SOUTH AFRICAN CIVIL AVIATION AUTHORITY

Section/division **Accident & Incident Investigations**

Form Number: CA 12-12a

AIRCRAFT ACCIDENT REPORT AND EXECUTIVE SUMMARY

			Reference:	CA18/2/3/8453	
Aircraft Registration	**ZS-LFU**	**Date of Accident**	7 March 2008	**Time of Accident**	1710Z
Type of Aircraft	Beech B200		**Type of Operation**	Private	
Pilot-in-command Licence Type	Commercial	**Age**	52	**Licence Valid**	Yes
Pilot-in-command Flying Experience	Total Flying Hours	14 500.0		Hours on Type	4 650.0
Last point of departure	Bloemfontein Aerodrome (FABL)				
Next point of intended landing	Cape Town International Aerodrome (FACT)				
Location of the accident site with reference to easily defined geographical points (GPS readings if possible)					
On Runway 19 at Cape Town International Aerodrome					
Meteorological Information	Surface wind; 220°/15 knots, Temperature; 23°C, Visibility; Good				
Number of people on board	1 + 6	**No. of people injured**	0	**No. of people killed**	0

Synopsis

The pilot, accompanied by six passengers, was engaged in a private flight from Bloemfontein Aerodrome to Cape Town International Aerodrome.

The aircraft was cleared for landing at Cape Town International Aerodrome (FACT), Runway 19 by ATC (Air Traffic Control). According to the pilot, he had selected the landing gear down and had three green light indications in the cockpit, indicating that the landing gear was down and locked. While the aircraft was established on final approach, the before-landing checklist checks were performed and full flaps were selected for landing. Touch-down was normal and about halfway during the landing roll the pilot felt “the left side of the aircraft is slowly sinking”. The left-hand propeller then struck the runway surface. The pilot made the necessary corrective action to keep the aircraft straight on the runway and to keep the sinking wing up as long as possible. The aircraft came to a halt to the left of the runway centre line.

Nobody was injured in the accident but the aircraft sustained substantial damage to the left-hand wing, flaps, propeller and engine.

Probable Cause

The left main landing gear assembly collapsed during the landing roll due to a fatigue fracture that had propagated over an undetermined period of time.

IARC Date		Release Date	

AIRCRAFT ACCIDENT REPORT

Name of Owner/Operator	**:** Invicta Bearings (Pty) LTD
Manufacturer	**:** Beech Aircraft Corporation
Model	**:** B200
Nationality	**:** South African
Registration Marks	**:** ZS-LFU
Place	**:** Cape Town International Aerodrome
Date	**:** 7 March 2008
Time	**:** 1710Z

All times given in this report are Co-ordinated Universal Time (UTC) and will be denoted by (Z). South African Standard Time is UTC plus 2 hours.

Purpose of the Investigation:

In terms of Regulation 12.03.1 of the Civil Aviation Regulations (1997) this report was compiled in the interests of the promotion of aviation safety and the reduction of the risk of aviation accidents or incidents and ***not to establish legal liability****.*

Disclaimer:

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

1. FACTUAL INFORMATION

1.1 History of Flight:

1.1.1 The pilot, accompanied by six passengers, was engaged in a private flight from Bloemfontein Aerodrome to Cape Town International Aerodrome on an instrument (IF) flight plan. Fine weather conditions prevailed at Cape Town and a visual approach was requested for landing. The pilot was cleared for landing, Runway 19 by Air Traffic Control (ATC).

1.1.2 According to the pilot, he had selected the landing gear down and had three green light indications in the cockpit, indicating that the landing gear was down and locked. While the aircraft was established on final approach, the before-landing

checklist was performed and full flaps were selected for landing. Touch-down was normal and about halfway within the landing roll, the pilot felt “the left side of the aircraft slowly sinking”. The left-hand propeller then struck the runway surface. The pilot made the necessary corrective action to keep the aircraft straight on the runway and to keep the sinking wing up as long as possible. The aircraft came to a halt on the runway to the left of the centre line.

1.1.3 The accident occurred in the late afternoon during twilight conditions at Cape Town International Aerodrome on Runway 19. Nobody was injured in the accident.

1.2 Injuries to Persons:

Injuries	Pilot	Crew	Pass.	Other
Fatal	-	-	-	-
Serious	-	-	-	-
Minor	-	-	-	-
None	1	-	6	-

1.3 Damage to Aircraft:

1.3.1 The aircraft sustained substantial damage to the left wing, flap as well as the propeller, which made contact with the runway surface.

Figure 1. A view of the aircraft as it came to rest on Runway 19.

1.4 Other Damage:

1.4.1 Minor damage was caused to the runway surface, following several propeller blade strike marks as well as scraping marks on the asphalt surface.

1.5 Personnel Information:

1.5.1 Pilot-in-command:

Nationality	South African	Gender	Male	Age	52
Licence Number	**********	Licence Type	Commercial		
Licence valid	Yes	Type Endorsed	Yes		
Ratings	Instrument Rating				
Medical Expiry Date	31 May 2008				
Medical Certificate	Class 1				
Restrictions	None				
Previous Accident/Incident	On 7 February 2003 while landing at Mombo Aerodrome in Botswana, the aircraft (ZS-LFU) had collided with an antelope that attempted to cross the runway. The pilot was unable to avoid the incident.				

