SOUTH AFRICAN CIVIL AVIATION AUTHORITY

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

LIMITED SERIOUS INCIDENT INVESTIGATION REPORT

Reference Number	CA18/3/2/1389								
Classification	Serious Incident	**Date**	3 February 2022	**Time**	1510Z				
Type of Operation	Private (Part 91)								
Location									
Place of Departure	Brits Aerodrome (FABS), North West Province	Place of Intended Landing	Grand Central Aerodrome (FAGC), Gauteng Province						
Place of Occurrence	Runway 35 at FAGC, Gauteng Province								
GPS Co-ordinates	Latitude	S25° 59'.13.44"	Longitude	E28°08'.25.97"	Elevation	5327 feet			
Aircraft Information									
Registration	ZS-IIZ								
Make/Model	Cessna 177RG Cardinal (Serial Number: 177RG-0134)								
Damage to Aircraft	Substantial	Total Aircraft Hours	3433.1						
Pilot-in-command									
Licence Valid	Yes	Gender	Male	Age	30				
Licence Type	Commercial Pilot Licence (CPL)								
Total Hours on Type	192.3	Total Flying Hours	824.8						
People On-board	1 + 1	Injuries	0	Fatalities	0	Other (On Ground)	0		
What Happened									

On Thursday afternoon, 3 February 2022, a pilot accompanied by a passenger on-board a Cessna 177RG Cardinal aircraft with registration ZS-IIZ took off on a private flight from Grand Central Aerodrome (FAGC) in Midrand, Gauteng province, to Brits Aerodrome (FABS) in the North West province with the intention to return to FAGC. Visual meteorological conditions (VMC) by day prevailed on the day and no flight plan was filed. The flight was conducted under the provisions of Part 91 of the Civil Aviation Regulations (CAR) 2011 as amended.

The pilot stated that before departure, he conducted a pre-flight inspection on the aircraft and nothing abnormal was detected. The flight folio had no outstanding defects. The duo boarded the aircraft, whereafter the pilot started the engine without any struggle. The pilot broadcasted his intentions to the FAGC control tower on 122.80-Megahertz (MHz) frequency and taxied the aircraft to the threshold of Runway 35 for departure. The pilot reported that before departure, he performed the pre-take-off checks, and all the engine indications were within the green arch.

Having been granted permission by the control tower to depart, the pilot opened the throttle and took off. The flight to FABS was uneventful. After landing at FABS, 107 litres (l) of Avgas 100LL was uplifted and the aircraft's fuel tanks were at full capacity. After recording the fuel-upliftment in the flight folio, the pilot carried out a turnaround flight inspection and, having started the engine, he took off and climbed to flight level (FL) 065, cruising at 120 knots indicated air speed (KIAS). During cruise, the engine revolutions per minute (rpm) indicated 2200 with the manifold air pressure (MAP) set at 25 inches. The engine indications were within the green arch and the pilot routed via Roodekoppies Dam, Rustenburg and Carletonville, before routing back to FAGC along the same route he took during the outbound leg.

The pilot reported that after joining FAGC circuit, he communicated with air traffic control (ATC) requesting permission to perform a few circuits before making a full-stop landing on Runway 35. The ATC granted him permission and he performed two successful touch-and-go landings. The pilot intended to perform a full-stop landing following his third circuit. He followed the pre-landing checks as conducted during the previous landings and made sure the landing gear was down and in the locked position with the green light illuminating in the cockpit; he also selected 30° (degrees) flaps for landing. The pilot also used the mirror to check the position of the nose gear, which he confirmed to have been in the down position. However, after touchdown on Runway 35 at approximately 75 knots ground speed and as the aircraft decelerated, the nose pitched down and the propeller struck the runway surface. The aircraft slid on the runway surface for approximately 40 metres (m) before coming to a stop in a nose-down attitude. The two occupants were not injured but the aircraft was substantially damaged. The duration of the flight was 2.0 hours.

Figure 1: The aircraft as it came to rest. (Source: Pilot)

The ATC activated the aerodrome crash alarm and the aerodrome rescue and fire-fighting (ARFF) personnel responded swiftly to the scene. Post-incident visual inspection of the aircraft showed that the propeller blades had bent backward, consistent with the engine producing power; the landing gear lever was in the down position and the flaps extended to 30°.

Figure 2: A bent propeller blade tip. (Source: Pilot)

Figure 3: A view of the cockpit with the landing gear lever and flap lever in the down position.

