DEPARTMENT OF CIVIL AVIATION

MALAYSIA

AIRCRAFT ACCIDENT REPORT

BELL 212 9M-SAA
KAMPONG NASOB, KOTA KINABALU
SABAH

BASIC INFORMATION

OPERATOR:	SABAH AIR SDN. BHD.
AIRCRAFT TYPE:	BELL 212
NATIONALITY:	MALAYSIAN
REGISTRATION:	9M-SAA
PLACE OF ACCIDENT:	KAMPONG NASOB, KOTA KINABALU
DATE AND TIME:	23RD DECEMBER, 1982 AT 1042 HOURS

ALL TIMES IN THIS REPORT ARE LOCAL TIME (LT)
i.e. +8 HOURS GMT

SYNOPSIS

The accident was notified to the Department of Civil Aviation (DCA) Malaysia on 23rd December, 1982 by the Operations Manager Sabah Air Sdn. Bhd.

The Bell 212 helicopter was carrying out a Certificate of Airworthiness (C of A) renewal flight test and during the descend, the helicopter struck an unpowered high tension cable and subsequently went out of control and crashed into a swamp killing both occupants on board.

Although there was no conclusive evidence it is considered that the helicopter was in an autorotative descent when the tail rotor struck the high tension cable.

1. FACTUAL INFORMATION

1.1. HISTORY OF THE FLIGHT

1.1.1. 9M-SAA a Bell 212 owned and operated by Sabah Air Sdn. Bhd. was originally scheduled to undergo a C of A renewal flight test on 22nd December, 1982. However, as the maintenance personnel were unable to prepare the helicopter on time, the flight test was postponed to the following day.

1.1.2. On 23rd December, 1982 9M-SAA with the Captain and an Engineer on board departed the Sabah Air dispersal area at 1010 for an annual C of A test flight in the vicinity of Kota Kinabalu airfield. Prior to the departure, maintenance personnel who monitored the engine's start-up, acceleration and deceleration checks did not observe anything unusual. The helicopter was flown to the western side of the airfield where the power assurance, hover,

low speed handling and maximum power checks were performed. These tests were also repeated when the helicopter was flown to the Eastern side of the airfield. In addition two landings from a tight left hand circuit were observed.

1.1.3. The weather at the time of departure was fine and the reported surface wind was 270 degrees at 03 kts. Traffic was light and no abnormal situation was noted.

1.1.4. At 1027 hours, the Capt. called the Tower for an air test clearance East of the Airfield at 2000 feet and was initially cleared to proceed East of the airfield at 1000 feet. At 1029 the helicopter proceeded to the eastern area which is about 3NM from the airfield for the air test. Two minutes later further clearance to climb to 2000 feet was given and the aircraft was seen climbing. During the transit, some R/T exchange as to traffic information were made and finally the Capt. transmitted his last R/T at 1035 acknowledging clearance for rejoining.

1.1.5. The helicopter was seen by a ground eye-witness to do two left hand turns with each having an approximate change of heading of 360 degrees at approximately 1500 to 2000 feet. After the manoeuvres and maintaining a general heading of 215 degrees, the helicopter was seen in a descent.

1.1.6. At about 135 feet above ground level, the helicopter struck the high tension cables spanning the flight path. Ground eye-witnesses' statements suggested that the helicopter was flying into the cables and then pitched up and rolled to the starboard. From then on due to trees nobody saw the

flight path to impact which was at the edge of a swamp approximately 166m from the point of the potential cable strike.

1.1.7. The accident occured in daylight at about 1042 LT at a position 0556N 11605E and at an elevation of 30 feet AMSL.

1.1.8. The horizontal distance from when the helicopter was seen making 2 left hand turns to the probable contact point with the cables is approximately 1.3 kms and the altitude loss approximately 1500 - 2000'.

