E-Med Rescue Centre at FYWE and informed the duty personnel that the patient and his daughter had been taken on board and the aircraft would be taking off for Cape Town shortly.

1.1.3 The aircraft subsequently took off from FYWE, and at 0343Z the pilots made contact with the Area Control Centre in Cape Town. At 0345Z, the aircraft was rerouted from the ERDAS1B arrival to the EVUKI1B arrival for Runway 19

1.1.4 At 0355Z, Area Control advised the pilot they had a complete radar system failure and the crew did not acknowledge this advice.

1.1.5 At 0410Z, the aircraft made contact with Cape Town Approach and was cleared inbound on a radial 010CTV for a descent to 10000 ft and was told to report passing 120DME. The crew was told to plan for a VOR approach onto Runway 19.

1.1.6 At 0427Z, the aircraft was cleared by Cape Town tower controller to continue with the approach. The surface wind was 180° at 15 knots and the runway was wet.

1.1.7 At 0428Z, tower asked the pilot whether he was on an instrument landing system (ILS) approach. The reply from the aircraft was negative, stating that they had been cleared for a VOR approach onto Runway 19.

1.1.8 At 0429Z, the aircraft was cleared to land onto Runway 19 and given the wind 180° at 15 knots. The pilot did not reply to the clearance and no further radio communication could be established with the aircraft. ATC declared a DETRESFA and activated search and rescue.

1.1.9 The South African Police Service was requested to send vehicles to the final approach area of Runway 19 at FACT to search an aircraft.

1.1.10 At 0507Z, the airport fire crew were dispatched to search the perimeter fence of the airport for the aircraft.

1.1.11 At 0544Z, a rescue helicopter was tasked to search for the missing aircraft. The helicopter crew found the wreckage at 0556Z at GPS position S 33°50'56.3" E 018°34'57.5" and a height of 468 ft above mean sea level (AMSL). All the occupants on board had been fatally injured, the aircraft destroyed by impact forces and the post-impact fire.

1.2 Injuries to Persons

Injuries	Pilot	Crew	Pass.	Other
Fatal	2		3	-
Serious	-	-	-	-
Minor	-	-	-	-
None	-	-	-	-

1.3 Damage to Aircraft

1.3.1 The aircraft was destroyed by impact forces and the post-impact fire.

Figure 1: The aircraft wreckage after the accident

1.4 Other Damage

1.4.1 None.

Figure 2: No damage caused to the environment.

1.5 Personnel Information

1.5.1 Pilot-in-command (PIC)

Nationality	South African	Gender	Male	Age	53
Licence Number	CA 0599 (Namibia)	Licence Type	Commercial		
Licence valid	Yes	Type Endorsed	Yes		
Ratings	Instrument Flight (Night Flight)				
Medical Expiry Date	30 September 2015				
Restrictions	Suitable corrective lenses				
Previous Accidents	No records on file				

Flying Experience:

Total Hours	6353.0
Total Past 90 Days	70.5
Total on Type Past 90 Days	25.5
Total on Type	1357.9

1.5.2 First Officer (FO)

Nationality	Namibian	Gender	Female	Age	24
Licence Number	CA 70650 (Namibia)	Licence Type	Commercial		
Licence valid	Yes	Type Endorsed	Yes		
Ratings	Instrument Flight (Night Flight)				
Medical Expiry Date	31 January 2016				
Restrictions	Suitable corrective lenses				
Previous Accidents	No records on file				

Flying Experience:

Total Hours	1394.8
Total Past 90 Days	29.6
Total on Type Past 90 Days	1.2
Total on Type	1.2

1.5.3 Air Traffic Controller 1

Nationality	South African	Gender	Female	Age	40
Licence Number	ATS 0654	Licence Type	Air Traffic Services		
Licence valid	Yes				
Ratings	Area, Area/RDR, AD, FIS, APP, APP/RDR, Instructor				
Medical Expiry Date	31 May 2017				
Restrictions	Nil				

1.5.4 Air Traffic Controller 2

Nationality	South African	Gender	Male	Age	26
Licence Number	ATS 1021	Licence Type	Air Traffic Service		
Licence valid	Yes				
Ratings	ATSA, ATSA/COORD, AD, APP, APP/RDR				
Medical Expiry Date	31 January 2016				
Restrictions	Suitable corrective lenses				

The abovementioned Air Traffic Controllers were on duty at FACT at the time of the accident.

1.6 Aircraft Information

Figure 3: Picture of the accident aircraft

1.6.1 General Information

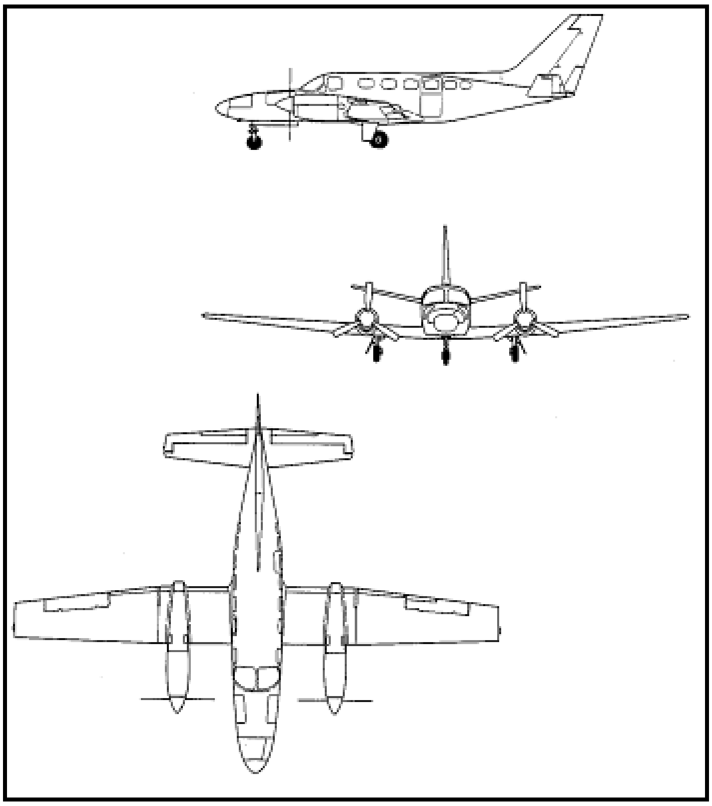


Figure 4: Schematic drawing of the Cessna 441

The Cessna 441 Conquest II is a 11-seater, twin-engine, turboprop-powered, pressurised aircraft, configured as a cantilever low-wing monoplane with a conventional tail. The airframe is of aluminium monocoque construction. The retractable tricycle landing gear features a trailing-link main-gear design, and has a single wheel on each unit. An air-stair door is located on the port side of the fuselage, aft of the wing.

The accident aircraft was fitted with a Med-Pac 400 stretcher system.

1.6.2 Airframe:

Type	Cessna 441	
Serial Number	441-0288	
Manufacturer	Cessna Aircraft Company	
Year of Manufacture	1982	
Total Airframe Hours (At Time of Accident)	7605.1	
Last phase inspection (Date & Hours)	21 May 2015	7569.5
Hours since Last Phase	35.6	
C of A (Issue Date)	26 November 2014	
C of R (Issue Date) (Present owner)	24 November 2014	
Operating Categories	Standard	

1.6.3 Engine: No.1 (Left)

Type	Garret-Honeywell TPE 331-10N-J125
Serial Number	P-77612C
Hours since New	7605.1
Hours since Overhaul	1426.9

1.6.4 Engine: No.2 (Right)

Type	Garret-Honeywell TPE 331-10N-J125
Serial Number	P-77611C
Hours Since New	7605.1
Hours Since Overhaul	1426.9

1.6.5 Propeller: No. 1 (Left)

Type	McCauley 3GFR 34C 601-AD
Serial Number	816209
Hours since New	7605.1
Hours since Overhaul	327.9

1.6.6 Propeller: No. 2 (Right)

Type	McCauley 3GFR 34C 601-AD
Serial Number	842708
Hours since New	7605.1
Hours since Overhaul	327.9

1.6.7 Weight Calculation

Weight of the aircraft	6260 lbs
Crew	524 lbs
Passengers	378 lbs
Fuel	1674 lbs
Baggage	100 lbs
Total	**8936 lbs**

The aircraft's weight for the take-off at Oranjemund was calculated at 8936 pounds, which was 14 pounds lower than the aircraft's maximum certified take-off weight of 8950 pounds.

After the accident, the operator provided the investigator with a weight and balance report. The date on this report was 17 August 2015, which was the day after the accident. This weight and balance report was not signed by any of the crew members. **(The Weight and Balance Report can be found in Appendix B.)**

1.7 Meteorological Information

1.7.1 Meteorological information entered in the table below was obtained from the South African Weather Service (SAWS).

The METAR's for Cape Town International Airport (FACT) indicate the presence of low level cloud with minimum base of 500ft above ground level (AGL) and minimum visibility reduced to 6000m between 04:30Z and 05:00Z. The weather conditions started to improve as from 05:30Z, with the low cloud becoming scattered at 800ft AGL and the visibility improving to greater than 10km. The average wind direction at the surface was constantly observed to be southerly to south-easterly, with an average speed of 14 knots.

The vertical wind and temperature profile for Cape Town at the time of the accident showed a southerly to south-easterly wind at about 20kts at the accident site height (468ft) and the mountain top (985ft). The wind direction turned to a westerly-north-westerly at 400ft. Low-level moisture stretching to about 4000ft resulted in low-level clouds.

From the above observation, it can be deduced that the low-level cloud observed at 500ft AGL covered the 985ft-high Tygerberg mountain peaks, and partly or completely hiding them.

Wind direction	160°M	Wind speed	15kts	Visibility	6000m
Temperature	11°C	Cloud cover	Broken	Cloud base	500ft
Dew point	11°C				

1.8 Aids to Navigation

1.8.1 The aircraft was equipped with standard navigational equipment as per the Minimum Equipment List approved by the regulator. There were no recorded defects to the navigational equipment prior to the flight.

1.8.2 In addition to the standard navigational equipment, the aircraft was also equipped with a Garmin GTN 750 touchscreen GPS/Navigation/Communication/Multi-Function Display unit and a Garmin GTN 650/Navigation/Communication unit.

Figure 5: Installation of the GTN 750 and GTN 650 GPS in the accident aircraft

1.8.3 Following the telephonic submission of the flight plan, the ATC at Oranjemund did not forward it to FACT.

1.8.4 At no stage during the flight or the approach for Cape Town International Airport did the crew request any aid for navigation.

1.9 Communications

1.9.1 The aircraft was equipped with standard communication equipment as per the Minimum Equipment List approved by the regulator. There were no recorded defects with the communication equipment prior to the flight.

1.9.2 Amongst others, the following Air Traffic Service (ATS) communication facilities were available at Cape Town International Airport at and before the accident:

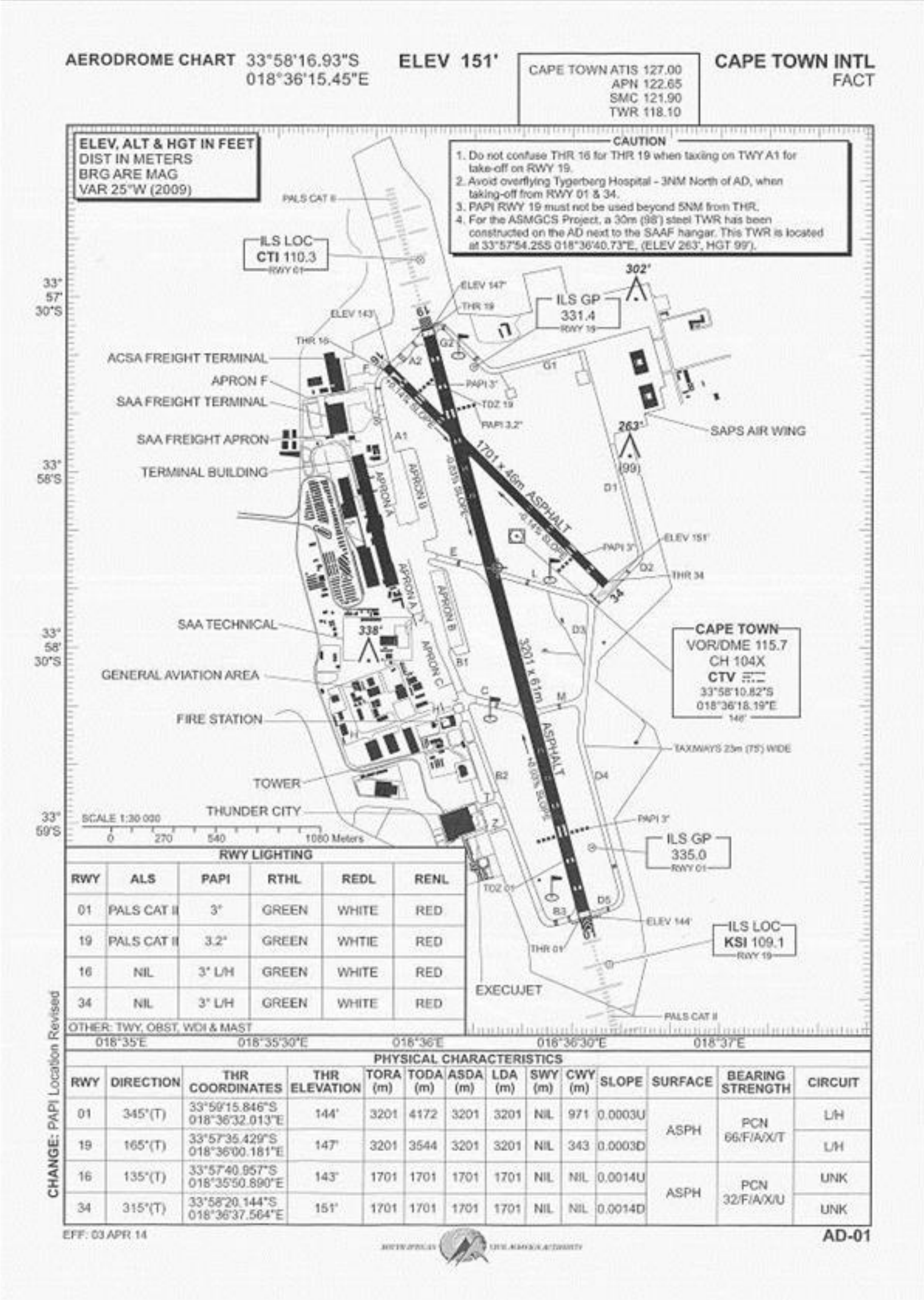
Service Designator	**Call Sign**	**Frequency**
ACC RSR	Cape Town Control	125.1 MHz
ACC RSR	Cape Town Information West	131.125 MHz
APP TAR	Cape Town Approach	120.05 MHz
TWR	Cape Town Tower	118.1 MHz
SMC	Cape Town Ground	121.9 MHz

1.9.3 The pilot did communicate his intentions on very high frequency (VHF) 118.1 MHz and 120.05 MHz.

1.9.4 Up until the last radio communication between the aircraft and the control tower, which was less than a minute before the conjectured accident time, the voice of the co-pilot was calm and relaxed without the presence of any fear or anxiety.

1.10 Aerodrome Information

1.10.1 Aerodrome Chart



RWY LIGHTING

RWY	ALS	PAPI	RTHL	REDL	RENL
01	PALS CAT II	3°	GREEN	WHITE	RED
19	PALS CAT II	3.2°	GREEN	WHTIE	RED
16	NIL	3° L/H	GREEN	WHITE	RED
34	NIL	3° L/H	GREEN	WHITE	RED

OTHER: TWY, OBST, WDI & MAST

PHYSICAL CHARACTERISTICS

RWY	DIRECTION	THR COORDINATES	THR ELEVATION	TORA (m)	TODA (m)	ASDA (m)	LDA (m)	SWY (m)	CWY (m)	SLOPE	SURFACE	BEARING STRENGTH	CIRCUIT
01	345°(T)	33°59'15.846"S 018°36'32.013"E	144'	3201	4172	3201	3201	NIL	971	0.0003U	ASPH	PCN 66/F/A/X/T	L/H
19	165°(T)	33°57'35.429"S 018°36'00.181"E	147'	3201	3544	3201	3201	NIL	343	0.0003D			L/H
16	135°(T)	33°57'40.957"S 018°35'50.890"E	143'	1701	1701	1701	1701	NIL	NIL	0.0014U	ASPH	PCN 32/F/A/X/U	UNK
34	315°(T)	33°58'20.144"S 018°36'37.564"E	151'	1701	1701	1701	1701	NIL	NIL	0.0014D			UNK

Figure 6: Cape Town International Aerodrome Chart

1.10.2 Aerodrome Information

Aerodrome Location	Cape Town International Airport is situated 7 NM South East of Cape Town city	
Aerodrome Co-ordinates	S 33°58’17” E 018°36’15”	
Aerodrome Elevation	143ft	
Runway Designations	01/19	34/16
Runway Dimensions	3201 x 61m	1701 x 46m
Runway Used	Runway 19	
Runway Surface	Asphalt	
Approach Facilities	VOR, ILS, NDB and DME	

1.10.3 The aircraft was cleared for the VOR approach for landing onto Runway 19 at FACT. All other approach facilities were available for use by the crew however, as they were cleared for VOR approach, the crew chose to continue on VOR.

