AIRCRAFT ACCIDENT REPORT AND EXECUTIVE SUMMARY

				Reference:		CA18/2/3/8278	
Aircraft Registration	**ZS-RSW**	**Date of Accident**	28 March 2007			**Time of Accident**	0900Z
Type of Aircraft	Aerospatiale AS 350 B (Helicopter)		**Type of Operation**		Domestic Flight		
Pilot-in-command Licence Type		Airline Transport (H)	**Age**	40	**Licence Valid**		Yes
Pilot-in-command Flying Experience		Total Flying Hours	5070		Hours on Type		280
Last point of departure	Simmerpan Eskom Yard, Germiston						
Next point of intended landing	Grand Central Aerodrome, FAGC.						
Location of the accident site with reference to easily defined geographical points (GPS readings if possible)							
Simmerpan Eskom Yard, Germiston; (GPS Position: S 26 13.544' E028 09.487')							
Meteorological Information	Temperature 18˚C; Wind 010˚/5kts; Visibility 8km; Cloud FEW at 1000ft and OVC at 2000ft.						
Number of people on board	1 + 3	**No. of people injured**	1	**No. of people killed**	1		

Synopsis

The pilot was tasked by the operator to uplift three (3) technicians at the Simmerpan Eskom Yard, Germiston, in order for them to carry out field work on electrical conductors for Eskom. The helicopter landed on an open grass area near some high rise buildings, in order to uplift the technicians. After the three occupants embarked, the helicopter was established into an In Ground Effect (IGE) hover flight and the pilot backtracked several metres in order to attain some additional space to accelerate into forward flight.

According to available video footage, the helicopter started to ascent into an Out of Ground Effect (OGE) hover at a height of approximately 22-25 ft above ground level (AGL) and the pilot performed an OGE power check and obtained 99% N1 engine indication and 100% torque indication on the main rotor gearbox. The helicopter then proceeded into forward flight at a speed of between 10-15kt when the low rotor rpm aural warning sounded. In an attempt to regain rotor rpm, the pilot reduced the collective pitch lever and descended towards the road intersection ahead. He regained the rotor rpm momentarily, but as he increased power in order to accelerate and to climb away, the low rotor aural warning sounded again.

The pilot attempted to avoid colliding with a light delivery vehicle at the intersection, but the right-hand skid impacted the windscreen of a vehicle, causing the helicopter to pitch nose down and roll over onto its left-hand side. The main rotor blades impacted with a second vehicle that was behind the first vehicle. The driver in the second vehicle was fatally injured. One of the passengers in the helicopter sustained minor injuries. The occupant of the first vehicle escaped unharmed.

Probable Cause

The helicopter exceeded the maximum permissible take-off weight during take-off, which had a direct effect on the power demand and power availability.

Contributory Factor: The area from where the pilot attempted to take off, consisted of high rise buildings in a confined area which most probably caused uneven wind patterns and conditions over the buildings, causing a decay in the main rotor RPM. There was also no proper windsock to indicate the wind direction and wind speeds and no safe escape route in case of an emergency.

IARC Date		Release Date	

AIRCRAFT ACCIDENT REPORT

Name of Owner/Operator : Sapphire Air
Manufacturer : Aerospatiale
Model : AS 350 B (Helicopter)
Nationality : South African
Registration Marks : ZS-RSW
Place : Simmerpan, Eskom Yard, Germiston
Date : 28 March 2007
Time : 0900Z

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.

SYNOPSIS:

On 28 March 2007 at 0930Z, the South African Civil Aviation Authority (SACAA) was notified by the Rand Aerodrome Tower (ATC) of an accident involving an Aerospatiale AS350B helicopter, ZS-RSW at the Eskom Refinery Road in Germiston. The accident occurred when the pilot, accompanied by 3 passengers, (technicians) attempted to execute a forward flight take-off from an open grass area at the Simmerpan Eskom yard in Germiston. The helicopter collided with two vehicles, fatally injuring the driver in one of the vehicles. One passenger in the aircraft sustained only minor injuries and the other two passengers escaped unharmed. The driver of the first vehicle (light delivery vehicle) also escaped unharmed.

1. FACTUAL INFORMATION

1.1 History of Flight

1.1.1 The pilot was tasked by the operator to uplift three (3) technicians at the Simmerpan Eskom Yard in order to carry out field work on electrical conductors for Eskom. The helicopter landed on an open grass area near some high rise buildings.

After the technicians had embarked, the helicopter was established in an (IGE) hover flight and the pilot backtracked several metres in order to attain some additional space to accelerate into forward flight.

1.1.2 According to available video footage, the helicopter started to ascend into an Out of Ground Effect (OGE) hover at a height of approximately 22-25 ft above ground level (AGL), the pilot then performed an OGE power check and obtained 99% N1 engine indication and 100% torque indication on the main rotor gearbox. The helicopter then proceeded into forward flight, at a speed of between 10-15kt, when the low main rotor rpm aural warning sounded. In an attempt to regain rotor rpm, the pilot reduced the collective pitch lever and descended towards the road intersection ahead. He regained the rotor rpm momentarily, but as he increased the power in order to accelerate and climb away, the low rotor rpm aural warning sounded again.

1.1.3 The pilot attempted to avoid colliding with a light delivery vehicle at the road intersection, but the right-hand main skid impacted the windscreen of the vehicle, causing the helicopter to pitch nose down and roll over to the left-hand side. The main rotor blades then impacted the second vehicle, which was behind the first vehicle. The driver in the second vehicle was fatally injured. One of the passengers in the helicopter sustained minor injuries. The occupant of the first vehicle escaped unharmed.

FIGURE 1: ELEVATED VIEW OF HELICOPTER ZS-RSW IN FORWARD FLIGHT TOWARDS INTERSECTION

1.1.4 The South African Police Service and Emergency Fire Services of Germiston were immediately despatched to the scene of the accident.

1.2 Injuries to Persons

Injuries	Pilot	Crew	Pass.	Other
Fatal	-	-	-	1
Serious	-	-	-	-
Minor		-	1	-
None	1	-	2	1

1.3 Damage to Aircraft

1.3.1 On impact with the two vehicles and with the ground surface, the helicopter sustained substantial damage to the main rotor blades, the tailboom, skid-gear and fuselage.

1.4 Other Damage

1.4.1 Both vehicles at the intersection were extensively damaged during the accident sequence.

1.5 Personnel Information

Nationality	South African	Gender	Male	Age	40
Licence No.	**********	Licence Type	Airline Transport (H)		
Licence valid	Yes	Type Endorsed	Yes		
Ratings	Night; Under-sling/ Winch.				
Medical Expiry Date	30 November 2007				
Restrictions	None				
Previous Accidents	Nil				

Flying Experience:

Total Flying Hours	5070.0
Total Past 90 Days	111.0
Total on Type Past 90 Days	42.0
Total on Type	280.0

1.6 Aircraft Information

Airframe :

Type	Aerospatiale AS-350-B (Helicopter)	
Model	AS 350 B	
Serial Number	2227	
Manufacturer	Aerospatiale	
Year of Manufacture	1989	
Total Airframe Hours (At time of Accident)	3042.6	
Last MPI (Hours & Date)	3005.9	11 January 2007
Hours since Last MPI	36.7	
C of A (Issue Date)	20 February 2004	
C of R (Issue Date) (Present owner)	22 January 2004	
Operating Categories	Standard	

Engine :

Type	Turbomeca Ariel 1 B
Serial Number	4287
Hours since New	13779.1
Hours since Overhaul	1688.0