1.2. INJURIES TO PERSONS

1.2.1. INJURIES TO PERSONS	CREW	PASSENGERS	OTHER
Fatal	2	0	0
Serious	0	0	0
Minor/None	0	0	0

1.3. DAMAGE TO AIRCRAFT

13.1. The aircraft was destroyed by impact forces.

1.4. OTHER DAMAGE

1.4.1. There was no other damage

1.5. PERSONNEL INFORMATION

1.5.1. The Pilot-in-Command held Commercial Pilot's Licence No. 506 (helicopter) which was re-issued on 1st July, 1982 valid until 30th June, 1983. His Type Rating on the Bell 212 was issued on 2nd April, 1980. He did not hold an Instrument Rating but had a current Bell 206B endorsement which was issued on 5th January, 1979. He had a total flying time of 5322.01 hours out of which 741.00 hours was on the Bell 212. The Captain had last

been rostered for duty on 22nd December, 1982 and last flew on 22nd December, 1982. He was well rested and had no recent illness or known significant worries prior to the flight.

1.5.2. Prior to the accident, the Captain of the aircraft spent a considerable time in the Philippines carrying out flying duties around Puerto Princesa area which was part of the joint venture Sabah Air had with an operator from Phillipines. For the last 8 months of 1983 the Captain's flying duties were carried out in Sabah and the Philippines to the following schedule:-

17th May	- 4 th June	- Sabah
5th June	- 15th June	- Philippines
16th June	- 6th September	- Sabah
7th September	- 28th September	- Philippines
29th September	- 30th October	- Sabah
31st October	- 16th December	- Philippines

From the above it was noted that the Captain was in the Philippines for 47 days before arriving in Kota Kinabalu on 16th December, 1982. Prior to the accident, i.e. between 16th to 22nd December, 1982 he made several flights in Sabah logging a total flying hours of 7.4 hours. From records, it was observed that most of the flights were to the Western side of Kota Kinabalu airfield. His experience in C of A Test Flights was limited to carrying out performance climbs and in in flight engine relights.

1.6. AIRCRAFT INFORMATION

1.6.1. GENERAL

1.6.2. The aircraft was a Bell 212, twin turbine engined helicopter manufactured in 1978 by the Bell Helicopter (Textron) Company, Fortworth, Texas, USA.

1.6.3. LEADING PARTICULARS

Registration	:	9M-SAA
Type	:	Bell 212
Certificate of Airworthiness	:	Transport Category (Passenger)
Certificate of Maintenance	:	Issued 23.12.82 at 2429:29 Aircraft Hours. Valid to 2529.29 hours or 3rd February, 1983 whichever the sooner.
Total Airframe Hours:		2429.29 hours
Maximum Take-off Weight	:	11200 lbs sea level to 4000 feet density altitude
Maximum Landing Weight	:	As above
Weight at Time of Accident	:	10875 lbs.
C of Range at 11200 lbs.	:	134 - 142 ins aft.
C of G at Time of Accident	:	138 ins aft.
Engine Type	:	Pratt & Whitney PT6T-3B Twin Pac

1.6.4. CERTIFICATION & OPERATING LIMITATIONS

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1.6.4.1. For Malaysian operations, a Certificate of Airworthiness No. M.245 was renewed by the Civil Aviation Department, Airworthiness Unit on the 30th January, 1982 and was valid until 29th January, 1983. An approved Flight Manual formed part of the Certificate of Airworthiness.

1.6.4.2. OPERATING LIMITATIONS

1.6.4.3. Only those detailed in the Approved Flight Manual and those specified in relevant Supplements were applicable at the time of the accident.

1.6.6. LOADING

1.6.6. The aircraft's maximum permissible take-off and landing weight is 11200lbs.

1.7. METEOROLOGICAL INFORMATION

1.7.1. Weather observations taken before and after the accident at Kota Kinabalu Airport by Perkhidmatan Kajicuaca Malaysia Cawangan Sabah were:-

Time (Local Time)	1030	1100	1130
Wind (knots)	270/03	290/05	290/05
Visibility (km)	10 or more	10 or more	10 or more
Clouds (Oktas and base)	1/8cu 1800ft. 4/8ci 30,000ft.	1/8cu 1800ft. 4/8ci 30,000ft.	1/8c . 1800ft. 4/8ci 30,000ft.
Temp (^{o}C)	30^{o}C	31^{o}C	31^{o}C
Dew point	26	27	27
QNH (Mbs)	1008	1003	1008

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1.8. AIDS TO NAVIGATION

1.8.1. Kota Kinabalu was equipped with an instrument landing system (ILS) operating on 110.3 MHZ, a VOR transmitter operating on 113.1 MHZ, a distance measuring equipment (DME) operating on channel 78 x and non directional beacon operating on 335 MHZ. These aids were in a serviceable condition when 9M-SAA departed Kota Kinabalu and at the time of the accident.