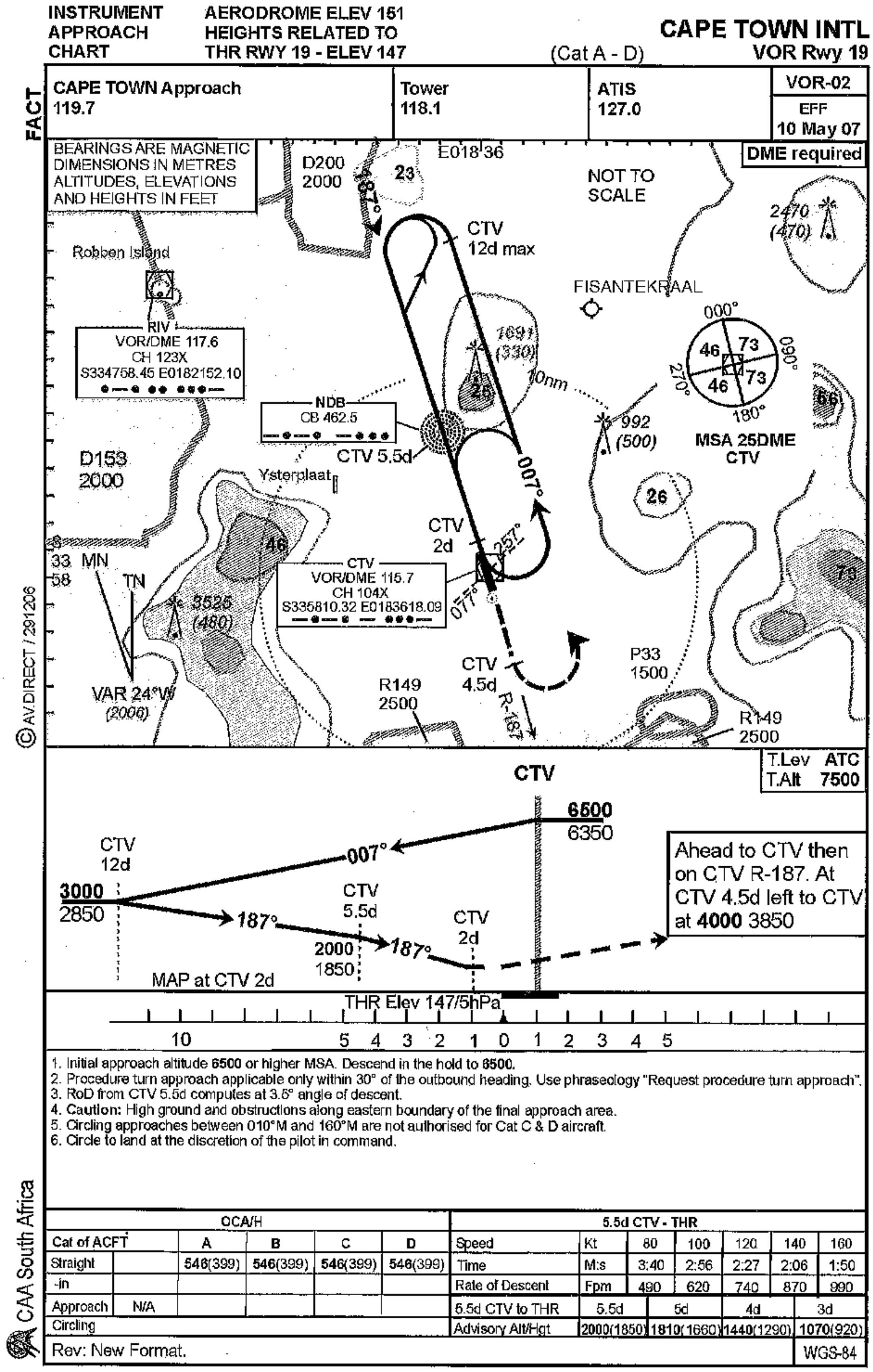


Figure 7: VOR Runway 19 Approach Plate

1.10.4 The accident happened in close proximity 8 NM North of Cape Town International Aerodrome.

Figure 8: The accident site is 8 NM to the North of Cape Town International Airport

1.10.5 Route flown during the approach in relation to the actual VOR 19 approach path

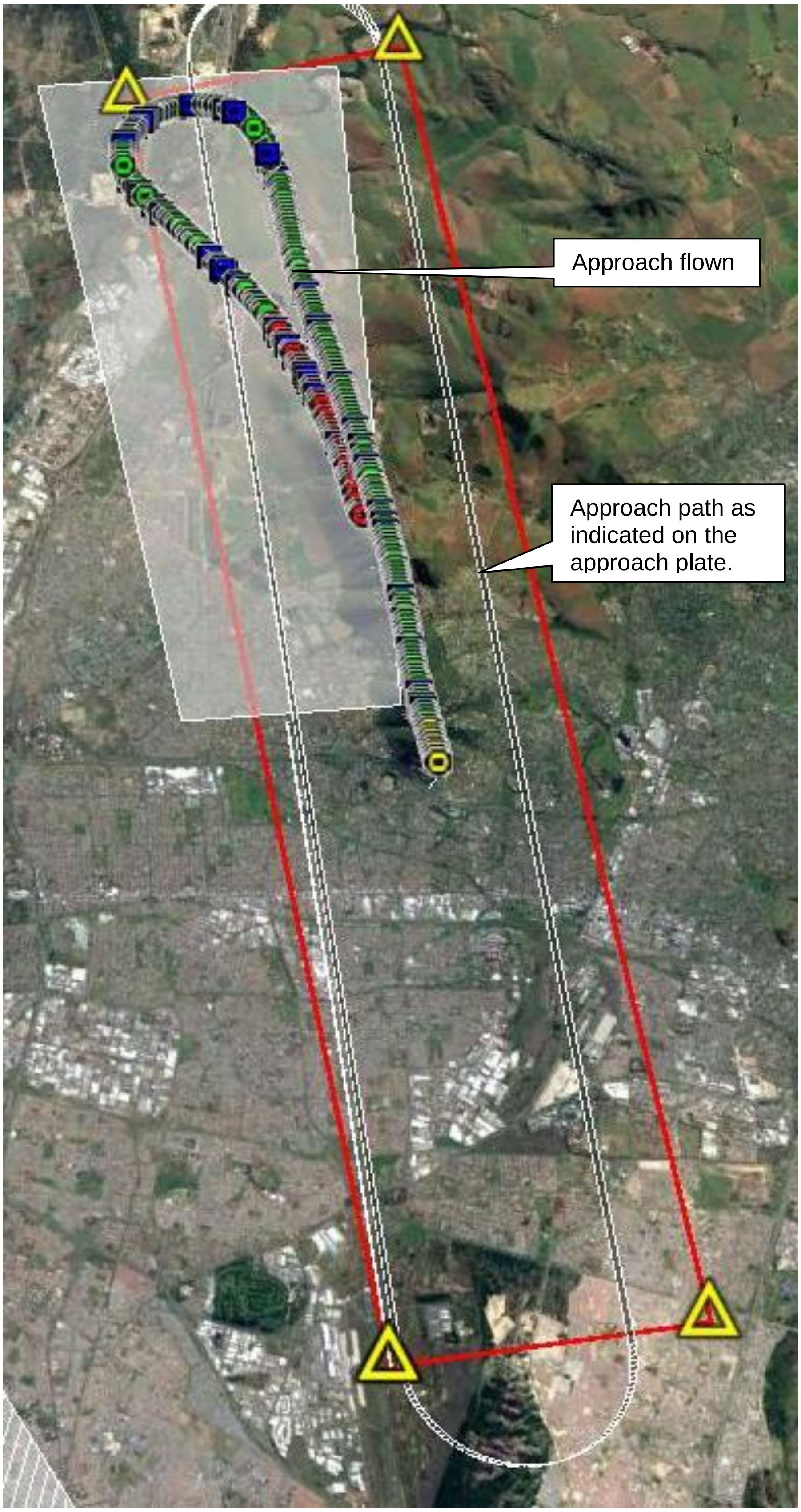


Figure 9: Reconstruction of the profile flown by the crew during the approach

1.10.6 The reconstruction in Figure 9, when each point as indicated and analysed, it indicates the last minute of flight that the aircraft's rate of descent was approximately 1100 feet/minute. The last speed before impact was 135 knots in a direction of 153°T.

ENCLOSURE 1

SACAA Chart: Cape Town VOR RWY 19 (VOR-02)

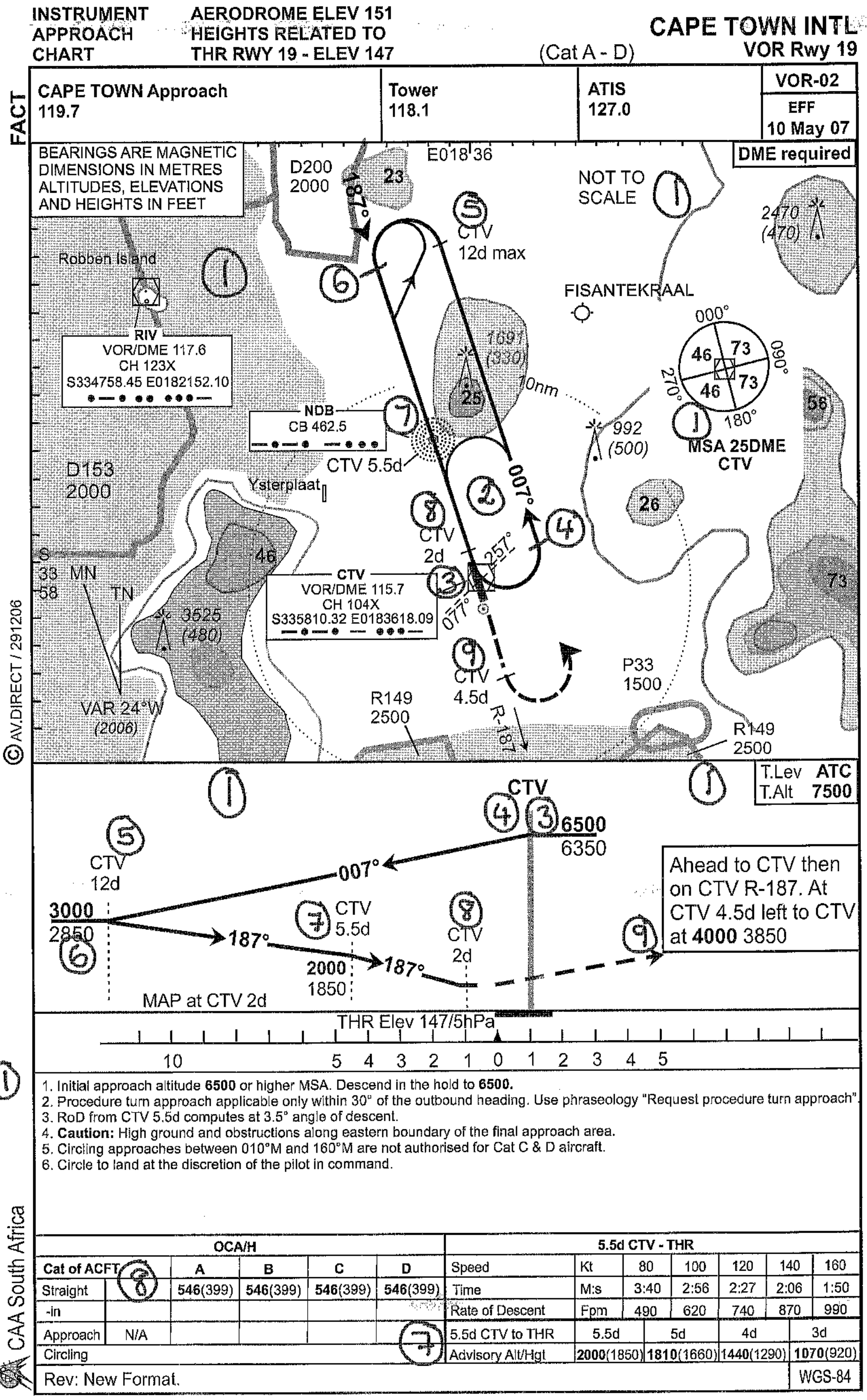


Figure 10: Cape Town VOR RWY 19 with reference points

SACAA Chart Textual Description: Cape Town VOR RWY 19

Aerodrome ELEV & heights '	RWY	Facility	Initial Approach ALT '	Procedure	Missed APCH procedure
1	2	3	4	5	6
CAPE TOWN INTL (FACT) *CAT A – D* *AD ELEV 151'* *THR ELEV 147'* *TRANSITION ALT 7 500'* *VAR W 24° (2006)* ***VOR*** *OCH ABOVE THR* *CAT A – 399'* *CAT B – 399'* *CAT C – 399'* *CAT D – 399'*	*19*	***DVOR*** *"CTV"* *115.7 MHZ* ***DME*** *"CTV"* *1191 MHZ* *CH 104X*	*6500' or higher MSA* ***MSA*** *25 DME "CTV"* *000°-180°M – 7300'* *180°- 360°M – 4600'*	***PROCEDURE: VOR RWY 19*** ***(DME Required)*** ***HOLD:*** *Hold in a left hand racecourse pattern over "CTV", inbound on R007, outbound on heading 007°M. Descend in the pattern to 6500' ALT. MAX 12 DME "CTV".* ***APPROACH:*** *Depart from "CTV" outbound in the holding pattern on a heading of 007°M, and descend to 3000' ALT. At maximum 12 DME "CTV" turn left onto R007 inbound "CTV". Descend to minimum 2000' ALT. Maintain 2000' ALT to 5.5 DME "CTV". At 5.5 DME "CTV" continue descend to MDA/H. Final approach slope computes at 3.5°.*	*MAPT is at 2 DME "CTV". If no other instructions received, at 2 DME "CTV" commence climb on R187 "CTV". Climb to 4.5 DME "CTV", then climbing turn left to "CTV" and climb to 4000' ALT.* ***NOTE:*** *1. Circle to land between 010°M and 160°M are not authorised for CAT C and D aircraft.* *2. Circle to land at the discretion of the Pilot in command.* *3. WGS-84.* ***AIP AD Chart: VOR-02*** ***EFF Date: 10 MAY 07***

Figure 11: Chart Textual Description

1.10.7 If the reconstruction of the flight path and the chart textual description are compared the following can be noted:

- Once established on heading 007°M or abeam VOR CTV, whichever comes later, the aircraft is required to descend to 3000ft ALT on a heading of 007°M to a maximum distance of 12 DME CTV. (Calculated Descent Gradient: ±4.8%). (See Point 5 in Figure 10.)

  From the radar tracks it appears that the aircraft was on a track of ±004/005°M in the outbound leg. At ±5DME CTV (outbound) the aircraft was already ±3100ft ALT (A calculated Descent Gradient of ±11.2% from abeam VOR CTV). At ±5.2DME CTV (outbound) the aircraft descended to 2700ft ALT (300ft below the required Minimum Obstacle Clearance Altitude (MOCA)).

- At 12 DME CTV the aircraft is required to maintain 3000ft ALT and execute a left turn onto CTV R007 (inbound) to arrive established on, or within 5° of, CTV R007 at 3000ft ALT by 12 DME CTV. (See Point 6 on Figure 10.)

  From the radar track it appears at ±11DME (outbound) the aircraft initiated the left turn onto the intermediate Approach Segment at an altitude between 2600ft and 2700FT, 300-400ft below the MOCA of 3000ft. The aircraft then continued the turn through CTV R007 (QDM 187°) onto a track of ±154°M (33° past the required inbound heading/track).

- At 12DME CTV on, or within 5° of, CTV R007° (Inbound) the aircraft is required to descend in order to reach 5.5DME CTV (FAF) (Final Approach Fix) at 2000ft ALT. (See Point 7 on Figure 10.)

  Once established on the track of ±154°M (±10.6DME CTV) the aircraft initiated a descent from 2600/2700ft ALT to 2100ft ALT. At ±9.3 DME CTV, it appears that the aircraft initiated a gradual turn right onto a track of ±179°M whilst continuing the descent. At ±9DME CTV, the aircraft descended through the MOCA of 2000ft ALT until impact at ±7.3DME CTV.

  See **Appendix E** for a complete report.

1.11 Flight Recorders

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

1.12 Wreckage and Impact Information

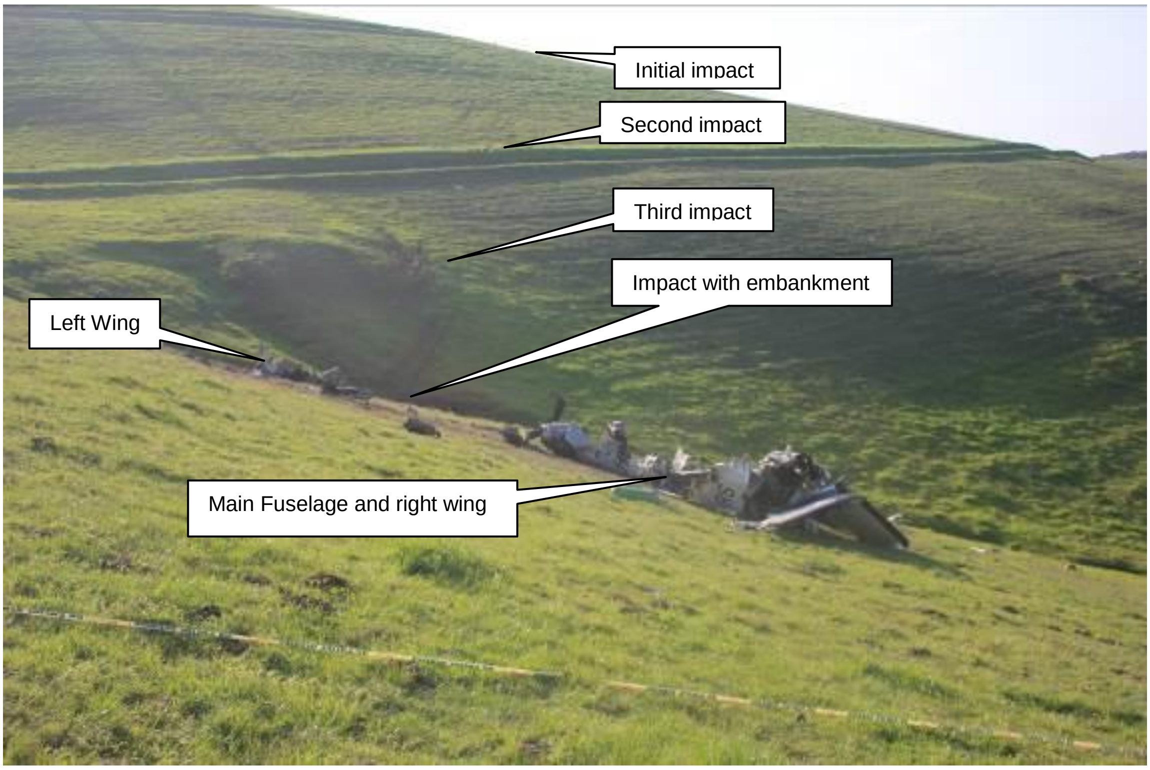


Figure 10: Impact sequence (Include an arrow to name the road)

1.12.1 The cockpit/cabin was crushed and destroyed by the impact forces and post-impact fire.

1.12.2 Both the left-hand and right-hand engines remained retained inside the engine mounting support, although heavy impact damage was displayed.

1.12.3 Two of the left propeller blades separated from the propeller hub when the aircraft hit the embankment. They were later found embedded in the embankment where the aircraft impacted the terrain.

1.12.4 After the impact with the embankment, the left wing separated from the fuselage.

1.12.5 The right wing remained attached to the fuselage during the sequence of the accident. All three right propeller blades remained attached to the propeller hub, although they were substantially damaged.

1.12.6 Both wings were destroyed during the impact. Orientation traces of impact by the wings and landing gear on the ground showed the general flight direction of the aircraft at impact was approximately 153° true north.

1.12.7 The left wing was found approximately 37m after the impact with the embankment.

1.12.8 The main wreckage was found in an inverted and twisted position, approximately 55m after the impact with the embankment. The general heading of the fuselage after the accident was approximately 045°true north.

1.12.9 Although the nose landing gear remained attached to the fuselage, the wheel had separated and was found in close proximity to the main wreckage in the direction of the impact. Both main landing gear legs broke off and was found in close proximity of the wreckage.

1.12.10 Personal objects belonging to the occupants were found ejected after impact in the area immediately after the impact point and around the main wreckage.

1.12.11 The empennage, although substantially damaged, was not consumed by the post-impact fire and was found in an inverted position.

1.12.12 The first investigation on the crash site concluded that no part of the airframe structure and no control surface was missing.

1.12.13 All engine, propeller and flight controls were destroyed during the post-impact fire and no positions could be verified.

1.12.14 The instruments were severely damage, beyond possible exploitation.

1.13 Medical and Pathological Information

1.13.1 The crew and three passengers were fatally injured during the sequence of the accident.

1.13.2 A post-mortem examination was performed on the deceased pilots after the accident.

According to the post-mortem examination report, the cause of death of the pilot-in-command was multiple injuries.

According to the post-mortem examination report, the cause of death of the first officer was multiple injuries, including burns.

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

1.14 Fire

1.14.1 The aircraft was destroyed by the post-impact fire during the impact sequence.

1.15 Survival Aspects

1.15.1 The accident was considered not survivable due to the high kinetic forces involved in the impact and the damage caused to the cock pit and cabin area as well as the post-impact fire.

1.16 Tests and Research

1.16.1 Engine teardown inspection

The aircraft was fitted with two Garret-Honeywell TPE 331-10N-512S engines, serial numbers P-77611C and P-76612C.

Both engines had external accident damage but no internal abnormalities could be found, which could result in any one of the two engines not performing as required prior to impact

The complete engine teardown reports can be found in **Appendix D** of this report.