1.6.1 Weight and Balance:

FUEL PLANNING	
RESERVE	
TRIP	368
STARTS (@ 10 lbs / start)	0
	368

HELICOPTER (A)	MASS (Kg)	ARM (m)	MOMENT
BASIC EMPTY WEIGHT (inc. Oils)	1261	3.569	4500.5
FUEL (See calculation above)	368	3.475	1278.8
CREW (1 x pilot)	80	1.55	124
BASIC OPERATING WEIGHT (A)	1709		5903.3
MAUW	1950		
AVAILABLE PAYLOAD	241		0

PAYLOAD (B)	MASS (Kg)	ARM (m)	MOMENT
Co-pilot / Front Pax	100	1.55	155
Rear Fwd Facing Pax (RH)	100	2.54	254
Rear Fwd Facing Pax (Mid – RH)	0	2.54	0
Rear Fwd Facing Pax (Mid – LH)	0	2.54	0
Rear Fwd Facing Pax (LH)	100	2.54	254
LH Side Baggage Hold (Max 120 kg)	0	3.2	0
RH Side Baggage Hold (Max 100 kg)	20	3.2	64
Aft Baggage Hold (Max 175 lbs)	0	4.6	0

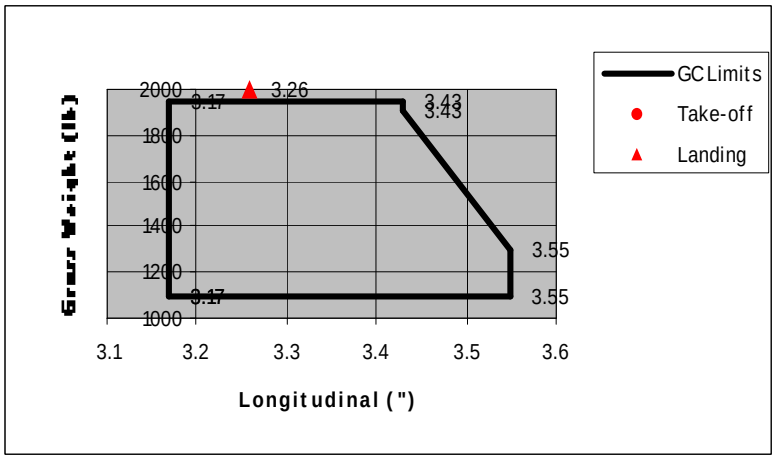
PAYLOAD (B)	320		727
BASIC OPERATING WEIGHT (A)	1709		5903.3
GROSS WEIGHT (A+B)	2029		6630.3
C of G (Take Off)		3.27	
Calculated Fuel Burn off (C)	30	3.475	104.25
TOTAL (A+B-C)	1999		6526.05
C of G (Landing)		3.26	

C of G Limits : 3.17 - 3.43

Consump. = 135 l/p = 105 kg/hr

	JET-A1	
Kg	**Arm**	**Moment**
8	3.475	28
16	3.475	56
32	3.475	111
47	3.475	163
63	3.475	219
79	3.475	275
119	3.475	414
158	3.475	549
198	3.475	688
237	3.475	824
277	3.475	963
316	3.475	1098
419	3.475	1456

% Fuel	Liters	Mass (kg)
10	53	42
20	106	83
30	159	125
40	212	167
50	265	209
60	318	250
70	371	292
80	424	334
90	477	376
100	530	418



According to the Pilot's Operating Handbook (POH), the MAUW (Maximum All Up Weight) for the aircraft is 1950 kg. The take-off weight (Gross Weight) for the helicopter according to Load Sheet for the aircraft at the time of the accident was 1999 kg. The helicopter therefore exceeded its maximum allowable take-off weight. The CG of aircraft was 3.26, which was within the C of G limits of 3.17 – 3.43.

1.7 Meteorological Information

1.7.1 The South African Weather Services' Meteorological Report concluded the following weather conditions at the time of the accident:

- Surface Analysis on 28 March 2007 at 0900Z.

  A high pressure system was east of the country, feeding moist air inland, causing cloudy conditions in Gauteng.

- Upper Air Analysis.

  An upper air high was present at 500hPa (+ 18000ft above amsl) over the far northern interior with westerly winds in the Gauteng area.

- Satellite Imagery

  The satellite imagery shows cloudy conditions over Gauteng.

- Weather Conditions in the vicinity of the Incident.

  The high east of the country caused cloudy conditions over Gauteng as well as the northern parts of the country. In the early morning of 28 March 2007, fog and rain occurred over Gauteng with very bad visibility. These conditions improved during the morning as the cloud base lifted and the visibility improved. No official observations are available at the time and place of the accident. The most likely weather conditions at the place of the accident were as follows:

  Temperature: 18˚C
  Dew Point: 15˚C

Wind Direction:	010˚ TN.
Wind Speed:	5 kt.
Visibility:	8km.
Cloud:	FEW cloud at 1000ft and OVC at 2000ft.
QNH:	1027 hpa.

1.8 Aids to Navigation

1.8.1 The helicopter was equipped with the standard navigation equipment approved for the aircraft type.

1.9 Communications.

1.9.1 The pilot communicated with the Rand Aerodrome ATC (Air Traffic Control) on VHF frequency 118.7 MHz prior to take-off from Simmerpan Eskom Yard.

1.10 Aerodrome Information

1.10.1 The helicopter landed and took off from a grass-covered area with high rise buildings located next to the take-off and landing area, as evident on the video footage available in this report.

1.10.2 This located helipad area was not approved by the CAA. There was only a piece of rag on a pole and no proper windsock to indicate the proper wind direction and wind speeds. There was also no safe escape route in case of an emergency.

1.11 Flight Recorders

1.11.1 The helicopter was not fitted with a Cockpit Voice Recorder (CVR) or a Flight Data Recorder (FDR) and neither was required by regulations to be fitted to this type of helicopter.

1.12 Wreckage and Impact Information

1.12.1 During take-off, the right-hand skid-gear penetrated the windscreen of a light delivery vehicle at the road intersection as can be seen in figure 3 (a) and (b) below, causing the helicopter to pitch down and roll over onto the left-hand side. During the accident sequence, the main rotor blades of the helicopter then impacted a second vehicle at the road intersection.

FIGURE 2: (a) & (b) ELEVATED VIEW OF ZS-RSW IN FWD FLIGHT JUST PRIOR TO IMPACT WITH TWO VEHICLES AT ROAD INTERSECTION.

FIGURE 3: VIEW OF WHERE THE ACCIDENT OCCURRED.

1.13 Medical and Pathological Information

1.13.1 One of the passengers on board the helicopter sustained minor injuries.

1.13.2 The motorist in the second vehicle sustained fatal injuries and died at the scene of the accident.

1.13.3 The occupants in the first vehicle escaped unharmed.

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 pilot and the three passengers that were on board the helicopter were properly restrained and survived the accident, due to the low impact forces associated with the accident sequence.

1.16 Tests and Research

1.16.1 The engine was removed from the wreckage and was subjected to an engine teardown examination at the facility of the engine manufacturer in Kempton Park, South Africa. The Engine Manufacturers submitted an engine Investigation (Examination) report which is attached to this report as per Appendix A.

Below is a brief description of the findings in the report:

1.16.1.1 During the investigation, no evidence could be found to suspect that the engine was not capable of delivering the design power. During the strip-down inspection of the engine, it was noticed that the drive gear-securing nut had a rotational displacement of approximately 3mm. This phenomenon is normally experienced during main rotor strike/impact while the engine is producing power.