1.9. COMMUNICATION

1.9.1. Communications were normal throughout the relevant period. Emergency was declared only after the accident as no distress call was made by the pilot.

1.10. AERODROME INFORMATION

1.10.1. Not applicable

1.11. FLIGHT RECORDERS

1.11.1. The helicopter was not, nor was it required to be equipped with a cockpit voice recorder or a flight data recorder.

1.12. IMPACT, WRECKAGE AND SITE INFORMATION

1.12.1. IMPACT INFORMATION

1.12.1.1. The helicopter crashed while on a heading of approximately 238°. The debris was scattered over an area extending 48 meters to the farthest point, covering a width of approximately 20 meters. A close examination of the scatter pattern and impact marks disclosed that the final flight path angle was approximately 31.2° while there were evidence, to indicate that the helicopter had a nose high attitude of

about 38°. Several trees along the final flight path were partially destroyed and from the locality of the trees which were mostly around the first impact point revealed that the final flight path was steep. The trees to the right of the final flight path were badly cut by the main rotor which formed an angle of approximately 18° while the damage on the trees which were on the left side of the flight path was negligible.

1.12.1.1. The first impact with the ground was experienced by the tail skid. The skid made a significant cut in the ground measuring approximately 69cm. deep and a length of about 33cm. Appromimately 6.96 meters from this mark was another impact mark which indicated that the right main skid had also struck the ground. Though this evidence was not conspicuous, the length, width and depth were measured to be 1.33 meters, 20cm and 5cm respectively.

1.12.2.1. Upon impact with the ground, the helicopter broke-up. The break-up was rapid and complete dispersing the parts along a general heading of 222° covering a distance from 13 meters to a farthest point of 46 meters. The lighter components were largely located in the area about 20 meters from the first impact point.

1.12.2.2. Among these items were the flotation device, a portion of the tail rotor and the left main skid. A portion of the tail boom was located at a distance of 36 meters from point of impact while the transmission together with the main rotor blades were 6 meters away from the tail boom.

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The engines and the cockpit were located at the end of the wreckage trail which was about 46 meters from point of first impact.

1.12.3. WRECKAGE EXAMINATION

1.12.3.1. It was established that the helicopter carried full fuel (217 US gallons) for the flight. Using test equipment both fuel valves were found in the OPEN position and all fuel controls including electrical switches were in their normal position with the exception of No. 2 fuel pump which was found in the OFF position. Due to the impact damage, only limited samples of fuel could be obtained and these were from the fuel filter and sump drain. The samples were sent to the laboratory of a major oil company, only a screen test could be achieved. The results indicated that the helicopter fuel was probably to specifications and that there was no extraneous contamination. It was also noted that the engine fuel system was in the FULL UP BEEP condition at the time of impact. A strip of the throttle control gear assembly was made and marks caused by the gear sectors becoming unmeshed indicated that the throttles were set at or below Flight Idle.

1.12.3.2. Both port and starboard particle separator doors were found in the fully closed position. The doors would close automatically if:-

a) the engine NG drops below 51% ± 2%
b) the fire handle was pulled or
c) a defect in the electronic RPM control box.

The doors could also be closed manually or remain closed by:-

a) tripping both particle separator doors before engine start (doors are normally in closed position before engine start) or

b) operating the particle separator manual control switch from normal to override (this could only be done before engine start).

1.12.3.3. The relay controlling the No. 2 engine particle separator K26 was checked using electrical test apparatus and found to be serviceable. There was no evidence of impact damage to either the port or starboard particle separator door actuators.