Flying Experience:

Total Hours	14 500.0
Total Past 90 Days	80.0
Total on Type Past 90 Days	80.0
Total on Type	4 650.0

1.6 Aircraft Information:

1.6.1 **Airframe:**

Type	Beech B200
Serial Number	BB-1018
Manufacturer	Beech Aircraft Corporation
Year of Manufacture	1983
Aircraft Age at time of accident	25 years

Maximum Take-off Weight	5 670 kg (12 500 pounds)	
Total Airframe Hours (At time of Accident)	8 667.2	
Last Inspection (Phase 1)(Hours & Date)	8 641.6	1 February 2008
Hours since Last Phase Inspection	25.6	
C of A (Issue Date)	19 May 1994	
C of A (Currency Fee Expiry Date)	18 May 2008	
C of R (Issue Date) (Present owner)	13 November 2001	
Operating Categories	Standard	

Engine No. 1:

Type	Pratt & Whitney PT6A-42
Serial Number	PCE-93394
Hours since New	8 580.6
Hours since Overhaul	1 947.2

Engine No. 2:

Type	Pratt & Whitney PT6A-42
Serial Number	PCE-93387
Hours since New	8 587.2
Hours since Overhaul	1 861.8

Propeller No. 1:

Type	Hartzell HC-D4N-3A
Serial Number	FY 1665
Hours since New	3 312.3
Midlife O/H inspection date	27 February 1998

Propeller No. 2:

Type	Hartzell HC-D4N-3A
Serial Number	FY 171
Hours since New	3 312.3
Midlife O/H inspection date	27 February 1998

1.6.2 According to the maintenance defect sheet pertaining to the last maintenance inspection (Phase 1 inspection, dated 1 February 2008) that was certified on the aircraft, the following defect was entered pertaining to the landing gear; “Left-hand main landing gear down lock indicator switch intermittent.” A new switch Part No. 100-380016-1 was fitted and a functional test was performed. According to the

AME (Aircraft Maintenance Engineer) that signed off the defect sheet, several retraction tests were performed following the installation of the new switch to ensure that the landing gear system was functioning satisfactorily.

1.6.3 Phase 4 Inspection, dated 30 May 2007.

On 30 May 2007 a Phase 4 maintenance inspection was certified on the aircraft at 8442.2 airframe hours. The Phase 4 maintenance inspection requirements pertaining to the landing gear of the Beech B200 type aircraft and the Phase 1 differ slightly in the sense that the Phase 1 inspection had a few additional inspection requirements regarding the landing gear as opposed to the Phase 4 inspection. It should be noted that neither of these two inspections require any disassembly of a component or components for any non-destructive crack testing.

1.6.4 Airworthiness Directives (AD) & Service Bulletins (SB).

Following the accident, the investigator contacted the aircraft manufacturer Hawker Beechcraft Corporation (HBC), Air Safety Investigations Department. In their response they indicated that to date they had no record of a hook down lock mechanism failure and there were no AD or SB issued by HBC that deal with this part or any associated inspection requirements.

1.6.5 Landing Gear (Beech B200)

Reference: Beech B200, Pilot's Operating Handbook, Section VII, Systems

A 28-volt motor a gearbox, located on the forward side of the centre-section main spar, extends and retracts the landing gear. The landing gear motor is controlled by the handle placarded LDG GEAR CONTROL – UP – DN on the pilot's right sub-panel. The landing gear control handle must be pulled out of a detent before it can be moved from either the UP or DN position. The motor incorporates a dynamic braking system controlling the "up" and "down" limit switch, which in conjunction with the landing gear locking mechanism prevents over-travel of the landing gear.

Torque shafts drive main gear actuators, and duplex chains drive the nose gear actuator. A spring-loaded friction type overload clutch in the gearbox prevents damage to the structure and to the torque shafts in the event of a malfunction. A 150 amp limiter, located on the landing gear panel forward of the main spar under the centre floorboard, protects the system from electrical overload.

The Beech air-oil type shock struts are filled with compressed air and hydraulic fluid. Linkage from the rudder pedals permits nose wheel steering when the nose gear is down. One spring loaded link in the system absorbs some of the force applied to any of the interconnected rudder pedals until the nose wheel is rolling, at which time the resisting force is less and more pedal motion results in more nose wheel deflection. Since motion of the pedals is transmitted via cables and linkage to the rudder, rudder deflection occurs when force is applied to any of the rudder pedals. With the nose landing gear retracted, some of the force applied to any of the rudder pedals is absorbed by the spring-loaded link in the steering system so that there is no motion at the nose wheel, but rudder deflection still occurs. The nose wheel is self-centring upon retraction.

When force on the rudder pedal is augmented by a main wheel braking action, the nose wheel deflection can be considerably increased.