1.17 Organisational and Management Information

1.17.1 The last phase inspection before the accident flight was certified on 21 May 2015 at 7569.5 airframe hours by a Namibian-approved Aircraft Maintenance Organisation (AMO) which was in possession of a valid AMO certificate. The aircraft was on a continuous inspection programme; at the last inspection, a phase 2, 3 and 4 inspection was certified.

1.17.2 Company procedures require a Master Dispatch List to be completed before each medical flight. The purpose of this list was to ensure the pilots for the flight are properly informed about the flight and all preparations needed for the flight were properly done. The list, once completed, must be signed by the pilot-in-command and is left in the operations room. After the accident, the company could not provide the investigator with the completed list for the accident flight.

1.17.3 When requested about the sign-on sheet that the pilot in command was to sign before each flight, the investigator was provided with the Daily Flight Programme for Sunday 16th August 2015 that was completed in writing but without a signature of either the pilot-in-command or the first officer. It was also explained to the investigator that the purpose of the sign-on sheet was the confirmation to a crew member that he/she is familiar with the following:

a) The NAMCARS (Namibian Regulations).
b) Familiarity with weather updates.
c) Familiarity with aviation circulars.
d) Familiarity with flight and duty procedure.
e) Confirmation that the crew is aware of the Operations Manual.

1.17.4 During the investigation, no procedure could be found to ensure the pilots had read the Operations Manual in regular intervals. During the induction phase each pilot completed a questionnaire on the content of the Operations Manual. The company, however, have a red-tag system in place to ensure the pilots are aware of all amendments or changes to the Operations Manual.

1.17.5 The company was in possession of a valid Air Operators Certificate that was issued on 24 June 2014, which had Emergency Medical Services endorsed on it.

1.17.6 Training

The company has its own Aviation Training Organisation (ATO) responsible for in-house training of pilots. During the investigation, the chief flight instructor (CFI) was interviewed. He could not provide answers regarding the training of the pilot in command of the accident aircraft as he was not part of this training.

When the CFI was interviewed, he mentioned that amendments had been made to the Training Procedure Manual (TPM). These amendments were proposed in February 2016 and were not yet approved by the time of the accident.

The first officer on the accident flight did a Cessna 406 conversion course in 2013 and a Cessna 425 conversion course in 2015 at the same training organisation. The CFI was unable to provide the investigation team with any proof of evaluation and briefings done during the conversion courses. No skills/test forms were available to the investigation team.

The following is an extract from the Namibian regulations:

Documents and records

141.02.14 (3) The holder of the approval shall establish procedures to identify, collect, index, store and maintain all records which may be necessary -

(a) for the specified standard training conducted by such holder;

(b) to determine compliance with the appropriate requirements prescribed in this Subpart.

(4) The procedure referred to in subregulation (3) shall ensure that-

(a) a record is kept of each quality assurance review of the holder of the approval;

(b) a record is kept of each person who conducts the specified standard training, including particulars of the competence assessment and experience of each such person;

(c) a record is kept of each student being trained or assessed by the holder of the approval, including particulars of enrolment, attendance, modules, instructor comments and any flight or similar practical sessions and assessments of each such student;

(d) all records are legible and;

(e) all records are kept for a period of at least five years calculated from the date of last entry made in such records.

The first officer of the accident flight did her conversion onto the Cessna 441 (accident aircraft) three days before the accident flight. She completed 1.9 hours in the simulator and the test was 1.2 hours. A 0.5-hour briefing before the flight and a 0.5-hour briefing after the flight were done during the conversion course. Familiarisation with the two GPS systems on board the accident aircraft – Garmin touch screen GTN 750 and GTN 650 – was carried out in between the 1.2-hour test.

The investigation team was informed that the pilot-in-command of the accident aircraft was also a training captain with the company. When the CFI was questioned about this, he said that to the best of his knowledge this was true, but he could not be sure about this. When questioned about the requirements for becoming a training captain, the CFI was unable to provide these. The CFI could not provide the investigation team with any documentation proving that the PIC was a training captain.

The CFI was also questioned about the oversight that was done on the PIC in his position as a training captain. The CFI could not provide the investigators with any documentation or any form of oversight that was done on the PIC in his capacity as training captain.

During the PIC line-orientation training, crew cooperation, briefings and the use of the checklist were mentioned several times as possible weak points. When the CFI was questioned how he had corrected these, he could not give any answer to any corrections that were implemented.

1.17.7 Operational procedures

No evidence could be found indicating that any written procedure existed between the operator and EMed 24 when an emergency flight needed to be dispatched. Responsibilities in this regards were not clear and neither the operator nor EMed 24 could provide the investigator with a clear view of the various responsibilities when the call came to dispatch an aircraft.

1.17.8 Operations Manual

The operator's operations manual clearly stated that the provision contained in Part 135 of the NAMCAR's and NAMCAT's shall apply to any aircraft operated by the operator whilst engaged in emergency medical service operations. The operator also undertakes to comply fully with Part 135 of the operations manual when engaged in medical evacuation flights.

1.17.9 Flight deck crew

According to the operations manual, in the case of any turbo prop aircraft operations or instrument flight rules (IFR) operations, the minimum flight deck crew is regarded as two.

The pilot-in-command qualifications are clearly set out in the operations manual, but there is no minimum requirements for the co-pilot set out in this manual. In this case, the co-pilot had only 1.2 hours actual flying time on the aircraft, which rendered her as having limited experience on the specific aircraft systems and equipment (navigational equipment).

1.17.10 Documentation and records

The operator stated that the operational procedures are part of the initial training. There was also no system or means in place to ensure that each crew member had access to the operations manual in order to make them aware of any changes to the operations manual.

1.17.11 Training records

The operator was not able to provide the investigation team with proper training records of the first officer on two different aircraft she had training on before the Cessna 441 training. According to the operations manual, these records should be kept for at least 12 months after the employee had left the company.

1.17.12 Navigation

According to the operations manual, maps, charts, navigational beacons and GPSs are primary used for navigation purposes. However, conventional navigation facilities are to be used as the primary navigational aid, some of which are non-directional beacons (NDB) and very high frequency omni-directional range (VOR) beacons.

The operations manual states clearly that the instrument landing system (ILS) is regarded by the company as an irreplaceable navigational aid. During the entire accident flight/approach this aid was never requested by the crew.

1.17.13 Responsibilities of the pilot in command

The operations manual clearly stated that it was the responsibility of the pilot-in-command to ensure he/she has adequate information pertaining to the flight, including the route aerodrome details.

It is also the responsibility of the pilot-in-command to ensure the correct documentation for the flight, such as weight and balance reports and flight plans, are completed. In this case, no completed weight and balance sheet was found after the accident; only a sheet without a pilot name and signature on it was given to the investigator. The date printed on this report was also 17 August 2015, which was the day after the accident.

Both the Namibian and South African Air Navigational Services confirmed there was no flight plan in any of their systems that was filed for the accident flight.

The following information is an extract from the Namibian regulations

Documents to be kept on the ground

135.04.2 (1) The operator of a small aeroplane shall ensure that –

- *(a) a copy of the operational flight plan;*
- *(b) copies of the relevant parts of the technical log;*
- *(c) the mass and balance documentation referred to in regulation 135.08.14(9) if required;*
- *(d) the passenger list or cargo manifest;*
- *(e) the special loads notification, if applicable; and*
- *(f) a general declaration, if the aeroplane is engage in an international flight,*

are retained in a safe place at the first point of departure in respect of each flight undertaken by the aeroplane.

(2) The documents referred to in subregulation (1), shall be retained for a period of at least 90 days.

1.18 Additional Information

1.18.1 Crew pairing

Crew pairing was done by the flight dispatcher in conjunction with the operations manager. The company could not provide the investigator with a proper procedure used to pair different crews for different operations. When interviewed by the investigators, the operations manager said that crew pairing was arranged by the flight dispatcher. During the pairing process the flight dispatcher would ensure that:

- The pilots had the necessary ratings.
- The pilots' files were up to date.
- The flight and duty requirements were within the pilots' hourly limits.
- The pilots were not scheduled to fly next day.
- A risk assessment was made.

Note:

- The co-pilot started her flying career on 28 February 2011. The accident flight was the first flight for the co-pilot on the Cessna 441 after her conversion onto the aircraft three days before the accident flight.
- The hours indicated above excludes the hours flown on the accident flight as these hours are not known.

The first officer had only 1.2 hours flying experience on the Cessna 441 prior to the accident flight

1.18.2 Pilot standby

No procedure governing pilots' standby duties was available. A pilot was placed on standby when he or she was available and not required to fly the following day. Both accident aircraft pilots were on standby since Saturday morning.

1.18.3 Radar failure

The following is an extract from the report received from Air Traffic and Navigation Services (ATNS). **(The entire report can be found in Appendix C.)**

"Sequence of events

The Johannesburg FIR (Flight Information Region) Radar Display System, Eurocat X, was reported unserviceable at 02:47 local South African time by ATC to the Fault Reporting Centre. "all Eurocat X display positions failed to display air traffic".

The Fault Reporting Centre alerted the Standby Engineering Technician. The Standby Engineering Technician on arrival at site found that the problem was *caused by the Eurocat X being set to the wrong year being 2027. Understanding the seriousness of this issue the Standby Engineering Technician call[ed] for extra assistance including his manager MTS ORTIA.*

The ORTIA technical team began investigating the reason for the wrong year, 2027, being set into Eurocat X. Their analysis identified that the problem was caused by the single GPS receiver that is used to provide accurate time to the Eurocat X.

Despite all efforts the ORTIA technical team couldn't set the Eurocat X GPS receiver back to 16 August 2015. The technical team investigated and ascertained that two later versions of GPS receivers at ARTYIA were showing the correct time of 16 August 2015. One of these later versions of GPS receiver is used to provide accurate time to the Advance Surface Movement and Guidance Control System (A-SMGCS), the other GPS receiver is used to provide accurate time to the System Support Suite (SSS). The SSS is in a separate building located approximately 5 minutes' walk from the Control Tower. The SSS can be used in three different ways. It can be used as a limited ATM system in the event of catastrophic disaster occurring at the main ATM Centre. It can be used as an ATM simulator for training and it can also be used to test new version of Eurocat X software. There is a SSS at both FAJA and FACT ATM Centres.

The ORTIA technical team then determined that the best solution to the problem would be to connect the Eurocat X to one of the other tw[0] GPS receivers that were indicating the correct year. Due to its proximity to the main Eurocat X system they chose the A-SMGCS GPS receiver.

At this time the MTS ORTIA, being the ex-Display Specialist in Cape Town realised that the Cape Town FIR Eurocat X would have the same problem as a similar GPS synchronized clock is also used there. The Cape Town standby Engineering Technician was alerted at 05:35 (local time), another Engineering Technician and the Display Specialist were requested to assist with the Eurocat X issue at 05:40. The Cape Town Radar Specialist and Operational Specialist were also called in to assist.

The ORTIA technical team connected the Johannesburg FIR Eurocat X to the working A-SMGCS GPS receiver, and the Johannesburg FIR Eurocat X system was restored to serviceable state at 06:50.

On arrival at site the Cape Operational Specialist began configuring the Cape Town FIR SSS to work in an operational configuration and by 08:52 the Cape Town FIR Area West was operating from the SSS and by 08:55 the Cape Town Area East was operating from the SSS.

The rest of the Cape Town team focused on connecting the main Cape Town FIR Eurocat X system to the Surface Movement Radar GPS receiver, this was achieved at approximately 11:00. After resetting all 14 operational positions the Cape Town FIR Eurocat X was fully serviceable and in use by 13:00.

Other CNS Systems at Cape Town's status during the time of the radar picture not being available.

All other systems were fully operational see table below:

Equipment	***Function***	***Status***
ATM System	*Radar Display Eurocat X*	*Non Operational*
CT Radar 1	*PSR*	*Operational*
CT Radar 2	*PSR*	*Operational*
CT Radar 1	*MSSR*	*Operational*
CT Radar 2	*MSSR*	*Operational*
Surface Movement NOVA	*Display*	*Operational*
Surface Movement Radar on Airfield	*PSR/SSR*	*Operational*
Navigation Aid	*CT VOR/DME*	*Serviceable*
ILS 01	*Instrument Landing System*	*Operational*
ILS 19	*Instrument Landing System*	*Operational*
VHF communication	*All VHF Frequencies*	*Operational*

Current conclusion to the root cause of failure

The GPS receiver that provides date and time to the Johannesburg and Cape Town FIR Radar Display System, Thales Eurocat X, malfunctioned at the same time 00:18 UTC. This malfunction caused the time of the Radar Display System to be set to December 2027.

The Radar Display System is time sensitive, in terms of displaying a radar picture. The radar display system is provided with multiple radar data inputs, Cape Town has 2 local radar systems which provide both primary and secondary radar data. The incoming radar data is time stamped, this time is also derived from a GPS receiver source, when the Radar Display System's time jumped to December 2027 it immediately rejected all incoming radar data as the radar data was time stamped with the correct date and time of 16 August 2015.

It is currently ATNS's understanding, that Radar Display System is designed to reject any radar data that is older than 4 seconds, if old radar data is displayed it would present a radar picture that no longer reflects the true and current position of aircraft."

During the aircraft's approach for landing, the aircraft was visible on the Surface Movement Radar on the airfield, but the ATC was not aware of this information as it only became available after the accident.

1.18.4 Interview with the operator

During the interview with the company's flight operations manager, who was also the fiancé of the deceased co-pilot, he indicated that while she had been preparing for the flight at home, he had used an application on his iPad, called Foreflight, to obtain the weather report, telling them that they could expect overcast conditions at approximately 600 feet. He had also briefed her on the ILS, saying that according to his information, a notice to airmen (NOTAM) had been issued, indicating the ILS was not operational in Cape Town. See appendix F below.

After the accident, the company could not provide the investigators with proof that the crew obtained official weather and aerodrome information of any en-route destinations aerodromes.

1.18.5 Namibian CAA oversight

During the investigation and subsequent interview conducted with the NCAA, it was evident as a result of limited resources ineffective oversight was conducted on the operator.

1.18.6 Flight sequence since call out:

Time	Action
18H48 Local	Call centre received a call from doctor at Oranjemund
20H24 Local	Call centre phoned the operators at Flight Dispatch to find out if it would be possible to land at Oranjemund
20H32 Local	Flight Dispatch confirmed the landing at Oranjemund was possible and immigration was available. (Flight Dispatch requested if it would be possible to do the flight in the morning.)
21H51 Local	V5-NRS departed from Eros
22H02 Local	Call centre confirmed the doctor had advised that the flight should take place as soon as possible
22H03 Local	NRS Flight Dispatch phoned Westair Dispatch advising them of the flight details. Westair confirmed the crew and aircraft
01H40 Local	V5-NRS landed at Oranjemund
02H07 Local	V5-NRS departed from Oranjemund
0604H07 Local	Westair called EMED and informed them V5-NRS was missing

1.18.7 GPS data base update

Both GPS systems installed in the aircraft had their data updated on 28 July 2015 and were serviceable at the time the aircraft commenced the flight.

1.18.8 Compass swing

The last compass swing on the accident aircraft was certified on 3 December 2015.

1.18.9 Audio transcript

The ATS audio transcript between the FACT Area/FACT Approach and FACT Tower voice recordings was received from ATNS after the accident. It was verified by ATNS approach surveillance radar from the ATNS recordings, with times given in hh:mm:ss UTC. The stations refer to any aircraft, ATC position or vehicle making the transmission.

1.18.10 ATC services in Windhoek.

On the evening of the aircraft taking off from Eros Airport, there was no qualified ATC in the tower.

The controller that was on standby duty was not called out for this flight as she had to be on duty early the following morning. During the investigation, it was evident that the crew of the accident flight never asked the tower for start-up. Their first contact with the tower at Eros was during their taxi for take-off when they asked for the runway lights to be switched on. The crew then informed the ATC assistant (who was talking to them in the absence of an ATC) that they could not wait any longer for clearance for their flight plan that was filed telephonically with the assistant earlier, as they needed to take off immediately.

Radio communication between the aircraft and tower was handled by the ATC assistant and not a qualified ATC. After take-off, clearance was given to the aircraft by an area controller and not a tower controller.

During the investigation, it was revealed that the ATC services had a serious challenge as far as manpower was concerned. This contributed to the fact that the same controller who was on standby had to work the following morning.

No ATC recordings at Eros Airport were available, as the request for these arrived too late.

1.18.11 Human performance

An analysis was made by a human performance expert after the accident, based on the available radar profile and ATC audio recordings. The analysis was also based on the fact that there was no evidence of any aircraft or instrument malfunction. The expert, who is also an airline captain, also flown the approach in a simulator to assist him with his analysis.

It appeared the crew attempted the VOR let-down but the intention of the ATC was that they utilised the VOR beacon/initial approach pattern to break cloud and continue with approach to runway 19.

It appears that, once the aircraft was overhead the beacon, and after it had turned onto the outbound leg, the pilot did not change the VOR inbound radial from 010° to 007°.

1.19 Useful or Effective Investigation Techniques

1.19.1 No new methods were applied.

2. ANALYSIS

2.1 Man

2.1.1 The pilot-in-command

The pilot-in-command was the holder of a valid commercial pilot licence (aircraft) at the time of the accident and had the aircraft type endorsed on it. The pilot was in possession of a valid medical certificate with corrective lenses as a restriction endorsed on it. The pilot's total flying hours at the time of the accident were 6356.0 hours, of which 1357.9 hours were on the Cessna 441 aircraft.

2.1.2 The co-pilot

The co-pilot was the holder of a valid commercial pilot licence (aircraft) at the time of the accident and had the aircraft type endorsed on it. The co-pilot was in possession of a valid medical certificate with corrective lenses as a restriction endorsed on it. The co-pilot's total flying hours at the time of the accident were 1394.8 hours, of which 1.2 hours were on the Cessna 441.

2.1.3 Air traffic controllers

Both the air traffic controllers that were manning the Cape Town tower frequency at the time of the accident were properly qualified and had the required ratings.

2.2 Machine

2.2.1 From the evidence found at the crash site, and the further inspection of the airframe and the engines, it may be concluded that the airframe did not suffer any pre-impact damage that would have influenced the controllability of the aircraft. The engines showed evidence of rotation at impact, demonstrating its capability of delivering power at impact.

2.2.2 The circumstances of the accident and the examination of the wreckage did not show any technical abnormality that could explain the accident.

2.2.3 Due to the weight classification of the aircraft, it was not a requirement for the type of aircraft (Cessna 441) to be equipped with a cockpit voice recorder (CVR) or a flight data recorder (FDR) and therefore no information was available of any abnormalities that could possibly be experience by the crew before the accident.

2.2.4 Both engines were subjected to an engine teardown inspection after the accident, and except for external accident damage, no internal abnormalities were found that indicated the engines had caused or influenced the accident.

2.2.5 Both GPS systems installed in the aircraft had their data updated on 28 July 2015 and there were no recorded defects to the two GPS systems before the flight.

2.2.6 The last compass swing on the accident aircraft was certified on 3 December 2015.

2.2.7 Maintenance documents revealed that the aircraft was properly maintained and all servicing was carried out on the interval as prescribed and no maintenance-related issues were found to have contributed to the accident.

2.3 Environment

2.3.1 The Tygerberg mountain where the accident took place was covered with low-level clouds at the time of the accident. A wind of 15 knots was also present at the time of the accident.

2.3.2 The crew was informed by area control more than an hour before last contact with the aircraft that they were experiencing a total radar system failure. The GPS receiver that provides date and time to the radar display system failed and caused the time of the radar display system to be set to December 2027. As the radar display system's time jumped to December 2027, it immediately rejected all incoming radar data, for the radar data was time-stamped with the correct date and time of 16 August 2015.

