SOUTH AFRICAN CIVIL AVIATION AUTHORITY

Section/division Accident and Incident Investigations Division Form Number: CA 12-57

LIMITED ACCIDENT INVESTIGATION REPORT

Reference Number	CA18/2/3/10093						
Classification	Accident	**Date**	19 December 2021	**Time**	0939Z		
Type of Operation	Private (Part 94)						
Location							
Place of Departure	Plettenberg Bay Aerodrome (FAPG), Western Cape Province	Place of Intended Landing	FAPG), Western Cape Province				
Place of Occurrence	Erica Pl Drive, Plettenberg Bay Residential Area, Western Cape Province						
GPS Co-ordinates	Latitude	34°02'.55. 4" S	Longitude	023°21'.57.8" E	Elevation	475 feet	
Aircraft Information							
Registration	ZU-FYG						
Make/Model	Van's RV-7 (Serial No. 70120)						
Damage to Aircraft	Substantial	Total Aircraft Hours	283.04				
Pilot-in-command							
Licence Valid	No	Gender	Male	Age	49		
Licence Type	Invalid Commercial Pilot Licence (CPL)						
Total Hours on Type	71	Total Flying Hours	992				
People On-board	1 + 1	Injuries	1	Fatalities	0	Other (On Ground)	0

What Happened

On Sunday morning, 19 December 2021, a pilot and a passenger (his wife) on-board a Van's RV-7 amateur-built aircraft with registration ZU-FYG took off on a private flight from Plettenberg Bay (FAPG) Aerodrome in the Western Cape province with the intention to return to the same aerodrome. Visual meteorological conditions (VMC) prevailed at the time, and the flight was conducted under the provisions of Part 94 of the Civil Aviation Regulations (CAR) 2011 as amended.

The pilot stated in the South African Civil Aviation Authority (SACAA) form CA 12-03 (Pilot: accident/incident questionnaire) dated 19 December 2021 that the aircraft had 50 litres of Avgas 100LL in the tanks on departure from Runway 12 at 0920Z. After approximately 19 minutes into the flight whilst returning to FAPG and flying at approximately 1000 feet (ft) above ground level (AGL), the engine started to run rough and eventually stopped. The pilot reported that he immediately

applied full rich mixture, switched on the electric fuel pump and switched the tanks from the left-side to the right-side to regain power, but this was without success.

The pilot broadcasted a distress call on the uncontrolled airspace traffic information broadcasts by aircraft (TIBA) frequency 124.80-Megahertz (MHz) stating that his aircraft had ran out of fuel and/or that it was experiencing a vapour lock and he did not think he would make it safely back to FAPG. The distress call was overheard by the Bitou Municipality Fire Station crew who were on standby, as well as by a pilot on-board a helicopter with registration ZS-HBU who was en route to Witelsbos in the Eastern Cape. The accident aircraft could not maintain height and the pilot executed a forced landing on Erica Pl Drive, located in a residential area in Plettenberg Bay. During the landing roll, the aircraft struck a tree, a perimeter wall and an access gate of Stand Number 3106 before it came to a stop at Global Positioning System (GPS) co-ordinates determined to be: 34°02´55.4" S 23°21´57.8" E. After the aircraft had come to rest, the pilot turned off the master switch. The pilot was not injured during the accident whilst the passenger sustained minor injuries. The pilot assisted the passenger to disembark the aircraft. The Bitou Municipality Fire Station Chief stated that after establishing the location of the accident site, they dispatched to the scene. On arrival, they found the Emergency Medical Services (EMS) administering first aid to the pilot and the passenger. Both occupants were later transported to a hospital in an ambulance for further medical check-ups. No person was injured on the ground. The Bitou Municipality Fire Station crew ensured that the scene was safe and that the wreckage was not tampered with.

Figure 1: Erica Pl Drive where the aircraft landed. (Source: Google Earth).

Figure 2: Damage to the right wing after it uprooted a tree. (Source: Fire Chief)

Figure 3: Damaged perimeter wall and motorised access gate. (Source: Fire Chief).

The Van's RV-7A series aircraft are an all-aluminium low-wing monoplane of riveted monocoque construction. The aircraft are deemed experimental – amateur built under authority by the Federal Aviation Administration (FAA) in the United States of America (USA) and are accepted under the corresponding category by several other aviation authorities around the world. In South Africa, the aircraft was registered under the Non-type Certified Aircraft (NTCA) category.

The aircraft was powered by a Lycoming IO-360-M1B four-cylinder, direct drive, horizontally opposed, fuel-injected air-cooled engine driving a three-bladed constant speed MT propeller with serial number 99172. The engine had a rated maximum continuous power output of 180-horsepower (hp) at 2700 revolutions per minute (RPM) at standard sea level conditions. The engine was installed on the aircraft as new and had operated for 283.04 hours. According to Lycoming Operator's Manual, the engine model performance cruise power is rated at 75% / 2 450 RPM and best economy cruise at 65% / 2 350 RPM.