A safety switch on the right main gear torque link opens the control circuit when the strut is compressed. The safety switch also activates a solenoid-operated down-lock hook on the landing gear control handle located on the pilot's right sub-panel. This mechanism prevents the landing gear control handle from being raised when the airplane is on the ground. The hook automatically unlocks when the airplane leaves the ground. In the event of a malfunction of the down-lock solenoid, the down lock can be released by pressing downward on the red down-lock release button. The release button is located just left of the landing gear control handle. The landing gear control handle should never be moved out of the DN detent while the airplane is on the ground; if it is, the landing gear warning horn will sound intermittently and the red gear-in-transit lights on the landing gear control handle will illuminate (provided the MASTER SWITCH is ON), warning the pilot to return the handle to the DN position.

Visual indication of landing gear position is provided by individual green GEAR DOWN annunciators placarded NOSE – L – R on the pilot's right sub-panel. The annunciators may be checked in flight by pressing the annunciator. Two red, parallel-wired indicator lights located in the control handle illuminate to show that the gear is in transit or not locked. They also illuminate when the landing gear warning horn is actuated. Absence of illumination indicates that the gear is up and locked or down and locked. The red control handle lights may be checked by pressing the HDL LT TEST button located to the right of the landing gear control handle.

Landing Gear Extension and Retraction (Hydraulic System)

The nose and main landing gear assemblies are extended and retracted by a hydraulic power pack in conjunction with hydraulic actuators. The hydraulic power pack is located in the left centre section, just forward of the main spar. One hydraulic actuator is located at each landing gear. The power pack consists of; hydraulic pump, a 28 Volt DC (direct current) motor, a two-section fluid reservoir, filter screens, gear selector valve, two solenoids, a fluid level sensor and an up-lock pressure switch. For manual extension the system has a hand-lever-operated pump located on the floor between the crew seats. Hydraulic lines, one for normal extension, and one for retraction, routed from the power pack, and one for manual extension from the hand pump, are routed to the nose and main gear actuators. The normal extension lines and the manual extension lines are connected to the upper end of each hydraulic actuator. The hydraulic lines for retraction are fitted to the lower ends of the actuators. Hydraulic fluid under pressure generated by the power pack pump and contained in the accumulator acts on the piston faces of the actuators, which are attached to folding drag braces, resulting in the extension or retraction of the landing gear.

An internal mechanical lock in the nose gear actuator and the over-centre action of the nose gear drag leg assembly, lock the nose gear in the down position. Notched hook, lock link and lock link guide attachments fitted to each main gear upper drag leg provide positive down-lock action for the main gear.

Electrical overload to the system is prevented through the use of a 60-ampere circuit breaker located below the flooring near the hydraulic power pack.

The landing gear hydraulic power pack motor is controlled by the use of the landing gear control handle with a LDG GEAR CONTROL – UP – DN placard located on the pilot’s sub-panel. The control handle must be pulled out of the detent before it can be moved from either the UP or DN position.

Safety switches, called squat switches, on the main gear torque link open the control circuit when the strut is compressed. The squat switches must close to actuate a solenoid, which moves a down-lock hook on the landing gear control handle to the released position. This mechanism prevents the landing gear control handle from being placed in the UP position when the airplane is on the ground. The hook automatically disengages when the airplane leaves the ground, and can

be overridden by pressing down on the red down-lock release button located to the left of the landing gear control handle.

In flight, as the landing gear moves to the full down position, the down lock switches are actuated and interrupt current to the pump motor. When the red gear in-transit lights on the landing gear control handle extinguish and the three green GEAR DOWN annunciators illuminate, the landing gear is in the fully extended position.

Two gear select solenoids located on the valve body of the pump are energized through positioning of the landing gear control switch handle either to the UP or DN position. Once energized, the gear select valve is actuated, allowing hydraulic fluid to flow to the actuators.

Hydraulic system pressure performs the up-lock function, holding the landing gear in the retracted position. When the hydraulic pressure reaches 2775 ±55psi (pounds per square inch), the up-lock pressure switch will cause the landing gear relay to open and interrupt the current to the pump to actuate, should the hydraulic pressure drop to approximately 2400psi.

A caution annunciator HYD FLUID LOW in the caution/advisory annunciator panel will illuminate (yellow) whenever the hydraulic fluid in the hydraulic power pack is low. The annunciator is tested by pressing the HYD FLUID SENSOR TEST button located on the pilot's subpanel.

The landing gear control handle should never be moved out of the DN detent while the airplane is on the ground. If it is, the landing gear warning horn will sound intermittently, and the red gear-in-transit lights on the landing gear control handle will illuminate (provided the MASTER SWITCH is ON), warning the pilot to return the handle to the DN position.

The landing gear position is indicated by an assembly of three green annunciators. When illuminated, the annunciators indicate that the particular gear is down. Absence of illumination indicates that the gear is up.

Two red parallel-wired indicator lights, located on the landing gear control handle, illuminate to show that the gear is in-transit or unlocked. The red lights in the handle also illuminate when the landing gear warning horn is actuated.

The red light may be checked by pressing the HDL LT TEST button located adjacent to the landing gear control handle.

Landing Gear Warning System (Hydraulic System)

The landing gear warning system is provided to warn the pilot that the landing gear is not down during specific flight regimes. Various warning modes result, depending upon the position of the flaps.

