AIRCRAFT ACCIDENT REPORT AND EXECUTIVE SUMMARY

				Reference:	CA18/2/3/8460
Aircraft Registration	**ZS-RTV**	**Date of Accident**	20 March 2008	**Time of Accident**	1145Z
Type of Aircraft	Robinson R22 Beta II (Helicopter)	**Type of Operation**	Private		
Pilot-in-command Licence Type	Private	**Age**	37	**Licence Valid**	Yes
Pilot-in-command Flying Experience	Total Flying Hours	361.6		Hours on Type	361.6
Last point of departure	Brits aerodrome (FABS), North West Province				
Next point of intended landing	Rustenburg aerodrome (FARG), North West Province				
Location of the accident site with reference to easily defined geographical points (GPS readings if possible)					
Open, grassy area near the town of Rustenburg; GPS position S25° 38.765' E027° 15.040'; elevation 3 588 ft					
Meteorological Information	**Temperature:** 23˚C; **Wind:** 135˚/10 kts; **Visibility:** 10 km				
Number of people on board	1 + 0	**No. of people injured**	0	**No. of people killed**	0

Synopsis

On 20 March 2008, the pilot took off from Brits aerodrome on a flight to Rustenburg aerodrome. While flying overhead a built-up area near Rustenburg at a height of about 1 500 feet above ground level (AGL), he lowered the collective pitch lever and the engine RPM immediately decreased to idle. The engine RPM remained at idle regardless of the input the pilot made on the throttle. The pilot then lowered the collective and performed an autorotation. The helicopter landed hard in a stretch of open veld approximately 1 km from where he had initiated the autorotation.

The helicopter was extensively damaged as a result of the hard landing. The pilot sustained no injuries.

Investigation showed that the throttle linkage had failed due to fatigue. This was considered to be the cause of the engine RPM decreasing to idle and remaining there. The possibility exists that the throttle linkage had been damaged before this flight and thus failed during throttle and collective operation.

Probable Cause

Unsuccessful autorotation landing following the inflight failure of the throttle linkage due to fatigue resulting on the engine spooling down to idle and a hard landing.

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AIRCRAFT ACCIDENT REPORT

Name of Owner/Operator	: Louis Fourie Game Capture (PTY) LTD
Manufacturer	: Robinson Helicopter Company
Model	: R22 Beta II (helicopter)
Nationality	: South African
Registration Marks	: ZS-RTV
Place	: Rustenburg, North West Province
Date	: 20 March 2008
Time	: 1145Z

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

Purpose of the Investigation

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

Disclaimer

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

1. FACTUAL INFORMATION

1.1 History of Flight

1.1.1 On 20 March 2008 at 1120Z, the pilot took off from Brits aerodrome on a flight to Rustenburg aerodrome. En route, he flew over a residential area in Rustenburg to alert his family so that they could collect him at the aerodrome.

1.1.2 The pilot stated that while he was flying at a height of approximately 1 500 feet AGL, he lowered the collective pitch lever and the engine RPM decreased to idle. The RPM remained at idle regardless of the input he made on the throttle. He then lowered the collective and performed an autorotation, landing hard in an open stretch of veld approximately 1 km from the built-up area where he had initiated the autorotation.

1.1.2 The accident occurred during daylight at the position South 25°38.776' East 027°15.054' at an elevation of 3 588 feet AMSL (Above Mean Sea Level).

1.2 Injuries to Persons

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

1.3 Damage to Aircraft

1.3.1 The helicopter sustained damage to the main rotor, tail rotor, tail boom and skid gear.

1.4 Other Damage

1.4.1 No other damage was caused.

1.5 Personnel Information

Nationality	South African	Gender	Male	Age	37
Licence Type	Private Pilot				
Licence Valid	Yes	Type Endorsed	Yes		
Ratings	None				
Medical Expiry Date	31 May 2008				
Restrictions	None				
Previous Accidents	14 July 2007, ZS-RTV: Whilst the pilot was on a game-counting flight, an animal jumped into the skid gear of the helicopter, resulting in a hard landing and a dynamic rollover.				