Cessna 177RG landing gear operation (Source – Pilot's Operating Handbook):

Retraction and extension of the landing gear is accomplished by a hydraulic system integrated with electrical control and indication circuits. There is one hydraulic actuator for the nose landing gear and one actuator that drives a gear system for both main landing gears. Hydraulic fluid is supplied to the actuators by an electrically-powered reversible pump. The hydraulic reservoir is an integral part of the pump. The electrical pump is controlled by the landing gear selector mounted in the cockpit instrument panel. As the landing gear selector is moved to either the up or down position, the pump directs hydraulic fluid through a power pack control valve assembly to the landing gear actuators. As the hydraulic fluid pressure increases at one side of the actuator pistons, the fluid at the other side of the pistons is directed back through the control valve assembly to the pump.

The landing gear extension and retraction pipes serve either as pressure or return lines depending on the rotation of the reversible pump and the position of the landing gear selector in the cockpit. Mechanical overcentre locks provide up and down locks for the nose landing gear. The main landing gears utilise hydraulic pressure for positive uplock and electro-mechanical downlocks. Mounted on the control valve, through which pressurised hydraulic fluid passes during landing gear retraction, is a pressure switch. This pressure switch opens the electrical circuit to the pump solenoid when the main landing gear is fully retracted and the hydraulic pressure has reached approximately 1,500 psi. The pressure switch will hold the electrical circuit open until the hydraulic pressure in the system drops to approximately 1,100 psi at which time the pressure switch closes allowing electrical power to the hydraulic pump. The hydraulic pump will run until the pressure reaches approximately 1,500 psi and the pressure switch opens the electrical circuit. This cycling of the hydraulic pressure maintains the main landing gears in their UP AND LOCKED positions whenever the landing gear selector in the cockpit is in the up position. With the landing gear selector in the down position the pressure switch has no effect on the operation of the hydraulic system. Other valves in the hydraulic system channel fluid to the correct outlets during landing gear extension and retraction, allow return fluid into the reservoir without producing any back pressure and allow for thermal relief. An emergency hand pump, located between the two front seats, is used to extend the landing gear manually in the event of electrical or hydraulic failure.

Mounted in the instrument panel are two landing gear position indicator lights. A single amber light illuminates when the landing gear is up and locked; a single green light illuminates when it is down and locked. Each of the three landing gears has a downlock microswitch and all three microswitches have to be made to complete the electrical circuit to illuminate the green down and locked light in the cockpit. In addition to illuminating the green indicator light, the making of all three downlock microswitches opens the electrical circuit to the hydraulic pump. Mechanically connected to the main landing gear downlock mechanisms are two unlock solenoids on the back of which are mounted sequence switches. These solenoids are mounted on pivots which allow them to pivot through approximately 7°. One of the functions of the sequence switches is to open the electrical circuit to the hydraulic pump when the main landing gears are in their downlock positions. All three downlock microswitches and the two sequence switches have to be operated before electrical power to the hydraulic pump is switched off during the landing gear extension sequence. When the hydraulic pump switches off, the pressure in the down lines slowly dissipates over a period of time which is dependent upon the seal leak rates in the landing gear actuators. The hydraulic pump will switch on when any of the downlock microswitches or sequence switches break, which, providing the landing gear selector is in the DOWN position, will pressurise the down lines. When a correctly adjusted landing gear is in the DOWN AND LOCKED position no hydraulic pressure is required to maintain it in that condition.

During the landing gear retraction sequence, only the sequence switches, the pressure switch and the landing gear selector in the cockpit have a controlling function of the electrical power to the hydraulic pump.

Post-accident engineering examination:

The aircraft was recovered to an aircraft maintenance organisation (AMO) at Wonderboom Aerodrome (FAWB) in Gauteng province for engineering investigation. The aircraft was placed on jacks in the hangar and external power was connected. The landing gear's unsafe warning horn was tested, and it operated normally. The pilot stated that during finals, the green landing gear down and locked indication light illuminated in the cockpit and at no time did the unsafe gear warning horn sound prior to touch down on the asphalt Runway 35.

The aircraft had adequate MIL-H-5606 hydraulic fluid in the reservoir and none of the circuit breakers (CB) had popped. The damaged nose gear doors were removed to facilitate the landing gear retraction and extension tests. The nose gear and wheel-well were inspected, and nothing abnormal was noticed. The nose gear microswitch was intact and it was also not faulty. The hydraulic system indicated 1500 pounds per square inch (psi) pressure which was adequate, according to the POH. The landing gear retraction and extension tests were carried out using the normal procedure and only the main landing gears extended and locked into position every time it was extended; the nose landing gear did not lock into position. The nose landing gear hydraulic lines and actuating cylinder were inspected, and no obvious signs of hydraulic leak were observed; all fasteners were in place and properly secured. The emergency landing gear extension procedure was conducted, and all three landing gears extended and locked into position with the green lights illuminating.

Figure 4: A view of the aircraft on jacks during the landing gear examination.