2.4 Navigation

2.4.1 There was never a request from the pilot-in-command for any aid to navigation during the entire flight or during the approach for landing. The pilot accepted all the route changes that were given to him and never enquired if the ILS was available or operational. He also accepted the VOR approach that he received from ATC and never requested an ILS approach.

2.4.2 During several stages of the approach onto the VOR for Runway 19, the aircraft was below the minimum obstacle clearance altitude (MOCA) as indicated by the approach plate for a specific point. The aircraft also failed to fly the correct heading/tracks during certain phase of the VOR approach, which the crew failed to correct.

2.5 Organisational and Management

2.5.1 During the investigation, the investigator was provided with a weight and balance report. The date on the weight and balance report was 17 August 2015, a day after the accident. This report was not signed by either the pilot-in-command or the co-pilot. Company procedures required the crew to leave a signed copy of the weight and balance sheet in the operations room before a flight. No proof could be found that a properly signed weight and balance sheet was on board the accident flight. A completed weight and balance sheet was a requirement according to the Namibian and South African regulations.

2.5.2 During the investigation, no proof of any of the following procedures was available:

- There was no procedure to prescribe the responsibilities to be accepted in the event of a call-out between the aircraft operator and the medical evacuation operator. The responsibilities were not at all clear.
- No procedure was found to indicate that the crew were required to read the company's operations manual at regular intervals.
- No procedure was found that needs to be followed when a crew was placed on standby.
- No procedure was available to be used for crew pairing.

2.5. 3 The operator’s operations manual clearly stated that the Instrument Landing System (ILS) should be seen by the company as an irreplaceable navigation aid. The crew never requested to make use of this navigation aid. The reason for the crew not requesting to make use of the ILS may be as a result of the incorrect information that was provided to the co-pilot before the flight, to the effect that the ILS was not operational in Cape Town, and the crew’s failure to follow up on this information by reading the official NOTAMS before departure.

2.5.4 During the investigation and subsequent interview conducted with the NCAA, it was evident as a result of limited resources ineffective oversight was conducted on the operator.

2.6 Training

2.6.1 The operator’s in-house training organisation was investigated and the investigation revealed the following:

- The training organisation had introduced several amendments to their Training Procedural Manual (TPM).These amendments were made in February 2016, and at the time of the accident, the amendments had not yet been approved by the Namibian Civil Aviation Authority.
- The co-pilot completed training on the Cessna 406 in 2013 and on the Cessna 425 in 2015. The CFI could not provide the investigation team with any proof of examinations, briefings or skills/test forms that were completed after completion of the abovementioned training.
- The co-pilot completed her conversion onto the Cessna 441 three (3) days before the accident flight. According to evidence provided she had flown 1.9 hours in the simulator and 1.2 hours during the test. During the 1.2 hours of her test, she was also briefed on the operation of the two GPS systems installed into the aircraft. No formal training was presented to the co-pilot on these instruments and their operation.

2.6.2 The aircraft was fitted with a Garmin GTN 750 touch screen and Garmin GTN 650 GPS. The only experience the co-pilot had on these two instruments was when she was introduced to them by the CFI during her test of 1.2 hours on the aircraft. Her experience was limited to what the instructor could introduced her to within the 1.2 hours during which she was doing her test with him. No system-specific training was done with her before or after the conversion flight. Both these instruments were situated on the co-pilot side of the cockpit. These two instruments with their advanced technology played a vital role during the crucial moments at the end of the flight. With the limited training the co-pilot had on these systems, it was possible that these instruments could cause confusion to the co-pilot, rather than assisting her, due to her limited knowledge of the operation of the systems.

Figure 12: Different points along the route before starting the approach

2.7 Flying the VOR approach

2.7.1 In figure 11 above it can be seen that the aircraft was constantly on radial 010 that was given by area controller at 04:03Z. The aircraft was handed over to approach at 04:09Z on descent to FL100. Approach advised the crew to plan for VOR approach runway 19. At 04:17 approach enquires if the aircraft is ready for the approach and they replied that they would advise when ready. If they were not ready overhead CTV at 6500 feet, approach would have instructed the aircraft to do racehorse holding pattern until they declare that they are ready. At 04:19Z the aircraft declares that they are ready and are now overhead CTV. Approach then immediately clears the aircraft to initiate the approach. From that point it is the duty of the pilot in command to follow the guidance of the approach plate.

- The aircraft rate of descent was faster than 870ft/min for aircraft flying at 140kts as a result the aircraft was 2700ft when it turned for the inbound track. The plate indicates that you have to be 3000ft at 12DME.
- The inbound turn must be initiated at 12DME. The aircraft initiated the turn at 10NM and at 04:26Z approach transferred the aircraft to tower after they indicated that they have turned inbound.
- The aircraft overshoot the inbound track i.e. radial 007° (HDG 187°). The aircraft is seen tracking and establishing on the previous radial 010°. This suggests that both pilots did not make sure that the correct radial is dialled into the VOR instrument.
- At 04:28Z tower controller asks if the aircraft is on ILS and they indicate that they are not. The hand over from approach controller to tower controller did not include all the relevant information such as EMD is on VOR approach and not ILS.
- At 04:29Z tower cleared the aircraft for landing but there was no reply.

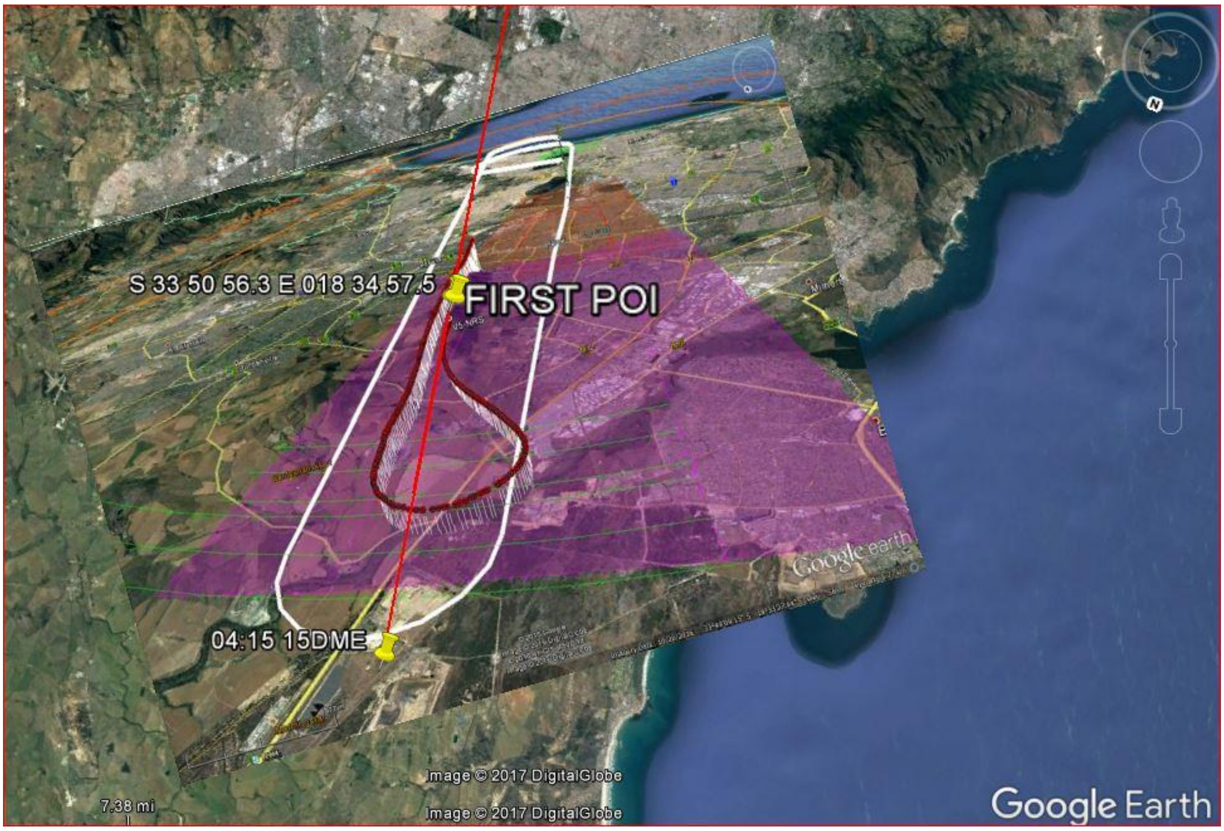


Figure 13: The red dots is the path flown by the aircraft and the white line is the pattern to be followed. Throughout the route the aircraft was tracking radial 010

2.8 Human Performance

2.8.1 At the time just before the accident, the crew was exposed to a high workload environment,., The pilot flying was trying to establish the aircraft on the inbound radial, ATC called and requested if they were established on the ILS for Runway 19. The pilot monitoring then answered they were cleared for the VOR and not the ILS. This could have led to distraction as well as confusion in the cockpit. The pilot flying did not adjust the VOR from radial 010° to 007° which put the aircraft in a collision course with higher ground, while the pilot non-flying failed to monitor the actions of the pilot flying.

3. CONCLUSION

3.1 Findings

3.1.1 Man

3.1.1.1 The pilot-in-command (pilot flying) was properly certified and qualified according to regulations to perform this flight and he was in possession of a valid medical certificate.

3.1.1.2 The co-pilot (pilot not flying) was properly certified and qualified according to regulations to perform this flight, although she only had 1.2 hours actual flying hours on the Cessna 441 before the accident flight.

3.1.1.3 All air traffic controllers (South African) were properly certified and qualified to perform controlling duties.

3.1.2 Air Traffic Services

3.1.2.1 The Air Traffic Services in Namibia are seriously understaffed and pose a serious threat to aviation safety.

3.1.2.2 During the take-off from Eros Aerodrome there was no Tower Controller on duty, resulting in the aircraft taking off without clearance.

3.1.2.3 Radio communication between the aircraft and the tower at Eros airport was handled by an ATC assistant.

3.1.2.4 Handover from Eros Tower was not done by a Tower Controller on duty but by an Area Controller.

3.1.3 Machine

3.1.3.1 The aircraft was properly maintained and all servicing was carried out in the prescribed intervals. No maintenance-related issues were found to have contributed to the accident.

3.1.3.2 A teardown inspection of both engines after the accident revealed no internal abnormalities that could have prevented the engines from delivering power at the time of the accident.

3.1.3.3 Both GPS systems installed in the aircraft were updated and the last compass swing was done within the prescribed time frame.

3.1.4 Environment

3.1.4.1The area where the accident took place was covered with low clouds and a strong wind was present at the time of the accident.

3.1.4.2The crew was informed of the total radar failure at their destination in Cape Town more than an hour before their estimated landing time and accepted their routing for landing at FACT.

3.1.5 Navigation

3.1.5.1 The crew never requested any aid to navigation and was satisfied with all the route changes and the VOR approach onto Runway 19 at FACT.

3.1.5.2 The crew did not execute the approach procedure in accordance with the published procedure requirements, causing the aircraft to descend below the safe altitudes and outside the protection areas offered by the procedure.

3.1.5.3They filed a flight plan telephonically in Namibia and the Namibian Air Traffic Services was responsible for transmitting it to South Africa via fax or telephone.

3.1.5.4 The crew was warned of a total radar failure in Cape Town, approximately one hour before the accident. The radar failure did not have an influence on the accident as the crew were instrument-rated and the radar was purely an aid to ATC for separation purposes.

3.1.6 Organisational and Management

3.1.6.1 The investigation revealed that the operator did not have proper procedures for the following:

- The responsibilities of the operator and the medical operator during a call-out.
- No procedures were found, indicating that the flying crew were required to read the company's operations manual at regular intervals.
- No procedures were in place addressing the protocol to be followed to place a flight crew member on standby.
- No procedure was available indicating for crew pairing.
- No procedures were available for fatigue management training or any means of tracking fatigue risks.

3.1.6.2 The following procedures were in place but were not followed during the time of the accident flight:

- No master dispatch list was available as described after the accident.
- No flight plan was filed for the flight.
- No signed copy of a weight and balance report was available after the accident, as described in the operations manual.
- The crew took off without proper clearance from a tower controller as there was no controller in the tower at the time of the take-off.
- The flight dispatcher was never subjected to a competency check as prescribed in the operator's procedures.
- No proof of any flight planning done for the flight was available after the accident.

3.1.7 Training

3.1.7.1 At the time of the accident, the training organisation was operating with a training procedural manual that was not approved by the Namibian CAA after amendments were made to the manual in February 2016.

3.1.7.2 The co-pilot of the accident flight had completed type-rating courses on two different aircraft since 2013, but the CFI of the training organisation could not provide any proof of examinations, briefings or skills/test forms to indicate that proper training had been done. This was a direct transgression of the Namibian regulations.

3.1.7.3 The co-pilot did not undergo any formal training on the two GPS systems installed on her instrument panel. The fact that she was possibly overwhelmed by the amount of information that was available could not be excluded.

3.1.7.4 The CFI could not provide any evidence of any oversight that was done on the pilot-in-command in his position as a training captain.

3.1.7.5 During several line-orientation training sessions, the following were highlighted as possible weak points during the training of the pilot-in-command: crew cooperation, briefings and the use of the checklist. The training organisation did not take any corrective actions to correct these weak points.

3.1.8 Namibian CAA oversight

3.1.8.1 During the investigation and subsequent interview conducted with the NCAA, it was evident as a result of limited resources ineffective oversight was conducted on the operator.

3.1.9 Environment

3.1.9.1 At the time of the accident, the accident site was covered in low clouds and a wind of 20 knots was present, which had an influence on the accident.

3.2 Probable Cause/s

3.2.1 The aircraft collided with terrain during instrument meteorological flight conditions while on the VOR approach Runway 19.

4. SAFETY RECOMMENDATIONS

4.1 The operator should have safety management system in place to identify hazards and mitigate risks with regard to the type of operations paying special attention to fatigue risk management, human performance and change management.

5. APPENDICES

5.1	Appendix A	Weather report.
5.2	Appendix B	Weight and balance report.
5.3	Appendix C	ATNS Report.
5.4	Appendix D	Engine teardown report.
5.5	Appendix E	Review on the Instrument Approach Procedure.

Appendix A

South African Weather Service

ISO 9001 Certified Organisation

AIRCRAFT ACCIDENT REPORT

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Version and Amendment Schedule

Version	Version Date	Author	Description of Amendments
1	17 August 2015	Luthando Masimini Xolile Jele	Document Created

Scope

The meteorological information provided in this report includes the following:

Observational weather data at/or in the vicinity of the aircraft accident/incident closer to the time of occurrence. These include but are not limited to:

(i) Remote sensing data such as Satellite; RADAR imagery; etc.
(ii) Observational surface data in the form of METARs or SYNOPs - which contain weather elements such as:

- Dry-bulb and Dew-point temperatures;
- Wind speed and direction;
- Cloud cover;
- Visibility;
- Weather; and the
- QNH.

Purpose

To provide the South African Civil Aviation Authority (SACAA) with meteorological information required for their inquest into an aircraft accident/incident closest to the time of occurrence.

Background

An aircraft registered V5-NRS which was inbound to Cape Town from Namibia is reported to have been involved in a fatal accident in the area of Tygerberg Mountain, Western Cape Province. The accident was reported to have lost contact with the ATC Cape Town at approximately 05:00Z and was discovered an hour later. The GPS coordinates for the accident site are given as **S33⁰ 50.93' E018⁰ 34.34'.**

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SUMMARY OF OBSERVED WEATHER CONDITIONS CLOSER TO THE ESTIMATED TIME OF OCCURRENCE OF THE AIRCRAFT ACCIDENT

(i) Satellite image:

The satellite images show mid-level and low level clouds over the accident site and surrounding areas. Refer to Attachment A.

(ii) Surface observations:

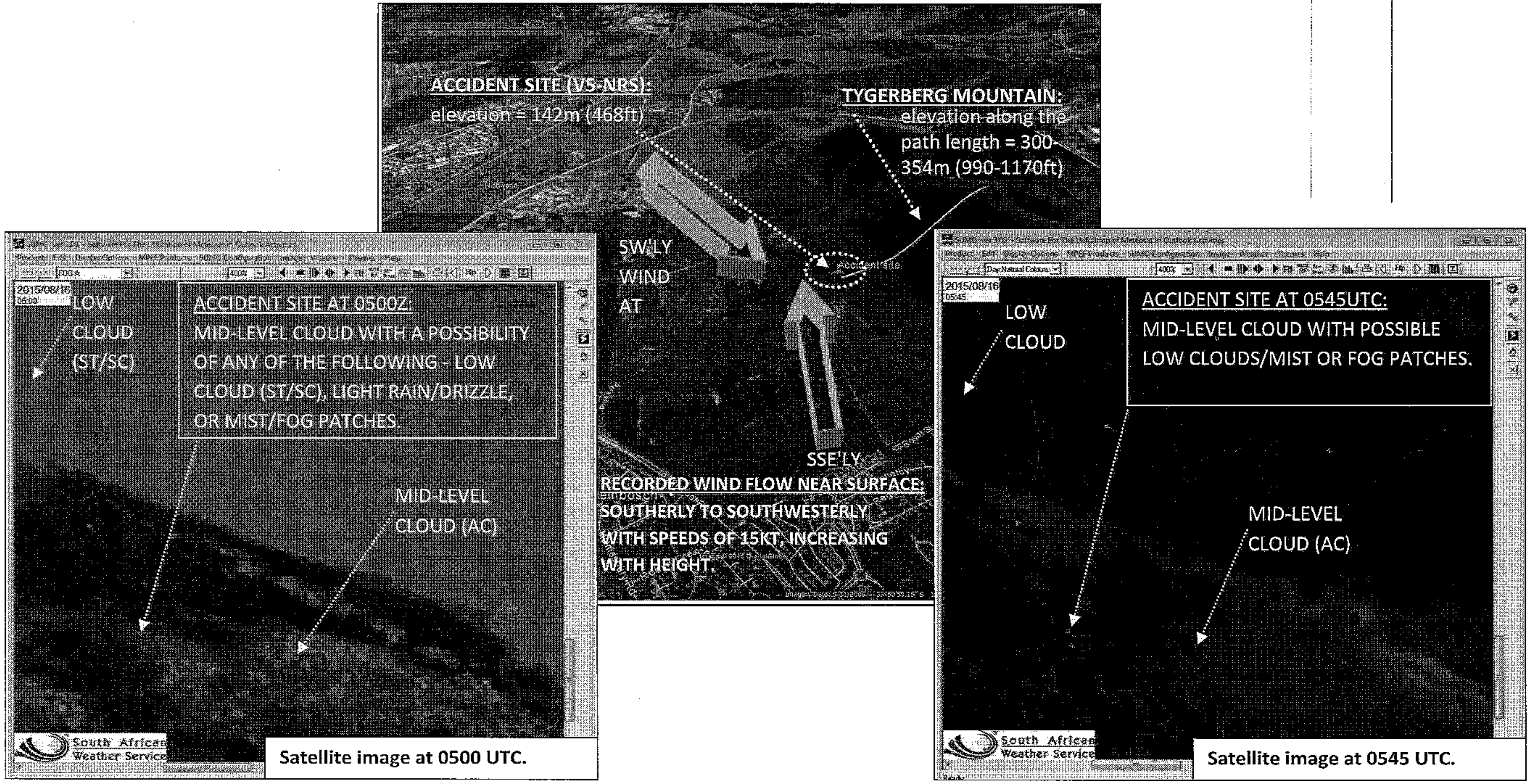
The METARs for Cape Town (FACT) indicate the presence of low level cloud with minimum base of 500ft AGL and minimum visibility reduced to 6000m between 0430Z and 0500Z. The weather conditions started to improve as from 0530Z with the low cloud becoming scattered at 800ft AGL and the visibility improving to greater than 10km. The average wind direction at the surface was constantly observed to be a southerly to south easterly with an average speed of 14kt. Refer to Attachment C

(iii) Vertical wind and temperature profile from the FACT Tephigram:

A Skew-T diagram recorded at Cape Town (FACT) valid for 0644Z showing the vertical profile of the winds and temperatures is included in Attachment B. The ascent shows a southerly to south-easterly wind at about 20kt at the accident surface (468ft) and the mountain top (985ft). The wind direction turned to a westerly to north westerly at about 4000ft. The ascent also shows low level moisture stretching to about 4000 ft which resulted in low level clouds as observed from the METAR and Satellite.