With the flaps in the UP or APPROACH position and either or both power levers retarded below approximately 80% N_1, the warning horn will sound intermittently and the landing gear control handle lights will illuminate. The horn can be silenced by pressing the WARN HORN silence button adjacent to the landing gear control handle; the lights in the landing gear control handle cannot be cancelled. The landing gear warning system will be rearmed if the power lever(s) are advanced sufficiently.

With the flaps beyond APPROACH position, the warning horn and landing gear switch handle lights will be activated regardless of the power settings, and neither can be cancelled.

Figure 2. View of right main landing gear (ZS-LFU) looking aft and up into the wheel bay.

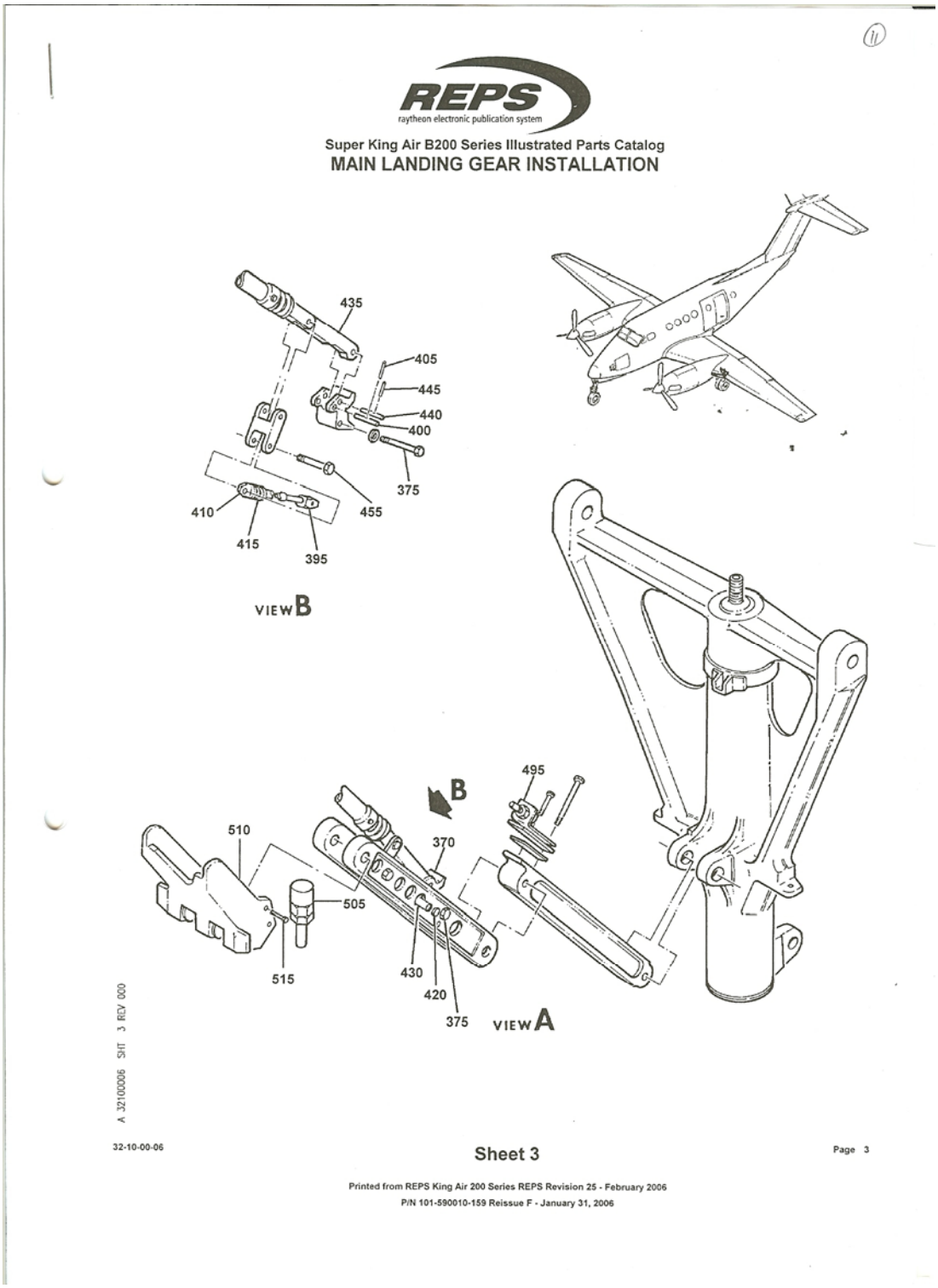

Figure 3. A view of the upper landing gear installation, including the hook down lock mechanism.

1.7 Meteorological Information:

1.7.1 Weather information was obtained from the pilot's questionnaire:

Wind direction	200°	Wind speed	15-19kt	Visibility	Good
Temperature	23°C	Cloud cover	Nil	Cloud base	N/A
Dew point	17°C				

1.7.2 The prevailing wind at the time was obtained from the ATC (Air Traffic Controller) transcript following landing clearance to the pilot of ZS-LFU, which was 220°/15 knots according to the weather information/data displayed in the control tower.