A decision was made to inspect the landing gear pump motor bearing Part Number 105932E and Serial Number 9832, located on the aft fuselages' left-side. After dismantling the pump motor, signs of excessive heat were observed on the electrical leads and the armature (see Figures 5 and 6). The bonding on the pigtails had melted due to excessive heat caused by the continuous running of the gear pump motor and had, eventually, detached. One of the tiny brush springs had contracted due to excessive heat and the brush had also detached. The burnt electric leads and

armature were an indication that the landing gear pump motor was operational at the time of the accident.

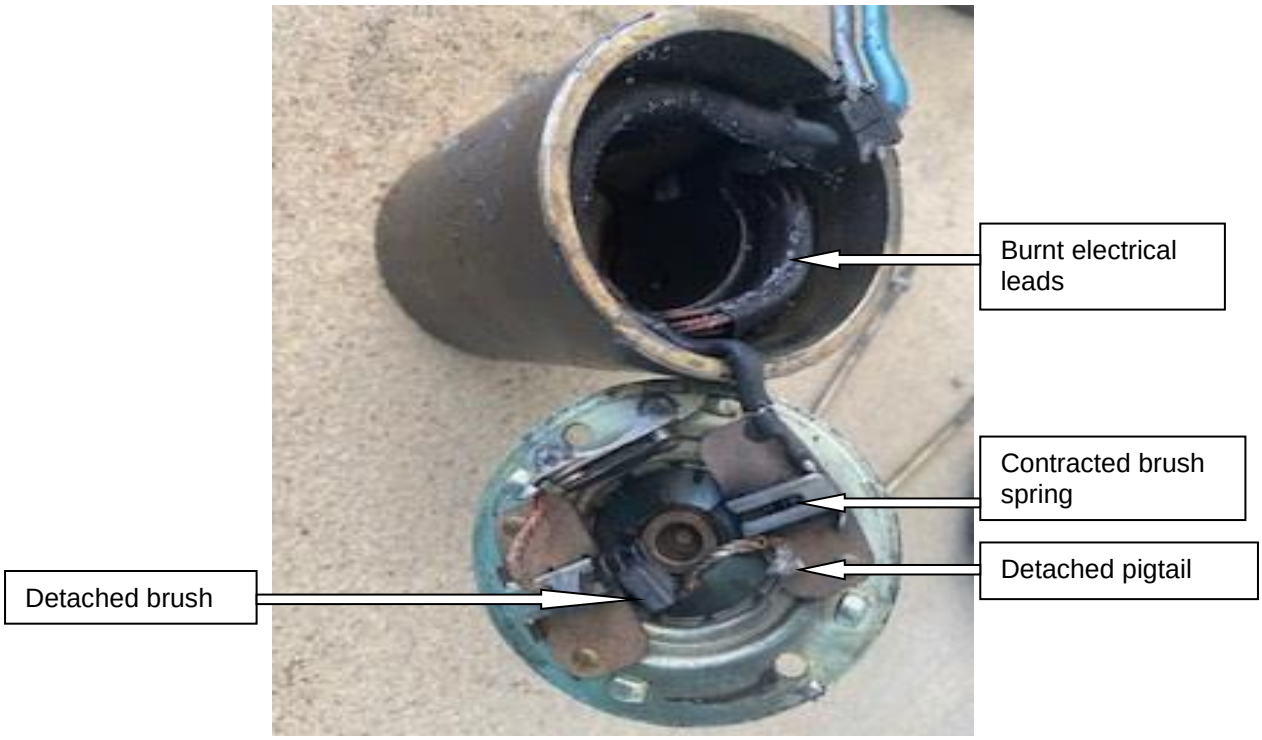

Figure 5: The landing gear pump motor after it was opened.

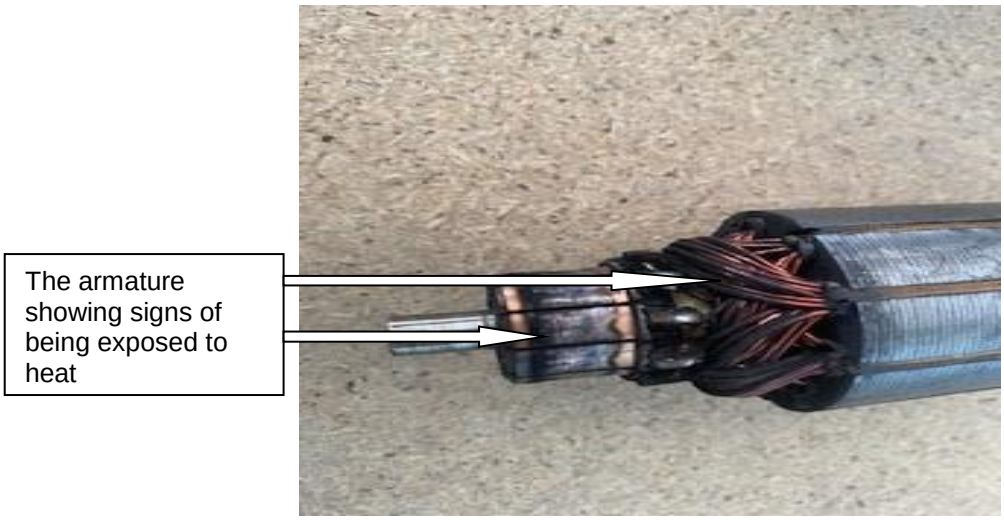

Figure 6: Heat signs on the armature.