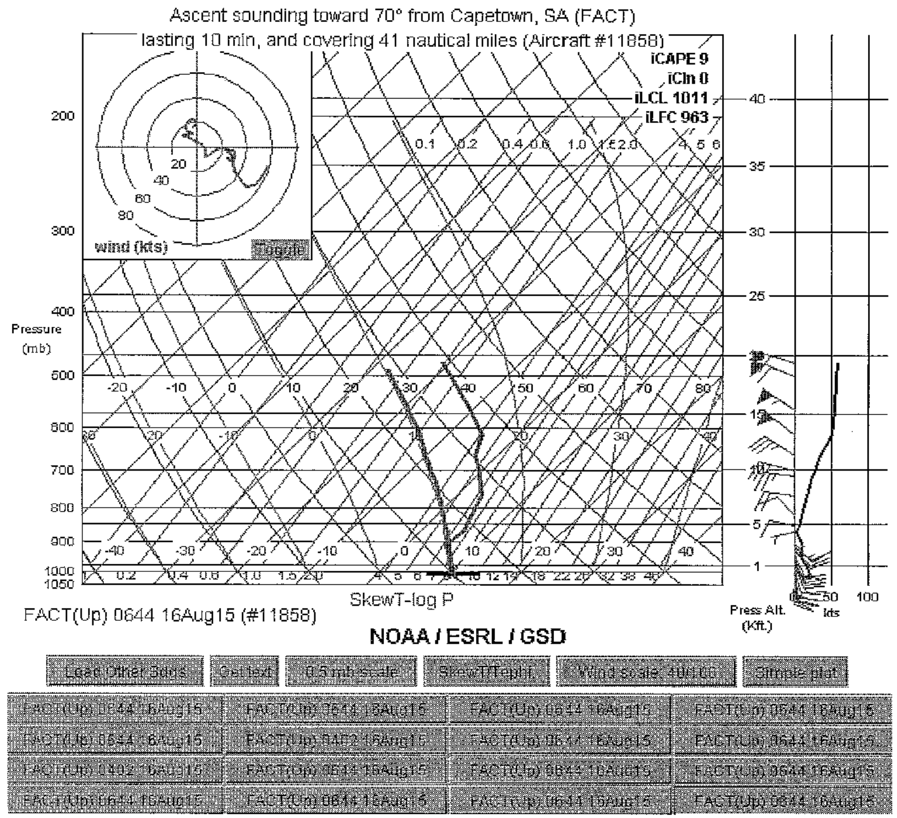
From the above observations, we can deduce that the low level cloud which was observed to be at 500ft AGL covered the Tygerberg mountain peaks which are approximately 985ft, resulting in poor visualization of the mountains.

ATTACHMENT A: Geographical location of the accident site in Tygerberg (top image) and satellite images recorded at 0500UTC and at 0545 UTC (bottom images) valid for 16 August 2015.



>>> back to summary page

ATTACHMENT B: Skew-T diagram recorded at Cape Town (FACT) valid for the 16 August 2015 at 0644Z.



>>> back to summary page

ATTACHMENT C: METAR messages recorded at Cape Town

Aviation Weather Centre
Designated Aeronautical Meteorological Authority for South Africa
South African Weather Service
ISO 9001 Certified Organisation
Weatherline 083 123 0500

Searching for historic data between 2015-08-16 and 2015-08-16

Results for Meteorological Aerodrome Report(s)

Station: FACT

Date: 2015-08-16
FACT 160630Z 17014KT 9999 FEW012 BKN033 12/11 Q1026 NOSIG=
FACT 160600Z 16015KT 9999 FEW010 BKN019 11/11 Q1026 NOSIG=
FACT 160530Z 17013KT 9999 SCT008 OVC019 11/11 Q1026 NOSIG=
FACT 160530Z 17013KT 9999 SCT008 OVC019 11/11 Q1026=
FACT 160500Z 16015KT 6000 BKN005 OVC020 11/11 Q1025 NOSIG=
FACT 160500Z 16015KT 6000 DZ BKN005 OVC020 11/11 Q1025 NOSIG=
FACT 160430Z 18012KT 7000 DZ BKN006 OVC020 12/11 Q1025 NOSIG=
FACT 160430Z 18012KT 7000 BKN006 OVC020 12/11 Q1025 NOSIG=
FACT 160400Z 19008KT 9999 FEW009 OVC020 11/11 Q1024 NOSIG=

Results for Special Meteorological Aerodrome Report(s)

Station: FACT

Date: 2015-08-16
SPECI FACT 160411Z 19009KT 9999 DZ BKN007 OVC030 11/11 Q1024 NOSIG=

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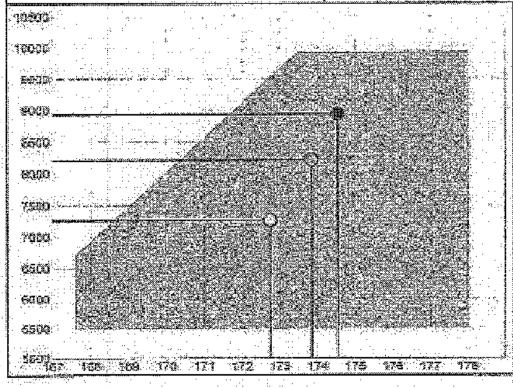
WEIGHT & BALANCE REPORT
FYOG -> FACT
(Page 1 of 1)

JEPPESEN *FliteStar 9.6.2.0*

REPORT DATE	August 17, 2015	AIRCRAFT TYPE	Cessna
		AIRCRAFT TAIL #	V5NRS

ITEM	ARM	MIN	MAX	WEIGHT (LBS)
BEW EXP 16.11.2019	169.1	–	–	6260
Crew	137.0	–	–	374
Fwd Seat x1	178.0	–	–	150
Stretcher	179.0	–	–	189
Aft Seats x2	296.0	–	–	189
Nose cargo	79.0	–	–	0
Equip Box in Cabin	185.0	–	–	0
Bay A	301.0	–	–	0
Bay B	317.0	–	–	0
Fuel	182.3	0	3120	1674
Cargo avionics	32.0	–	–	0
Aft cabin	281.0	–	–	100



RAMP WEIGHT	8936
CG	174.5
% MAC	–
LANDING WEIGHT	8210
LANDING CG	173.9
LANDING % MAC	–

AS LOADED
LANDING
ZERO FUEL

LOAD MANIFEST
(Page 1 of 1)

JEPPESEN *FliteStar 9.6.2.0*

REPORT DATE	August 17, 2015	AIRCRAFT TYPE	Cessna
		AIRCRAFT TAIL #	V5NRS

CUSTOMER		FLIGHT ID	V5-WAI	PAX	0
ROUTE	FYOG -> FACT	DEP DATE	August 17, 2015	DEP TIME	12:00

DESCRIPTION	TYPE	ARM	MIN	MAX	WEIGHT (LBS)
BEW EXP 16.11.2019	Fixed	169.1	–	–	6260
Crew	Passenger	137.0	–	–	374
Fwd Seat x1	Passenger	178.0	–	–	150
Stretcher	Passenger	179.0	–	–	189
Aft Seats x2	Passenger	296.0	–	–	189
Nose cargo	Baggage	79.0	–	–	0
Equip Box in Cabin	Baggage	185.0	–	–	0
Bay A	Baggage	301.0	–	–	0
Bay B	Baggage	317.0	–	–	0
Fuel	Fuel	182.3	0	3120	1674
Cargo avionics	Other	32.0	–	–	0
Aft cabin	Other	281.0	–	–	100

	WEIGHT	CG	%MAC		
				RAMP WEIGHT	8936
TAKEOFF	8936	174.5		MAXIMUM WEIGHT	9925
LANDING	8210	173.9		MINIMUM CG (IN)	171.5
MAX ALLOWABLE TAKEOFF WEIGHT				MAXIMUM CG (IN)	178.0

PIC ______ DATE ______ CREW ______

THIS MANIFEST COMPLIES WITH FAR 135.63(C)

(5)

MEMORANDUM

FROM	:	David Watts SM:TS
TO	:	Jeremiah Visser South African Civil Aviation Authority
	:	Chris Williams South African Civil Aviation Authority
	:	Ahmed Motala South African Civil Aviation Authority
DATE	:	14 September 2015

Technical Incident: Cape Town: 16 August 2015

1. Purpose

1.1. To provide additional information and clarification from a technical perspective of the event at ATNS's Cape Town Air traffic Management Centre 16 August 2015.

2. Background

2.1. **ATNS Maintenance Philosophy**

2.1.1. ATNS's maintenance philosophy is to only carry out Operator level (O level) and Intermediate level (I Level) maintenance activities in house. O level maintenance activities are typically resetting or reloading configuration settings and I level maintenance activities involve the swapping out of failed modules.

2.1.2. ATNS's maintenance philosophy requires ATNS to have Maintenance Support Contracts in place with the original equipment manufacturers to facilitate Depot level (D level) maintenance activities. D level maintenance activities include the repair of failed electronic modules and hardware modules and the modification and upgrade of embedded software programs as required.

2.1.3. ATNS maintenance system and support contracts are carefully planned and evaluated and implemented to provide throughout life support of the systems and the life cycle cost of the system is optimised.

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2.2. **ATNS Management System.**

2.2.1. ATNS operates a computerised Maintenance Management System (MMS) which is operated on a software platform called MS Dynamics GP (Great Plains) this is a Microsoft Certified Enterprise Resource Planning solution.

2.3. The MMS operates in conjunction with a National Fault Reporting Centre facility, located at the Johannesburg FIR ATM centre, is responsible for all ATNS Communications, Navigation Aids and Surveillance (CNS) infrastructure.

2.4. All CNS faults (corrective maintenance) are reported to the National Fault Reporting Centre (Single telephone number for fault reporting). The fault is recorded on the MMS by a Fault Reporting Centre operator. The logging of a fault on the MMS is relatively simple as the MMS has pre-loaded configurations of all services, and systems, down to line replacement module level and, where necessary, consumables. Therefore the configuration of all CNS systems in use is defined and recorded in almost real time.

2.5. Each fault logged is registered with a unique number, such as 1508160006,this example is in fact the fault number for the Cape Town incident on the 16th August 2015, the first set of 2 numbers indicate the year(2015), the second set of 2 numbers (08) indicated the month (August) the third set of 2 numbers indicate the day (16) then the last 4 numbers,(0006) indicate the unique fault number for that day, i.e. on the 16th August 2105 the Cape Town incident was the 6th fault logged in sequential time.

2.6. Once the fault is logged on the MMS system an appropriate job card for the repair of the fault is created and issued to the correct Technical Support department (Airport) to ensure that the fault is repaired within the defined Service Level Agreement (SLA).

2.7. The SLA's for all the CNS infrastructure is also preloaded into the MMS system, to enable the MMS to flag and escalate, via e mail, any service and /or system outage that has exceeded the SLA.

2.8. Having received the job card for the repair of the facility, the Engineering Technician attends to the fault and returns the CNS service and/or system to a serviceable state. The details of the repair, what the exact problem was, what parts were required to repair the system, and the time taken to repair the system is entered on the job card which is loaded into MMS.

2.9. Using this methodology the MMS data base, MS Server SQL, contains sufficient details to provide the following functionality:
2.9.1. Reliability and Availability Criteria.
2.9.2. Service Status Criteria, also available on a web-based dynamic geographical map.
2.9.3. Equipment Status Indicators.
2.9.4. Equipment Status.
2.9.5. Inventory Control.
2.9.6. Asset management.
2.9.7. Facilities status (Services, Systems, Equipment and building status)
2.9.8. Service Level Commitments.
2.9.9. Job Costing (Corrective). – Parts subsistence and travel, labour suppliers, repairs.
2.9.10. Personnel Costing (Corrective maintenance).

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Directors: MD Mamashela (Chairman), DST Mthiyane (Chief Executive Officer), MW Ndlovu (Chief Financial Officer), FZ Msimang, HT Makhathini, FKN Tlhakudi, TN Mgoduso, SV Zilwa, SG Mseleku
Company Secretary: S Mngomezulu

2.10. Required Preventative Maintenance activity schedules for all the CNS infrastructure is preloaded into the MMS system, and given a unique fault number as described in paragraph 2.6. The Preventative Maintenance activity schedules detail the exact maintenance tasks that are required at the appropriate intervals. A Job card detailing the required Preventative Maintenance tasks to be done on any preventative schedule is automatically generated at the appropriate Technical Service Department (Airport) and a Technician is assigned to complete the Preventative Maintenance activity.

2.11. Having completed the Preventative Maintenance activity, the Engineering Technician enters the details of the Preventive Maintenance activity, what exactly was done, what parts were required to carry out the preventative maintenance, and the time taken to do the preventative maintenance as well as the time the CNS system was out of service due to the preventative maintenance schedule, if applicable.

2.12. If any Preventative Maintenance activity is not completed on time the MMS flags and escalates, via e mail, that the Preventative Maintenance activity is overdue.

2.13. Again by using this methodology the MMS utilise a MS Server SQL data base that contains the sufficient details to provide the following functionality:

2.13.1. Reliability and Availability Criteria.
2.13.2. Service Status Criteria.
2.13.3. Equipment Status Indicators.
2.13.4. Equipment Status.
2.13.5. Inventory Control.
2.13.6. Asset management.
2.13.7. Facilities status (building and Services)
2.13.8. Service Level Commitments.
2.13.9. Job Costing (Preventive maintenance) – parts subsistence and travel, labour suppliers, repairs.
2.13.10. Personnel Costing (Preventive maintenance).

2.13.11. CNS service availability reports are accessible from the MMS and are using MS SQL Reporting Services to generate the availability figures dynamically.

3. Maintenance Support Contract With Original Equipment Manufacture

3.1. As previously mentioned for every major CNS system acquisition ATNS enters into a Maintenance Support Contract for the Life of the CNS system. The Support Contract ensures that ATNS has preferential maintenance support services from the OEM throughout the useful life of the CNS system.

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4. Logistic Support Plan

4.1. The Logistic Support Plan is integrated (linked) with the Maintenance Support Contract and typically the Logistic Support plan details the following aspects of maintenance activities:

4.1.1. Scope of Work: Systems, sub system and modules that are cover under the support contract and need to be maintained.

4.1.2. Responsibility of Each Entity: OEMs responsibilities and ATNS responsibilities.

4.1.3. Fault Management: How faults are reported to the OEM and the process of returning failed modules to the OEM for repair and the turnaround time expected when the serviceable module will be returned to ATNS stores.

4.1.4. Performance Management: The target availability and reliability of the CNS system is measured and if the target is not archived what action is to be taken to ensure that the target availability and reliability is achieved.

4.1.5. Configuration Management: How the configuration of hardware, software and technical documents are controlled.

4.1.6. Training: Details the training required by ATNS support staff to be able to maintain the system.

4.1.7. Technical Documents: Defines what technical documents are required to maintain the system.

4.1.8. Test Equipment: Defines what test equipment is required to maintain the system.

4.1.9. Materials Supply and Management: Details the quantity and location of spares required to maintain the system.

4.1.10. Design Expertise. Details which entity is responsible for the design of the system and which entity will be responsible for upgrades and modification of the system.

4.2. Note: A copy of the Logistic Support plan of the Eurocat- X can be provided on request

5. ATNS Technical Support

5.1. The entity responsible for the O and I level maintenance support is the ATNS Technical Support Department. As mentioned previously D level Maintenance is carried out via a support contract with the OEM.

5.2. At Cape Town ATNS Technical support provides a 24 hour 7 day per week and 356 days per year service. This is achieved by nominating dedicated Engineering Technicians to be on standby outside of normal working hours, these dedicated Engineering Technicians respond to calls from the National Fault Reporting Centre who alerts the Cape Town Engineering Technicians rostered for standby as soon as a fault

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that has been logged requires immediate attention. The Engineering Technician then reacts to the instruction from the National Fault Reporting Centre and immediately attends to the fault.

5.3. ATNS provides extensive training, which is a combination of theoretical and practical training at ATNS's Training Academy, on the job training is given by experts in the field. Having gained competence on a system or piece of equipment ATNS's Engineering Technicians are awarded Competency Points, in line with the complexity of the system or piece of equipment. Refresher training is provided to maintain competence on each system or piece of equipment.

6. Technical Report 16 August 2015

6.1. **Sequence of events**

6.1.1. The Johannesburg FIR Radar Display System, Eurocat X, was reported unserviceable at 02:47 local South African time: (note all times stated in this report are with reference to local South African time unless otherwise indicated) by ATC to the Fault Reporting Centre, "all Eurocat X display positions failed to display air traffic".

6.1.2. The Fault Reporting Centre alerted the Standby Engineering Technician. The Standby Engineering Technician on arrival at site found that the problem was caused by the Eurocat X being set to the wrong year being 2027. Understanding the seriousness of this issue the Standby Engineering Technician, call for extra assistance, including his manager MTS ORTIA.

6.1.3. The ORTIA technical team began investigating the reason for the wrong year, 2027, being set into Eurocat X. Their analysis identified that the problem was caused by the single GPS receiver that is used to provide accurate time to the Eurocat X.

6.1.4. Despite all efforts the ORTIA technical team couldn't set the Eurocat X GPS receiver back to 16 August 2015. The technical team investigated and ascertained that two later versions of GPS receivers at ORTIA were showing the correct time of 16 August 2015. One of these later versions of GPS receiver is used to provide accurate time to the Advance Surface Movement and Guidance Control System (A-SMGCS), the other GPS receiver is used to provide accurate time to the System Support Suite (SSS). The SSS is a separate building located approximately 5 minutes' walk away from the Control Tower. The SSS can be used in 3 different ways. It can be used as a limited ATM system in the event of a catastrophic disaster occurring at the main ATM Centre, It can be used as an ATM simulator for training and it can also be used to test new versions of Eurocat X software. There is a SSS at both at the FAJA and FACA ATM Centres.

6.1.5. The ORTIA technical team then determined that the best solution to the problem would be to connect the Eurocat X to one of the two other GPS receivers that were indicating the correct year. Due to its proximity to the main Eurocat X system they chose the A-SMGCS GPS receiver.

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6.1.6. At this time the MTS ORTIA, being the ex-Display Specialist at Cape Town realised that the Cape Town FIR Eurocat X would have the same problem as a similar GPS synchronized clock is also used there. The Cape Town standby Engineering Technician was alerted at 05:35, another Engineering Technician and the Display Specialist were requested to assist with the Eurocat X issue at 05:40. The Cape Town Radar Specialist and Operational Specialist were also called in to assist.

6.1.7. The ORTIA technical team connected the Johannesburg FIR Eurocat X to the working A-SMGCS GPS receiver, and the Johannesburg FIR Eurocat X system was restored to serviceable state at 06:50.

6.1.8. On arrival at site the Cape Operational Specialist began configuring the Cape Town FIR SSS to work in an operational configuration and by 08:52 the Cape Town FIR Area West was operating from the SSS and by 08:55 the Cape Town FIR Area East was operating from the SSS.