1.16.1.2 Testing of the fuel control unit showed that the FCU NG maximum controlling RPM was 4720 as opposed to the rig requirement of 4786±3 RPM. It was, however, calculated that this observed RPM was sufficient to permit maximum engine take-off power according to the aircraft's weight and environmental conditions as reported on the day of the accident. Re-setting of the FCU to achieve the 4786±3 RPM was easily obtained by a 90˚ clock-wise turn during the investigation rig setting. Adjustment of the temperature compensator is permitted by the operator during the operation so as to achieve the Maintenance Manual requirement. The non-installation of a manufacturer's seal on the temperature compensator adjuster cover of the FCU in question, would suggest that some adjustment of the temperature compensator by the operator had been made during the service.

1.17 Organisational and Management Information

1.17.1 The Air Operating Certificate (AOC) No. G304D, Part 127 for Eskom; trade name: Sapphire Executive Air had expired on 19 January 2007 which rendered the AOC invalid at the time of the accident. The aircraft, registration ZS-RSW, was not included in the AOC.

1.17.2 The Aircraft Maintenance Organisation, AMO No. 830 that certified the last MPI (Mandatory Periodic Inspection) was in possession of a valid AMO certificate that was issued on 01 October 2006 with an expiry date of 31 October 2007.

1.18 Additional Information

1.18.1 Flight Manual AS 350 B: (Aural Warning).

- According to the Flight Manual Section 3, Emergency procedures, Chapter 3.6, the aural warning horn will sound when the Rotor speed (NR) drops between approximately 250 rpm to 335 rpm or the hydraulic pressure drops below 30 bar.

- The aural warning horn will also sound during normal flight when testing the caption panel and is operative only when the "Horn" pushbutton is pushed in.

1.18.2 Alarm Procedure: (When the aural warning horn sounds) :

- Reduce the collective pitch.

- Reduce the speed and straighten up if in a turn.

- If the hydraulic caption light is on, the hydraulic system is malfunctioning, which requires immediate action. If the red caption chip light is on and the amber light is on, no immediate action is necessary.

1.18.3 According to a Safety Notice that was issued by Robinson Helicopter Company earlier, a primary cause of helicopter accidents is failure to maintain rotor RPM. To avoid this, every pilot must have his reflexes conditioned so that he will instantly add throttle and lower collective so as to maintain RPM in any emergency. Low RPM rotor stall occurs when the pilot allows the rotor RPM to become dangerously low by pulling too much collective pitch or otherwise, mishandling the controls. Low-RPM rotor stall can occur in any flight regime, including cruise, climb, autorotation, or hover. No matter what causes the low RPM, the pilot must first roll on throttle and lower the collective simultaneously to recover RPM before investigating the problem. It must be a conditioned reflex. In forward flight, applying aft cyclic to bleed off airspeed will also help recover lost RPM.

1.18.4 In respect of the landing and take-off, the following Civil Aviation Regulations, 1997, have relevance:

Helicopter landings and take-offs, Part 91.07.4;

(a) No pilot-in-command of a helicopter shall land at or take off from any place unless the place is so situated to permit the helicopter, in the event of an emergency arising during such landing or take-off, to land without undue hazard to persons or property on the surface.
(b) No pilot-in-command of a helicopter shall land on, or take off from, any building, structure or place situated within 100 metres of any other building or structure, in the area of jurisdiction of a local government, unless such building, structure or place has been approved for the purpose by the Commissioner: Provided that this restriction shall not apply –
(a) to a helicopter landing on, or taking off from, a building, structure or place within

an industrial area, a commercial warehouse area or an open farm land which is suitable for such purposes and in respect of which helicopter the pilot-in-command is the holder of a valid commercial or airline transport pilot's licence (helicopter) or, in the case of the holder of a private pilot's licence (helicopter), with the written permission of the Commissioner, unless specifically prohibited by the local government.

1.19 Useful or Effective Investigation Techniques

1.19.1 None.

2. ANALYSIS

2.1 The helicopter landed on a grass-covered area with high rise office buildings at the Simmerpan Eskom yard in Germiston to uplift three (3) technicians for some upper work which had to be carried out on electrical conductors.

2.2 After the helicopter was established in IGE hover flight, the pilot back-tracked the helicopter several metres in order to provide for some additional space to accelerate into forward flight.

2.3 Video footage that was made available showed that the helicopter started to ascend into an Out of Ground Effect (OGE) hover at a height of approximately 22-25 ft above ground level; the pilot then performed an OGE power check before proceeding into forward flight. According to the pilot, he obtained 99% N1 engine power indication and 100% torque indication from the main rotor gearbox before proceeding into forward flight at a speed of between 10-15kt when the low rotor rpm aural warning sounded .

2.4 In an attempt to regain main rotor rpm, the pilot reduced the collective pitch lever and descended towards the road intersection ahead. He regained rotor rpm, but as he increased the power in order to accelerate and to gain height, the low rotor aural warning sounded again.

2.5 The helicopter collided with a light delivery vehicle at the road intersection; the right hand main skid impacted the windscreen of the vehicle, causing the helicopter to pitch nose down and roll over to the left-hand side. During the impact sequence, the main rotor blades then impacted a second vehicle behind the first vehicle, causing fatal injuries to the driver in the vehicle. One passengers in the helicopter sustained only minor injuries. The occupant of the first vehicle escaped unharmed.

2.6 The area at Simmerpan Eskom Yard from where the helicopter landed and attempted to take off, was within a confined area with a grass-covered surface near high rising buildings and with no escape route/area in case of an emergency.

2.7 The high rise buildings most probably caused uneven wind patterns and conditions above the buildings. Furthermore, there was no proper windsock to indicate the wind direction and wind speed to the pilot, but only a piece of cloth on a pole.

2.8 During the engine teardown and examination, no evidence could be found to suspect that the engine was not capable of delivering the design power. It was also noted that the drive gear-securing nut had a rotational displacement of approximately 3mm. This phenomenon is normally experienced during main rotor strike/impact while the engine is producing power.

2.9 Testing of the fuel control unit showed that the (FCU) fuel control unit's maximum controlling RPM was 4720 as opposed to the rig requirement of 4786±3 RPM. It was, however, calculated that the RPM was sufficient to permit maximum engine take-off power according to the aircraft's weight and environment.

3.0 According to the Pilot's Operating Handbook (POH), the MAUW (Maximum All Up Weight for the aircraft is 1950kg. The take off weight (Gross Weight) for the helicopter according to Load Sheet for the aircraft at the time of the accident was 1999 kg. The helicopter therefore exceeded its maximum allowable take-off weight. The CG of aircraft was 3.26 which was within the C of G limits of 3.17 – 3.43.

3. CONCLUSION

3.1 Findings

3.1.1 The pilot was the holder of a valid helicopter commercial pilot's licence and the aircraft type was endorsed on his licence.

3.1.2 There was no evidence that indicated any pre-existing medical or behavioural condition that might have adversely affected the pilot's performance during the accident.

3.1.3 According to available records, the helicopter was serviceable prior to the accident flight and no history of any malfunctions were recorded that could have contributed to the cause of the accident.

3.1.4 According to available records, the Aircraft Operating Certificate (AOC) (No:G304D; Part 127) for ESKOM, trade name: Sapphire Executive Air had expired on 19 January 2007 which rendered the AOC invalid. The accident helicopter, registration ZS-RSW was not included (listed) in the AOC.

