RN FSAIC

Royal Navy Flight Safety
& Accident Investigation Centre

Accident Report 3/01 (Field)
Hind Mi24V SL202
On 19 October 2001

Royal Navy Flight Safety & Accident Investigation Centre
RNAS Yeovilton, YEOVIL, Somerset, BA22 8HT

Mil: [redacted] PSTN: [redacted]
Fax: [redacted] Navy E-Mail: [redacted]

Reference: FSAIC/R3/01

Advisor on Aircraft Accidents
MOD DNO/AD(PC&A)

Date: 15 January 2002

Sir

ACCIDENT TO HIND Mi24V SL202 ON 19 OCTOBER 2001

Reference:

A. DNO/49/1 dated 31 Oct 01.

In accordance with the Reference, I have the honour to forward the report by [redacted] Royal Navy and [redacted] on the investigation into the accident to Hind Mi24V, SL202 on 19 October 2001 in Sierra Leone. The aircraft crashed in a paddy field 3 miles SSW of Kenema in the Eastern Province.

I have the honour to be,
Sir,
Your obedient Servant

[redacted]

Lieutenant Commander Royal Navy
Accident Investigation Adviser

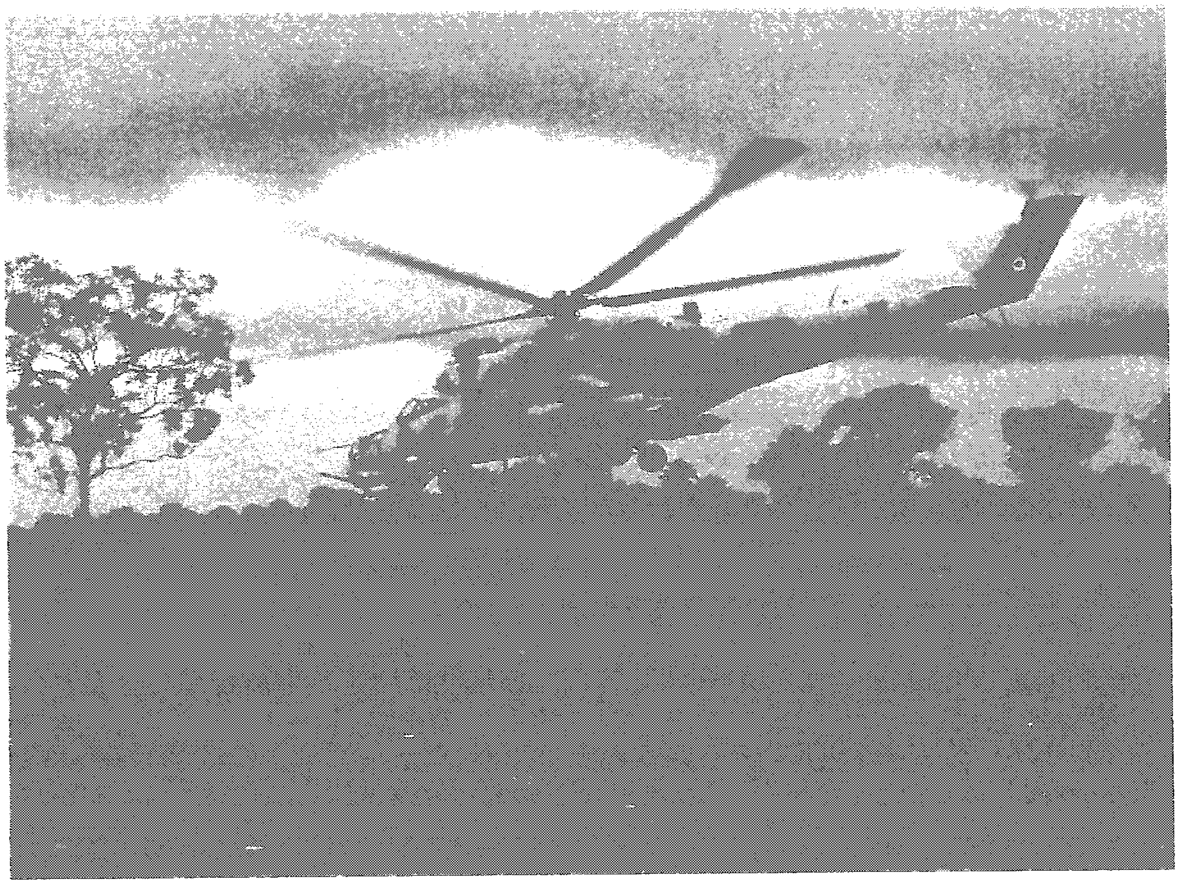
RNFSAIC

REPORT 3/01 (FIELD)