Flying Experience

Total Hours	361.6
Total Past 90 Days	1.6
Total on Type Past 90 Days	1.6
Total on Type	361.6

1.6 Aircraft Information

1.6.1 Airframe

Type	Robinson R22 Beta II	
Serial Number	3586	
Manufacturer	Robinson Helicopter Company	
Date of Manufacture	11 March 2004	
Total Airframe Hours (at time of accident)	1 359.6	
Last MPI (Hours & Date)	1 357.6	7 March 2008
Hours since Last MPI	2.0	
C of A (Issue Date)	14 March 2008	
C of R (Issue Date) (Present Owner)	20 May 2004	
Operating Categories	Standard	

Engine

Type	Lycoming 0-360-J2A
Serial Number	L-39505-36A
Hours since New	1 357.6
Hours since Overhaul	86.1

1.6.2 According to the helicopter's logbooks, the helicopter was certified, equipped and maintained in accordance with existing regulations and approved procedures.

1.6.3 No maintenance defects were recorded in the logbooks prior to this flight.

1.6.4 During the on-site investigation, it was determined that the helicopter had approximately 10 US gallons of Avgas 100LL fuel remaining in the fuel tank. Avgas 100LL is the fuel type recommended by the manufacturer.

1.6.5 The helicopter had been involved in two previous accidents prior to this one:

a) 7 July 2004: during landing, it entered a vortex ring state and nosed over on touchdown.
b) 14 July 2007: during a game counting flight, an animal jumped into the skid gear, resulting in a hard landing and a dynamic rollover.

1.6.6 Following the on-site investigation, the helicopter was recovered to an aircraft maintenance organisation (AMO) at Wonderboom aerodrome where further examination showed that the throttle linkage was broken. The throttle linkage – part no. A759-1 – forms part of the engine controls. None of the other engine controls sustained damage.

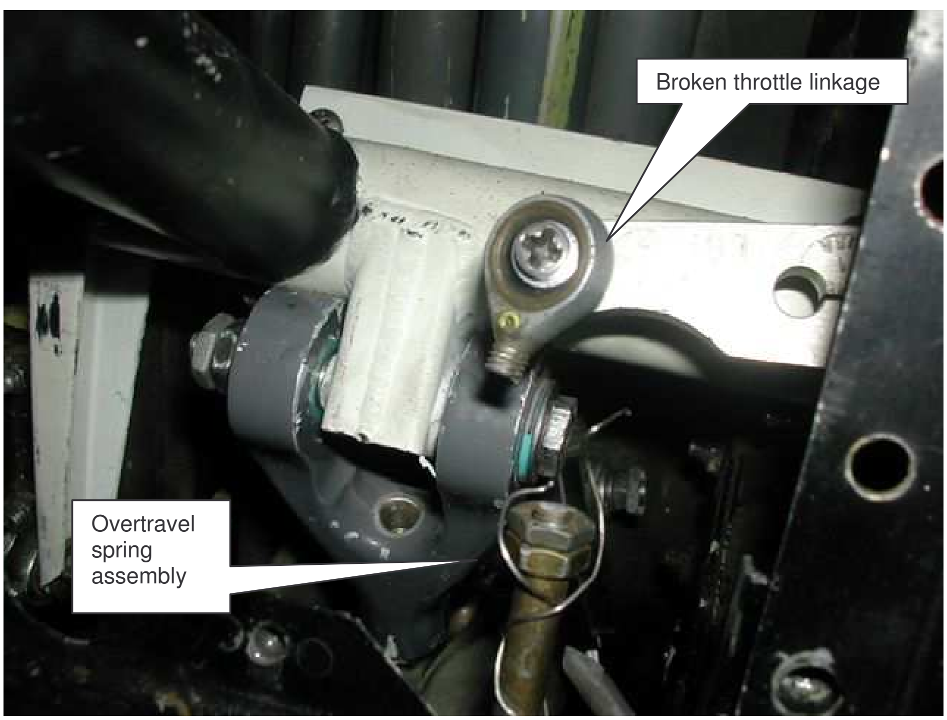

Figure 1. The broken throttle linkage and overtravel spring assembly.