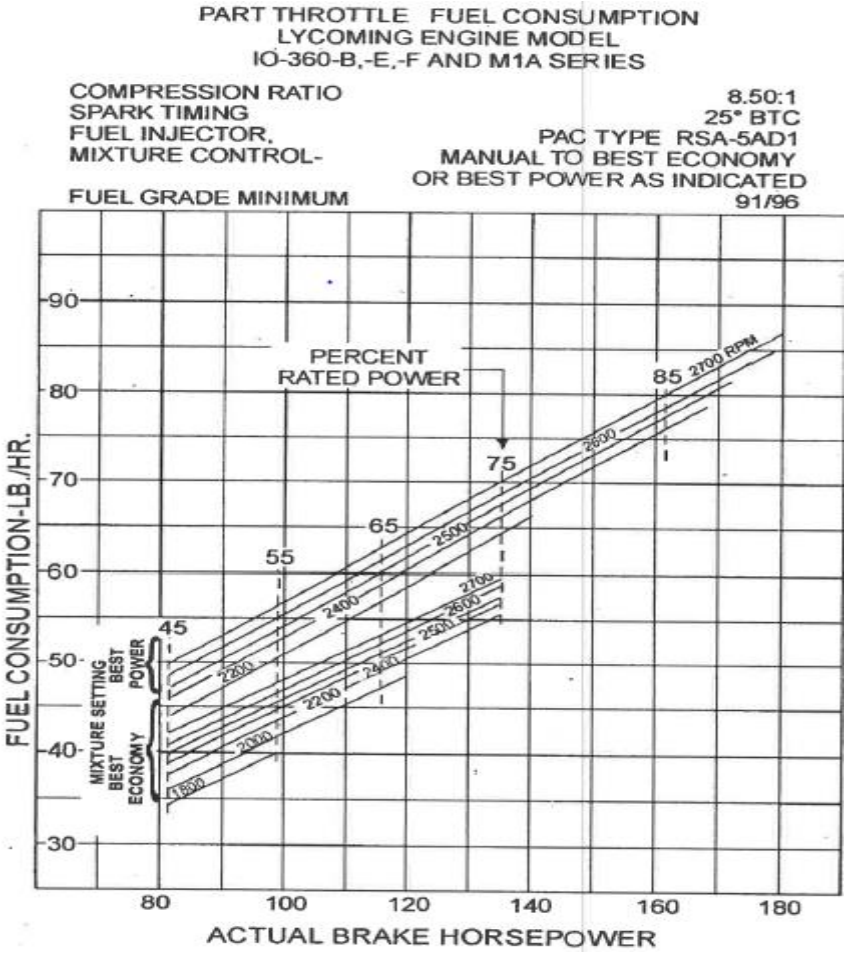


Chart 1: Fuel consumption at different power settings. (Source: Lycoming Operator's Manual)

The table (below) shows the aircraft's cruise performance at 8000 feet (ft) in accordance with (IAW) Lycoming Operator's Manual. The range calculations on the table include 3 US Gallons (11 litres) for engine start, taxi and climb with the engine learned for best economy.

Miles per hour (MPH)	**RPM**	**Manifold Air Pressure (MAP)**	**Fuel flow**	**%Power**
197	2450	23 inches	10.5 GPH	75%
187	2350	22 inches	9.5 GPH	65%
177	2250	21 inches	8.5 GPH	55%

The aircraft was issued an Authority to Fly (ATF) certificate on 27 January 2020 with an expiry date of 31 January 2023. The aircraft was equipped with dual Electronic Flight Instrument System (EFIS) glass panels bearing Serial Numbers iE120700041 and iE120700042 with downloadable Secure Digital (SD) cards and a built-in black box flight data recorder (FDR). The glass panels function as a flight instrument system and display fuel levels in the liquid-crystal display (LCD) touch pressure sensitive screen. The aircraft also had a flop tube, a flexible hose with weight in the free end installed in the right fuel tank to allow uninterrupted fuel supply during display mode. The aircraft comprised two wing fuel tanks with the capacity of 79 litres each, that is 158 litres (42 US Gallons) in total, of which 4 litres (1.2 gallons) is unusable from both wings fuel tanks.

Figure 4: The cockpit showing the EFIS glass panels and fuel level display.

Pilot's Qualifications:

According to the South African Civil Aviation Authority's (SACAA) EMPIC database (a software designed for managing the Regulator's safety and security oversight), the pilot's Commercial Pilot Licence (CPL) was invalid at the time of the accident flight. The available information from the South African Institute of Aviation Medicine (IAM) showed that the pilot did not have a valid medical certificate. The pilot had a known medical condition and had a restriction to fly under visual flight rules (VFR) by day only. In addition, flying an EFIS-equipped aircraft where EFIS is the primary flight instrument (PFI) was prohibited for the pilot. According to the database, the pilot's licence was last renewed on 9 September 2016 and the accident flight occurred on 19 December 2021. Therefore, the provisions of Part 61.05.1 and 61.01.6 of the Civil Aviation Regulations 2011 as amended were not complied with.