1.12.3.4. The No.1 engine (S/N COPS - 61419) was partially stripped. Both power turbine and compressor sections could be rotated freely and there was no sign of foreign object damage (FOD) No.2 engine (CPPS - 61420) had suffered impact damage and could only be rotated from its power turbine section. It was also found out that the free wheel unit was in a satisfactory condition.

1.12.3.5. The transmission filler neck cap was found missing when the unit was recovered. Although the filler neck was missing, there was no evidence to indicate overheating or dry running due to loss of oil. A full strip of the transmission units indicated that adequate lubrication was available. A subsequent strip of the unit revealed that several planetary gears were seized which was due to the corrosion as the unit had laid in the water for approximately four days.

1.12.3.6. The fire bottles fitted to both engine installations had not been discharged nor had the fire handles been activated.

1.12.3.7. The tail rotor blades were found with one blade damaged with about 10 inches of its tip missing. Initial examination of the blade with its jagged edge and markings suggested a possible tail rotor strike. The damage tail rotor blades was subjected to further metallurgical examination (see Tests and Research). The 90° tail rotor gearbox was stripped and 3 of the gear teeth indicated that it had been subjected to impact loading. The tail rotor drive shaft was damaged at the middle section and the damage was consistent with torsional loading.

1.12.3.8. Examination of the flight controls and its associated hydraulic system indicated post impact damage and there was no evidence to indicate pre-impact failure. The pilot and co-pilot's collective sticks were recovered and from the score marks found on the half moon transfer gears indicated that both engine throttles were at or below flight idle position.

1.12.3.9. Portions of the pilot, co-pilot and centre instrument panels were recovered and readings and positions of the instruments and switches indicated the following:-

	CO-PILOT PANEL	PILOT PANEL
a) Airspeed Indicator	0	0
b) Altimeter	1200ft. set at QNH 1008	1700ft. set at QNH 1009
c) Artificial Horizon	0°/Right wing down	0° Right wing down
d) Torquemeter	No:1 - 22% No.2 - 5% Total (A) - 26%	No.1 - 20% No.2 - 0% Total (A) - 20%
e) Triple Tach	N1 - 0% N2 - 18% NR - 168% or 0%	N1 - 0% N2 - 0% NR - 0%

CENTRE INSTRUMENT

a) Fuel quantity	-	1300 lbs
b) No. 1 oil temperature	-	60°C
c) No. 1 oil pressure	-	0 psi
d) No. 2 temperature	-	50°C
e) No. 2 oil pressure	-	120 psi
f) No. 1 fuel pressure	-	0 psi
g) No. 2 fuel pressure	-	8 psi
h) Standby artificial horizon	-	$4\frac{1}{2}^{\circ}$ up
i) Hydraulic system No.1 & No.2	-	On
j) Particle separator No. 1 & No. 2	-	Normal
k) Fuel cross feed	-	Normal
l) Fuel selector switches No.1&No.2	-	On
m) Booster pump No. 1	-	On
n) Booster pum No. 2	-	Off
o) Clock	-	0242
p) Fire handles	-	'In' position

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1.12.3.10 Portion of the instrument panel were heavily damaged or destroyed by impact forces. A number of light bulbs from the warning systems incorporated in the aircraft were recovered and inspected for filament stretch. If the impact forces are of sufficient magnitude, shock loads will be imparted to the filaments. The reaction of the filament to those impact loads will be a function of the operational state of the bulb at the time. If a light bulb is illuminated the filament would be very ductile with a low yield strength by virtue of the high filament temperatures.