1.8 Aids to Navigation:

1.8.1 The aircraft was equipped with the following navigational aids, which were in compliance with the approved equipment list:

- Transponder
- VOR (VHF Omni Range) (Navigational Beacon)
- ADF (Automatic Direction Finder)
- DME (Distance Measuring Equipment)
- GPS (Global Positioning System)

All of the above navigational equipment was reported serviceable during the flight.

1.9 Communications:

1.9.1 The pilot of ZS-LFU was in radio communication with Cape Town tower on the VHF frequency 118.1 MHz. He was cleared for landing on Runway 19 by ATC.

1.9.2 Following the collapse of the left main landing gear during the landing roll, the ATC activated the crash alarm. The ARFF (Airport Rescue & Fire-Fighting) personnel immediately dispatched to the aircraft on the runway. They kept radio communication with the control tower, as the accident had a direct effect on all traffic arriving and departing Cape Town International Aerodrome, with the runway being closed for approximately one hour.

1.10 Aerodrome Information:

Aerodrome Location	7nm SE of Cape Town City	
Aerodrome Co-ordinates	South 33° 58 053’ East 018° 36 167’	
Aerodrome Elevation	151 feet AMSL (above mean sea level)	
Runway Designations	01/19	16/34
Runway Dimensions	3 201m x 61m	1 701m x 46m
Runway Used	19	
Runway Surface	Asphalt (Runway was dry at the time of the occurrence)	
Approach Facilities	Cat II ILS, VOR, DME, NDB, PAPI’s, Runway lights	
Aerodrome Status	Licensed	

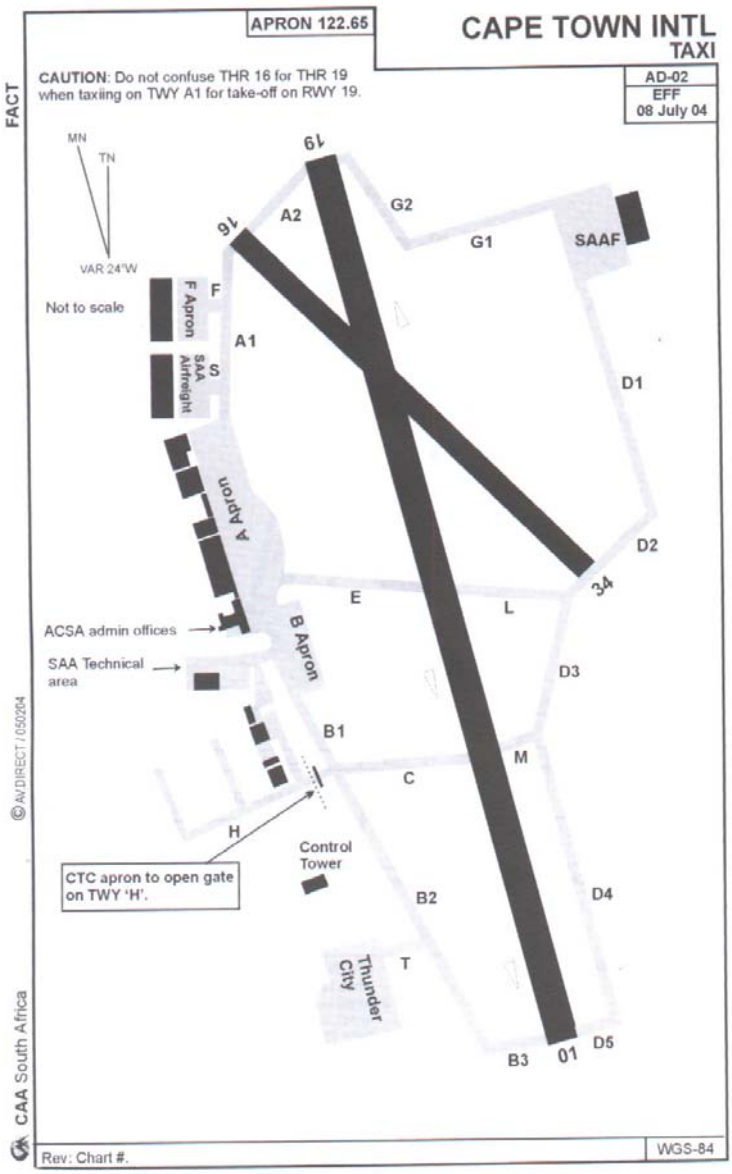

Figure 4. Layout of FACT as illustrated in AIP (Aeronautical Information Publication)

1.11 Flight Recorders:

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

1.12 Wreckage and Impact Information:

1.12.1 The left main landing gear collapsed during the landing roll with the aircraft coming to a halt on the runway surface, in a left wing low attitude.

1.13 Medical and Pathological Information:

1.13.1 Nobody was injured in the accident.

1.14 Fire:

1.14.1 There was no evidence of a pre- or post-impact fire.

1.15 Survival Aspects:

1.15.1 The accident was considered to be survivable due to the fact that the cockpit/cabin area did not sustain any damage that could have caused any serious or fatal injuries to any of the occupants. The left landing gear collapsed at a relatively slow speed, which limited the risk of injury associated with this type of failure.