HIND Mi24V SL202

19 OCTOBER 2001

This investigation was carried out in accordance with JSP 318 (*Military Flying Regulations*) and the principles enshrined in Annex 13 to the Convention on International Civil Aviation (*Aircraft Accident Investigation*)



Photograph 1 – Hind Mi24V SL202

ROYAL NAVY FLIGHT SAFETY AND ACCIDENT INVESTIGATION CENTRE

Report Number		3/01(Field)
Operator		Jesa Air West Africa on behalf of the Sierra Leone Army
Aircraft Type	Type	Hind
	Mark	Mi24V
	Serial Number	3532423015379
	Tail Number	SL202
Place of Occurrence		Kenema, Eastern Province, Sierra Leone DGIA(UK) Series G742, Sheet 92, GR 558674
Date and Time		19 October 2001 at 0721 Hours (Zulu)

INTRODUCTION

1. On the 19 October 2001, a Sierra Leone Army (SLA) Air Wing Hind Mi24V helicopter carrying 3 passengers from the International Military Advisory Training Team (IMATT), crashed into a paddy field shortly after taking off from Kenema. The aircraft's crew of 3, and 2 of the passengers, survived the accident with minor injuries. The remaining passenger sustained serious injuries during the accident and died shortly afterwards.

2. The RNFSAIC were directed to investigate the technical and other relevant factors surrounding the accident, and to provide a Field Report detailing their findings.

FACTUAL EVIDENCE

History of Flight

3. On the 18 October 2001 the aircraft, a Mi24V Hind (Tail No. SL 202), was tasked to fly from Cockerill Barracks in Freetown Sierra Leone to HQ 3 Brigade at Kenema via Sulima. (See figure 1). The crew consisted of a pilot, co-pilot and air gunner. The pilot was an ex-South African Air Force pilot working as a civilian for Jesa Air West Africa. The co-pilot (Flight Lieutenant) and air gunner (Lance Corporal) were from the (SLA) Air Wing. The crew all occupied their normal positions in the aircraft with the pilot in the rear uppermost cockpit, the co-pilot in the front lower cockpit and the air gunner by the cabin left-hand side doorway. The aircraft was carrying 3 British Forces passengers, working for the IMATT; a Lieutenant Commander (Lt Cdr), a female Army Major and a Lance Corporal (L/Cpl) medic.