1.12.3.11. Shock loads would then cause significant distortion and stretch of the filaments. Thus if extensive filament stretch is observed there is reasonable evidence that the particular bulb was illuminated at the time of impact. Filament failure without significant stretch is normally an indication that the failure was brittle in nature and indicates that the filament was cold at the time of the failure. The result of the visual inspection of the panel light bulb filaments was as follows:-

IDENTIFICATION	FILAMENT CONDITION
No. 1 engine OUT	Hot stretch
No. 2 engine OUT	Hot break
Capt. Rotor RPM	Cold break
Co-pilot Rotor RPM	Hot stretch
Capt. Master Caution	Hot stretch
Co-pilot Master Caution	Hot stretch
No.1 Part Set Off	Hot stretch
No. 2 Part Sep Off	Hot stretch
Transmission Oil Press	Intact

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IDENTIFICATION	FILAMENT CONDITION
Combine Box Chip	Intact
Transmission Chip	Intact
$42^{O}/90^{O}$ Chip	Intact
Transmission Oil Temp	Cold break
Hydraulic	Intact
Combine Box Oil Temp	Intact
Caution Panel	Intact
No.1 engine Governor	Intact
No.2 engine Governor	Intact

1.12.4. ADDITIONAL SITE INFORMATION

1.12.4.1. A high tension power cable system crosses the Kampong Nasob area in a general direction of 245^{O} which is close to and converging with the final flight path. The cables are carried on convential 'grid' towers. The system at the time consisted of one 8 mm steel 'neutral' cable connecting the tops of the towers and three 'line' cables consisting of aluminium on a steel core. The 'line' cables are hung on one side of the towers only and are roughly one below the other. The thinner 'neutral' cable is significantly higher than the 'line' cables. At the probable point of impact the cables cover a height band of 30-40 meters. The cables were strung approximately 2 months before the accident and were unpowered at the time.

1.13. MEDICAL AND PATHOLOGICAL INFORMATION

1.13.1. The autopsy revealed that the crew members' death were caused by the injuries they sustained due to impact forces. There was no evidence of negative influences (drug, alcohol,

etc.) that might have caused physical or mental incapacitation of the crew member. Examination of the crews' medical history disclosed no evidence of pre-existing medical problems which may have affected their judgement or performance.

1.14. FIRE

1.14.1. There were no indication of pre-impact or post-impact fire.

1.15. SURVIVAL ASPECTS

1.15.1. The cockpit was completely destroyed after the ground impact. The accident was not survivable due to the high decelerative forces which completely destroyed the aircraft on ground impact.

1.16. TESTS AND RESEARCH

1.16.1. An examination of the fractured surface of the tail rotor blade showed evidence characteristic of failure by rapid ductile overload. An impact mark measuring approximately 70 x 35 mm was present on the leading edge close to a fractured surface. The shape and appearance of the surface of this impact mark suggested an impact with a blunt cylindrical object. Further examination on the impression revealed the presence of a jagged edge and markings.

1.16.2. Witness had confirmed that the helicopter had been heading in a direction of 215° and was converging the previously described cables at an approximate angle of 30°. The helicopter was seen flying into the cables then pitched up and made a steep bank to the starboard. The distance

between the probable cable strike and impact with the ground was 166 meters.

1.16.3. Three samples of wire representative of those installed on pylons were submitted for examination to identify whether the impact evidence on the blade could be attributed to these wires. Measurement of scratch width and scratch spacing were taken on three distinctive scratched lines on the white painted surface of the tail rotor. Examinations were also conducted on the indented part of the tail rotor which measured approximately 65mm x 45mm. This indented part showed a small indent of 13mm width approx. followed by the larger indented area. The pattern of indentation was most probably caused by impact against a blunt object. The suggestion that the wire could be the blunt object was a very probable one because the scratch mark was fairly deep exposing the base metal through the paint at certain portion of the scratch. This type of deep scratches had not been successfully simulated with sharp pointed wood specimen on the painted surfaces. It could only be deduced that both the scratches and the indentations were caused by a harder material than wood. The regular patterned scratches suggested something of man-made origin. The steel wires of aluminium transmission wires fitted closest to this pattern. A comparison between the spacing of scratch marks on the rotor blade and the imprints made on paint panels in the laboratory suggested that the aluminium wire of 12mm diameter was probable cause.

1.16.4. The overall indentation mark 13mm width (comparing against the wire diameter of 12mm) suggested this as the first impact area followed by subsequent deformation and abrasion. The indentation and scratch marks as observed on the rotor blade suggested that the indentation was most probably caused by the 12mm diameter aluminium transmission wire.