6.1.9. The rest of the Cape Town Team focused on connecting the main Cape Town FIR Eurocat X system to the Surface Movement Radar Systems GPS receiver, this was achieved at approximately 11:00. After resetting all 14 operational positions the Cape Town FIR Eurocat X was fully serviceable and in use by13:H00.

6.1.10. These details of the events are captured on ATNS's MMS as Fault number 1508160006. See attachment A

6.2. **Other CNS Systems at Cape Town's status during the time of the radar picture not being available.**

6.2.1. All other systems were fully operational see below table:

EQUIPMENT	FUNCTION	STATUS
ATM system	Radar Display Eurocat X	NON OPERATIONAL
CT Radar 1	PSR	OPERATIONAL
CT Radar 2	PSR	OPERATIONAL
CT Radar 1	MSSR	OPERATIONAL
CT Radar 2	MSSR	OPERATIONAL
Surface Movement NOVA	Display	OPERATIONAL
Surface Movement Radar on Airfield	PSR / SSR	OPERATIONAL
Navigation Aid	CT VOR /DME	OPERATIONAL
ILS 01	Instrument Landing System	SERVICEABLE
ILS 19	Instrument Landing System	OPERATIONAL
VHF communications	All VHF Frequencies	OPERATIONAL

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6.3. **Current Conclusions to the Root Cause of Failure**

6.3.1. The GPS receiver that provides date and time to the Johannesburg and Cape Town FIR Radar Display System, Thales Eurocat X, malfunctioned at the same time 00:18 UTC. This malfunction caused the time of the Radar Display System to be set to December 2027.

6.3.2. The Radar Display System is time sensitive, in terms of displaying a radar picture. The radar display system is provided with multiple radar data inputs, Cape Town has 2 local radar systems which provide both primary and secondary radar data. The incoming radar data is time stamped, this time is also derived from a GPS receiver source, when the Radar Display System's time jumped to December 2027 it immediately rejected all incoming radar data as the radar data was time stamped with the correct date and time of 16 August 2015.

6.3.3. It is currently ATNS's understanding, that the Radar Display System is designed to reject any radar data that is older than 4 seconds, if old radar data is displayed it would present a radar picture that no longer reflects the true and current position of aircraft.

6.4. **After Event Investigations**

6.4.1. After event analysis proved that both the ORTIA and Cape Town Eurocat X systems stopped working at the same time. The log files from the Eurocat system indicates this was at 00:18 UTC.

6.4.2. Both GPS receivers, ORTIA and Cape Town, were of the same make and version number manufactured by a French company, GORGY.

6.4.3. On closer inspection although the manufacturer was GORGY, the actual GPS receiver, a sub unit of the main GORGY GPS receiver, was made by Motorola in 1996. From the information contained in the Motorola technical manual for this device, obtained on line after the event, at the time of manufacture the date of 1st January 1996 is programed into this receiver.

6.4.4. After further investigations, online, looking at other manufacturers of GPS receiver web sites and general GPS information sites, it is currently believed that both GPS receivers failed because their reference date was 1st January 1996. GPS receivers manufactured around this time had a limited life of 19.6 years, to be precise 7167 days. This was due to their internal reference clock not being able to count higher than 7167 days.

6.4.5. From a start date of 1st January 1996 the day count of 7167 takes you to the precise date of 15th August 2015.

6.4.6. Until after event investigations it was never known to ATNS that some GPS receivers have a limited life span.

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Company Secretary: S Mngomezulu

6.5. **Current Status of the Technical Investigation.**

6.5.1. ATNS has requested Thales the OEM of the Radar Display System, see attachment B, to do the following actions.

6.5.1.1. Engage Gorgy Timing, the manufacturer of the GPS receiver, to investigate why the GPS receivers at Johannesburg and Cape Town inputted the year 2027, at 02:18 on 16th August 2015 to the Eurocat-X ATM system.

6.5.1.2. Investigate the reason why the Eurocat-X ATM systems at Johannesburg and Cape Town accepted a date and time that was 12 years ahead of the previous correct date and time update; confirm that the Eurocat-X system responded to the incorrect date input as designed; propose mitigations to be introduced into the Eurocat-X to prevent a reoccurrence of the failure to display radar and flight plan tracks; advise by when such mitigations will be available for introduction into the Eurocat-X system.

6.5.2. ATNS has provided Thales with all the information requested to assist with the investigation.

6.5.3. ATNS is currently waiting for a detail response from Thales as to why the GPS receiver malfunctioned at 00:18 UTC on the 16 August 2015.

6.6. **Information Requested by SACAA.**

6.6.1. ATNS approved maintenance program for the Radar Display System;

See attachment C.

6.6.2. Information of scheduled and non-scheduled maintenance performed on the radar system over the last twelve months;

See attachment D and E, a list of the unique MMS numbers that record when scheduled and non-scheduled maintenance actions have occurred. Note a more detail of any of these actions can be provided on request.

6.6.3. Technical report of trouble shooting and defect identification which was performed to resolve the radar failure;

See paragraph 6.1 of this document and attachment A

6.6.4. The corrective action/s report which identify the steps taken to resolve the identified failure;

See paragraph 6.1 and 6.3

6.6.5. Entity which was responsible to perform the maintenance on the radar system;

As described in paragraph 5, ATNS Technical Support Department performs O and I Level maintenance and via a Maintenance Support Contract Thales performs D Level.

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ATTACHMENT A Page 1

New Service Call History Entry

History Report | Job Sheet | Serviceability Report | Fault Report | Fault Analysis Report | LIVE

Current Service Status

Service Number 1508160006 CORRECTIVE SubFault 1 Number Of SubFaults 1 Still Open 0

Service Status	FCL Fault Cleared		NOTAM Request	Ext. Ref. Coy.	Facility	EUROCAT-X CT
Date	19/08/15	12:17:43		Ext. Ref. No.	EUROCAT-X ATM CAPE TOWN	
Service Equipment	CT_EURX-OPS ROOM	Status	UP	Assigned Agent 00332	Henk Ellis	
System Code	CT_EURX-OPS ROOM	EUROCAT-X OPERATIONS ROOM			User ID	ct-henke

Fault Cleared

New Details

Service Status		NOTAM	Facility	EUROCAT-X CT
Event Date/Time	08/09/15 09:58:08			EUROCAT-X ATM CAPE TOWN
Service Equipment	CT_EURX-OPS ROOM	Status	Assigned Agent	
System Code	CT_EURX-OPS ROOM	EUROCAT-X OPERATIONS ROOM	User ID	js-davidw

Narrative

Service History

Sequence	Fault Status	Date	Time	System Code	Status	Assigned Agent	Ref.	No.
4	ATNS Feedback	16/08/15	09:57:42	CT_EURX-OPS ROOM	DOWN	Neville Gleeson		
3	ATNS Repair	16/08/15	06:01:51	CT_EURX-OPS ROOM	DOWN	Neville Gleeson		
2	Confirmed	16/08/15	05:33:00	CT_EURX-OPS ROOM	DOWNGRADED	Sanelisiwe Mkhize		
1	Initiated	16/08/15	05:33:00	CT_EURX-OPS ROOM	DOWNGRADED	Sanelisiwe Mkhize		

Narrative:

4 – tried in vain to restore time to current time. we found that GORGY clock had wrong date and time. it kept getting wrong time from satellite.

3 – Came in and found that all servers were at 31 dec 2027.

2 – Call Confirmed on 16/08/15 at 05:36:08 . Reported to Siyanda

1 – Call Entered on 16/08/15 at 05:35:49 . CT APP reported EUROCAT-X on degraded mode

"S" Number | ADDL INFO | Ad Hoc | FeedBack Codes SD:ND:IF "S" Number S23 Version 9.00270

ATNS/TS/ Technical Incident: Cape Town: 16 August 2015	Page 9 of 20	14 September 2015

ATTACHMENT A Page 2

New Service Call History Entry

History Report | Job Sheet | Serviceability Report | Fault Report | Fault Analysis Report | LIVE

Current Service Status

Service Number 1508160006 CORRECTIVE SubFault 1 Number Of SubFaults 1 Still Open 0

Service Status FCL Fault Cleared | NOTAM Request | Ext. Ref. Coy | Facility EUROCAT-X CT

Date 19/08/15 12:17:43 | Ext. Ref. No | EUROCAT-X ATM CAPE TOWN

Service Equipment CT_EURX-OPS ROOM | Status UP | Assigned Agent 00332 | Henk Elk

System Code CT_EURX-OPS ROOM | EUROCAT-X OPERATIONS ROOM | User ID ctvhenke

Fault Cleared

New Details

Service Status | NOTAM | Facility EUROCAT-X CT | EUROCAT-X ATM CAPE TOWN

Event Date/Time 08/09/15 09:58:08

Service Equipment CT_EURX-OPS ROOM | Status | Assigned Agent

System Code CT_EURX-OPS ROOM | EUROCAT-X OPERATIONS ROOM | User ID jo-davidw

Narrative

Service History

Sequence	Fault Status	Date	Time	System Code	Status	Assigned Agent	Ref.	No.
6	ATNS Feedback	16/08/15	10:35:21	CT_EURX-OPS ROOM	DOWNGRADED	Neville Gleeson		
Narrative: Found GPS receiver to be at fault. A spare is on its way from Jo'burg. We are working on a procedure to move timing to NOVA, and DBM as TMH.								
5	ATNS Feedback	16/08/15	10:13:26	CT_EURX-OPS ROOM	DOWNGRADED	Neville Gleeson		
Narrative: ATC have moved to SSS while we continued to work on fault. Mr Fisher assisted in the transition to SSS. ATC operating successfully at SSS.								
4	ATNS Feedback	16/08/15	08:57:42	CT_EURX-OPS ROOM	DOWN	Neville Gleeson		
Narrative: tried in vain to restore time to current time. we found that GORGY clock had wrong date and time. it kept getting wrong time from satellite.								
3	ATNS Repair	16/08/15	08:01:51	CT_EURX-OPS ROOM	DOWN	Neville Gleeson		
Narrative: Came in and found that all servers were at 31 dec 2027.								

"S" Number | ADDL INFO | Ad Hoc | FeedBack Codes SD:NO IF | "S" Number S23 | Version 9.00270

ATNS/TS/ Technical Incident: Cape Town: 16 August 2015	Page 10 of 20	14 September 2015

ATTACHMENT A Page 3

New Service Call History Entry

History Report | Job Sheet | Serviceability Report | Fault Report | Fault Analysis Report

Current Service Status

Service Number 1508160006 CORRECTIVE SubFault 1 Number Of SubFaults 1 Still Open 0

Service Status	FCL Fault Cleared	NOTAM Request	Ext. Ref. Coy.	Facility EUROCAT-X CT
Date	19/08/15 12:17:43		Ext. Ref. No.	EUROCAT-X ATM CAPE TOWN
Service Equipment	CT_EURX-OPS ROOM	Status UP	Assigned Agent 00332	Henk Ellis
System Code	CT_EURX-OPS ROOM	EUROCAT-X OPERATIONS ROOM		User ID ct-henke

Fault Cleared

New Details

Service Status		NOTAM	Facility EUROCAT-X CT
			EUROCAT-X ATM CAPE TOWN
Event Date/Time	08/09/15 09:58:08		
Service Equipment	CT_EURX-OPS ROOM	Status	Assigned Agent
System Code	CT_EURX-OPS ROOM	EUROCAT-X OPERATIONS ROOM	User ID js-davidw

Narrative

Service History

Sequence	Fault Status	Date	Time	System Code	Status	Assigned Agent	Ref.	No.
Narrative								
9	ATNS Feedback	16/08/15	20:21:04	CT_EURX-OPS ROOM	DOWNGRADED	Neville Gleeson		
GPS receiver has arrived from FAOR. installed it, and found it operational. we need to try and connect to Eurocat. will mitigate risk by doing it once sectors I								
8	ATNS Feedback	16/08/15	13:18:24	CT_EURX-OPS ROOM	DOWNGRADED	Neville Gleeson		
Most nodes started successfully. ATC can now return to OPS building.								
7	ATNS Feedback	16/08/15	11:35:19	CT_EURX-OPS ROOM	DOWNGRADED	Neville Gleeson		
Successfully getting time from NOVA NTP. restarting all nodes now to restore operations.								
6	ATNS Feedback	16/08/15	10:35:21	CT_EURX-OPS ROOM	DOWNGRADED	Neville Gleeson		
Found GPS receiver to be at fault. A spare is on its way from Jo'burg. We are working on a procedure to move timing to NOVA, and DBM as TMH.								

"S" Number | ADDL INFO | Ad Hoc | FeedBack Codes SD:NO:IF "S" Number S23 Version 9.00270

ATNS/TS/ Technical Incident: Cape Town: 16 August 2015	Page 11 of 20	14 September 2015

ATTACHMENT A Page 4

New Service Call History Entry.

History Report | Job Sheet | Serviceability Report | Fault Report | Fault Analysis Report

Current Service Status

Service Number 1508160006 CORRECTIVE SubFault 1 Number Of SubFaults 1 Still Open 0

Service Status FCL Fault Cleared | NOTAM Request | Ext. Ref. Coy. | Facility EUROCAT-X CT

Date 19/08/15 12:17:43 | Ext. Ref. No. | EUROCAT-X ATM CAPE TOWN

Service Equipment CT_EURX-OPS ROOM | Status UP | Assigned Agent 00332 | Henk Ellis

System Code CT_EURX-OPS ROOM | EUROCAT-X OPERATIONS ROOM | User ID ct-henke

Fault Cleared

New Details

Service Status | NOTAM | Facility EUROCAT-X CT

Event Date/Time 08/09/15 09:58:08 | EUROCAT-X ATM CAPE TOWN

Service Equipment CT_EURX-OPS ROOM | Status | Assigned Agent

System Code CT_EURX-OPS ROOM | EUROCAT-X OPERATIONS ROOM | User ID jc-davidw

Narrative

Service History

Sequence	Fault Status	Date	Time	System Code	Status	Assigned Agent	Ref.	No.
Narrative								
12	Fault Cleared	19/08/15	12:17:43	CT_EURX-OPS ROOM	UP	Henk Ellis		
Fault Cleared								
11	Fault Complete	16/08/15	23:27:58	CT_EURX-OPS ROOM	UP	Neville Gleeson		
System finally placed back into full service.								
10	ATNS Complete	16/08/15	23:27:42	CT_EURX-OPS ROOM	UP	Neville Gleeson		
Simulated some tests at SSS to reconnect GPS receiver. All tested ok. Transitioned back to existing GORGY clock. all o.k.								
9	ATNS Feedback	16/08/15	20:21:04	CT_EURX-OPS ROOM	DOWNGRADED	Neville Gleeson		
GPS receiver has arrived from FAOR. installed it, and found it operational. we need to try and connect to Eurocat. will mitigate risk by doing it once sectors I								

ADDL INFO | Ad Hoc | FeedBack Codes SD:NO:IF | "S" Number S23 | Version 9.00:270

ATNS/TS/ Technical Incident: Cape Town: 16 August 2015	Page 12 of 20	14 September 2015

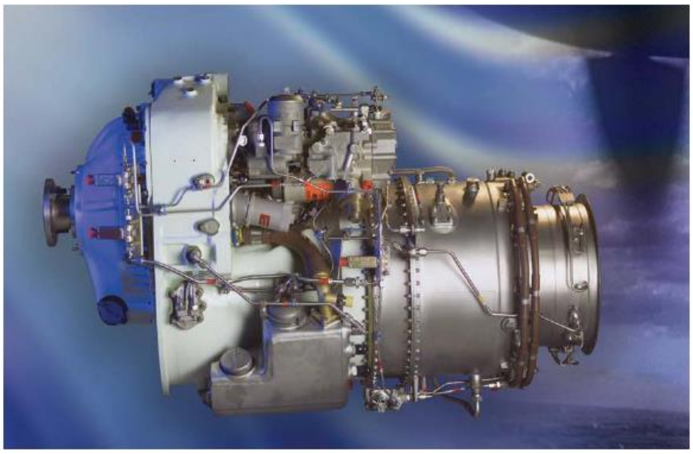
Technical Teardown Report

Chris Williams

P-77611C

TPE331-10N-512S

18 April 2016



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Engine Details

Customer:	Chris Williams (S.A.C.A.A.)
Engine S/N:	P-77611C
Engine Model:	TPE331-10N-512S
Engine P/N:	3103700-2
Engine TSN:	7605.1
Engine CSN:	T.B.A.
Engine TSO:	1426.9
Engine CSO:	T.B.A.
Work Scope Requested:	Air Crash Investigation

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Induction

Engine P-77611C was inducted on the 15th of April 2016. A number of airframe related components were noted to have shipped along with the engine. Please see pictorial report for findings:

Image #1: The dark deposit/discolouration on the engine is indicative of exposure to fire.

Image #2: The F.C.U. was noted to have broken off the Fuel Pump Assembly at F.C.U. – Fuel Pump split line.

Image #3: Most externally mounted components were burnt and/or severely damaged.

Image #4: The Exhaust Duct was noted to be bent severely.

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Findings

Image #5: Upon disassembly of the engine it was noted that the P.P.C. and F.C.U. protractors were possibly indicating the cockpit power lever position to have been at 60 degrees Power Lever Angle.

Image #6: Abnormal wear noted on the inside of the Accessory Housing in numerous areas.

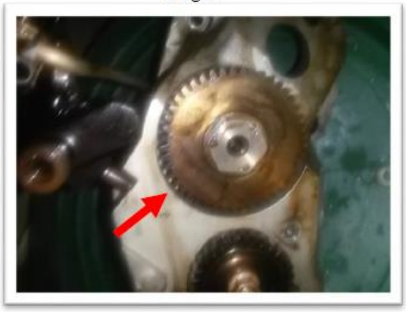

Image #7: In conflict to standard disassembly procedure, it was not possible to remove the Pilot Valve from the Hydraulic Torque Sensor.

Image #8:The run-off torque was very low on most of the fasteners.

Findings

Image #9: The Output Housing Carbon Seal Carrier was noted to be cracked severely. Also, the retaining studs were noted to be missing or migrated forward.

Image #10: The nuts and retaining studs securing the Output Housing Seal Carrier were found sheared within the Output Housing.

Image #11: Indications of soil ingestion were noted between the Combustion Chamber and the Combustion Liner.

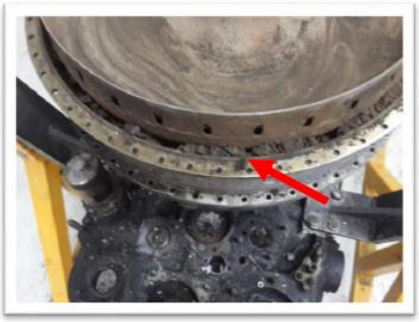

Image #12: Further indications of soil ingestion were noted between the Compressor Housing and the Outer Transition Liner.

Findings

Image #13: Numerous vanes of the 1st Stage Impeller were found to be bent severely. Indications of soil ingestion found between the vanes.

Image #14: Indications of soil ingestion noticed on the 1st Stage Shroud. No Impeller to Shroud contact noted.

Image #15: Indications of soil ingestion noted on the Outer Transition Liner.

Image #16:Indication of soil ingestion noted within the Inner Transition Liner.