During communication via WhatsApp post-accident, the investigator-in-charge (IIC) requested the copy of the pilot's licence, to which the pilot responded, "*his valid licence from the SACAA was with him in the aircraft at the time of the crash and that it has since been stolen from the aircraft whilst he was in hospital* (time stamped 19 December 2021, 17:34 local time)". At 17:35 on the same day, the pilot communicated again via WhatsApp that "*the SACAA must have records of his valid CPL licence"*. On 25 January 2022 at 13:10, the pilot communicated via WhatsApp, advising the IIC to stop asking him more questions and that he must contact his attorney for any further questions. The pilot's instructions were acknowledged.

Maintenance of Competency and Skills Tests:

Part 61.01.5 (1) *Unless the holder of a pilot licence or rating maintains competency and recency by complying with the appropriate requirements prescribed in this Part or Part 62 and Part 91, as the case may be, the licence holder shall not exercise the privileges granted by the licence.*

(2)(a) The holder of a pilot licence shall not exercise the privileges of that licence unless he or she has successfully passed an initial licence skills test, or a revalidation check in the same category of aircraft.

Medical Requirements and Fitness:

Part 61.01.6 (1) *An applicant for a pilot licence in terms of this Part must hold an appropriate valid medical certificate issued in terms of Part 67 of these Regulations.*

(2) The holder of a pilot licence issued in terms of this Part may not exercise the privileges of that licence –

(a) unless that person holds an appropriate valid medical certificate issued in terms of Part 67 and complies with all medical endorsements on that medical certificate.

The pilot's logbook (hard copy) revealed that he performed his conversion to Van's RV-7 on 15 March 2021 during which 1.2 hours were flown. The designated flight examiner (DFE) who conducted the conversion training was interviewed. He stated that he certified the pilot competent on the day and the SACAA form CA61-09.7 (notification of aircraft differences or familiarisation training) dated 15 March 2021 was signed by both parties. There is no evidence in the pilot's file that the above-mentioned form was submitted to the SACAA within the 30-day window period of completion as called for in Part 61.09.1(2)(a)(b) of the CAR 2011 as amended.

The DFE was asked whether he had verified the validity of the pilot's licence before conducting a type conversion training flight; and his response was that he did not consider doing that because he had flown with the pilot on many occasions in the past. Scrutiny into the DFE's file at the SACAA revealed that he had an Airline Transport Pilot Licence (ATPL) and was appropriately certified IAW Part 61.18.1 of the SACAA regulations. The DFE had a Van's RV-7 tail dragger aircraft endorsement on his licence.

What was found

The propeller damage signatures were consistent with a complete lack of engine power at the time of impact. Examination of the airframe, engine and propeller revealed no evidence of any pre-impact mechanical malfunctions or failures that would have precluded normal operation. Continuity and integrity of the control columns and mixture/throttle levers in the cockpit were examined by a pilot with a valid CPL and who was assigned by the IIC; no anomalies were noted. None of the circuit breakers (CB) had popped and the fuel selector was found in the off position. Both fuel tank caps were in place and properly latched. The left wing sustained minor damages, but the fuel tank remained intact. Upon unlocking and opening the left fuel tank, no fuel was found in it (the tank was dry). With the fire team on standby, the fire chief drained fuel from the left tank drain valve and less than a litre of unusable fuel was recovered (Figure 6). The fuel was consistent with Avgas 100LL. This was overseen and confirmed by the pilot assigned by the IIC. The right-wing fuel tank had raptured after impacting the tree and showed aft crash damage on the in-board leading-edge side, but no trace of fuel spillage was found on the tarmac. There was also no evidence of fuel smell and of post- or pre-impact fire.

Figures 5 and 6: Dry/empty left tank (left picture). Unusable fuel drained from the left tank drain valve post-accident in a one litre bottle. (Source: Fire Station Chief)

Figure 7: The area where the aircraft stopped on Erica PI Drive showing no evidence of fuel spillage. (Source: Fire Station Chief)

Figure 8: The tarred Erica PI Drive post-accident showing no evidence of fuel spillage. (Source: Fire Station Chief)

After the wreckage examination at the accident site, the IIC authorised its removal to a secure location in accordance with Part 12.04.5 of the CAR 2011. Later, a tow truck was used to recover the wreckage to FAPG under escort of Bitou Municipality Fire Station crew for further investigation. The fire chief reported that on arrival at FAPG, the pilot and another person (who appeared to be a hangar owner) asked him who gave them permission to examine the aircraft's fuel levels and if the pilot admitted that he ran out of fuel. The fire chief stated that the interrogation by the pilot and the other person (at the hangar) was conducted in a defensive manner, and that they also took a video of him while asking questions.

Later, during the investigation, the IIC discovered that all parts or components and associated wiring were removed from the wreckage before it was transported to Tedderfield Airfield (FATA) in Johannesburg, Gauteng province. Major components such as the engine, propeller, MGL Avionics glass panels, MGL explorer iBOX with serial number IB120700030, Dynon capacitance to voltage converters and the MGL Avionics Resistive Digital to Analog Converter (ARDAC) were removed without authorisation from the IIC, which is non-compliant with Part 12.04.3 of the CAR 2011 as amended.