1.7 Meteorological Information

1.7.1 The weather information was obtained from the pilot's questionnaire:

Wind direction	135˚	Wind speed	8-10 knots	Visibility	10 km
Temperature	23℃	Cloud cover	Unknown	Cloud base	Unknown
Dew point	Unknown				

1.8 Aids to Navigation

1.8.1 No malfunctioning of the navigational aids was reported.

1.9 Communications

1.9.1 No malfunctioning of the communication equipment was reported.

1.10 Aerodrome Information

1.10.1 The accident occurred in an open veld near Rustenburg about 1 km from a built-up area at the position South 25°38.776' East 027°15.054' and at an elevation of 3 588 feet AMSL.

1.11 Flight Recorders

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

1.12 Wreckage and Impact Information

1.12.1 The wreckage was located in an open stretch of grassveld. The helicopter sustained damage to the main rotor, tail rotor, tail stabiliser and skids. The tail stabiliser and tail rotor were located approximately 3 m and 35 m from the main wreckage respectively.

Figure 2. The helicopter after the hard landing.

1.13 Medical and Pathological Information

1.13.1 The pilot sustained no injuries.

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 cabin area was not damaged and the pilot was properly restrained by the safety harness, which helped to prevent injuries. The accident was therefore considered survivable.

1.16 Tests and Research

1.16.1 The broken throttle linkage was removed from the wreckage and examined by a metallurgical laboratory to determine the cause of the failure.

The laboratory's conclusion was as follows:

The investigation results suggest that the component was exposed to a single (or more) tensile overload during operation/fitment resulting in the initiation of cracks in the thread root areas. These surface stress raises then enhanced the formation of fatigue-type fractures supported by vibration and operating conditions.

The meaning of tensile in this context is: "capable of being stretched or pulled out of shape".

The metallurgical report is attached to this report as Appendix A.

Figure 3. The failed throttle linkage – part no. A759-1.

1.17 Organisational and Management Information

1.17.1 This was a private flight.

1.17.2 The last maintenance carried out on the helicopter prior to the accident was conducted by an approved AMO who was in possession of a valid AMO approval certificate to perform the required maintenance.

1.18 Additional Information

1.18.1 <u>Throttle, collective and governor</u>

Description and operation:

(a) The throttle can be controlled as follows:
- by rotating the throttle twist-grip on the collective
- the upwards or downwards movement of the collective
- automatically with the governor

(b) A failure of a linkage at the collective, throttle twist-grip or carburettor will render the governor inoperative. The throttle and engine speed will then stay in the last selected position regardless of throttle, collective or governor inputs as there is no "spring-loaded" position on the carburettor throttle.

(c) The overtravel spring assembly has a spring-loaded dampening function that protects the control system when the collective pitch lever movement limit is exceeded.