Findings

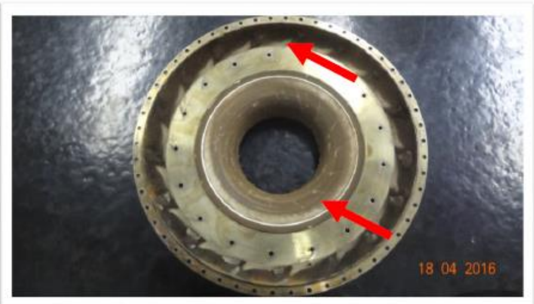

Image #17: Indications of soil ingestion noticed on the Compressor Housing. No Impeller to Shroud contact noted.

Image #14: Indications of soil ingestion noticed on the 1st Stage Diffuser.

Image #19: The Feathering Valve did not appear to have been stroked at disassembly.

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Conclusion:

No major abnormalities other than incident/accident related damage were noted at disassembly.

ExecuJet strives to provide exceptional technical service, so please call if you require any other information.

This report was compiled by:

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ExecuJet Maintenance
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Technical Teardown Report

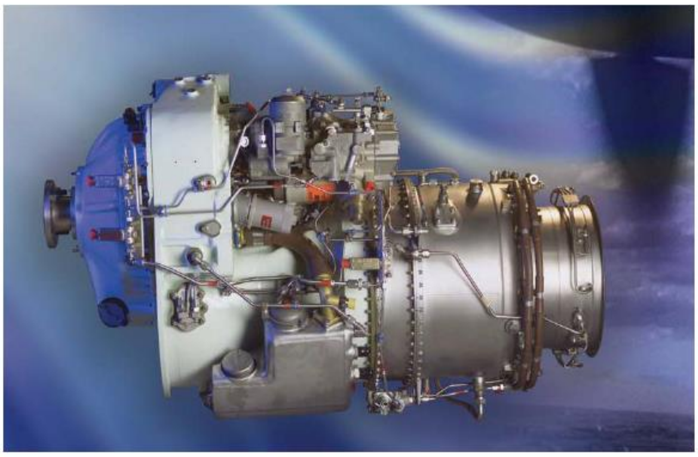
ExecuJet
AVIATION GROUP

Chris Williams

P-77612C

TPE331-10N-512S

19 April 2016



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Engine Details

Customer:	Chris Williams (S.A.C.A.A.)
Engine S/N:	P-77612C
Engine Model:	TPE331-10N-512S
Engine P/N:	3103700-2
Engine TSN:	7605.1
Engine CSN:	T.B.A.
Engine TSO:	1426.9
Engine CSO:	T.B.A.
Work Scope Requested:	Air Crash Investigation

Table of Contents

Induction

Engine P-77612C was inducted on the 15th of April 2016. A number of airframe related components were noted to have shipped along with the engine. Please see pictorial report for findings:

Image #1: Severe impact damage was noted on numerous components of the engine.

Image #2: The remains of the engine propeller were shipped with the engine.

Image #3: Severe damage noted to the engine intake.

Image #4: Output Housing severely damaged. Retaining studs on Output Housing Carbon Seal carrier are missing.

Induction

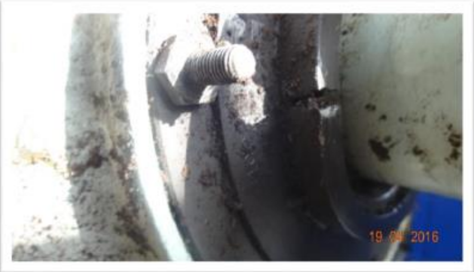

Image #5: Output Housing Carbon Seal Carrier severely damaged.

Image #6: Deposits of soil found within the engine intake. Numerous vanes on the 1st Stage Impeller are damaged.

Image #7: Propeller Governor found parted from the mounting pad.

Image #8: Fuel Pump Assembly mounting studs missing from Accessory Housing. Splined drive shaft was noted to be sheared.

Induction


Image #9: Oil Tank appears to be crushed.


Image #10: Sections of the fuel manifold and fuel nozzles were broken off.


Image #11: Igniter boss appears to have partially parted from Combustion Chamber.


Image #12: Combustion Chamber has been distorted in numerous areas.

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Findings

Image #13: Remains of retaining studs and nuts from Output Housing Carbon Seal Carrier found in bottom of Output Housing.

Image #14: Abnormal wear noted on the retention plate retaining the ring gear.

Image #15: Abnormal wear noted on Propeller Shaft, possiblly caused by rub from the Sun Gear.

Image #16: Abnormal wear noted on the Sun Gear, possibly caused by rub from the Propeller Shaft.

Findings

Image #17: Large metal debris found in the Accessory Housing suspected origin from the No. 1 Bearing Assembly.

Image #18: Abnormal wear noted on the Torque Sensor body.

Image #19: Indications of soil deposits within the Accessory Housing.

Image #20: Deposits of soil noted within the Deswirl Vane in the Combustion Section.

Findings

Image #21: Indication of soil ingestion found on the Outer Transition Liner.

Image #22: The Outer Transition Liner was noted to be distorted.

Image #23: The vanes of the 1st Stage Impeller have been severely damaged. Large amounts of soil ingestion noted on the 1st Stage Shroud.

Image #24: Rub noted on the hub of the 2nd Stage Impeller

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Work scope

1. Induction
2. Disassembly
3. Conclusion

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Conclusion:

No major abnormalities other than incident/accident related damage were noted at disassembly.

ExecuJet strives to provide exceptional technical service, so please call if you require any other information.

This report was compiled by:

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29 November 2016

Mr Chris Williams
Accidents & Incident Investigations Department
South African Civil Aviation Authority

Dear Mr Williams

V5-NRS: REVIEW AND COMMENTS ON EXECUTION OF INSTRUMENT APPROACH PROCEDURE

Appendix A: Abbreviations
B: Definitions
C: Google Earth Images

Enclosure 1: SACAA Chart: Cape Town VOR RWY 19 (VOR-02)
2: SACAA Chart Textual Description: Cape Town VOR RWY 19
3: Jeppesen Chart: Cape Town VOR RWY 19 (Chart 13-3)

Your request for the review of the radar track data relating to the accident of V5-NRS refers.

The functions of the South African Civil Aviation Authority's (SACAA) PANS-OPS section, an acronym for Procedures for Air Navigation Services – Aircraft Operations, includes the validation, verification, testing, certification and approval of instrument and related flight procedures, including the associated Instrument Approach Charts (IAC), prior to publication.

The supplied radar track data of V5-NRS was loaded into the section's GIS software and exported to Google Earth to assist with the visualisation of the tracks. The protection areas of the Cape Town VOR RWY 19 (Chart VOR-02) Instrument Approach Procedure (IAP) were reconstructed in accordance with the ICAO Doc 8168 Vol 2 (Construction of Visual and Instrument Flight Procedures) design criteria (Aircraft Category B) using AutoCAD. The protection areas were also exported to Google Earth and overlaid on the radar track data of V5-NRS.

The radar track data was reviewed in relation to the IAP protection areas in order to determine if the aircraft was operated within the protection areas afforded by the IAP. The required action versus the possible actions of the V5-NRS crew derived from the radar track data are tabled below. The table must be read in conjunction with the enclosed IACs.

The table consists of 3 columns:

Ref Point	Reference points as depicted on the SACAA and Jeppesen IACs
Required Action	The action the pilot is required to perform at each reference point.
Observations	Observations based on the radar track data.

General Requirements for the execution of an Instrument Approach Procedure:

1) During an IAP all turns are based on an average achieved bank angle of 25°, or the bank angle giving a rate of turn of 3°/second (Rate 1 turn), whichever is less. The Missed Approach Procedure protection area makes provision for a 15° achieved bank angle during the Missed Approach Segment.

2) Descend in the turn of a Holding Procedure is permitted.

3) Descend in the turn of Racetrack Procedure is NOT permitted.

4) During the IAP, descend can only commence once established within 5° of the required heading/track/radial and once abeam the navigation facility or at the fix, whichever comes later.

5) A Missed Approach should be executed immediately if:

   a) The pilot is unable to establish within 5° of the required heading/track/radial.

   b) The descent was initiated too late which will cause excessive descend rates to achieve the required fix crossing heights.

   c) Or at any time the pilot deems it necessary.

Required Actions vs V5-NRS Radar Track Observations:

The required action to execute the IAP versus the observed actions of V5-NRS derived from the radar track data are tabled below:

Ref Point	Required Action	Observations based on V5-NRS Radar Track data
1	**Arrival:** The aircraft can approach VOR CTV (IAF) from any direction at minimum 6500FT ALT or higher MSA (7300FT ALT).	No data/information available.
2	**Sector Entry & Holding Procedure:** Overhead VOR CTV the aircraft is required to perform a Sector Entry manoeuvre to enter the Holding Pattern and arrive back at VOR CTV on Radial 007 (Inbound) at minimum 6500FT ALT.	No data/information available.
3	**Initial Approach Segment (Racetrack Procedure):** At VOR CTV and maintaining 6500FT ALT, the aircraft is required to turn left onto a heading of 007°M to arrive abeam VOR CTV at 6500FT ALT established on heading 007°M (Point 4).	No data/information available.
4	Once established on heading 007°M or abeam VOR CTV, whichever comes later, the aircraft is required to descend to 3000FT ALT on a heading of 007°M to a maximum distance of 12 DME CTV (Point 5). (Calculated Descend Gradient: ±4.8%).	From the radar tracks it appears that the aircraft was on a track of ±004/005°M. At ±5DME CTV (outbound) the aircraft was already at ±3100FT ALT (A calculated Descend Gradient of ±11.2% from abeam VOR CTV). At ±5.2DME CTV (outbound) the aircraft descended to 2700FT ALT (300FT below the required MOCA).
5	At 12 DME CTV the aircraft is required to maintain 3000FT ALT and execute a left turn onto CTV R007 (Inbound) to arrive established on, or within 5°of, CTV R007 at 3000FT ALT by 12 DME CTV (Point 6).	At ±11DME CTV (outbound) the aircraft initiated the left turn onto the Intermediate Approach Segment at an altitude between 2600FT & 2700FT ALT (300-400FT below the MOCA of 3000FT ALT). The aircraft continued

		the turn through CTV R007 (QDM 187°) onto a track of ±154°M (33° past the required inbound heading/track).
6	**Intermediate Approach Segment:** At 12 DME CTV on, or within 5°of, CTV R007 (Inbound) the aircraft is required to descend in order to reach 5.5 DME CTV (FAF) (Point 7) at 2000FT ALT.	Once established on the track of ±154°M (±10.6DME CTV) the aircraft initiated a descent from 2600FT/2700FT ALT to 2100FT ALT. At ±9.3DME CTV it appears that the aircraft initiated a gradual turn right onto a track of ±179°M whilst continuing the descent. At ±9DME CTV the aircraft descended through the MOCA of 2000FT ALT until impact at ±7.3DME CTV.
7	**Final Approach Segment:** At 5.5 DME CTV on, or within 5°of, CTV R007 (Inbound) the aircraft is required to descend in order to reach 2 DME CTV (MAPT) (Point 8) at the OCA ("Minima") of 546FT ALT or higher.	No data/information available. Point not reached due to impact with terrain.
8	**Missed Approach Segment:** If the pilot, at 2 DME CTV (MAPT), has at identified at least one of the required visual references of the intended runway, visually continue the approach to land on the intended runway. If the pilot, at 2 DME CTV (MAPT), has not identified at least one of the required visual references of the intended runway, he/she may not continue the approach and has to immediately initiate the published Missed Approach. The Missed Approach requires the aircraft to climb straight ahead on CTV R007 (Inbound)/CTV R187 (Outbound) to 4.5 DME CTV (Point 9) whilst climbing to 4000FT ALT.	No data/information available. Point not reached due to impact with terrain.
9	At 4.5 DME CTV the aircraft is required to turn left direct VOR CTV whilst continuing the climb to 4000FT ALT if not already at 4000FT ALT to arrive back at VOR CTV at 4000FT ALT. At VOR CTV perform a Sector Entry manoeuvre to enter the Hold or Racetrack procedure.	No data/information available. Point not reached due to impact with terrain.

Summary:

The observations can be summarised as follow:

1. If the aircraft initiated the IAP from 6500FT ALT (Point 4), it would have had an excessively high descend gradient of ±11.2% to reach 5DME CTV (outbound) at 3100FT ALT.

2. At ±5.2DME CTV (outbound) the aircraft descended to 2700FT ALT (300FT below the required MOCA of 3000FT ALT).

3. The inbound turn onto CTV R007 (QDM 187°) was initiated at ±11DME CTV (outbound) instead of the required 12DME CTV.

4. The pilot continued the turn through CTV R007 (inbound) (QDM 187°) onto a track of ±154°M (33° past the required heading/track).

5. The pilot initiated the descent even though the aircraft was not established on, or within 5° of, CTV R007 (inbound) (QDM 187°). This could probably have been due to fact that the aircraft were ±1NM past the Intermediate Fix (12DME CTV inbound) due to the early inbound turn at 11DME CTV.

6. At ±9DME CTV (inbound) on a track of ±154°M the aircraft descended through the Intermediate Approach Segment's MOCA of 2000FT ALT until impact at ±7.3DME CTV.

Comments:

Even though the aircraft was at 2700FT ALT (300FT below the required MOCA of 3000FT ALT) during the outbound segment, it still would have had 700FT clearance above terrain and obstacles as ICAO Doc 8168 Vol 2 design criteria provide 1000FT (300M) vertical clearance within the Racetrack protection area.

If the aircraft was established on, or within 5° of, CTV R007 (inbound) (QDM 187°) in the Intermediate Approach Segment, and descended below the MOCA of 2000FT ALT, the aircraft would have been clear of Tygerberg Hill and any significant obstacles within the Intermediate and Final Approach Segments.

The turn onto a track of ±154°M instead of CTV R007 (inbound) (QDM 187°), coupled with the descent below the MOCA of 2000FT ALT, put the aircraft of a direct course to Tygerberg Hill.

It appears from the radar track data of V5-NRS juxtaposed against the ICAO Doc 8168 Vol 2 protection areas of the Cape Town VOR RWY 19 IAP that the crew of V5-NRS did not execute the IAP in accordance with the published procedure requirements causing the aircraft to descend below the safe altitudes and outside the protection areas afforded by the procedure.

I hope this adequately addresses your requirement with regards to the review of the V5-NRS radar track data against the Cape Town VOR RWY 19 IAP but please contact me should you require any clarification or additional information.

Yours faithfully

Werner Kleynhans
Acting Manager / Inspector:PANS-OPS/Cartography
PANS-OPS (Procedures for Air Navigation Services – Aircraft Operations)
Air Navigation Services
Tel: +27 11 545 1468 | **Mobile:** +27 82 774 8994
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APPENDIX A

Abbreviations:

ALT	Altitude
CTV	Cape Town VOR/DME Navigation Aid
DME	Distance Measuring Equipment
QDM	Magnetic heading (zero wind) Will you indicate the MAGNETIC heading for me to steer towards you (or ...) with no wind?"
FAF	Final Approach Fix
FT	Feet
IAC	Instrument Approach Chart
IAF	Initial Approach Fix
IAP	Instrument Approach Procedure
IF	Intermediate Fix
MAPT	Missed Approach Point
MOCA	Minimum Obstacle Clearance Altitude
NM	Nautical Mile
OCA	Obstacle Clearance Altitude
R	Radial
VOR	VHF Omnidirectional Radio Range

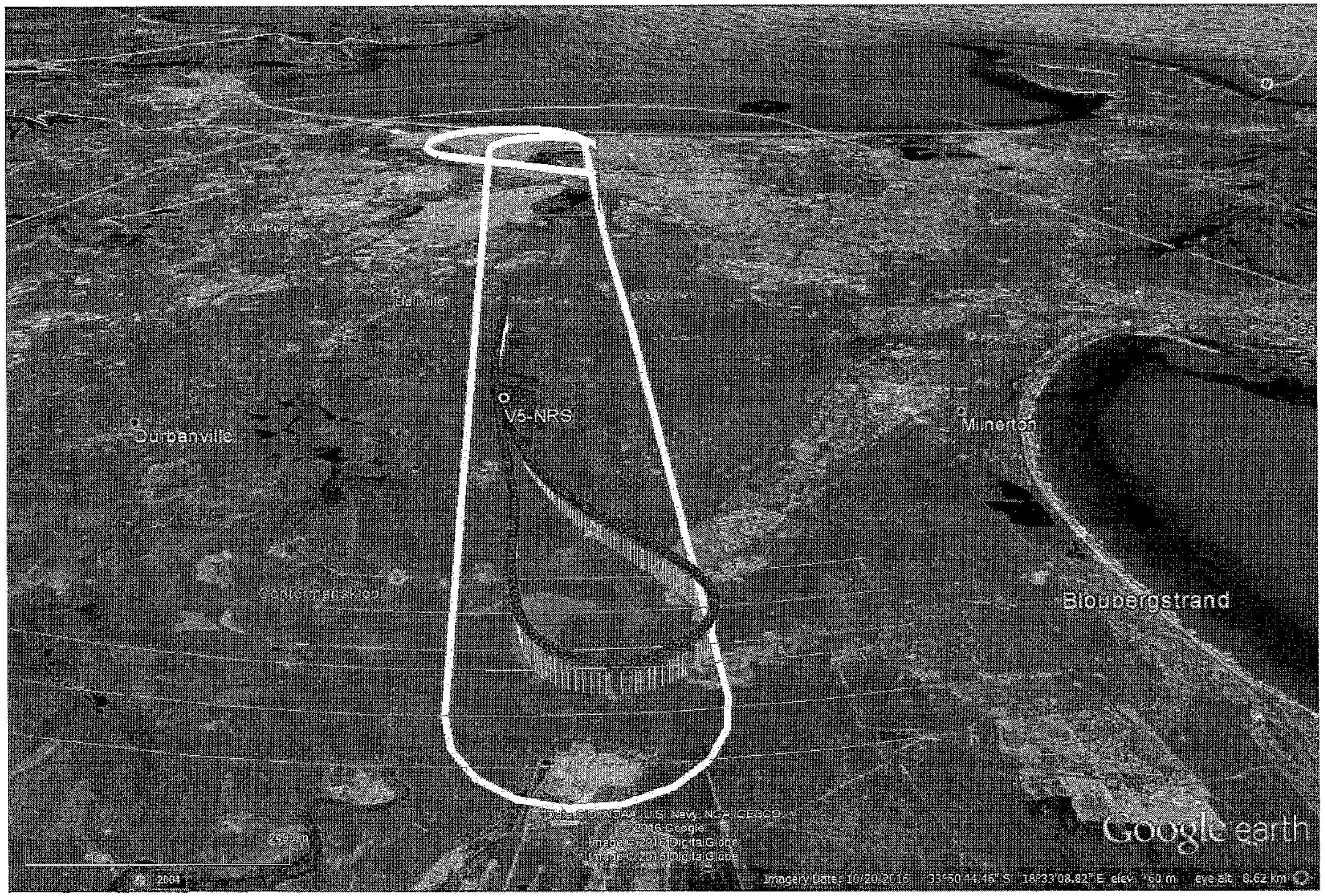
APPENDIX B

Definitions:

DME	The line of sight distance (slant range) from the source of a DME signal to the receiving antenna (Distance in NM).
Final Approach Segment (FAS)	That segment of an Instrument Approach Procedure in which alignment and descent for landing are accomplished.
Holding Procedure	A predetermined manoeuvre which keeps an aircraft within a specified airspace while awaiting further clearance.
Initial Approach Fix (IAF)	A fix that marks the beginning of the initial segment and the end of the arrival segment, if applicable.
Initial Approach Segment	That segment of an Instrument Approach Procedure between the Initial Approach Fix and the Intermediate Fix or, where applicable, the Final Approach Fix or Point.
Instrument Approach Procedure (IAP)	A series of predetermined manoeuvres by reference to flight instruments with specified protection from obstacles from the Initial Approach Fix, or where applicable, from the beginning of a defined arrival route to a point from which a landing can be completed and thereafter, if a landing is not completed, to a position at which holding or en-route obstacle clearance criteria apply.
Intermediate Approach Segment	That segment of an Instrument Approach Procedure between either the Intermediate Fix and the Final Approach Fix or Point, or between the end of a reversal, racetrack or dead reckoning track procedure and the Final Approach Fix or Point, as appropriate.
Intermediate Fix (IF)	A fix that marks the end of an initial segment and the beginning of the intermediate segment. In RNAV applications this fix is normally defined by a fly-by waypoint.
MAPT	That point in an Instrument Approach Procedure at or before which the prescribed missed approach procedure must be initiated in order to ensure that the minimum obstacle clearance is not infringed.
Minimum Obstacle Clearance Altitude (MOCA)	The minimum altitude for a defined segment that provides the required obstacle clearance.
OCA	The lowest altitude or the lowest height above the elevation of the relevant runway threshold or the aerodrome elevation as applicable, used in establishing compliance with appropriate obstacle clearance criteria.
Racetrack Procedure	A procedure designed to enable the aircraft to reduce altitude during the initial approach segment and/or establish the aircraft inbound when the entry into a reversal procedure is not practical.