Part 12.04.3 - Control of evidence:

The aircraft, the wreck or wreckage and anything transported therein and any marks resulting from the accident which may be of assistance in an investigation, shall remain under the control of the investigator-in-charge until released by such investigator-in-charge.

Aircraft's Maintenance History:

The aircraft's file held at SACAA was scrutinised and the available information showed that the builder had fuel level calibration values as well as Dynon fuel level converters installed on the aircraft. According to MGL Avionics, both fuel tank's calibration procedures were identical, and the raw readings were consistent with the fuel level in the tanks. The fuel data readings after calibration were accurate and in the expected range. The source of fuel level information was the engine monitoring module installed on the engine firewall.

Below is the calibrated fuel levels data extracted from the iBOX as programmed:

Left tank was calibrated in 3-point attitude and readings were 0.5 litres 0.666 volts (v), 5.5 litres 0.707v, 10.5 litres 0.748v, 15.5 litres 0.789v, 20.5 and 25.5 litres (the transition point between capacitance plates) were the same at 0.830v, so 20 litres point was discarded. 30.5 litres 0.870v, 35.5 litres 0.895v, 40.5 litres 0.912v, 45.5 litres 0.953v, 50.5 litres 0.957v, 55.5 litres 0.994v, 60.5 litres 1.008v, 65.5 litres 1.035. Reading then stays the same for full tank, about 68 litres.

Right tank was calibrated in-flight attitude and readings (at same intervals) were 0.5 litres 0.669v, 0.710v at 5.5 litres and10.5 litres (5.5l discarded) 0.751v, 0.792v, 0.833v, 0.874v at 30 litres and 35 litres (30 litres reading discarded) then from 40 litres 0.915v, 0.954v, 0.956v, 0.997v, 1.001v, 1.039v at 65 litres and no change to full.

*NOTE: The above are maximum readings the probes returned. This does not mean that the fuel tank was actually full; it was the top of the probe inside the tank, which means that if fuel level exceeds the top, the reading does not change any further. This was not related to the physical size of the tank as it was programmed. The top of the probe is dependent slightly on the way it is installed. There are inevitably small differences between the two tanks, and the Dynon fuel quantity senders have fairly large tolerances. In this case, about 3 litres of the maximum reading was entirely within the expected tolerance.

The aircraft flight folio page serial number 22228 indicated that on 24 April 2021, the aircraft was subjected to a cockpit upgrade at FATA. The wiring was deemed by the pilot/owner as not neat and wanted it rearranged and bundled together in a loom. The task was conducted by the SACAA-approved aircraft maintenance engineer (AME). No changes were carried out on the existing EFIS monitoring modules connections or wiring. Upon installing the switches, circuit boards (CBs) and radios and all systems were found to be satisfactory. The flight folio page serial number 22229 indicated that the aircraft was subjected to an engine ground-run post-cockpit upgrade. No abnormalities were recorded post-engine ground run; and on 5 May 2021, the aircraft was released for a test flight. The test flight took approximately 19 minutes, and the aircraft was reported to be airworthy with the fuel sensors operating normally and providing accurate readings. The aircraft was then released to service in accordance with the provisions of Part 24 of the CAR 2011 as amended.

The MGL Avionics Technical Report:

On 15 February 2022, after consultation with his attorney, the pilot brought the EFIS glass panels and three “loose” SD cards to the Accident and Incident Investigations Division (AIID) offices for downloading with the intention to obtain the total amount of fuel in the tanks prior to the commencement of the accident flight on 19 December 2021. Upon receiving the glass panels, they were checked and the serial numbers on the tags matched with the numbers on the aircraft equipment maintenance list (EML). Upon examining their condition, signs were observed which suggested that they have been opened before they were brought to the AIID.

Figures 9 and 10: The EFIS glass panels with SD cards.

The EFIS glass panel and SD cards were packaged by the AIID administrator and couriered to MGL Avionics' s facility in Somerset West, Cape Town.

The first technical report from MGL Avionics' Chief Executive Officer (CEO) confirmed what the AIID had observed; the glass panels seemed to have been opened prior to being delivered. According to the report, it was impossible for the CEO to identify which SD card belongs to which EFIS glass panel. *The glass panels were, according to the report, not configured for automatic flight detection and that normal recording did not take place. The report further stated that the aircraft was operated for a long period without any form of fuel quantity indication.*

The IIC disputed the specified findings because the pilot had no other means of fuel monitoring in the cockpit other than a serviceable fuel quantity indication display. The pilot also contradicted the findings during a WhatsApp communication with the IIC post-accident at 17:55 when he was informed the fuel tanks contained no useable fuel and his response was: *"I don't think that is correct based upon my fuel at departure this morning. I had more than 20l per side indicated on departure".* In addition, another contradiction of the findings came to light after the left-side EFIS glass panel display screen picture taken in the hangar at FAPG two days after the accident was made available to MGL Avionics, which showed no display of a red cross. *According to the CEO, it indicated the fuel information display was functional at the time the picture was taken.*

Examination of the flight folio showed that the last annual maintenance inspection on the aircraft was certified on 30 October 2021 at 264.15 hours. There was no evidence of open or differed maintenance items listed in the flight folio before the accident flight.