1.16.5. The United Kingdom Investigation Branch (UK-AIB) was approached for a second opinion on the blade failure. Metallurgical examination indicated that the blade had struck a cable but in the AIB's view the steel neutral cable was most likely.

1.16.6. Both metallurgical analyses were of the opinion that the rotor blade had struck a cable and we are inclined to agree with the UK-AIB suggestion as the steel cable was the highest cable of the group.

1.16.7. Attempts were made to visually inspect these cables for matching strike marks. Unfortunately the difficult terrain did not allow a Snorkel high lift device to be positioned directly for detailed inspection of the cables. A helicopter was used to hover over the cables using binoculars to sight the cables, this also proved to be unsatisfactory. Finally one of the contractor's men 'walked' the middle power cable whilst suspending himself from the upper one. Although not altogether satisfactory there is reasonable confidence that any significant marking of the aluminium power cables would have been

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noticed. It was not possible to effectively inspect the top 'neutral' cable which being steel galvanised wire would not readily show up marks made by impact with softer and smooth materials.

2. ANALYSIS

2.1. Evidence from eye witnesses indicated that the aircraft initiated a descent at about 1,500 feet after making 2 left hand turns. During the descent at approx. 135 feet above ground level, the aircraft struck an unpowered high tension cable. Impact with the high tension cables resulted in the loss of 10" of blade material from one tail rotor blade which would have caused the aircraft to pitch up and yaw to the right accompanied by intense vibration reflecting the severe out of balance condition. The subsequent flight manoeuvre of the aircraft pitching up and yawing to the right is consistent with the loss of a tail rotor blade.

2.2. Prior to impact the aircraft was on approximate heading of 216° and the crash heading was approximately 238°. The final flight path prior to impact was steep and the impact forces were high, as characterised by the destruction of the aircraft and severe injuries to the bodies. This leads to the conclusion that difficulties were encountered in controlling the aircraft following impact with the high tension cables.

2.3. The aircraft left the airfield at 1029 hours and the accident occurred at 1042 hours, the elapsed time being

13 minutes. The C of A test flight sequence would require departing the airfield and heading 3 nautical miles East to a suitable area. After an initial Maximum Power Check a No.1 engine climb would be flown for 4 minutes, followed by a No.2 engine climb also for 4 minutes, and an Autorotation check, etc. Based on timing and the sequence of the C of A test flight the assumption can be made that the first 4 to 5 minutes were spent on positioning and stabilising the aircraft and cockpit preparation for initiating the C of A test flight, 1 to 2 minutes for performing and recording the Max Power Check and next 5 to 6 minutes for completing the No. 1 Engine Climb test and recording the results. It is assumed that when the aircraft was last seen making 2 left hand turns in level flight, this indicated the completion of the No. 1 engine climb, and a pause to complete recording of the test results and selecting a suitable site to undertake the check autorotation is reasonable in that from the point of initiating the descent to impact with cables, the lateral distance traversed is approximately 1.3 km and the flight profile is consistent with an autorotative descent.

2.4. Consideration has been given as to whether the descent was related to an emergency forced landing but there was no evidence to suggest the aircraft experienced pre-impact distress in that:-

a) The descent profile did not reflect a prepared forced landing situation and there were other suitable landing sites along the descent heading upon which to force land the aircraft.

b) No distress calls were transmitted by the pilot.

c) Both engines were capable of delivering power, there were no signs of pre-impact damage, the combining gearbox and free wheel units were in satisfactory condition.

d) A full strip of the transmission indicated that it was fully serviceable.

e) Examination of flight controls indicated only post impact damage.

2.5. Wreckage findings indicated that both engine throttles were set at or below flight idle, the closed position of the particle separator doors would indicate that both engines were below flight idle. A tail rotor strike on the high tension cable, resulting in loss of approximately 10" of blade material, would cause a severe tail rotor out of balance condition and resulting vibration with a degradation of directional control. It is considered that both engines were shut down by the pilot in his attempts to lessen the effect of engine torque, which would have tended to swing the aircraft after the partial loss of the tail rotor.

