DEPARTMENT OF CIVIL AVIATION MALAYSIA

AIRCRAFT ACCIDENT REPORT NO. 03/91

OPERATOR	:	HORNBILL SKYWAYS SDN. BHD
REGISTERED OWNER	:	HORNBILL SKYWAYS SDN. BHD.
AIRCRAFT TYPE	:	BELL JETRANGER III
MODEL	:	B206B
NATIONALITY	:	MALAYSIAN
REGISTRATION	:	9M-AZL
PLACE OF ACCIDENT	:	25 N.M SOUTH OF MARUDI LATITUDE : 03° 57' NORTH LONGITUDE: 114° 19' 30" EAST
DATE AND TIME	:	15 JUNE 1991 AT 1014 HOURS

ALL TIMES IN THIS REPORT ARE LOCAL
(+ 8 HOURS U.T.C)

SYNOPSIS

The accident was notified by Hornbill Skyways Sdn. Bhd. to the Department of Civil Aviation (DCA) at 1800 hours on 15 June 1991. An investigation began onsite on the 17 June 1991.

The helicopter with a pilot and four passengers on board was on a communication flight. The flying was in visual meteorological conditions (VFR) when the pilot transmitted a distress call due to ~~because~~ of engine failure.

The helicopter accomplished an autorotative descend and ~~it turned~~ and crash with a considerable vertical velocity into a marshy land. All the occupants escaped unhurt. The helicopter sustained a substantial damage due to the impact.

1. FACTUAL INFORMATION

1.1 History of the flight

The purpose of the flight was to convey a team of medical staff for flying doctor services to several locations in Division Four Sarawak. The helicopter took off from Miri airfield at 0952 hours for Ba Lai, its first destination. It is located 28 Nautical Miles(NM) to the South of Miri Airport. The departure was uneventful.

At 0954 hours the pilot contacted Miri base on company High Frequency radio for a standard departure call. Shortly after that call the pilot levelled the helicopter at 2000 feet pressure altitude. ~~and~~ At that junture he encountered low clouds and hazy weather. He descended to 1000 feet pressure altitude. In order to maintain VFR flight.

AT 1014 hrs the pilot reported experiencing unusual jerk followed by audio warning and illumination of the `ENG OUT' light on the caption panel. The symtoms indicated that the engine had failed. He immediately ~~he~~ established the helicopter into autorotation by lowering the collective lever fully down and transmitted a distress calls on High Frequency radio. He turned the helicopter to the starboard to attempt a landing at a clearing within the vicinity. A few seconds later, on levelling after 260 degrees turn, the helicopter was already close to the ground surface and crash landing short of the clearing was imminent. The pilot then flared the helicopter in order to reduce its forward speed. He allowed it to drop to about 10 feet above the ground whereby the collective lever was raised fully up to cushion the touch down. The helicopter impacted with a slight forward speed and came to a halt in an upright position.

All the passengers evacuated the helicopter unhurt. The pilot carried out the shut down procedures and escaped without any injury. They were picked up some 5 hours later by a Royal Malaysian Airforce Force helicopter.

1.2 Injuries to persons

Injuries	Crew	Passengers	Others
Fatal	-	-	-
Serious	-	-	-
None	1	4	-

1.3 Damage to aircraft

On site inspection revealed that the helicopter airframe was intact and in uprigth position. The landing skid collapsed rearward. The engine compresser casing around the 2nd stage area was raptured with holes piercing through the casing. The tail boom was deformed at 2 places. Right stabiliser deformed upward and the lower vertical fin experienced slight damge. Right hand windshield and left hand chin buble were cracked. Intake cowling was contacted by the swashplate. The transmission deck was striked by the drag pin of the main transmission. The main rotor and tail rotor blades were dented at various places.

1.4 Other damage

Nil

1.5 Personnel information

Pilot : Male, aged 36 years

Licence : Malaysian Airline Transport Pilot's Licence (Helicopter). Valid until 31 March 1992.