The IIC scrutinised the flight folio and interviewed pilots who did most of their flying on the aircraft (in the past), including many hours of instructions conducted on the aircraft, and their individual testimonies indicated that the aircraft's EFIS glass panels were in a good working condition and that the fuel level indication displays were accurate.

Figure 11: The left-side EFIS glass panel showing fuel indications, fuel pressure at 5.0 bar, and 19 minutes flight time.

Later, MGL Avionics' CEO requested that the Dynon fuel level converters be sent for analysis. Confirmation of their arrival in Cape Town by MGL Avionics facility was made on 14 April 2022.

Operational Principle of the Dynon Fuel Level Converters (Source: MGL Avionics)

The converters measure the capacitance of a two-plate probe immersed in aviation fuel. The amount of plate covered by the fuel determines the fuel level. The fuel's dialectic constant is different from air. This causes a change of capacitance. The converter contains a Cypress Semiconductor CY8C27243 chip. This was an older generation "system on chip" containing a small processor memory, and a few peripheral components. The capacitance is measured in the traditional way by charging the capacitor via a fixed but small current and measuring the time it takes to reach a threshold voltage. The capacitor is then discharged by shorting it using a small transistor and the process restarts. The processor then converts the measured capacitance (time) to a voltage utilising a Pulse Width Modulation (PWM) converter based on a resistor and capacitor to integrate the signal into a variable direct current (DC) voltage. This voltage is then output as signal. The chip and circuit are supplied via a common 7805 voltage regulator from typically 12 volts (v) or 24v DC aircraft power system.

An email communication was sent to the pilot's attorney requesting that the two Dynon converters be made available for further investigation. The converters were delivered to the AIID offices, and they were packaged as received and couriered to MGL Avionics for analysis.

The two Dynon fuel level converters (MFR Model - 100654-000) were subjected to functionality checks; these were the findings.

Right-side tank fuel level converter:

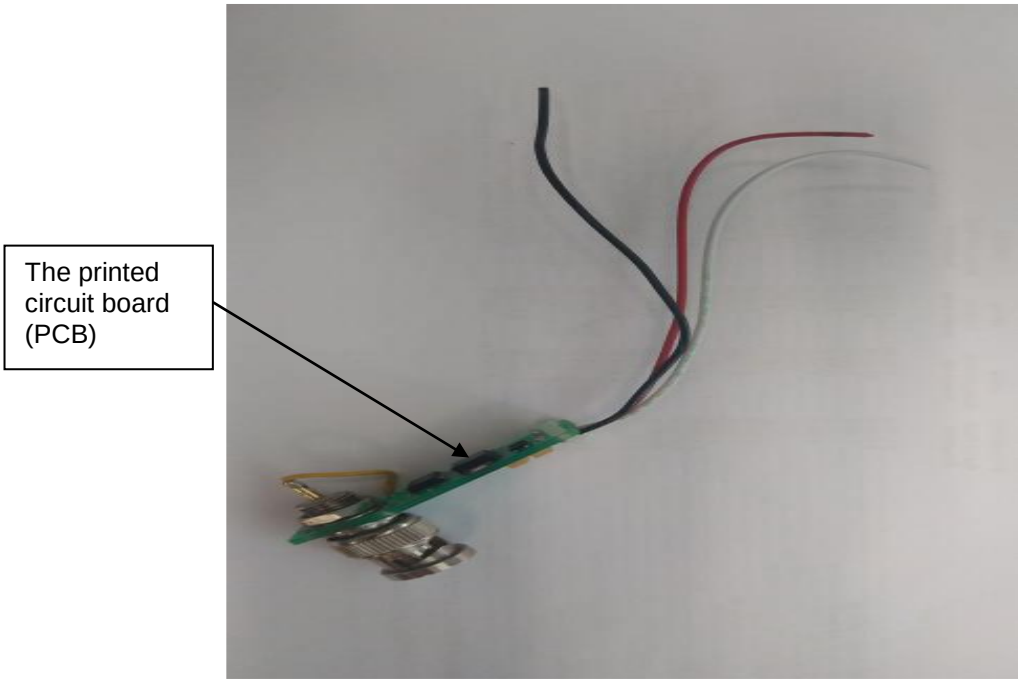


Figure 12: Right-side tank fuel level converter.

The printed circuit board (PCB) for the right-side tank fuel level converter was severely damaged, most probably from impact during the accident sequence and had broken in half at the connector point. The converter would have given a “zero” reading as it disconnected from one of the probe plates.