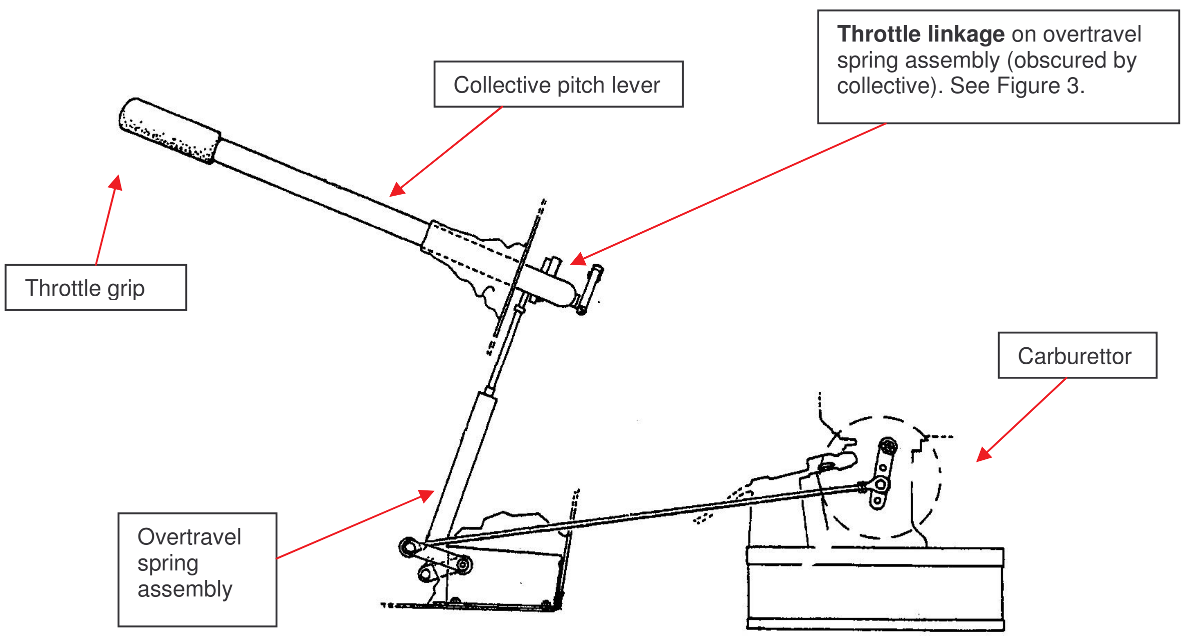

Figure 4 . Collective, overtravel spring assembly and carburettor link.

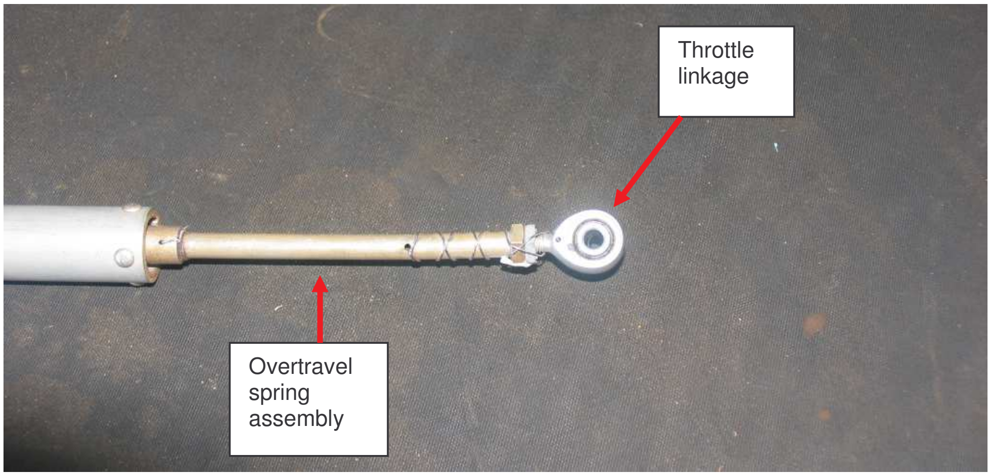

Figure 5. The throttle linkage on the overtravel spring assembly
(photograph taken of similar overtravel spring assembly from different helicopter)

1.18.2 The throttle linkage, as shown above, is screwed onto the end of the overtravel spring rod.

1.18.3 Further investigation established that, during throttle movement, a small amount of longitudinal force is exerted on the throttle linkage and overtravel spring assembly. The diameter of the threaded part of the throttle linkage is very small (approximately 10/32 inches) and during operation no bending force is exerted on it as the overtravel spring protects it through dampening when the collective pitch lever movement limits are exceeded.

1.18.4 No evidence was found to suggest that the throttle linkage, part no. A759-1, fitted to the helicopter had been damaged prior to this accident or replaced from the time the helicopter came into service until this accident occurred.