Aircraft Rating(A) Part I Pilot in command	:	BELL 206B
Medical Certificates	:	Last examination 09th March 1991 valid to exercise the privileges of the licence until 31 March 1992.
Flying experience	:	Total : 3968 hours Total on type : 2,500 hours Total in previous 28 days: 25 hours
Rest period prior to accident flight.	:	More than 12 hours

1.6 Aircraft Information

1.6.1 Leading particulars

Type :	Bell 206 B Jetranger III
Constructor's No.:	3210
Date of construction:	20 November 1980
Maximum permissible weight:	3200 lbs
Weight at time of accident:	3,000 lbs

Certificate of Airworthiness: Transport category	(Passenger)
Certificate of Maintenance review	: Valid until 28 June 1991 Issued 29 May 1991 and next maintenance review on 30 September 1991.
Total airframe hours:	6339 hours.
Engine model :	Allison Model 250 C20J

1.6.2 Maintenance History

Documentations indicated that previous related defects had been rectified and accomplished in accordance to the requirements of the Department of Civil Aviation Malaysia. Records indicated that the following defects and maintenance actions had been taken prior to the accident.

Date	Defect	Rectification
25/6/90	High TOT on cruise	- Compressor case halves removed cleared, inspected. Found satisfactory and reinstall.
1/09/90	N_2 droop	- linear actuator found not working.

15/09/90 Linear actuator adjustment
screw defective - replaced

19/12/90 Linear actuator adjustment
screw defective - replaced

18/02/91 Turbine assembly replaced due for retirement.

The known history of relevent components is summarised below, hours refer to component flying hours:

i) Compressor P/NO 6890550 S/No. GAC 39277 was installed on 11 February 1990 - Time since new 4772.43 hrs and time since overhaul 1273.4 hrs

ii) Hours since last gearbox change 863.04 hrs

Records indicated that the compressor assembly was sent to a servicing agency in Singapore for overhaul on 3rd April 1989. The condition inspection report of the related components revealed the following :-

ITEM	PART NAME		REASON
1.	# Bearing	Replace	CEB 1171 compliance
2.	Nut # Bearing	Replace	CEB 1171 complaince
3.	Carbon Seal Assembly	Replace	Chipped carbon face
4.	Body Press Reducer	Replace	Hex. head rounded

5.	Spur adapter Gear	Replace	Spline worn, corrosion pits on raceway.
6.	# 2 Bearing	Replace	Groving & indentation .
7.	Compling Adapter	Replace	Scrup in set with spur adapter gearshaft.
8.	Tie Bolt	Replace	Corrosion on surface.
9.	Impeller	Replace	Time expired
10.	6th Stage wheel	Replace	Corrosion pits beyond blend limits
11.	5th stage wheel	Replace	Corrosion pits beyond blend limits
12.	1st stage wheel	Replace	Corrosion pits beyond blend limits
13.	Plugs	Replace	CSL 1113 compliance
14.	Compressor case -	Exchange	Separation, cracked & chipped plastic

Compressor wash was carried out in compliance to CEB A-1234 Rev.II for the last 6 months at interval as follows:-

6/1/91, 18/1/91, 17/3/91, 17/4/91, 16/5/91 and 2/6/91

1.6.3 Emergency procedures

The emergency procedures to be adopted in the event of engine failure are given in section 3 of the flight manual. The pilot shall quickly establish the helicopter in autorotative flight. The time delay between lowering the collective pitch lever from its position during cruise flight to that required for autorotation, ie minimum pitch, varies with pilot's reaction time.

Excessive delay e.g 3 to 5 seconds can cause the rotor RPM(NR) to decay below to a value below which normal autorotation will not be possible.

When the engine N1 decreases to 55% or less an intermittent audio signal is produced and the ENG OUT light caption will illuminate.

Following the engine failure the pilot should close the fuel trottle as soon as he has regained control of the helicopter. This is a precautionary action to minimise the possible effects of an engine fire.

1.6.4 Safety equipment

The survival pack had been tampered with and some of the contents were found missing. The pilot reported that essential items were not available for use.

1.6.5 Search and rescue (SAR)

Mayday call was declared by the aircraft commander at 1014 hrs and SAR was activated immediately. First aircraft B206B - 9M-BLL airborne for the search area at 1035 hrs followed by 2nd B206 - 9M-SKJ at 1133 hrs. Third aircraft B206 took off at 1236 to the search area. The crash site was spotted by one of the search aircrafts at ~~time~~ 1630 hrs and was rescued by S61 belonged to RMAF some 5 hours after the crash.