3.1.5 No application had been submitted by the Operator to the SACAA for permission or approval to operate within the Simmerpan Eskom Yard. As such, there was no approval granted by the Commissioner for Civil Aviation for the operator to carry out flight operations from the Simmerpan Eskom Yard.

3.1.6 The flight operations that were conducted at Simmerpan Eskom Yard were also in a non-designated and confined area, near high rise buildings which rendered the flight operations dangerous to people and property on the ground. There was also no escape route for the aircraft in case of an emergency.

3.1.7 The weather conditions were fine and the surface temperature was 18˚C. The surface wind direction was 010˚/5kt. with a few clouds at 1000ft and OVC at 2000ft.

The high rise buildings most probably caused uneven wind patterns and conditions over the buildings. Furthermore, there was no proper windsock to indicate the wind direction and wind speeds for take-off and landings.

3.1.8 The engine was stripped down and examined by the Engine Manufacturer after the accident occurred. According to the investigation and analysis report, no evidence could be found to suspect that the engine was not capable of delivering the designed power. The drive-gear securing nut had a rotational displacement of about 3mm, which showed that the engine was producing power on impact. Testing of the fuel control unit (FCU) showed that the maximum controlling RPM was sufficient to permit maximum engine take-off power according to the weight and environmental conditions.

3.1.9 The helicopter weight during take-off, exceeded the maximum allowable all-up weight by approximately 49kg. The Centre of Gravity (CG) was within the specified limits.

3.1.10 The pilot backtracked the helicopter several metres to allow for some additional space to accelerate in forward flight. After he had performed a power check, he proceeded into forward flight when he received a low rotor RPM aural warning. The main rotor RPM was restored momentarily, where after the helicopter impacted two vehicles at the road intersection ahead. The driver of the one vehicle sustained fatal injuries on impact.

3.1.11 According to Civil Aviation Authority Regulations, 1997, the duties of a pilot-in-command includes :

Regarding flight preparation Part 91.02.7:

(1) The pilot-in-command of an aircraft shall not commence a flight unless he or she is satisfied that the mass of the aircraft does not exceed the maximum certificated mass.

Regarding flight operations Part 91.02.8:

(1) The pilot-in-command of an aircraft shall be responsible for the operation and safety of the aircraft while he or she is in command.

Regarding routes and areas of operation, Part 91.07.1:

The owner or operator of an aircraft shall ensure that operations are only conducted along such routes or within such areas, for which approval or authorisation has been obtained, where required from appropriate authority concerned.

Regarding helicopter landings and take-offs, Part 91.07.4:

No pilot-in-command of a helicopter shall land at or take off from any place unless the place is so situated as to permit the helicopter, in the event of an emergency arising during such landing or take-off, to land without undue hazard to persons or property on the surface, and

No pilot-in-command of a helicopter shall land on, or take off from, any building, structure or place situated within 100 metres of any other building or structure, in the area of jurisdiction of a local government, unless such building, structure or place has been approved for the purpose by the Commissioner: Provided that this restriction shall not apply –

(a) To a helicopter landing on, or taking off from, a building, structure or place within an industrial area, a commercial warehouse area or an open farm land which is suitable for such purposes and in respect of which helicopter the pilot-in-command is the holder of a valid commercial or airline transport pilot's licence (helicopter) or, in the case of the holder of a private pilot's licence (helicopter), with the written permission of the Commissioner, unless specifically prohibited by the local government.

3.2 Probable Cause/s

3.2.1 The helicopter was at or exceeded the maximum permissible take-off weight during take-off, which had a direct effect on the power demand and power availability.

3.2.1 Contributory Factor:

The area from where the pilot attempted to take off, consisted of high rise buildings at a confined area which most probably caused uneven wind patterns and conditions over the buildings, causing a decay in the main rotor RPM. There was also no proper windsock to indicate the wind direction and wind speeds and no safe escape route in case of an emergency.

4. SAFETY RECOMMENDATIONS

4.1.1 It is recommended that the Commissioner for Civil Aviation instructs the SACAA Flight Operations Department to enhance its safety oversight activities over helicopter operators to ensure the safety of property and people on the ground, with specific attention to unauthorised flight operations taking place in confined areas and high rise buildings.

5. APPENDICES

5.1 Appendix A - Turbomeca SAFRAN Group Engine Investigation Report.

-END-

Report reviewed and amended by the Advisory Safety Panel
5 May 2009

Appendix A

5.1 Turbomeca SAFRAN Group Engine Investigation Report.

Turbomeca
SAFRAN Group

INVESTIGATION REPORT

REF : I 310 - 1

ENGINE FAMILY	S/N	DATE OF REPORT	WARRANTY CLAIM	COMMERCIAL FILE
ARRIEL 1B	04287	20-June-2007	N/A	N/A

OPERATOR	DATE OF INVESTIGATION	REASON FOR ENGINE EXAMINATION
Henly Air-Rand Airport	28-May-2007	ACCIDENT

ACCIDENT	INCIDENT
YES ☒ NO ☐	YES ☐ NO ☒

REFERENCE ACCIDENT / INCIDENT

2007/084

ACCESSORY	S / N	WORKS PERFORMED	TOTAL HOURS	HOURS SINCE OH
P/N 70BM011080 (Module 1)	4291	INVESTIGATION	13779.1	N/A
P/N 70BM021060 (Module 2)	4306	INVESTIGATION	13630.8	4685,4
P/N 70BM031090 (Module 3)	4304	INVESTIGATION	13630.8	1688,1
P/N 70BM041040 (Module 4)	1088	INVESTIGATION	10117.9	1688,1
P/N 70BM055020 (Module 5)	4097	INVESTIGATION	12673.9	1688,1
P/N 0164448430 (FCU)	260B	INVESTIGATION	No info	No info

Circumstances reported to Turbomeca:

It was reported by the pilot, that the aircraft experienced a power loss while taking off and subsequently crashed into two cars.

CONCLUSION

During the investigation, no evidence could be found to suspect that the core engine was not capable to deliver the design power.
During the stripping-down inspection of the engine, it was noticed that the drive gear-securing nut had a rotational displacement of approximately 3mm. This phenomenon is normally experienced during main rotor strike/impact while the engine is producing power.
Testing of the fuel control unit showed that the FCU NG maximum controlling rpm was 4 720 as opposed to the rig requirement of 4786±3 rpm. It was however calculated that this observed rpm was sufficient to permit maximum engine take off power according to the aircraft weight and environmental conditions as reported on the day of the accident. Re-setting of the FCU during the investigation rig testing to achieve the 4786±3 rpm was easily obtained by a 90° clock-wise turn. Adjustment of the temperature compensator is permitted by the operator during operation so as to achieve Maintenance Manual requirement. The non-installation of a manufacturer's seal on the temperature compensator adjuster cover of the FCU in question, would suggest some adjustment of the temperature compensator by the operator during service.

COMPILED BY	DATE
DSOMTEA	06-July-2007.

1 INVESTIGATION REPORT

1.1 ENGINE HISTORY

• TSN 13779,1 Hrs
• TSO 1688,0 Hrs
• This engine was fitted to ZS-RSW during 2005 at 13483,3 Hrs since new.
• Aircraft Tail strike incident on 21-Aug-2006 at 13742,4 Hrs:
• This accident on 28- March-2007 at 13779,1 Hrs

After the tail strike incident the following actions were performed on the engine to render it again serviceable. Record of the work performed are kept on job pack # 600 and is available for inspection if required:

a) MPI/500 hour inspection in accordance with GMR 43-02-06 (31-Jan-2007).
b) Freewheel shaft assembly replaced
c) Mo 4 and Mo 5 removed/inspected. Items were found serviceable and refitted to engine.
d) FCU mounting flanges crack tested and found serviceable.
e) Test flight carried out and aircraft found serviceable.