1.19 Useful or Effective Investigation Techniques

1.19.1 None considered necessary.

2. ANALYSIS

2.1 The pilot was on a flight from Brits aerodrome to Rustenburg aerodrome when the accident occurred. According to the pilot, as he flew over his house at an altitude of 1 500 feet AGL, he lowered the collective but the engine RPM decreased to idle. The RPM remained at idle even with inputs from the collective, throttle twist-grip and governor. The pilot performed an autorotation and executed a hard landing in an open stretch of veld.

2.2 There were no recorded maintenance defects prior to the accident in the technical logbook or flight folio of the helicopter.

2.3 The helicopter had been involved in two previous accidents. It had been flown for two hours since it returned to service after being re-issued with a certificate of airworthiness following repairs relating to the accident of 14 July 2007. No maintenance defects were reported during these two hours.

2.3 During investigation, the throttle linkage was found to be broken. This was considered to be the cause of the engine RPM decreasing to idle and remaining at idle even with inputs from the collective, throttle twist-grip and governor. No other engine controls sustained damage. The metallurgical investigation results suggest that the component was exposed to a single (or more) tensile overload during operation/fitment resulting in the initiation of cracks in the thread root areas. These surface stress raises then enhanced the formation of fatigue-type fractures supported by vibration and operating conditions.

2.4 No evidence was found that suggest that the throttle linkage, part no. A759-1, found fitted to the helicopter had been replaced from the time the aircraft came into service until this accident occurred. As the helicopter was involved in two previous accidents the possibility exists that the threaded part of the throttle linkage was damaged prior to this accident. The damage might have initiated fatigue cracks in the threaded part of the throttle linkage which caused it to fail following normal operation.

3. CONCLUSION

3.1 Findings

3.1.1 The pilot was licensed for the flight in accordance with existing regulations.

3.1.2 The pilot sustained no injuries.

3.1.3 The helicopter had a valid certificate of airworthiness.

3.1.4 The helicopter had sufficient fuel for this flight.

3.1.5 The engine RPM went down to idle and the pilot performed an autorotation and executed a hard landing.

3.1.6 The throttle linkage was found to be broken.

3.1.7 The helicopter had been involved in two previous accidents and had accumulated two airframe hours since the last accident repair was completed. The possibility exists that the threaded part of the throttle linkage was damaged prior to the accident.

3.1.8 The helicopter landed hard following an unsuccessful autorotation landing which resulted in damage to the main rotor, tail rotor, tail boom and skid gear.

3.2 Probable Cause/s

3.2.1 Unsuccessful autorotation landing following the inflight failure of the throttle linkage due to fatigue, resulting on the engine spooling down to idle and a hard landing.

4. SAFETY RECOMMENDATIONS

4.1 None.

5. APPENDICES

5.1 Appendix A: Metallurgical Report

Report reviewed and amended by the Advisory Safety Panel 30 October 2009

-END-

Appendix A: Metallurgical Report

COMPILED BY	CrashLAB	PAGE 1 OF 1	
COMPILED FOR: **Civil Aviation Authority**	**INVESTIGATION REPORT: THROTTLE CABLE FAILURE, ROBINSON R22, ZS-RTV**	DOCUMENT NUMBER **MET-004-03-08**	
		DATE **2008-03-27**	ISSUE **1**

ITEM: **CONNECTING ROD EYE END, THROTTLE CABLE, ROBINSON R22 HELICOPTER**

1. INTRODUCTION

1.1. The failed throttle control cable ball eye end (Photo 1) from a Robinson R22 Helicopter, aircraft number ZS-RTV, was submitted to determine the possible reason/s for failure during operation.