1.15.2 The crash alarm was activated by ATC following the collapse of the left main gear during the landing roll, and aerodrome emergency services responded immediately.

1.16 Tests and Research:

1.16.1 Following recovery of the aircraft it was found that the Hook Down Lock mechanism, Part No. 50-810338-5 on the left main landing gear assembly had failed during the landing roll.

Figure 5. A view of the hook down lock mechanism that failed.

All the relevant parts were recovered and were made available to the investigating team. On evaluation of the parts it was decided to have them subjected to metallurgical examination.

Conclusion of the Metallurgist:

The investigation revealed that the relevant component had failed over an undetermined period of time. The most probable sequence of events is a single overload incident that led to the propagation of a fatigue fracture until final failure during operation.

The official metallurgical report can be found attached as Annexure A.

1.17 Organisational and Management Information:

1.17.1 This was a private flight as defined in Part 91 of the Civil Aviation Regulations of 1997. The aircraft was owned and operated by a private company, with a substantial percentage of flights being conducted to unlicensed aerodromes with gravel surface runways.

1.17.2 The Aircraft Maintenance Organisation (AMO) No. 221 that certified the last maintenance inspection on the aircraft prior to the incident, was in possession of a valid CAA AMO Approval that was issued on 29 November 2007, with an expiry date of 30 November 2008.

1.18 Additional Information:

1.18.1 None.

1.19 Useful or Effective Investigation Techniques:

1.19.1 None.

2. ANALYSIS

2.1 The aircraft was being owned and operated by a private company, in the private category. The flight in question was a routine flight from Bloemfontein to Cape Town. The landing at Cape Town was uneventful with no cockpit indication that could have pre-warned the pilot (three gear down lights) that there was an impending failure on the left main landing gear. However, during the landing roll the left wing suddenly collapsed, as the landing gear hook down mechanism failed. The pilot had no option but to try and keep the left wing in the air for as long possible, however, as the airspeed decayed and with no landing gear to support the wing it made contact with the runway surface with the aircraft coming to a halt in a left wing low attitude.

2.2 The aircraft ZS-LFU was maintained in accordance with the prescribed maintenance inspections as called for by the aircraft manufacturer (maintenance manuals). The aircraft was, however, 25 years old. Maintenance records indicate that the aircraft did have some minor landing gear problems, but nothing untoward that required a major repair. It was, however, noted that none of the required phase inspections prescribed in the maintenance manual required that the main landing gear hook down mechanism be removed and subjected to any specified non-destructive crack test procedure during any of these inspections.

2.3 Ideally a maintenance programme should be proactive and identify during scheduled servicing the potential for a defect to occur. This can prevent major disruptions to an operation and reduce the possibility of an accident/incident occurring. The majority of aircraft flying privately, in the training environment or commercially in South Africa were maintained in accordance with maintenance

programmes. There were no ADs or SBs issued by Hawker Beechcraft Corporation that dealt with the hook down lock mechanism.

3. CONCLUSION

3.1 Findings

(i) The pilot was the holder of a valid commercial pilot's licence and had the aircraft type endorsed in his logbook.

(ii) AMO No. 221 certified the last maintenance inspection that was performed on the aircraft on 1 February 2008.

(iii) The aircraft had flown 25.6 hours since the last maintenance inspection was certified.

(iv) The aircraft was operated under Part 91 (private category).

(v) The aircraft ZS-LFU was recorded as serviceable for the flight.

(vi) There was no cockpit indication(s) at any stage (prior to touch-down or there-after) that indicated to the pilot that there might have been an impending problem with the left main landing gear.

(vii) The left-hand landing gear hook down mechanism was found to have failed in fatigue.

(viii) There was no Airworthiness Directive or Service Bulletin issued by the aircraft manufacturer on the hook down lock mechanism. According to Hawker Beechcraft Corporation this was the first reported failure of such a nature on a Beech 200 series aircraft.

(vix) Following the incident ATC activated the crash alarm immediately and emergency personnel responded accordingly.

3.2 Probable Cause/s

(i) The left main landing gear assembly collapsed during the landing roll due to

a fatigue fracture that had propagated over an undetermined period of time.

4. SAFETY RECOMMENDATIONS

4.1 It is recommended in the interests of aviation safety, that the SACAA Airworthiness Department engage with the FAA (Federal Aviation Administration) and aircraft manufacturer Hawker Beechcraft Corporation by bringing the occurrence to their attention and recommending proactive measures to prevent a recurrence of this nature in the form of an Airworthiness Directive or Service Bulletin.

4.2 It is recommended that the remainder of the relevant aircraft's main and nose landing gear be inspected for related damage as per Original Equipment Manufacturer (OEM) specification before being certified as airworthy.

5. APPENDICES

5.1 Annexure A (CrashLab Metallurgical Report)

-END-

Report reviewed and amended by the Advisory Safety Panel
24 February 2009.