• Last power assurance check was completed prior to take off on the day of this accident (see pilot report attached as Appendix 1)

1.2 INTRODUCTION

On the day of the present accident (28-March-2007), according to the Pilot's report attached to this report as Appendix 1, two power checks were completed prior to take-off and engine performance was judged as being satisfactory. Gas Generator speed during the power check in ground effect was between 95 and 96% and out of ground effect (± 20 to 25 feet above the ground), the rpm was between 99 to 100%.

After the power checks, the pilot positioned the helicopter for an approximate 40 meters level take off. During the take off, as the helicopter reached an altitude of approximately 20 to 25 feet at a speed of between 10 to 15 knots, the low main rotor speed warning sounded. The power demand was immediately reduced and the warning stopped, but when the power demand was again increased, the low main rotor speed warning sounded again. At this point crash impact commenced.

The pilot could not recall if the engine was still running after impact, he did however follow the emergency shut down procedure by closing the mechanical fuel shut off lever. Although there was no post impact fire, the emergency crew sprayed fuel vapour suppressing agent onto the aircraft and surrounding area as a precautionary measure to prevent the possible spontaneous ignition of the spilled fuel.

1.3 FINDINGS ON SITE ARRIVAL (NAC HANGER RAND AIRPORT SOUTH AFRICA)

• All engine electrical and fuel/oil fittings and fuel control linkages appeared correctly installed and properly secured.
• The engine main oil filter pre-blockage warning (pop out) indicator had not been activated, suggesting a contamination free condition of the engine oil system, refer figure 01.

• By reference to figure 02 it can be observed that accident impact force had moved the engine rearward, causing separation between the engine and airframe intake casing.
• Engine power shaft to main gearbox was ruptured disconnected at the level of the flex coupling with total destruction of the coupling and drive assembly, see figures 02 and 03.
• The tail rotor drive coupling at the level of the engine flex coupling was still intact.
• Although no post impact fire occurred, fuel vapour suppression agent had been discharged into the engine.
• Power turbine rotation was free without obvious blade rubbing evidence and a positive connection to the tail rotor drive and main drive free wheel was confirmed.

• The axial rotor appeared free from pre or post impact debris ingestion, but was however not free to rotate, possibly due to contamination by the post accident induced fuel vapour suppression agent.
• Inspection of the entire oil system magnetic plugs and chip detector assemblies did not reveal any abnormal accumulation of metal particle contamination, refer figures 04 to 07.
• All the fuel and oil filter elements and screens were also contamination free, see figures 08 to 13.

1.4 FINDINGS ON ARRIVAL (TURBOMECA FRANCE)

• The engine was received sealed in a wooden engine transport box and stand assembly, see figures 14.
• Receipt inspection of the engine, after removal from the transportation box, revealed accident impact damage to the engine exhaust, refer figure 15.
• The Mo1 liaison tube also showed impact damage at the level close to the rear support, see figure 16.
• By reference to figure 17, axial compressor casing attachment to air intake housing flange separation/fracture due to engine crash impact movement can be noticed.
• All pipes appeared to be correctly installed and properly tightened. The FCU N1/N2 drainpipe did however show some impact bending distortion.
• Inspection of the axial compressor confirmed no ingestion or impact damage to the blade surfaces and blade erosion appeared to be satisfactory at 1mm, see figure 18.
• It was also confirmed that the gas generator was not free to rotate whilst the rotation of the power turbine was satisfactory.
• Free wheel operation appeared normal, although with some rotational friction.
• Visual inspection of the main power drive (fig 19) and of the tail rotor drive (fig 20) showed both splined gear drive shafts to be free from any spline rupture or abnormal wear.
• Visual inspection of the compressor bleed valve confirmed the butterfly valve to be in the "OPEN" position, see figure 21. It was however noticed that the P3 air supply union pipe connection was loose and it required approximately 10° rotation of the torque wrench to obtain a satisfactory torque tightening value, see figure 22.
• Permeability check performed on the fuel injection wheel achieved a satisfactory flow of 7.6 seconds.

1.5 FINDINGS ON TEST BED

• Due to the inability to rotate the gas generator and the engine internal contamination by fuel vapour suppressing agent, the engine was not test, but subjected to a detailed stripping-down inspection which also included rig testing of the main fuel and air components.

1.6 FINDINGS DURING DISASSEMBLY

1.6.1 FUEL CONTROL UNIT (FCU) S/NO 260B (NO LOG CARD AVAILABLE)

• The fuel control unit was removed from the engine to facilitate a detailed rig test in accordance with CCT 0 164 04 943 0. During this removal operation, a positive drive to the accessories was confirmed when decoupled from the "seized" gas generator.
• This test disclosed the FCU to operate satisfactorily. It was however observed that the FCU NG maximum controlling rpm to be 4 720 as opposed to the rig requirement of 4786±3 rpm. This condition resulted in the unit static droop curves also to be out of the test specification requirement.
• This NG maximum rpm was easily reset to 4785 rpm on the test rig by 90°clockwise rotation of the temperature compensator adjuster. In service on engine adjustment of the temperature compensator is permitted in the range not exceeding +90°to -90° from the original rig setting.
• Re-testing of the unit with having the temperature compensating adjuster reset, showed the unit to perform within the test specification requirement.

1.6.2 START PURGE VALVE S/NO A291B

• Removal and rig testing of the start purge valve showed the unit to function within the Turbomeca test specification requirement.

1.6.3 OVER-SPEED AND DRAIN VALVE S/NO A638B

• The results of the functional check performed on this valve were found to be in accordance with the test specification.

1.6.4 PRESSURIZING VALVE S/NO 2067M

• Rig testing of this unit also showed it to function within the test specification.

1.6.5 BLEED VALVE S/NO 122 (ENGINE DOCUMENTS SHOWS 984)

• Rig testing of the compressor bleed valve disclosed the item to operate within the test specification, even when the P2 pipe securing union was slightly loosened as was found on the engine, refer paragraph 1.4.

1.6.6 TACHOMETER BOX S/NO 2276B (ENGINE DOCUMENT SHOWS 107B)

• Testing of the tachometer box disclosed the unit to operate as required by the Turbomeca test specification.

1.6.7 MODULE MO5 (REDUCTION GEARBOX) S/NO 4097

• The module was free to rotate and the gears and gear securing nuts all appeared to be in a satisfactory mechanical condition and properly secured.

• The drive gear and securing nut disclosed a rotational displacement of the index marks of approximately 3mm, see figure 23. This displacement of the securing nut is indicative of the engine having produced power at the time of the main rotor accident impact.

1.6.8 MODULE MO4 (POWER TURBINE) S/NO 1088

• The power turbine was free to rotate without any evidence on the turbine blade profiles to suspect abnormal operating temperature. By reference to figure 24 the fire extinguisher contaminated condition of the assembly can be seen.

• Removal of the power turbine nozzle did not show any deterioration or abnormal carbon build-up of the assembly. All pipes were found properly tightened and the oil-serviced items contained a level of oil wetness.