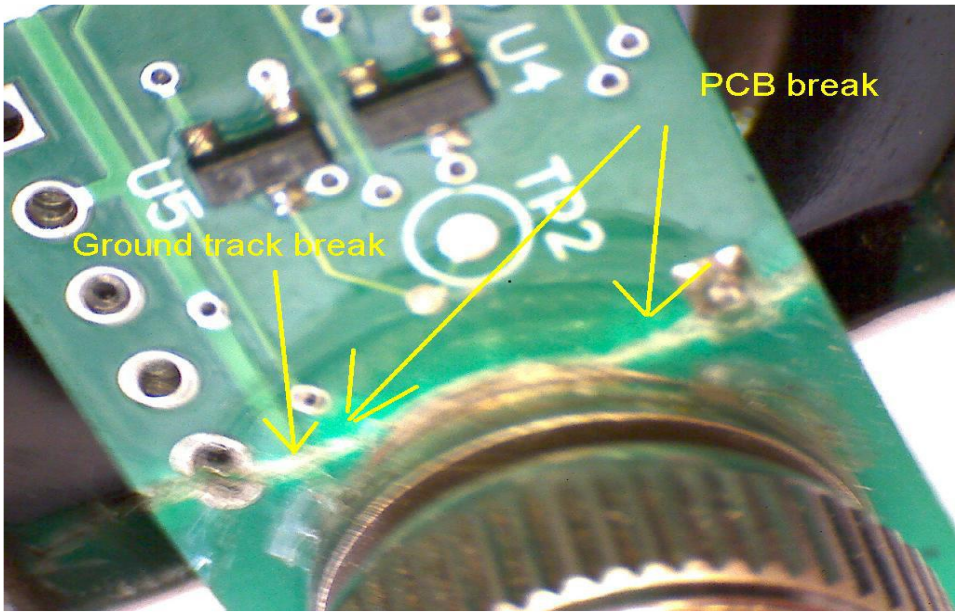
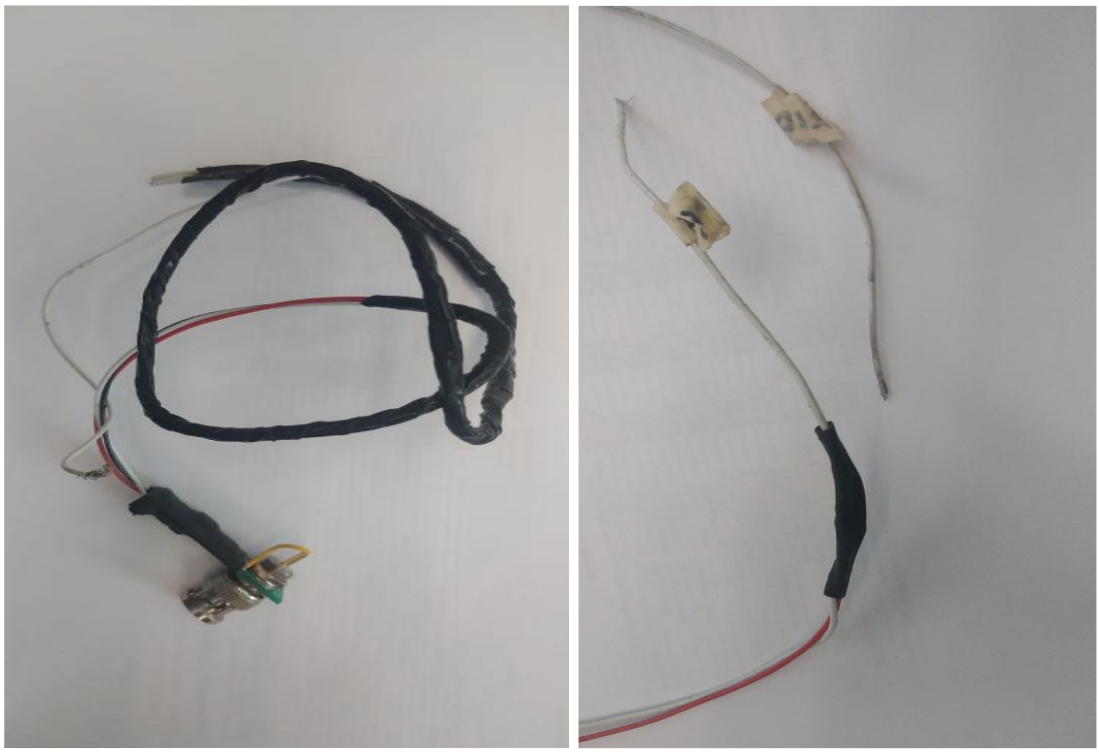


Figure 13: A damaged right-side tank fuel level converter PCB.

Left-side tank fuel level converter:

The left-side fuel level converter appeared to be in good condition. The three wires (ground, power and signal) had been extended. The extension was wrapped in black electrical insulation tape. The wiring harness extension, still attached, could not have provided any meaningful reading as the output lead had no electrical connection to the converter. This meant that the Remote Data Acquisition Computer (RDAC) input was electrically floating (high impedance) and will return a reading related to other electrical leakage currents that may be induced by other wiring. In other words, the reading was meaningless. The black electrical insulation tape was removed. The joints of all the wires where they were extended had about one inch of heat shrink sleeve. The signal wire could easily be slipped out of the heat shrink sleeve.



Figures 14 and 15: The left-side tank fuel level converter (left picture). The wires on the converter after the removal of the heat shrink sleeve (right picture).

Figures 16 and 17: Pictures of the left-sided tank fuel converter after removal of the heat shrink sleeve – these images were of each wire end.