1.7 Meteorological information

The weather was reported to be fine at Miri Airport. The pilot reported that the weather conditions deteriorated after leaving Miri zone boundary. The cloud base was estimated to be at 1000 feet and the visibility was hazy. The pilot was still in visual contact with the ground after he decended to 1000 feet pressure altitude.

1.8 Aids to navigation.

Not applicable

1.9 Communications

1.9.1 Radio Telephony

The helicopter was under the control of Miri tower on frequancy 123.3 Khz during the initial departure. At zone boundary East (20 NM from Miri) at time 1002 hrs., the radio control of the helicopter was transferred to Marudi on radio frequency 122.4 Khz.

Shortly after the transfer, the pilot made a distress call to his base using company High frequency radio. The contents of the transmission was " MAYDAY MAYDAY, engine failure, 3 miles East of Long Panai". The transmission was received clearly by the company radio operator at Miri base.

1.10. Aerodrome information

Not applicable

1.11 Flight Recorder

No fitted

1.12 Wreckage and impact information

1.12.1 The helicopter crashed into an area of marshy land covered by thick undergrowth. There were tall trees of 80-100 ft high, sparsely grown surrounding the impact point.

An aerial survey revealed that an open ground of 50 by 50 Meters existed along the direction of the final flight path. There were evidents to suggest that the pilot was attempting to force land the helicopter onto that area, however he landed short of 50 Meters from the open ground.
The helicopter was virtually levelled with slight forward speed on impact. Its heading at impact was 050° (m). The fuselage structure was still intact with only minor damage to its belly. There were evidence to indicate that the main and the tail rotor blades were rotating even after the impact. This was exhibited by several trees severed by the main rotor blades around the impact area. There was no visual sign of significant damage to the tail rotor blades.

1.12.2. Engine strip examinations

During the teardown examination it became evident that the damage was initiated at the axial compressor section. All the rotor blades from stages 2 through to 6 had been fractured at their roots and all stator vanes from stages 3 through to 6 and some from stages 2 had also been fractured at their roots. The remaining blades and vanes were extensively damaged by the debris generated during the failure.

1.13 Medical and pathological aspect

There was no indication of medical factors which could have caused or contributed to the accident.

1.14 Fire

There was no fire during and after the accident.

1.15 Survival aspect

The accident was survivable

2. ANALYSIS

2.1 General

From the evidence of the pilots distress call, it was clearly indicated that the emergency occurred suddenly and without warning. Twelve minutes before the distress call, the pilot did a routine radio call without any mention of any problem arising in his flight. A passenger seating at the back seat confirmed that a red warning caption light was seen illuminated at the instrument panel. The pilot knowing that the engine had failed established into autorotation by lowering the collective lever fully down and in time to restore the rotor rpm. He had done his drill correctly by selecting an open area for the forced landing. Due to several factors ie. aircraft weight, temperature, speed, and pilot's reaction time, the pilot misjudged the distance covered which resulted in crashing short of the open area.

The rotational energy exhibited by the main rotor at impact and witness accounts confirmed that the rotor RPM was sufficient to make a safe landing if the ground surface was favourable. It is also known that at the time of impact the engine did not deliver power to the main rotor.

The stoppage of the engine without prior warning to the pilot was positively established as being due to the failure of the axial compressor of the engine. The air intake area was found undamaged and clear of any sign of foreign object ingestion. Other subtle components of the engine were examined and did not suggest any abnormality.

2.2 The axial compressor

2.2.1 Rotor Blade Fractures

All the rotor blades from stages 2 through to 6 had been fractured near their roots. The rotor assembly was dismantled to allow a detailed examination of each of the rotor blade fractures.

Sixth Stage

Although the fracture surfaces had been damaged during the failure of the compressor, evidence of fatique crack growth was present on each fracture surface. Fatique crack initiated at multiple origins on the convex side of the blade section and extended to a depth of approximately 30% of the blade thickness.

Fifth, Fourth, Third and Second Stages

Fatigue crack growth was evident in all blades in which some of the original fracture surface was intact. In each case fatique initiated at multiple origins on the convex side of the blades, similar to the fatigue in the sixth stage, and extended to various distances through the thickness of the blades.