1.6.9 MODULE MO3 (GAS GENERATOR HIGH PRESSURE SECTION) S/NO 4304

• This module was seized by contamination with fire extinguisher powder. Separation of the gas generator high pressure section (MO 3) and the axial compressor from the (MO2) from the transmission shaft and accessory gearbox showed the torque loading to facilitate unscrewing of the turbine bolt to be satisfactory at 140Kg.

• The centrifugal compressor assembly was contaminated with fire extinguisher powder, but showed no pre or post impact damage, see figure 25.

• Slight rubbing was evident on the centrifugal casing at the bottom level, see figure 26.

• The centrifugal compressor diffuser and injection manifold assembly did not disclosed any anomaly that could be related to the reported power loss, and only showed some fire extinguisher powder contamination, see figure 27.

• Slight rotational contact was visible on the turbine shaft labyrinth seal bottom, see figure 28. All curvic-couplings appeared to be in a satisfactory condition without abnormal wear evidence on the couplings.

• The combustion chamber appeared generally in a serviceable condition without heat erosion degradation being evident on the dilution tubes or any other part. The assembly was severely contaminated with fire extinguisher powder, see figure 29.

• The gas generator turbine nozzle guide vane did not show any abnormal combustion exit flame pattern or high temperature erosion, see figure 30.

• Figure 31 shows the gas generator turbine, severely contaminated with fire extinguisher powder. No blade tip rubbing could be confirmed on this assembly.

1.6.10 MODULE MO2 (GAS GENERATOR AXIAL COMPRESSOR) S/NO 4306

• When this module was separated from the fire extinguisher contaminated MO3, it was free to rotate. Figure 32 shows the axial compressor diffuser, heavily contaminated with fire extinguisher powder, but free from operational anomalies.

1.6.11 MODULE MO1 (TRANSMISSION SHAFT AND ACCESSORY GEARBOX) S/NO 4291

• Apart from crash impact damage to the transmission shaft protection tube, this assembly also appeared to be in a serviceable condition. The output shaft splines showed satisfactory engagement.

1.7 ANALYSIS/DISCUSSION

• Although testing of the fuel control unit showed that the FCU NG maximum controlling rpm to be 4 720 as opposed to the rig requirement of 4786±3 rpm, it was calculated to be sufficient to permit maximum engine take off power according to the aircraft weight and environmental conditions as reported. The adjustment of the temperature compensator that controls this rpm, may be performed by the operator within the range not exceeding +90°to -90° from the manufacturer's original rig setting. During the investigation rig testing the required NG maximum rpm could be achieved with a 90° clockwise turn of the adjuster, indicating satisfactory unit response to adjustment. Figure 33 shows receipt inspection of the FCU, depicting locking of the temperature compensator adjuster cover without the manufacturer's seal, suggesting some operator intervention during service operation, which is permitted in accordance with the Maintenance Manual Chapter 73-21-00. It is however a point of concern that no log card or history adjustment for the FCU was available for inspection during the investigation.

• Although the bleed valve and tachometer box did not disclose any anomalies during the investigation rig test, it was a concern that the serial numbers for both these components were different as to the serial numbers recorded in the available engine documentation.

• Examination of the core engine did not disclose any evidence to suspect that the engine was not capable to deliver the designed power. The observed drive gear and securing nut rotational displacement (fig 23) is a phenomenon normally associated with main rotor blade strike/impact while the engine is producing power.

Figure 01
Main oil filter pre-blockage indicator not activated

Figure 02
Flex coupling destruction
Figure 03
Main gearbox drive shaft impact ruptured disconnected

Figure 04
Transmission shaft and accessory gearbox (MO1) magnetic plug, free from magnetic particles
Figure 05
Reduction gearbox (MO5) oil scavenge magnetic plug, free from metal particles

Figure 06
Rear bearing chip detector, contamination free
Figure 07
Oil system main chip detector, contamination free

Figure 08
Accessory gearbox (MO1) oil return strainer, contamination free.
Figure 09
Gas Generator rear bearing oil return strainer, contamination free.

Figure 10
Reduction gearbox (MO5) oil return strainer, contamination free.
Figure 11
Fuel control unit filter element, contamination free.

Figure 12
Aircraft fuel system filter, contamination free.
Figure 13
Engine main oil filter, contamination free.

Figure 14
Engine received in Turbomeca seal in box
Figure 15
Impact damage to engine exhaust

Figure 16
Impact damage to liaison tube
Figure 17
Axial compressor casing to air intake housing flange showing impact displacement

Figure 18
Axial compressor, no impact damage and erosion level satisfactory
Figure 19
Main power drive spline in a serviceable condition

Figure 20
Tail rotor drive spline in a serviceable condition
Figure 21
Compressor bleed valve in the open position

written authorization

Figure 22

P3 air supply union to bleed valve

Figure 23

Drive gear securing nut rotational displacement of index marks

Figure 24

Power turbine contaminated with fire extinguisher powder

Figure 25

Centrifugal compressor showing fire extinguisher powder

Figure 26

Centrifugal compressor casing showing slight rubbing

Figure 27

Centrifugal compressor diffuser and injection manifold assembly

Figure 28

Turbine shaft labyrinth showing slight rubbing at the bottom plane

Figure 29

Combustion chamber

Figure 30

Gas generator turbine nozzle guide vane

Figure 31

Gas generator turbine showing fire extinguisher powder contamination

Figure 01: Main oil filter pre-blockage indicator not activated

Figure 02 Flex coupling destruction

Figure 03: Main gearbox drive shaft impact ruptured disconnected.

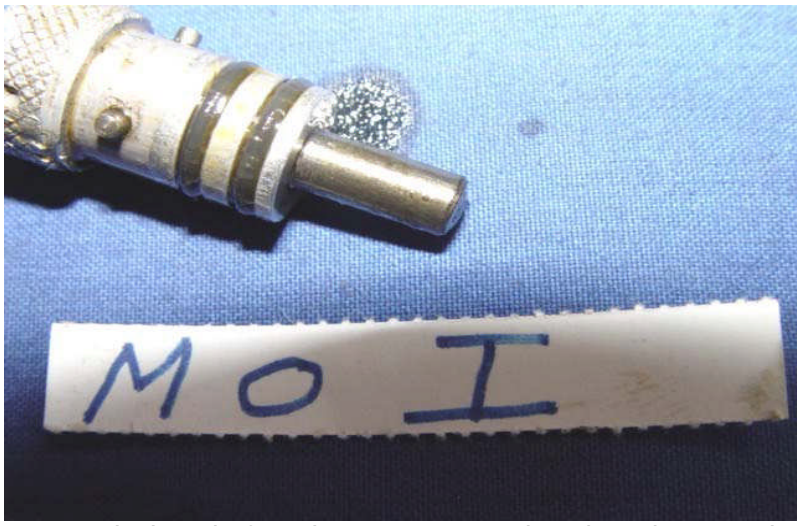


Figure 04: Transmission shaft and accessory gearbox (MO1) magnetic plug, free from magnetic particles

Figure 05 : Reduction gearbox (MO5) oil scavenge magnetic plug, free from metal particles

Figure 06: Rear bearing chip detector, contamination free.

Figure 07
Oil system main chip detector, contamination free.

Figure 08: Accessory gearbox (MO1) oil return strainer, contamination free.