ANNEXURE A

COMPILED BY	CrashLAB	PAGE 1 OF 1	
COMPILED FOR: Civil Aviation Authority	INVESTIGATION REPORT: UNDERCARRIAGE FAILURE, KING AIR, ZS-LFU	DOCUMENT NUMBER MET-004-05-08	
		DATE 2008-04-29	ISSUE 1

ITEM: **MAIN UNDERCARRIAGE, KING AIR B200, ZS-LFU**

1. INTRODUCTION

1.1. The fractured component of a main undercarriage from a King Air B200, aircraft number ZS-LFU (Photo 1), was submitted to determine the possible reason/s for failure during operation.

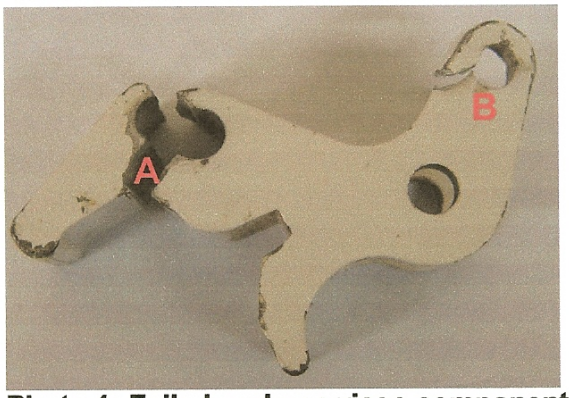

Photo 1: Failed undercarriage component (digital)

1.2. Fatigue Failures. Repeated cycling of the load causes metal fatigue. It is a progressive localized damage due to fluctuating stresses and strains on the material. Metal fatigue cracks initiate and propagate in regions where the strain is most severe. Metal fatigue is a significant problem because it can occur due to repeated loads below the static yield strength. This can result in an unexpected and catastrophic failure in use.

The process of fatigue consists of three stages:

- Initial crack initiation
- Progressive crack growth across the part
- Final sudden fracture of the remaining cross section

Surface imperfections and/or damages cause surface stress-raisers. These elevated surface stresses are detrimental to the fatigue strength of the component. The location of such stress -raisers serves as the initiation point from where a fatigue crack will progress. Three basic factors are necessary to cause fatigue failure. These are:

- maximum tensile stress of sufficiently high value,
- large enough variation or fluctuation in the applied stress, and
- Sufficiently large number of cycles of the applied stress.

1.3. This report is divided into the following sections:

2. APPLICABLE DOCUMENTS

(a) None.

3. DEFINITIONS

(a)	OEM	Original Equipment Manufacturer
(b)	CAA	Civil Aviation Authority

4. PERSONNEL

(a) The investigative member and compiler of this report is Mr C.J.C. Snyman, ID number 6406105057080. Mr Snyman is a qualified Physical Metallurgist (H.N.Dip Metallurgical Engineering, Tech. PTA), Radiation Protection Officer (RPO) registered with the National Nuclear Regulator (NNR) and Aircraft Accident Investigator (SCSI).

5. APPARATUS AND METHODOLOGY

(a) The apparatus employed for this investigation are Stereo Microscopes and Digital Camera.

(b) The methodology included a visual investigation of supplied parts followed by a Stereoscopic investigation.

6. INVESTIGATION

6.1. Visual and Stereomicroscope Investigation. The visual inspection revealed that the component failed at two positions as marked A and B (Photo 1). The fracture surfaces at point A displayed signs of fatigue (Photo's 2 and 3). The thin section fracture surface (Photo 2, blue arrow) showed clear signs of fatigue type geometry with beach marks (Photo 3, blue arrow) and an initiation point (red arrow) opposite to the thick section exit point (Photo 2, red arrow). The larger section revealed a clear 'lipped' area (Photo 2, red arrow) indicating the exit point on final fracture as well as indications of a smaller fatigue crack propagation area.

The fractures at point B displayed a small area of fatigue crack propagation with the remainder of the fracture surface that of final fracture (Photo 4). It can be derived that the fractures at point A be propagated prior to that at point B. The failure at point A resulted in the subsequent overload at point B.

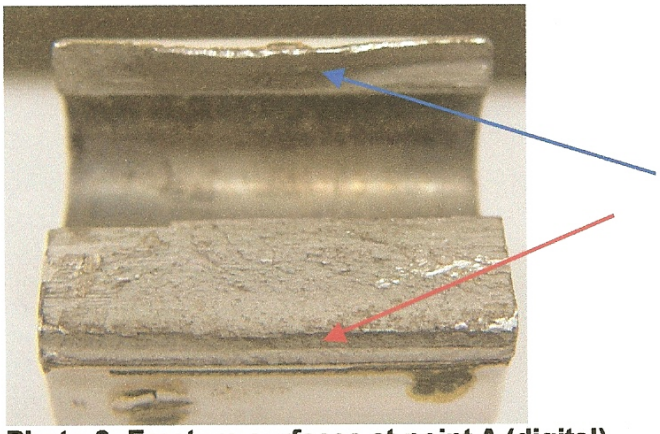

Photo 2: Fracture surfaces at point A (digital)

Photo 3: Thin section fracture surface, point A (digital)