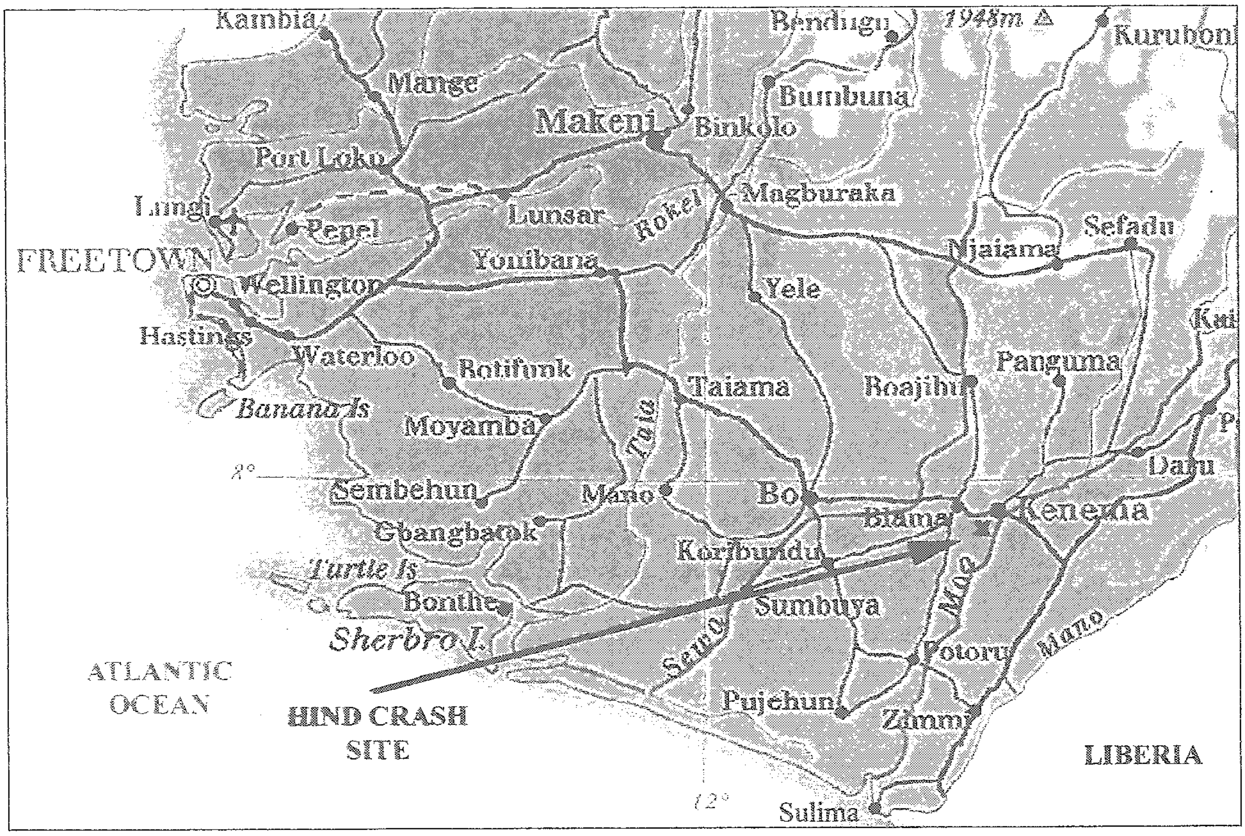


Figure 1 – Crash site location.

4. The flight from Cockerill Barracks was uneventful; the Lt Cdr was dropped off at Sulima as arranged and the aircraft continued on to Kenema as tasked. On arrival at Kenema airfield the aircraft was refueled to full (2100 litres in the main tanks and 150 litres in each of the 2 drop tanks) and then parked next to the runway at HQ 3 Brigade where protective covers were fitted. The air gunner guarded the aircraft overnight.

5. On the morning of 19 October 2001, following flight-servicing inspections carried out by 2 locally trained SLA Air Wing technicians based at Kenema and a pre-flight inspection carried out by the pilot, the aircraft took off at 0705 for the return flight to Cockerill Barracks via Sulima. The passengers were the Major and L/Cpl from the previous day and an Australian Army Major working for IMATT. The weather conditions at take-off were low cloud (100ft cloud base), an air temperature of +20°C and a 3kt wind coming from the SW.

6. Initially, the aircraft flew at low level between 200ft and 300ft above the ground for 2 minutes, but then climbed to 1000ft to avoid the low cloud. After 5 minutes the aircraft was descended to 150ft with the intention of flying below the cloud but after another 5 minutes the pilot decided to climb again as the cloud base had dropped to ground level. As soon as the pilot climbed the aircraft, there was a sudden loud continuous screeching noise that appeared to come from the area of the left-hand side engine (No 1 engine). The pilot continued to fly the aircraft up through the cloud (IFR) and while scanning his instruments noticed no warnings or abnormal indications. No abnormal vibrations were felt through the airframe at this time. Once clear of the cloud, the pilot

levelled the aircraft at 1000ft, turned the aircraft left through 180°, reduced speed to 180 km/hr and set a course back to Kenema airfield.

7. Approximately one minute later, the pilot reported that he saw the right-hand side engine (No 2 engine) vibration warning light flicker on the pilot's cockpit Centralised Warning Panel (CWP). At this time all temperature and pressure indications were within limits. The pilot then further reduced the aircraft's speed to 150 km/hr and the flickering No 2 engine vibration warning stopped. Almost immediately afterwards there was a loud bang and sparks were seen by the air gunner coming from the No 1 engine's exhaust. The No 1 engine chip warning light illuminated closely followed by an accompanying increase in the No 1 engine's oil temperature to 150°C (the gauge limit), a rapidly reducing No 1 engine oil pressure and an audio warning confirmation that the No 1 engine had failed (the aircraft is equipped with an audio voice warning system nicknamed "Natasha" that speaks in Russian). The pilot immediately selected each separate engine throttle control lever to its maximum power setting to confirm that the problem was with the No 1 engine, to ensure that the No 2 engine was functioning normally and also to prevent main rotor speed (NR) droop once the No 1 engine had been shut down. Once this was confirmed he shut the No 1 engine down by selecting the fuel flow to 'off' (HP cock) and closing the fuel shut off valve (LP cock). There was no fire indication on the cockpit instrument panel at this time but reflections of a fire in the area of the No 1 engine could be seen on the left-hand side stub wing by the aircraft passengers. The air gunner looked upwards and to the rear of the aircraft through the cabin's open left-hand side forward window and saw flames coming from the No 1 engine exhaust.