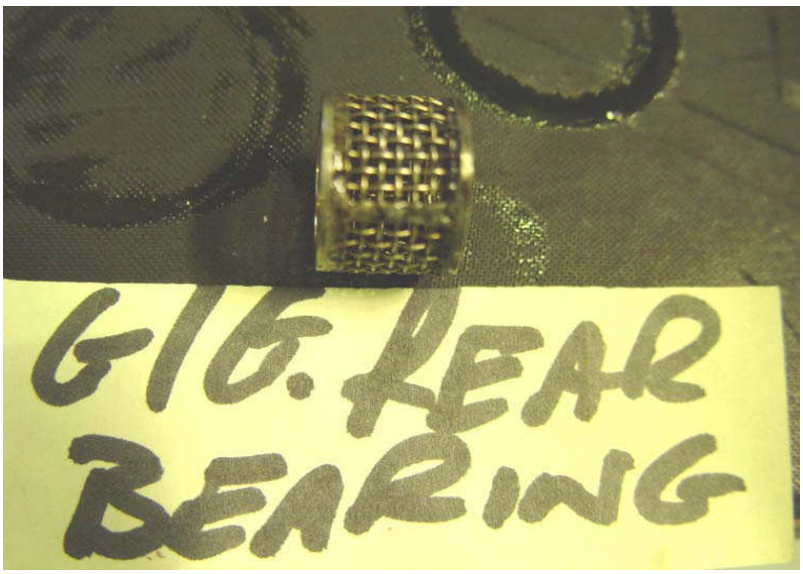


Figure 09: Gas Generator rear bearing oil return strainer, contamination free.

Figure 10: Reduction gearbox (MO5) oil return strainer, contamination free.

Figure 11: Fuel control unit filter element, contamination free.

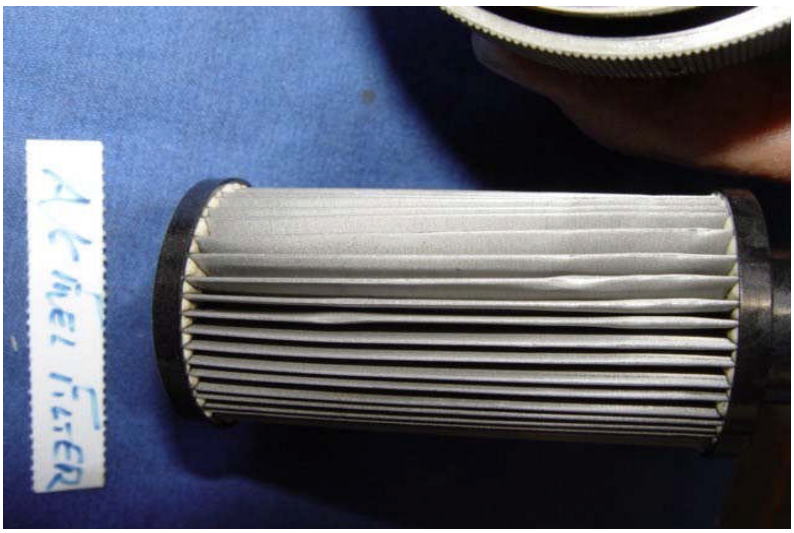


Figure 12: Aircraft fuel system filter, contamination free

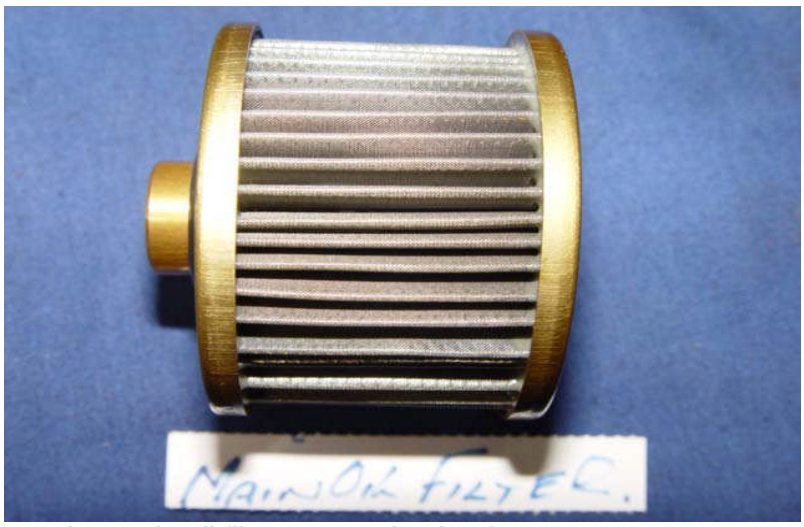


Figure 13: Engine main oil filter, contamination free.

Figure 14 Engine received in Turbomeca seal in box

Figure 15: Impact damage to engine exhaust.

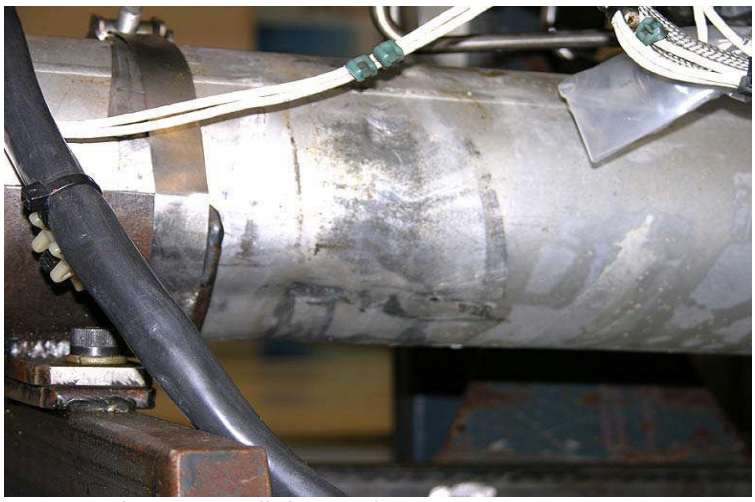


Figure 16 Impact damage to liaison tube

Figure 17 Axial compressor casing to air intake housing flange showing impact displacement

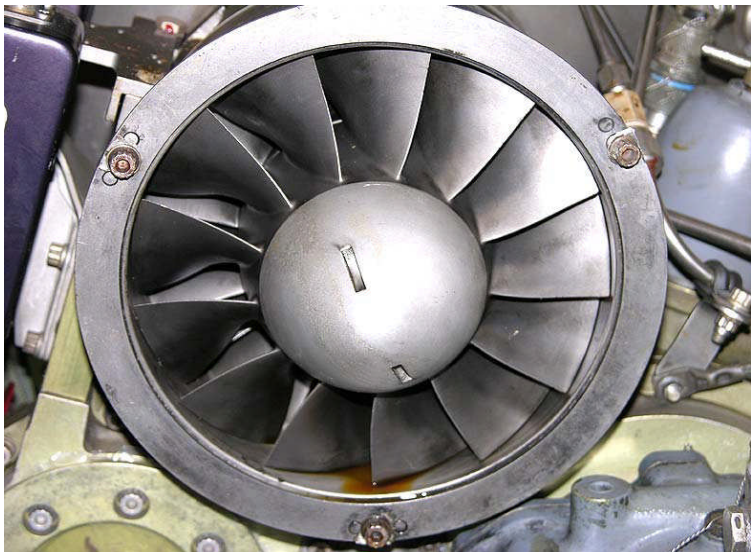


Figure 18 Axial compressor, no impact damage and erosion level satisfactory.