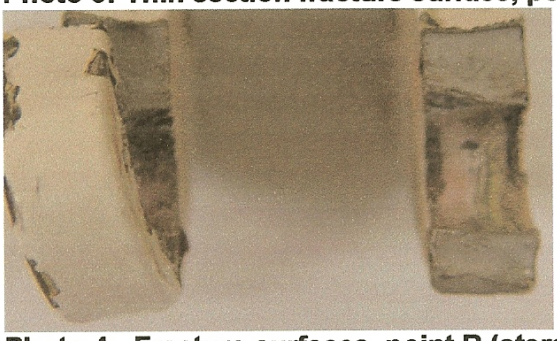

Photo 4: Fracture surfaces, point B (stereo)

6.2. Electron Microscope Investigation. The SEM investigation of the thin section fracture surface at point A revealed a clear distinction line between the final Photo 5, blue arrow) and fatigue crack propagation (red arrow). At higher magnification the fatigue striations is more clear (Photo 6, red arrow). Smearing damages (Photo 7) on

the fracture surfaces are an indication of a failure over a period of time. One fracture surface from point B revealed fatigue striations (Photo 8, red arrow).

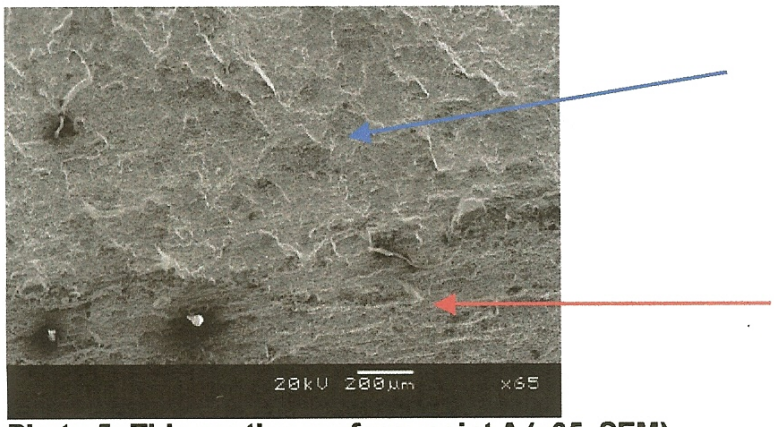

Photo 5: Thin section surface, point A (x65, SEM)

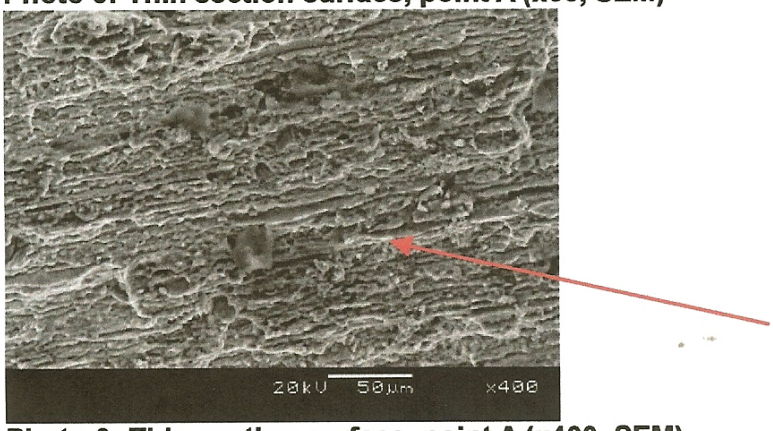

Photo 6: Thin section surface, point A (x400, SEM)

Photo 7: Thin section surface, point A (x55, SEM)

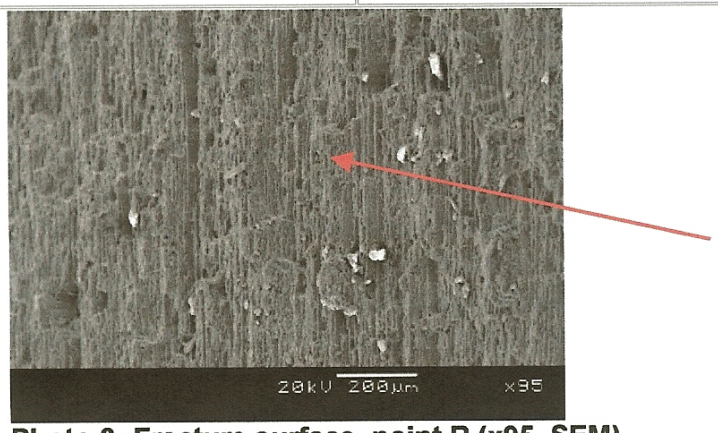

Photo 8: Fracture surface, point B (x95, SEM)

7. DISCUSSION AND CONCLUSIONS

Note: All deductions and conclusions are based on the investigation results obtained from the supplied parts only.

7.1 The investigation revealed that the relevant component failed over an undetermined period of time. The most probable sequence of events is a single overload incident that led to the propagation of a fatigue fracture until final failure during operation.

8. RECOMMENDATIONS

8.1. It is recommended that the remainder of the relevant aircraft's main and nose undercarriages be inspected for related damages as per OEM specifications before certified as airworthy.

9. DECLARATION

9.1. All digital images has been acquired by the author and displayed in an un-tampered manner.