8. The pilot then directed the co-pilot to select a suitable landing site and the air gunner to warn the passengers to assume the crash position. The latter request was carried out using hand signals as the air gunner had problems hearing the pilot even though he was wearing a headset. The pilot identified a suitable landing site in a paddy field near a small village and noted that the aircraft could not maintain its NR. The pilot put the aircraft into autorotation whilst making a 'Mayday' call on 118.1MHz and lowering the undercarriage. During the autorotation, there was a bang followed by another loud continuous screeching noise and the No 2 engine chip warning light illuminated, closely followed by the No 2 engine oil temperature and oil pressure captions on the CWP. Approximately 4 small pieces of hot metal, glowing bright orange/white, entered the cabin from above and bounced around the cabin narrowly missing the air gunner's head. Because the aircraft was already in autorotation, the pilot shut down the No 2 engine by selecting the fuel flow to 'off' (HP cock) and he possibly also closed the fuel shut off valve (LP cock). During the autorotation, the aircraft characteristically yawed from left to right slightly.

9. At an altitude of 100ft, the pilot started to flare the aircraft in order to reduce forward speed and, when closer to the ground, reduced the flare to a more level attitude of 10° nose up. He then cushioned the touchdown by raising the collective. The passengers and crew reported that the aircraft made a relatively firm landing in the paddy field, bounced once and landed coming to rest with the left-hand side of the aircraft's nose wedged on a ½ metre high tree stump. This caused the aircraft to lean over on its right-hand side at an angle of 45° lying on its right-hand side stub wing. During the bounce, the decelerating tips of the tail rotor blades struck another tree stump and the soft ground causing one of the 3 blades to fracture close to its root end and depart the aircraft. Simultaneously, because the aircraft was leaning over to the right, 3 out of the 5 decelerating main rotor blades struck the soft ground on the right-hand side of the aircraft causing them to fracture approximately one

metre from their respective root ends and detach from the aircraft. The aircraft was on fire in the area around the both main engines and the front of the main rotor gearbox. This fire spread rapidly and consumed most of the aircraft apart from the tail pylon.

Photograph 2 – Hind Mi24V SL202 shortly after impact.

Aircraft Information

10. General. The Hind Mi24V helicopter (also known as the Mi35) employs a single main rotor configuration with a tail rotor. The helicopter's fuselage is of semi-monocoque, variable cross-section, all metal riveted construction and comprises a nose, centre section, tail boom and tail pylon. (See figure 2).

11. Airframe. The nose and centre sections are integral and form a common pressurized compartment for the pilots and crew. Located in the nose section are the armour plated tandem cockpits both of which are equipped with seats, appropriate instruments and flying controls. The forward lower cockpit is for the co-pilot and in addition to the flying controls is equipped with a sight and operating mechanism for the nose mounted gun. The rear upper cockpit is for the pilot. Each cockpit has its own entry hatch. The centre section houses the cabin/cargo compartment and a radio