In brief, according to the report, the left-side tank fuel converter wire joint was not properly soldered; a small amount of solder was present on one of the ends, but this was not allowed to flow onto the second wire, leaving a "cold" wire junction. This typically works for a while until the build-up of oxide on the wire stands or mechanical movement breaks the electrical connection. According to the report, this may well have resulted in an intermittent fault but eventually tends to become a permanent break. In this form, the fuel level reading on the EFIS will be incorrect and will likely vary with the quality of the remaining electrical contact (if any). In closing, none of the converters worked in the form in which they were presented and a question regarding the status of fuel in the tanks at departure time remains unanswered.

Previous flights recorded in the flight folio were considered important in trying to calculate the amount of fuel burnt between flights, starting with a flight from FATA to FAPG on Sunday, 12 December 2021, which took 3 hours and 18 minutes.

The flight folio page serial number 22238 entry dated 12 December 2021 showed that the aircraft was last refuelled at FATA at 276.31 recorded Hobbs Meter hours. One hundred litres (6.4 US gallons) of fuel was uplifted. The pilot was inconsistent with regards to information about the total amount of fuel on-board before departing FATA on 12 December 2021.

The first WhatsApp communication sent to the IIC at 17:49 read: "*when I loaded 100l, I had about 15l per-side on-board*", meaning that the aircraft had 130 litres total fuel in the tanks. Another WhatsApp communication at 17:51 reads "*I departed FATA with 145l*". Again, another WhatsApp communication at 18:03, reads "*on the 12th I had approx. 130l on board*".

Another WhatsApp communication sent two days after the accident at 16:59 read: "*before departure at FATA, I personally fuelled the aircraft to full capacity which made both tanks full*." The pilot's evidence about fuel uplift was inconsistent.

The IIC maintains that at no time was the pilot under duress during the interrogation post-accident and evidence of such was at the start of the WhatsApp conversation post-accident on 19 December 2021 at 16:47 when the IIC complemented him, saying: "*You did a very good job Sir, I am looking at the street you landed on, very short*" and the pilot's response at 16:49 read: "*Thank you Sir...but I am not to be praised*". This was considered sufficient evidence to prove that the pilot was in a good state of mind during the conversation/interrogation.

After the IIC had established the aircraft was not refuelled after landing at FATA, and that a flight that lasted one (1) hour with two touch-and-go landings was flown the next day (13 December 2021), the full tanks capacity (158l) scenario was considered possible, considering 4 hours and 18 (0.30) minutes total flight time recorded in the flight folio where approximately 154 litres of fuel was consumed from the 158 litres total fuel that was in the tanks. This consumption was calculated at an estimated hourly fuel burn of 35l per hour at 65% best economy with the engine leaned at 22 inches MAP.

A calculated fuel consumption after the aircraft was refuelled to capacity at FATA on 12 December 2021:

Date	**From**	**To**	**Flight duration**	**Fuel on-board**	**Fuel consumed**
12 December 2021	FATA	FAPG	3 hours + 18 min	158 litres	115 litres
13 December /2021	FAPG	FAPG	1 hour + 2 landings	43 litres	38 litres
				5 litres (4 litres unusable)	**Fuel remaining**

During the investigation, the pilot informed the IIC that he uplifted another 100 litres of fuel at FAPG on 14 December 2021 to bring the fuel level to approximately 105 litres. The fuel uplift on 14 December 2021 was not recorded in the flight folio, which is not in accordance with Part 91.03.6 of the CAR 2011 as amended. A follow-up with FAPG fuel supplier was made and the invoice with serial number 10072 was made available to the IIC showing the 100 litres amount of fuel that was uplifted, and a payment made thereof.

Fuel record:

Part 91.03.6 *(1) The owner or operator of an aircraft shall maintain fuel records for each flight undertaken by the aircraft under the control of such owner or operator.*

(2) The PIC of the aircraft shall enter the fuel and oil records referred to in sub-regulation (1) in the flight folio.

On 15 December 2021, the aircraft flew another hour (01.00) locally, during which two touch-and-go landings were conducted. During this flight, approximately 38 litres of fuel was consumed with about 67 litres remaining in the tanks. On 18 December 2021, the pilot flew another 56 minutes (0.93) during which two touch-and-go landings and approximately 36 litres of fuel was consumed, with about 31 litres remaining in the tanks. *The estimated amount of fuel consumed during the above two flights by far contradicted the 50 litres amount of fuel the pilot stated the aircraft had before the commencement of the accident flight on 19 December 2021. The accident flight lasted about 19 minutes (0.32) and the calculated fuel consumption was approximately 11 litres*. Approximately 20 litres total fuel was missing.