APPENDIX C

Google Earth Images:



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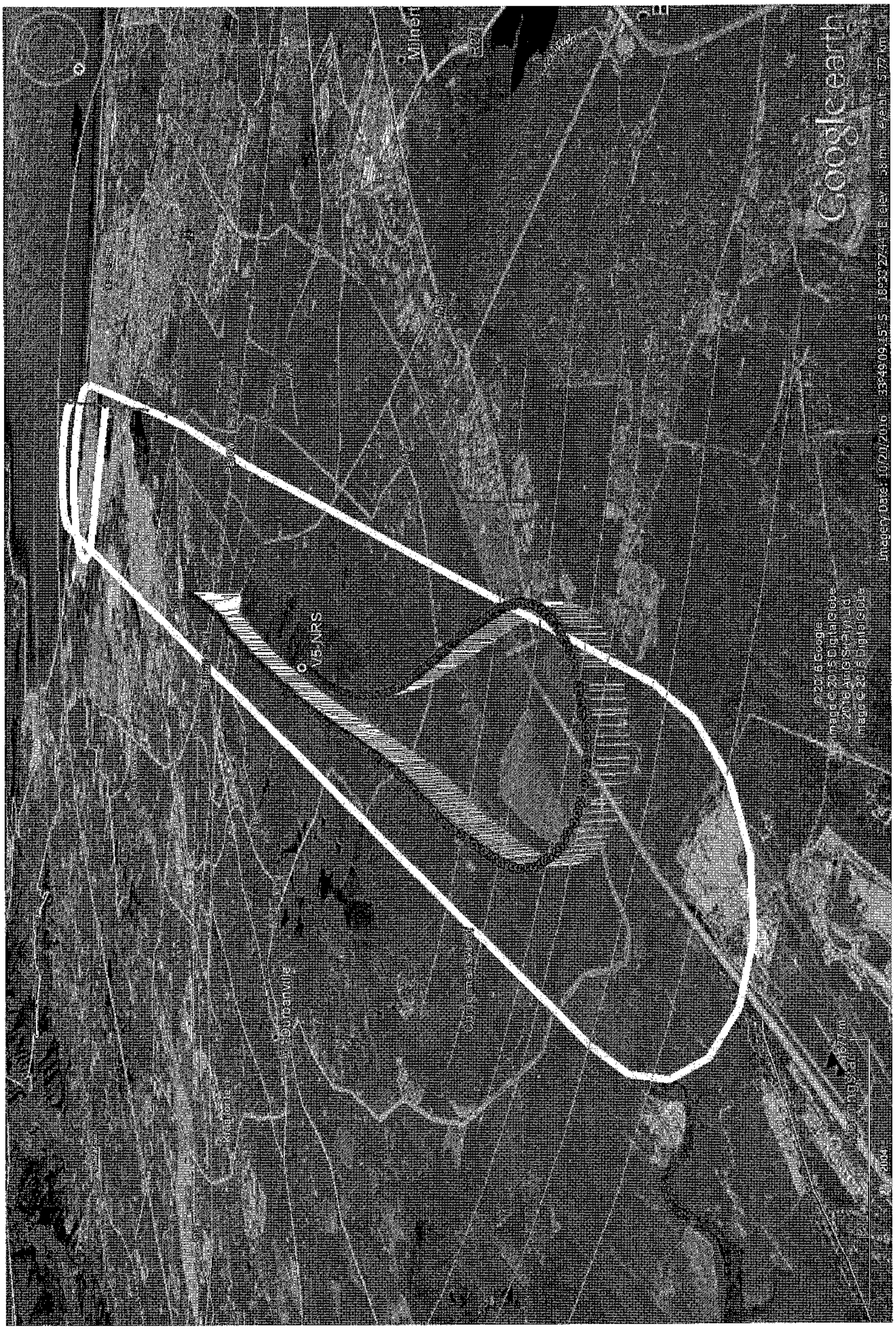

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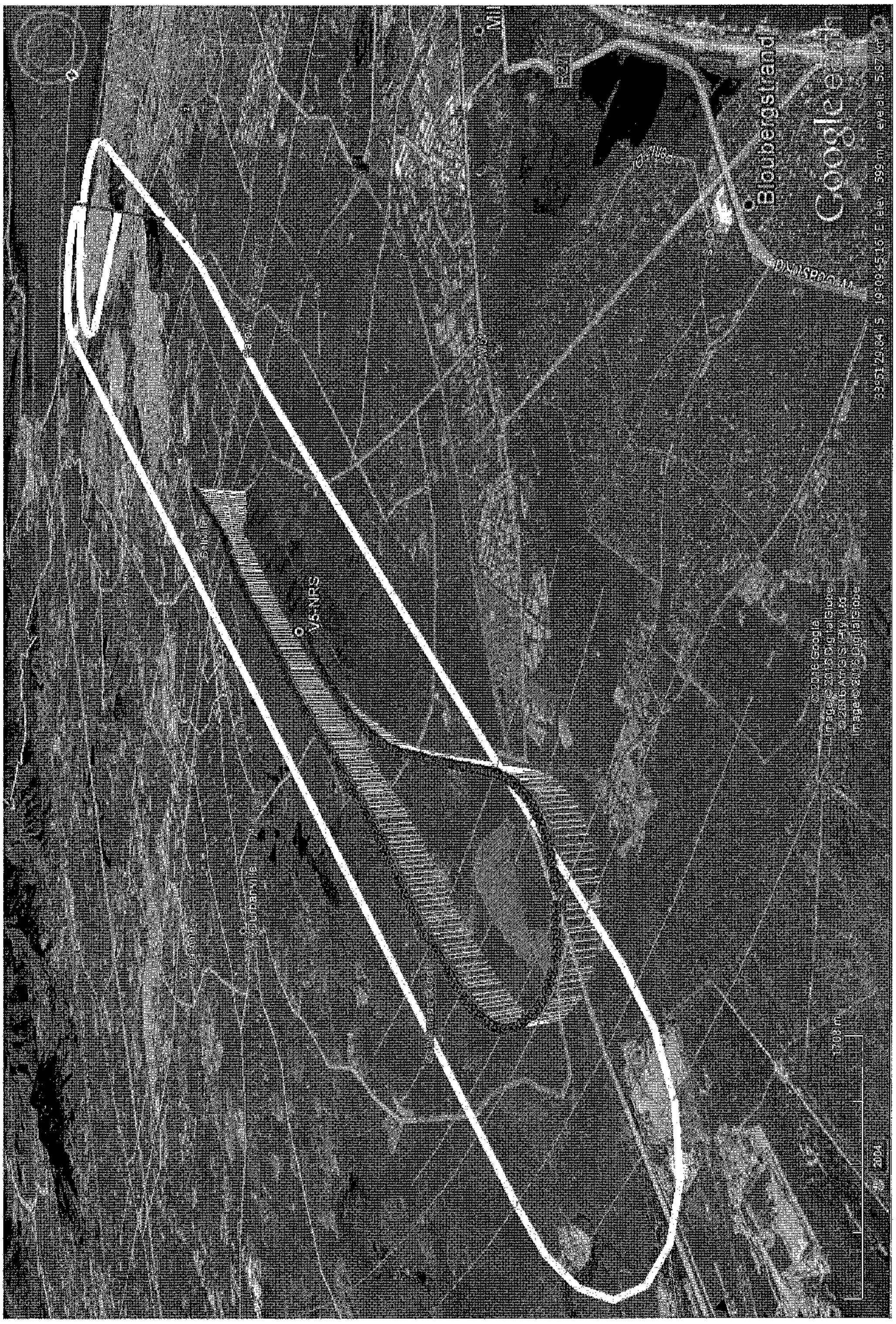

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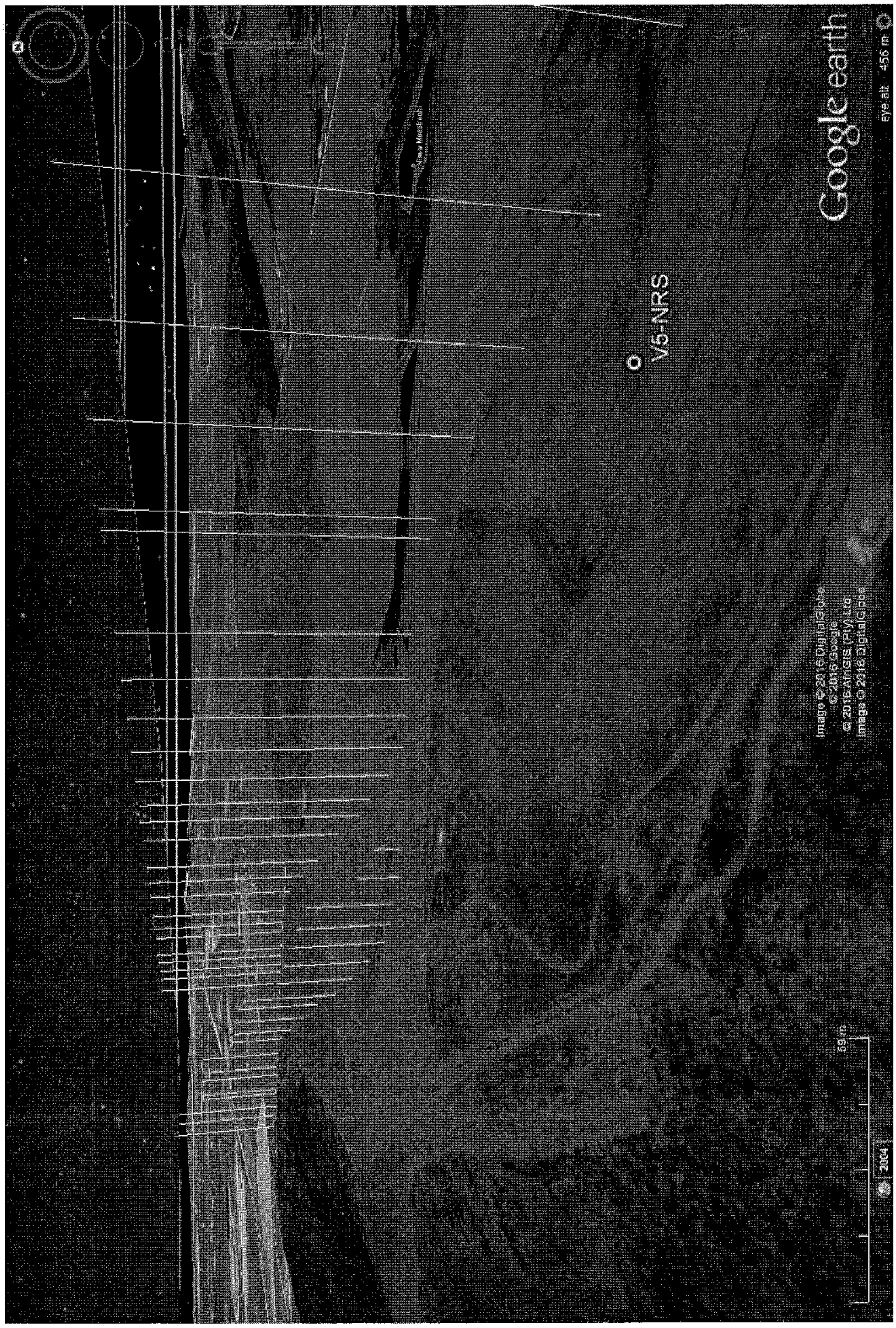
V5-NRS
Google earth
Image © 2016 DigitalGlobe
© 2016 Google
© 2016 AfriGIS (Pty) Ltd
Image © 2016 DigitalGlobe
59 m
2004
eye alt 456 m

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ENCLOSURE 1

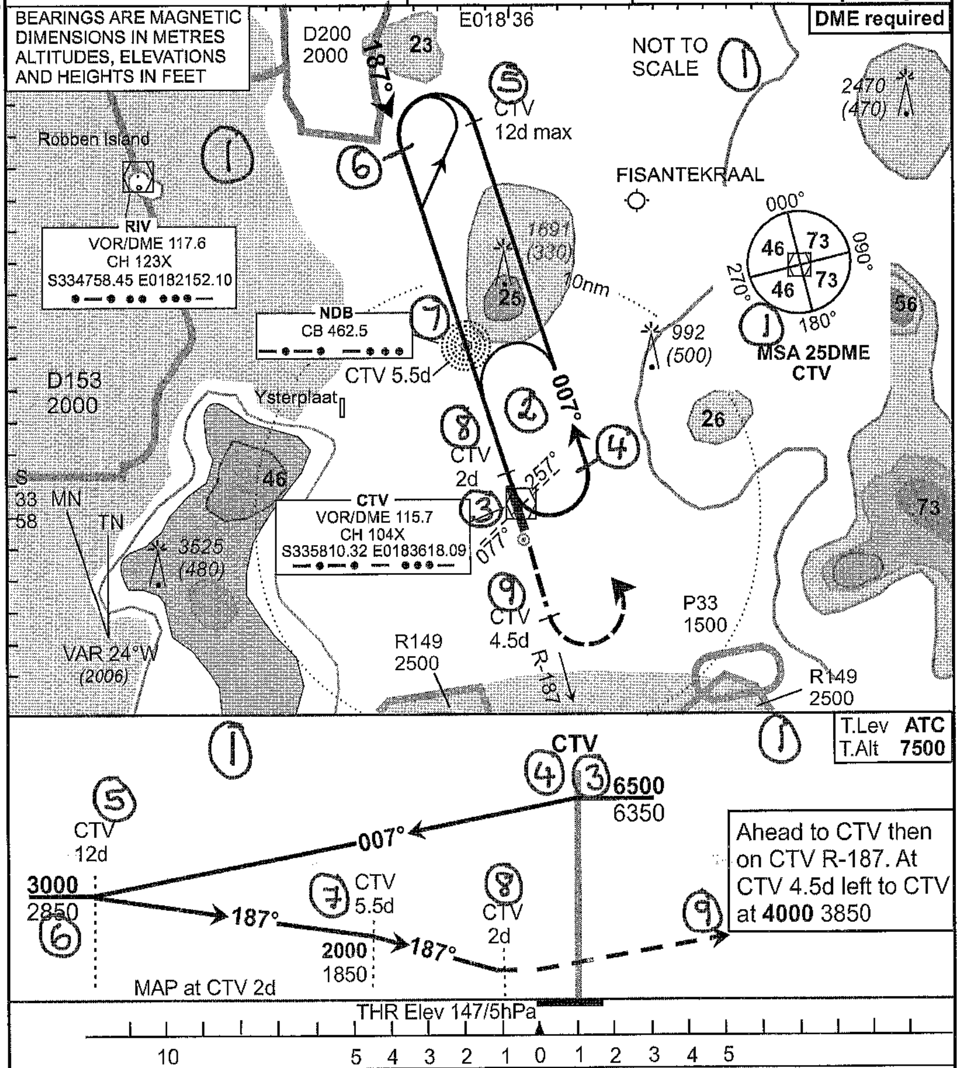
SACAA Chart: Cape Town VOR RWY 19 (VOR-02)

INSTRUMENT APPROACH CHART — AERODROME ELEV 151 — HEIGHTS RELATED TO THR RWY 19 - ELEV 147 — (Cat A - D)

CAPE TOWN INTL
VOR Rwy 19

FACT

CAPE TOWN Approach	Tower	ATIS	VOR-02
119.7	118.1	127.0	EFF 10 May 07



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1. Initial approach altitude **6500** or higher MSA. Descend in the hold to **6500**.
2. Procedure turn approach applicable only within 30° of the outbound heading. Use phraseology "Request procedure turn approach".
3. RoD from CTV 5.5d computes at 3.5° angle of descent.
4. **Caution:** High ground and obstructions along eastern boundary of the final approach area.
5. Circling approaches between 010°M and 160°M are not authorised for Cat C & D aircraft.
6. Circle to land at the discretion of the pilot in command.

OCA/H				
Cat of ACFT	A	B	C	D
Straight -in	546(399)	546(399)	546(399)	546(399)
Approach	N/A			
Circling				

5.5d CTV - THR						
Speed	Kt	80	100	120	140	160
Time	M:s	3:40	2:56	2:27	2:06	1:50
Rate of Descent	Fpm	490	620	740	870	990
5.5d CTV to THR	5.5d	5d	4d	3d		
Advisory Alt/Hgt	**2000**(1850)	**1810**(1660)	**1440**(1290)	**1070**(920)		

CAA South Africa

Rev: New Format. WGS-84

ENCLOSURE 2

SACAA Chart Textual Description: Cape Town VOR RWY 19

Aerodrome ELEV & heights	RWY	Facility	Initial Approach ALT	Procedure	Missed APCH procedure
1	2	3	4	5	6
CAPE TOWN INTL (FACT) *CAT A – D* *AD ELEV 151'* *THR ELEV 147'* *TRANSITION ALT 7 500'* *VAR W 24° (2006)* ***VOR*** *OCH ABOVE THR* *CAT A – 399'* *CAT B – 399'* *CAT C – 399'* *CAT D – 399'*	*19*	***DVOR*** *"CTV"* *115.7 MHZ* ***DME*** *"CTV"* *1191 MHZ* *CH 104X*	*6500' or higher MSA* ***MSA*** *25 DME "CTV"* *000°-180°M – 7300'* *180°- 360°M – 4600'*	***PROCEDURE: VOR RWY 19*** ***(DME Required)*** ***HOLD:*** *Hold in a left hand racecourse pattern over "CTV", inbound on R007, outbound on heading 007°M. Descend in the pattern to 6500' ALT. MAX 12 DME "CTV".* ***APPROACH:*** *Depart from "CTV" outbound in the holding pattern on a heading of 007°M, and descend to 3000' ALT. At maximum 12 DME "CTV" turn left onto R007 inbound "CTV". Descend to minimum 2000' ALT. Maintain 2000' ALT to 5.5 DME "CTV". At 5.5 DME "CTV" continue descend to MDA/H. Final approach slope computes at 3.5°.*	*MAPT is at 2 DME "CTV". If no other instructions received, at 2 DME "CTV" commence climb on R187 "CTV". Climb to 4.5 DME "CTV", then climbing turn left to "CTV" and climb to 4000' ALT.* ***NOTE:*** *1. Circle to land between 010°M and 160°M are not authorised for CAT C and D aircraft.* *2. Circle to land at the discretion of the Pilot in command.* *3. WGS-84.* ***AIP AD Chart: VOR-02*** ***EFF Date: 10 MAY 07***