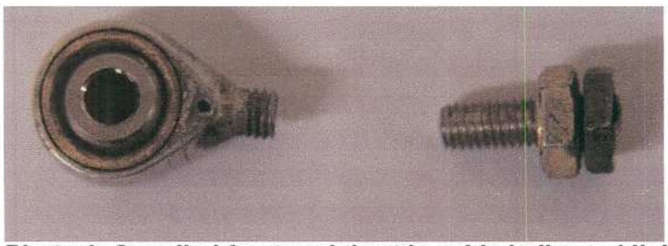

Photo 1: Supplied fractured throttle cable ball eye (digital)

1.2. **Fatigue**

1.2.1. **Fatigue Failures**

FATIGUE is the progressive, localized, and permanent structural change that occurs in a material subjected to repeated or fluctuating strains at nominal stresses that have maximum values less than (and often much less than) the tensile strength of the material. Fatigue may culminate into cracks and cause fracture after a sufficient number of fluctuations. The process of fatigue consists of three stages:

- Initial fatigue damage leading to crack initiation
- Crack propagation to some critical size (a size at which the remaining un-cracked cross section of the part becomes too weak to carry the imposed loads)
- Final, sudden fracture of the remaining cross section

Fatigue damage is caused by the simultaneous action of cyclic stress, tensile stress, and plastic strain. If any one of these three is not present, a fatigue crack will not initiate and propagate. The plastic strain resulting from cyclic stress initiates the crack; the tensile stress promotes crack growth (propagation). Careful measurement of strain shows that microscopic plastic strains can be present at low levels of stress where the strain might otherwise appear to be totally elastic. Although compressive stresses will not cause fatigue, compressive loads may result in local tensile stresses. 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.

In addition, there are a host of other variables, such as stress concentration, corrosion, temperature, overload, metallurgical structure, residual stresses, and combined stresses, which tend to alter the conditions for fatigue.

1.2.2. **Prevention of Fatigue Failure**

The most effective method of improving fatigue performance is improvements in design:

- Eliminate or reduce stress raisers by streamlining the part
- Avoid sharp surface tears resulting from punching, stamping, shearing, or other processes
- Prevent the development of surface discontinuities during processing.
- Reduce or eliminate tensile residual stresses caused by manufacturing.
- Improve the details of fabrication and fastening procedures.

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
(c)	SEM	Scanning Electron Microscope
(d)	EDS	Energy Dispersive X-ray analytical system

4. PERSONNEL

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, Digital Camera, Micro-hardness tester and a SEM equipped with EDS.

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

6. INVESTIGATION

6.1. Scanning Electron Microscope Investigation. The SEM investigation revealed secondary crack formation in the adjacent threads (Photo 2, red arrow) indicating that the component was exposed to a possible tensile overload during operation or fitment. The fracture surfaces revealed some smearing damages as well as foreign matter deposits (Photo 3) indicating fracture propagation over a period of time. The remainder of the fracture surface showed two distinct fatigued areas (Photo 4, red arrows), opposing a central area of final fracture (green arrow).

Photo 2: Secondary crack formation (x430, SEM)

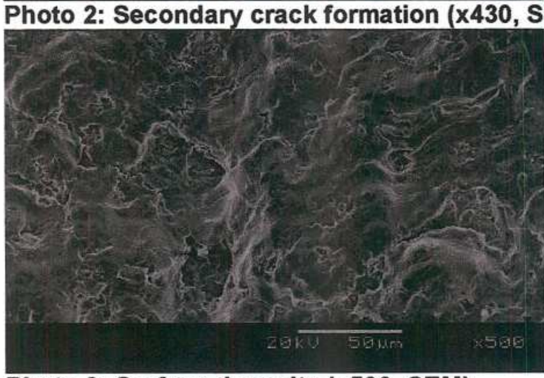

Photo 3: Surface deposits (x500, SEM)

Photo 4: Fatigue and final fracture areas (x60, SEM)

7. DISCUSSION AND CONCLUSIONS

No other part/s from the aircrew jump-seat assembly was available for this investigation. Therefore all conclusions were derived from the investigation results obtained from the supplied parts only.

7.1 The investigation results suggest that the component was exposed to a single (or more) tensile overload during operation/fitment resulting in the initiation of cracks in the thread root areas. These surface stress raisers then enhanced the formation of fatigue type fractures supported by vibration and operating conditions.

8. RECOMMENDATIONS

8.1. It is strongly recommended that the source of the overload as well as the fluctuating stress are determined to prevent future failures of type.

9. DECLARATION

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

Submitted through the office of the SM for ASP review October 2009.