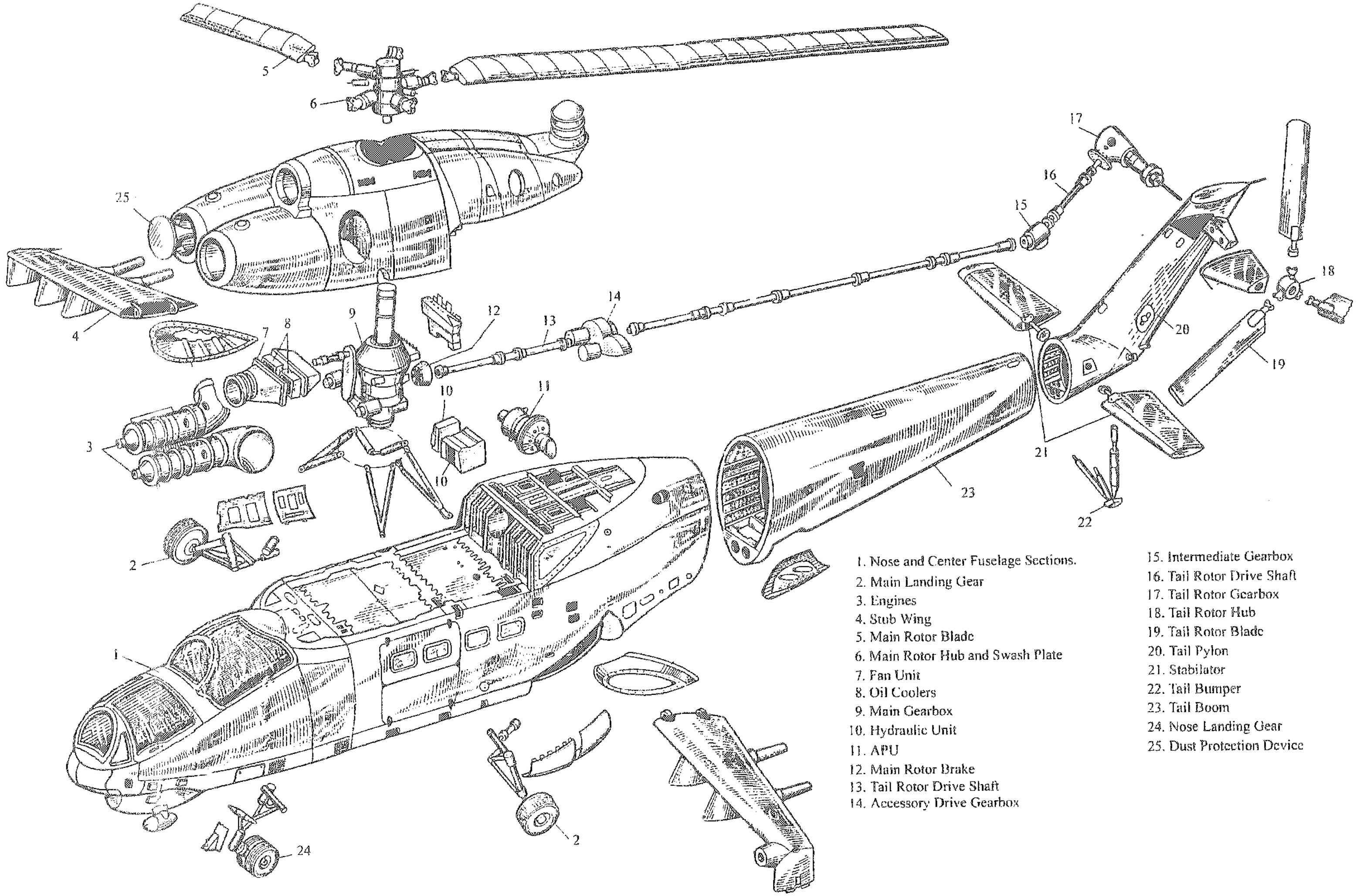


Figure 2 – Aircraft components.

equipment compartment. Its forward left-hand side and right-hand side walls are provided with doors. The cabin can be equipped with up to 8 troop-carrying seats fitted with lap straps (4 each side, fitted along the centreline facing outboard). This particular aircraft was fitted with a 2-man troop seat located at the rear end of the cabin and mounted along the centreline facing outboard to the left-hand side of the aircraft. Lap straps were not fitted.

12. The tail section comprises a tail boom and tail pylon. The pylon is fitted with an adjustable stabilator and a fixed vertical fin.

13. <u>Engines.</u> The aircraft is powered by 2 TB3-117 gas turbine engines each producing 2225 shaft horse power (SHP). The helicopter can be upgraded with the more powerful TB3-117VMA series 3 version of the engine (producing 2800 SHP) but these were not fitted to this particular aircraft. The engines are installed on top of the fuselage front centre section, each side of the aircraft's centreline.

14. These engines are similar in concept to the Rolls Royce Gnome engine as fitted to the Sea King helicopter. Each consists of the following main assemblies:

a. Dust protection particle separator intake.
b. Twelve stage axial-flow compressor.
c. Annular combustion chamber.
d. Two stage compressor turbine.
e. Two stage free-power turbine.
f. Exhaust pipe.
g. Output shaft.
h. Engine accessory drive gearbox.
i. Compressed air starter.

15. The engines are air started with compressed air fed from an AN-9B turbine Auxiliary Power Unit (APU) located behind the main rotor gearbox.

16. <u>Rotor Transmission.</u> The rotor transmission transmits the torque from the 2 main engine free-power turbines to the main and tail rotors. The main rotor gearbox (MRGB) is mounted above the fuselage centre section, directly behind the engines. Both the engine output shafts drive the MRGB via couplings with spherical splines (to accommodate misalignment). To allow for helicopter flight with 1 engine inoperative or with the main rotors windmilling in autorotation, the 2 inputs to the MRGB are fitted with free-wheel units that can automatically disengage one or both engines from the rotor transmission.