2.6. The main transmission oil filler cap was not recovered. It could only come adrift because it was not properly secured or was physically removed. It was possible to

conclusively determine how long it would take for the transmission oil to be lost such that high temperature or low pressure would be indicated on the cockpit instruments and warning lights. Examination of the transmission did not reveal any evidence of internal distress due to lack of lubrication. Examination of the transmission oil temperature and pressure warning light filaments did not indicate they had been illuminated. It is considered that the missing oil cap had no bearing on the accident.

2.7. Metallurgical examinations done both locally and overseas confirmed that the tail rotor blade had struck a cable. The metallurgical findings differed only in the opinion as to which cable had been struck. It is most probable that the blade struck the steel earth cable as it was the highest cable strung across the flight path and was significantly less visible.

2.7.1. Although no damage was noted on any of the cables it is felt that the aluminium conductors, which were examined quite thoroughly, would by their nature have suffered some noticeable impact damage.

2.8. The pilot had been absent in Manila for 47 days prior to 16th December, 1982. It is noted that in the 6 days prior to the accident, he made several flights most of which were to the Western side of the Airfield. He was obviously not aware of the installation of the cables across the pylons, therefore his possible lack of knowledge on recent developments on the Eastern side of the Airfield is a [illegible] ry contributory cause to this accident.

2.9. The findings relating to bulb filament analysis were consistent with wreckage findings in that both No. 1 and No. 2 engine out warning and particle door separator doors warning lights were probably on at time of impact.

3. CONCLUSIONS

(a) FINDINGS

(i) 9M-SAA had been maintained in accordance with the approved maintenance schedule and its Certificate of Airworthiness was valid.

(ii) The Pilot-in-Command held a valid licence, his experience on Bell 212 Certificate of Airworthiness (C of A) Test Flights was however limited to single-engine climbs and in-flights relight only.

(iii) Prior to the accident the Pilot-in-Command spent a considerable time in the Philippines and was therefore not aware of recent developments relating to power line installations on the Eastern side of the airfield.

(iv) Metallurgical examination confirmed that one tail rotor blade had struck a power line cable.

(v) Both throttles were found set at below flight idle position and this was probably initiated by the Pilot-in-Command subsequent to tail rotor strike with the power line cable.

(vi) Both particle separator doors on the engines were found in the closed position as both engines were

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below flight idle.

(vii) The evidence indicates that the C of A test flight sequence was probably not observed as following completion of the No. 1 engine climb, the Pilot-in-Command probably initiated a check auto-rotation instead of a No.2 engine climb. This procedure seems to be a prevalent practice amongst pilots employed by the Company.

(viii) There was no evidence to suggest that the aircraft experienced any malfunction or failure prior to impact with the power line.

(ix) Subsequent to the tail rotor blade strike with the power line cable, difficulties were encountered in controlling the aircraft which quickly led to an uncontrolled descent.

(b) CAUSE

The accident was caused by the helicopter flying into power line cables resulting in severe tail rotor damage. Subsequently the helicopter went out of control and crashed violently killing both occupants.

The Pilot-in-Command's inexperience in C of A test flights and unawareness of recent power line installation on the Eastern side of the Airfield were contributory factors.

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4. SAFETY RECOMMENDATIONS

It is recommended that:-

4.1 The present practice relating to Pilots carrying out C of A Test flights should be reviewed as it is felt that only pilots with considerable experience should be nominated by Operators to carry out C of A test flight on Transport Category aircraft. These pilots must also be acceptable by the Civil Aviation Department Flight Examiner and Airworthiness Units prior to carrying out the C of A test flights.

4.2. Operators must be reminded on the need to observe the C of A test flight sequence and this is essential towards achieving safe execution of the Test flight.

4.3. Pilots must be adequately briefed on recent development, especially when such development may pose dangers towards safe execution of a flight.

4.4. Where power lines run in the vicinity of the Airport or at selected training areas, marker balls should be placed on these power lines to warn pilots on these potential dangers.

4.5. Cockpit Voice Recorder (CVR) should be fitted to helicopters of 2,700 kg. weight or equipped to carry 9 passengers and above to facilitate helicopter accident investigation.