Pre-accident landing gear maintenance:

The flight folio page serial number 13883 showed that on 30 September 2021, the aircraft was flown to the AMO in Lanseria International Airport (FALA) for the landing gear inspection at 3311.1 airframe hours. The aircraft was placed on jacks and the landing gear extension and retraction tests were carried out. The main landing gear was intermittent, which meant that it could not retract to the locked position every time it was operated, but the nose gear operated normally.

An aircraft maintenance engineer (AME) from Rand Aerodrome (FAGM) with ratings for both Category W and X was contacted to assist. The AME uncovered that the main landing down lock solenoid brackets were worn out to an extent that they could not appropriately activate the micro switches. During manual extension, the landing gears were able to travel to the down and locked position with the green indication light illuminated. The AMO stated that the pilot was notified of the spares required to rectify the defect on the main landing gear. In addition, a recommendation to overhaul the landing gear pump motor was made. The purchase order, dated 7 October 2021, indicated that the landing gear pump motor was removed from the aircraft and sent to FAGM for overhaul. Once overhauled, it was bench-tested at 12 volts and the current was drawn as per normal. The landing gear pump motor was returned to FALA and refitted on the aircraft. The flight folio page serial number 13883 indicated that on 13 October 2021, the aircraft took off from FALA to FAGM with the landing gear in an extended position.

During the interview with the investigator, the pilot was asked why the aircraft was flown with the worn-out main landing down lock solenoid brackets. His response was that the AMO at FALA took long to replace the identified components and had decided to relocate the aircraft to another AMO at FAWB that he thought had a better understanding of how the defect should be rectified.

The AMO at FALA stated that the pilot could not wait until the replacement parts were available. The aircraft, however, was not relocated to FAWB as indicated. On 14 October 2021, the pilot flew to Zebula Lodge in Bela-Bela, Limpopo province, with the landing gear still in an extended position. The flight folio entries indicated that from Zebula Lodge, the aircraft was flown to multiple aerodromes and had accumulated approximately 36.2 airframe hours before it was flown back to the AMO at FAWB. On 25 November 2021, the last 100-hour mandatory periodic inspection (MPI) was certified on the aircraft at 3347.3 airframe hours. During this maintenance, a detailed examination of the landing gear was carried out and the engineers noted the voltage and current flow degradation on the landing gear pump motor, which was caused by a corroded cable lug. The lug was replaced, and the landing gear pump motor tested normal.

Figures 7 and 8: A disconnected gear pump motor cable (left picture); and a connected gear pump motor cable after maintenance (right picture).

During the interview with the AMO representatives (FAWB), they stated that the main landing down lock solenoids were not replaced because they were within limits. A video of the landing gear extension and retraction test was shown to the investigator-in-charge (IIC), and it operated normally. The landing gear position indications were also visible. The landing gear's unsafe warning horn was tested, and it sounded normal. The IIC tried to acquire a loaner serviceable gear pump motor to assist cycle the landing gear normally, but without success.

The circumstantial evidence showed that the landing gear down indicator light illuminated in the cockpit during manual extension, and for the gear unsafe horn to be mute during the test was an indication that all three legs were in a down and locked position. The IIC did not find any evidence of a mechanical fault with the main landing gear or the nose gear. No evidence of improper nose gear rigging was noticed. Available evidence showed that the gear pump motor was operational at the time of the accident.

The aircraft's Certificate of Release to Service was issued on 25 November 2021. The aircraft had accumulated 85.8 hours since the last MPI was certified. The aircraft's flight folio indicated no open or deferred maintenance items listed before the flight. Post-accident examination of the pilot's file kept at the South African Civil Aviation Authority (SACAA) indicated that the pilot had a valid Commercial Pilot Licence (CPL) and had the aircraft type endorsed on his licence.

Probable cause

The aircraft's nose landing gear collapsed during the landing roll on Runway 35 at FAGC.

Contributory factor

Undetermined.

Safety Action/s

None.

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****.*

Disclaimer

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

This report is issued by:

Accident and Incident Investigations Division
South African Civil Aviation Authority
Republic of South Africa