17. The MRGB supports and drives the main rotor assembly and the tail rotor through tail rotor drive shafts, an accessory gearbox, intermediate gearbox and tail rotor gearbox. The tail rotor output coupling from the MRGB is fitted with a rotor brake, which is used to reduce the rotor rundown time during shut down and to prevent the rotors from turning when the aircraft is parked. The MRGB also drives a fan unit mounted on its the forward face above and to the rear of the main engines. This fan unit is used to cool the oil in the engines and MRGB via oil coolers, as well as to cool the hydraulic

pumps and the air compressor. The hydraulic pumps and air compressor are mounted on and driven by the MRGB. Two AC generators are mounted on and driven by the accessory gearbox.

18. <u>Rotors.</u> The main rotor assembly comprises a fully articulated rotor head with 5 all metal main rotor blades (pressurized hollow leading edge alloy spar with light alloy trailing edge pockets). Collective and cyclic controls are provided by means of a swash plate. To counteract the main rotor's torque reaction and to provide directional control (yaw) of the aircraft, a tail rotor assembly is mounted on the top left-hand side of the tail pylon. The tail rotor assembly consists of a gimbal hub and 3 metal blades (non pressurized hollow leading edge alloy spar with composite covered metal, honeycomb trailing edge). To reduce main rotor loading the aircraft is fitted with an anhedral wing. This wing is of all metal construction and consists of right-hand and left-hand tapered stub wings. Each stub wing is fitted with 2 carriers for the suspension of drop tanks and weapons.

19. <u>Hydraulic Systems.</u> The aircraft has the following hydraulic power systems:

a. The main hydraulic power system.
b. The auxiliary hydraulic power system.
c. The utility hydraulic power system.

20. The main and auxiliary systems supply hydraulic power to the flying controls. The main system also provides hydraulic power to the collective pitch and throttle control lever friction clutch as well as the landing gear emergency extension system. The utility hydraulic system supplies power to operate the following systems:

a. Landing gear.
b. Yaw damper.
c. Co-pilot's cyclic engage/disengage.
d. Nose gun sight doors.

21. <u>Engine and Flying Controls.</u> The helicopter engine and flying controls comprise the following sub systems:

a. Pitch and roll (cyclic stick).
b. Yaw (rudder pedals).
c. Collective, throttle and stabilator interlink (collective lever).
d. Individual engine power, speed and shut down.
e. Spring operated artificial feel.
f. Rotor brake.

22. All the helicopter controls are duplicated in the pilot's and co-pilot's cockpits. If required, the co-pilot's cyclic stick can be disengaged and his yaw pedals retracted behind the side armour plates.

23. <u>Automatic Flight Control.</u> The aircraft is equipped with an automatic flight control system that provides stabilization in roll, pitch, yaw, height and air speed.

24. Fuel System. The helicopter fuel system consists of 5 flexible fuel tanks (2 service, 1 vertical and 2 lower) plus up to 4 additional stub wing mounted drop tanks if required. The aircraft is gravity fuelled through filler points in each of the service, vertical and drop tanks. Each engine is supplied by an independent fuel supply from its respective service tank. A network of pipelines, shutoff valves, a valve box and a check valve unit ensures a fuel supply to both engines from either service tank as required.

25. Fire Protection. The aircraft is equipped with a centralized fire protection system (utilizing 2 x 4 litre Freon charged fire extinguisher bottles with squib-mounted heads) that is intended for suppressing fires in the engine, APU, MRGB, vertical fuel tank and service fuel tank compartments of the aircraft. Fire detectors are mounted in all of these compartments. The system is designed to discharge in 2 shots; the first can be operated both automatically by the fire detectors and manually by the pilot. The second shot can only be discharged manually.

26. Landing Gear. The aircraft is fitted with a retractable tricycle landing gear comprising rear mounted main undercarriage and nose wheel. A fixed tail bumper is also fitted to the underside of the tail pylon. The main undercarriage wheels are equipped with brakes.

27. Pneumatic System. Powered by an MRGB driven air compressor, the pneumatic system provides main wheel braking, cockpit and cabin compartment door sealing and cockpit windscreen wash.

28. Flight Data Recorder. The aircraft is equipped with a CAPMM-12N flight data recorder system intended for recording analogue flight data onto photographic film. Unlike conventional flight data recording systems that run on a continuous recording loop, this system requires the film to be changed after flight. The film then needs specialized facilities in order to develop and analyze the data. These facilities are not available locally and so the system was not being utilized on this particular aircraft.