Date	**From**	**To**	**Flight duration**	**Fuel-onboard**	**Fuel consumed**
15 December 2021	FAPG	FAPG	1 hour + 2 landings	105 litres	38 litres
18 December 2021	FAPG	FAPG	56 min + landings	67 litres	36 litres
19 December 2021	FAPG	FAPG	19 min	31 litres	11 litres
				20 litres	**Missing**

The IIC argued that if indeed the aircraft had 50 litres total fuel in the tanks at the commencement of the accident flight or 31 litres as per the above calculated fuel consumption, assuming half amount (25l or 15½ litres) in each tank, a reasonable amount of fuel could have been recovered from the left tank that was intact. The pilot, after he was informed about the amount of unusable fuel recovered from the left tank (less than a litre) that was intact (WhatsApp communication at 18:02), responded; "*I understand that Sir*". The question is why this evidence was acknowledged when he had reported the tanks had 50 litres total fuel, with each carrying more than 19 minutes of useable fuel. The absence of a stain on the tarmac at the accident scene was an indication the raptured right tank contained no fuel. Also, if the raptured right-side wing fuel tank contained fuel, the pilot would have not switched to the left-side fuel tank.

The 20 litres of fuel missing in the calculation remains a concern. The two flights recorded on 15 and 18 December 2021 appeared identical, yet it was impossible for the IIC to make sense of what

exactly happened during the flights and to trace every single drop of fuel consumed in the absence of a flight plan. The pilot stated that he flew the aircraft with the selector on the left tank up until the engine's mishap in-flight. The statement was deemed erroneous because the right tank contained no fuel post-accident, which made the IIC suspect that fuel was ported from the right tank on departure and the left tank was selected after the right tank was emptied. It was also possible that aerobatic manoeuvres were at some point performed during the accident flight which led to more than estimated fuel consumption. The predictability of fuel consumption figures for the aerobatic manoeuvres according to Lycoming Operator's Manual varies from 20 litres per hour to 50 litres per hour.

In addition, the fact that the pilot flew an aircraft where the EFIS is the PFI, and was prohibited from doing so, may have increased the risk of him misreading the fuel level indications displayed on the screen and, consequently, assuming there was adequate fuel on-board for a planned flight than was actually present in the tanks. The investigation revealed the following findings:

I. The pilot's CPL was invalid at the time of the accident.

II. The available information from the South African Institute of Aviation Medicine (IAM) showed that the pilot did not have a valid medical certificate. The pilot had a known medical condition and had a restriction to fly under visual flight rules (VFR) by day only. In addition, flying of EFIS-equipped aircraft where the EFIS is the Primary Flight Instrument (PFI) was prohibited for him. According to the database, the pilot's licence was last renewed on 9 September 2016 and the accident flight occurred on 19 December 2021, an indication that Part 61.05.1 and 61.01.6 of the CAR 2011 were not adhered to.

III. The pilot's Van's RV-7 aircraft type conversion rating was not conducted IAW the South African Civil Aviation Technical Standards (SA-CATS) 61; it was, therefore, considered unlawful.

IV. The pilot's evidence (Page 11) and the information displayed on the left-side EFIS glass panel picture (Figure 11) taken two days after the accident contradicted the findings of the EFIS glass panels and Dynon fuel level converters.

V. The pilot disregarded the SACAA regulations and safe standard operating procedures (SOP).

VI. The calculated fuel consumption contradicted the pilot's 50 litres total fuel at departure time, captured in the pilot's questionnaire.

VII. A visual on-site inspection of the aircraft's fuel tanks revealed that there was no useable fuel on-board at the time of the accident.

VIII. The fuel system was examined and there was no evidence of a system defect or malfunction prior to or during the flight.

IX. The accident scene showed no evidence of fuel leak or spillage on the tarmac and no signs of post-impact fire.

X. The aircraft was certified, equipped and maintained IAW with the existing regulations and approved procedures. Scrutiny into the aircraft's flight folio/logbook showed no entries

indicating open defects and differed maintenance items.

Post-accident investigation concluded that the cause of the accident was attributed to fuel exhaustion.

Fuel supply:

Part 91.07.12 (1) *The pilot shall not commence a flight unless he or she is satisfied that the aircraft carries at least the planned amount of fuel to complete the flight safely, taking into account operating and meteorological conditions and the expected delays.*

(2) The PIC shall ensure that the amount of usable fuel remaining in flight is not less than the fuel required to proceed to an aerodrome or, in the case of a helicopter, a suitable landing place, where a safe landing can be made.

(3) If the usable fuel on board the aircraft is less than the final reserve fuel, the PIC of such aircraft, shall –

(a) in the case of an aeroplane, declare an emergency; or

(b) in the case of a helicopter, land as soon as possible.

(4) The method of calculating the amount of fuel to be carried for each flight shall be as prescribed in Document SA-CATS 91.

Probable cause:

The pilot experienced engine stoppage 19 minutes after take-off which was caused by fuel exhaustion, and had performed an unsuccessful forced landing on a private road (Erica PI Drive) during which he could not bring the aircraft to a stop and struck a tree, perimeter wall and gate.

Contributory Factor:

1. Lack of airmanship.

2. Disregard for the SACAA regulations and safe standard operating procedures (SOP): flying without a valid licence and without a valid medical certificate, flying the aircraft fitted with EFIS that he was prohibited from operating, lack of proper fuel uplift record keeping, and having no rating on the type of aircraft.

Safety Message and/or Safety Recommendation/s

None.

Purpose of the Investigation

In terms of Regulation 12.03.1 of the Civil Aviation Regulations (CAR) 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 apportion blame or liability****.*

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