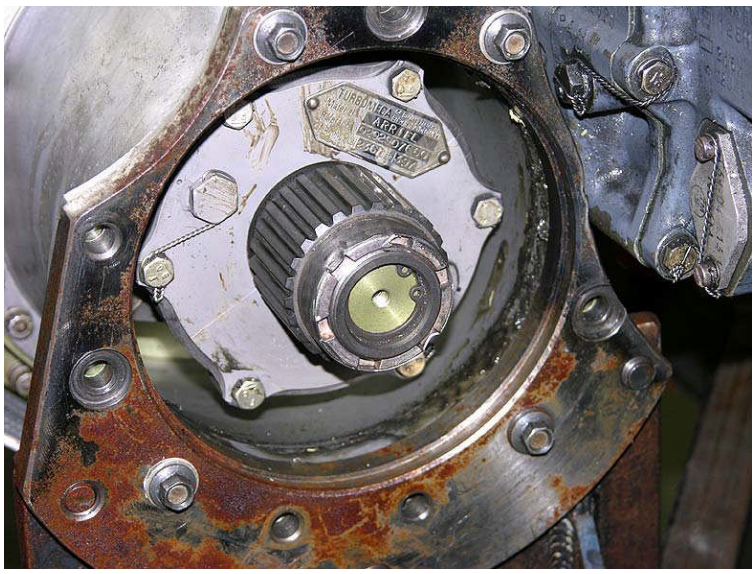


Figure 19 Main power drive spline in a serviceable condition

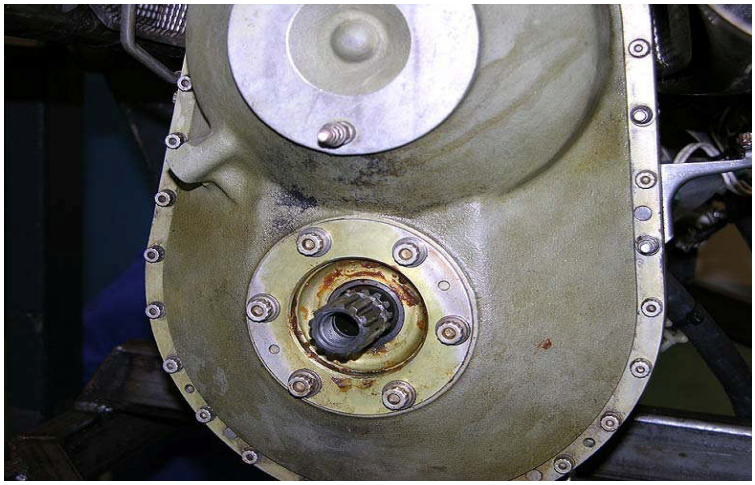


Figure 20 Tail rotor drive spline in a serviceable condition

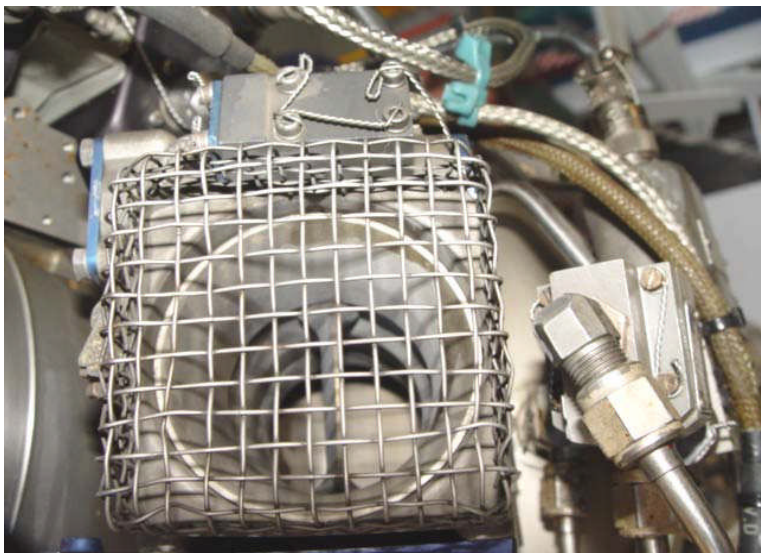


Figure 21: Compressor bleed valve in the open position.

Figure 22: P3 air supply union to bleed valve

Figure 23: Drive gear securing nut rotational displacement of index marks

Figure 24: Power turbine contaminated with fire extinguisher powder

Figure 25: Centrifugal compressor showing fire extinguisher powder.

Figure 26: Centrifugal compressor casing showing slight rubbing

Figure 27: Centrifugal compressor diffuser and injection manifold assembly.

Figure 28 Turbine shaft labyrinth showing slight rubbing at the bottom plane

Figure 29: Combustion chamber

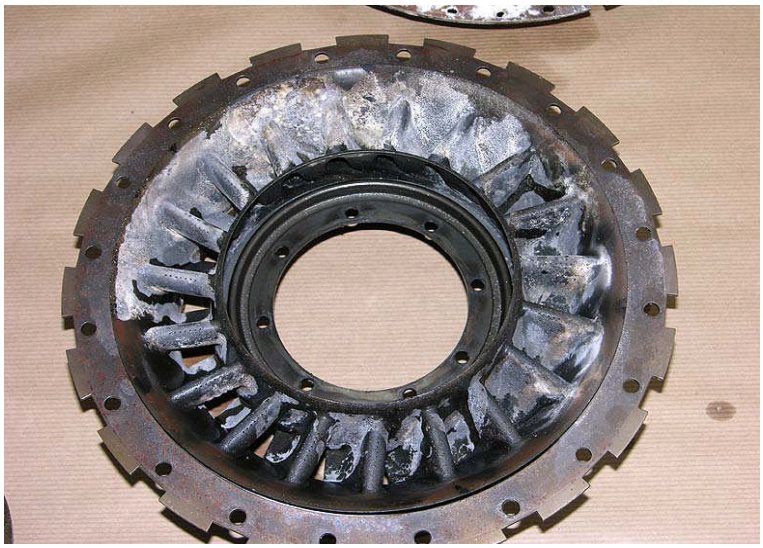


Figure 30: Gas generator turbine nozzle guide vane

Figure 31: Gas generator turbine showing fire extinguisher powder contamination

Figure 32: Axial compressor diffuser, contaminated, but free from operational anomalies.

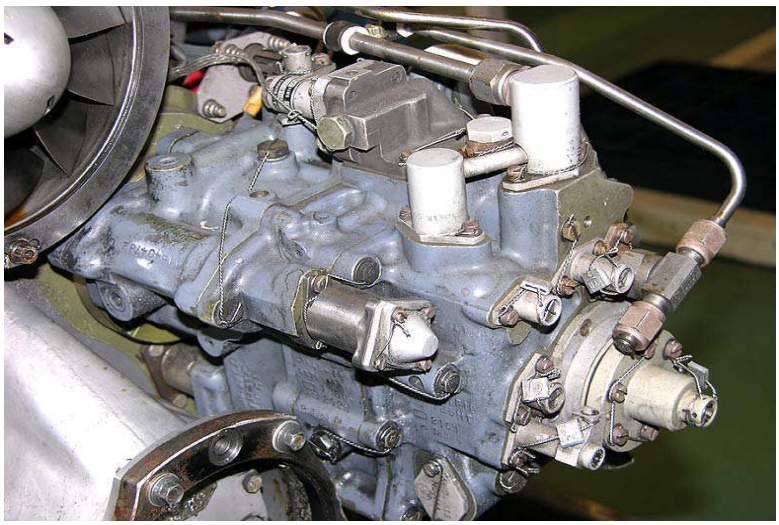


Figure 33: FCU showing the temperature compensator adjuster cover without the manufacturers Seal.