It is apparent that fatigue crack growth was more extensive in the sixth stage and was less extensive in stages toward the front of the compressor, that is, the second and third stages.

Examination of several fracture surfaces in a scanning electron microscope revealed that the fatigue fracture surfaces had been burnished, possible during crack closure associated with compressive load cycles.

The evidence of fatigue initiation on the convex side of the blade section and the burnished features of the fracture surfaces associated with fatigue crack growth indicates that the blades had been subjected to some form of reversed bending loading. Note, the convex side of the blade will be subjected to a greater stress during bending about the chordwise axis of the blade because it is farther from the neutral bending axis.

On the basis that the most extensive fatigue crack growth was present in the fractures of the sixth stage blades, it appears likely that the failure of the compressor and the fracture of the remaining rotor blades and stator vanes was precipitated by the fatigue fracture of a sixth stage blade. Damage to the other stages of the compressor occurred as liberated sixth stage blades moved forward under the influence of the pressure gradient in the compressor.

2.2.2 Compressor Case and Stator Vanes

The compressor case and stator vanes were damaged extensively by debris generated during the failure of the compressor. The abradable plastic lining had been removed from all areas except at the entrance to the compressor and all stator vanes from stages 3 through to 6 had been fractured at their roots or pulled from the braze joint in the vane bands.

Although the surface of the vane bands, to which the plastic liner is bonded, was damaged extensively by the peening action of the debris generated during the failure some regions were left undamaged, particularly those areas in the lee of the remnants of stator vanes. Examination of these areas, stages 2 through to 6, revealed that corrosion had occurred at the interface between the vane bands and the plastic lining.

In contrast, no surface corrosion was evident where the plastic lining had been lifted from around the first stage stator vanes.

Corrosion was also evident at the flange of the compressor halves in the region of the fourth, fifth and sixth stages.

Evidence of corrosion at the interface between the stator vane bands and the plastic lining indicates that the bond between the plastic lining and the compressor case had been affected adversely by the operating environment. It is possible that small sections of the plastic lining, especially toward the rear of the compressor, had lifted during service. The loss of small sections of the lining may have created sufficient turbulence in the airflow to induce vibrations in the rotor blades, with accompanying reversed bending loading conditions at the blade roots.

3. Conclusions

a) Findings

i) The pilot was correctly licenced and medically fit to conduct the flight.

ii) The helicopter was correctly loaded and carried sufficient fuel for the flight.

iii) The helicopter had been properly maintained and its documents and maintenance records were in order.

iv) The engine failed suddenly during level flight.

v) The pilot reacted correctly and in time to establish into autorotation and complying to the drill as required by the flight manual.

vi) The compressor case stationary vanes had been punctured and dented. All the axial compressor rotor blades from stages 2 throught to 6 had been fractured at their roots and all stator vanes from stages 3 through to 6 and some from stage 2 had also been fractured at their roots.

vii) Corrosion was present at the interface between the stator vane bands and the plastic lining of the axial compressor.

viii) The Search and rescue was alerted immediately however the number of aircraft involved to assist the search was considered inadequate.

ix) Some of the items in the survival pack essential for survival were found missing.

b) Cause

The accident was caused when the helicopter, whilst flying at 1000 feet in VFR condition suffered a total loss of engine power due to failure of axial compressor. It is likely that the failure of the axial compressor was caused by the fatigue of a sixth stage rotor blade.

4. Safety recommendations

It is recommended that:

4.1 To prevent corrosions on the compressor blades, the operator should daily water rinse the engine when aircraft are operated in a salt laden or chemical laden athmosphere. The proper rinse procedures are given in paragraph 3-35, page 3-37 of the C20 Operation and maintenance manual.

4.2 A compressor which has experienced partial or total inlet blockage during operation, must have the axial compressor wheel replaced.

4.3 Helicopter operations in East Malaysia is exposed to hostile terrain and uninhabited areas. SAR will become difficult in the event of any forced landing. It is recomended that operators to consider twin engine helicopter for operations into these areas.

4.4 A review of the operations manual should be conducted on the SAR procedures.

4.5 The emergency survival pack should be inspected regularly by companys safety officer and the procedures should be incoperated in the Operations Manual.

[illegible]