TECHNICAL INVESTIGATION

Examination of Wreckage

29. Due to the logistical difficulties of cordoning off and securing the crash site, and the high potential for the wreckage to be plundered, the larger parts of the wreckage were recovered from the location by the Royal Engineers and taken overland to a Freetown tobacco warehouse where the wreckage was examined by the 2 RNFSAIC accident investigators.

30. Initially the available major components were identified and laid out, in representative installed positions. It was very difficult to positively identify the main engines as their serial numbers had melted away in the fire and their exhaust casings were missing. Eventually a combination of photographic evidence taken shortly after the accident, when the exhausts were still partially attached, and a physical examination of each main engine, confirmed their installed positions.

31. A more detailed examination of the wreckage was then carried out revealing the following details.

32. No 1 Engine

a. The intake casting had been consumed by fire and the dust protection device inner assembly was still fitted.

b. The accessory gearbox had been consumed by fire.

c. No foreign object damage (FOD) was evident on the 1st stage variable inlet guide vanes (VIGV's).

d. No FOD was evident on the 1st stage compressor blades.

e. The VIGV external linkages were intact.

f. The free power turbine casing was fractured and holed on the engine's left-hand side. The casing was missing on the right-hand side of engine. The damage was consistent with objects passing through the casing from within. (See photographs 3 and 4).

g. The free power turbine and exhaust assembly were missing.

h. Evidence of impact damage and FOD was evident on the aft surfaces of compressor turbine rear stator blades. The impact damage and FOD appeared to have come from the free power turbine side of the stator blades.

i. The 2nd stage compressor turbine blades appeared undamaged.

33. No 2 Engine

a. The intake casting and dust protection device were completely missing.

b. The accessory gearbox had been consumed by fire.

c. The first stage VIGV blades were detached from their housings but were undamaged by FOD.

d. Some very minor areas of FOD were evident on both leading and trailing edges of the 1st stage compressor blades. The damage appeared to have come from within.

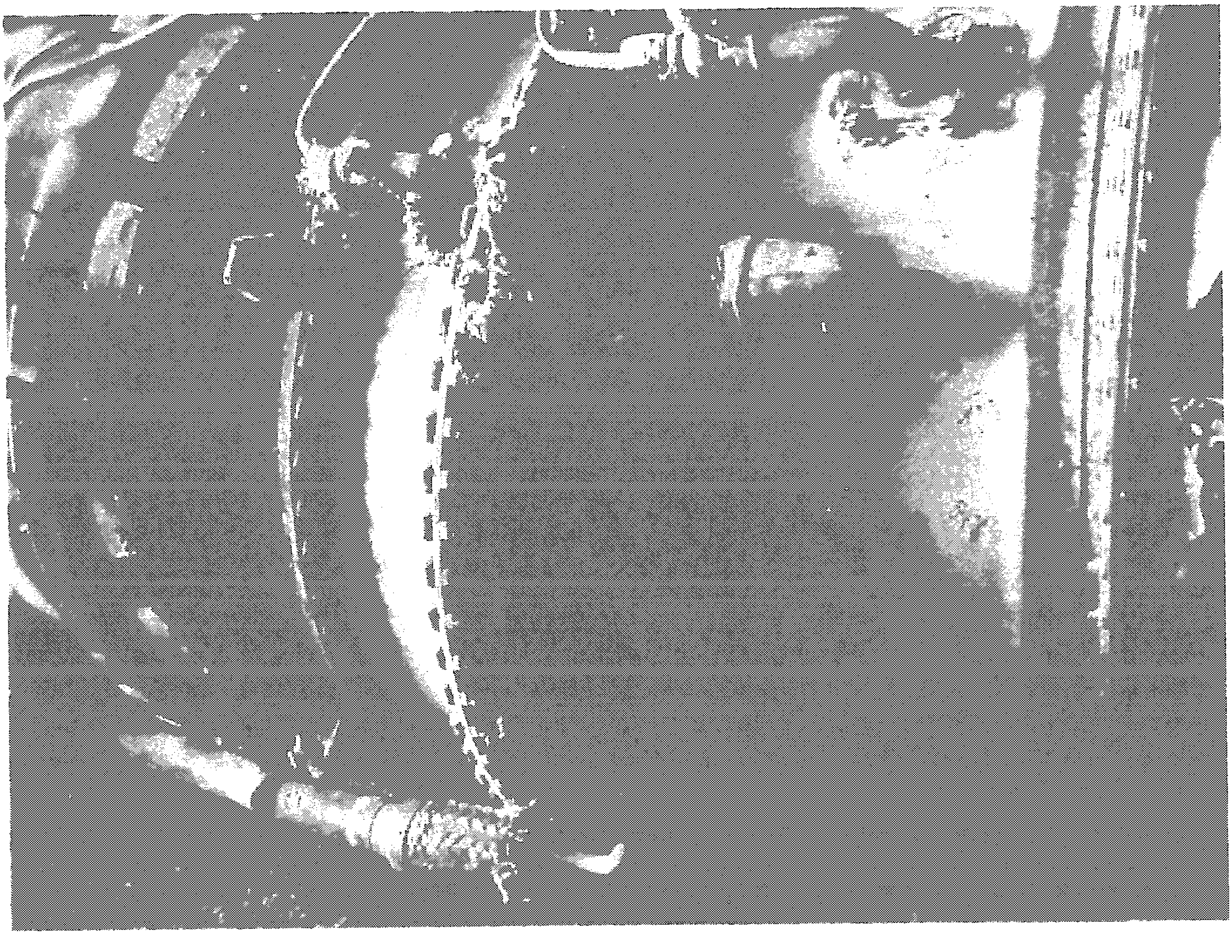
e. The VIGV external linkages were intact but the right-hand side was contaminated with ash where the engine had rolled over in the fire.

f. All the casings aft of the combustion chamber had been completely consumed by fire and exposed the compressor turbine and stator blades beneath. These blades were partially consumed by fire. (See photograph 5).

g. The right-hand side of combustion chamber had been consumed by fire where the engine had rolled over.

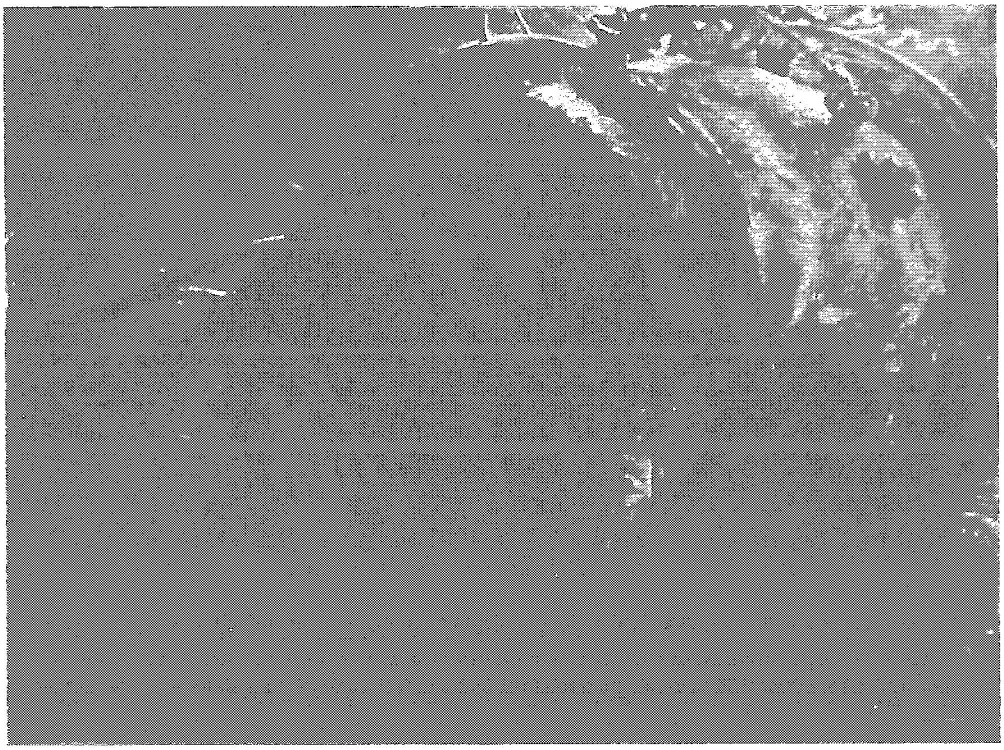
h. The compressor turbine rear stator blade assembly was detached from the engine. One third had been consumed by fire. The remainder had small areas of impact damage on the aft surfaces. The impact damage appeared to have come from the free power turbine side of the stator blades. (See photograph 6).

i. One-third segment of the free power turbine, including the complete hub, was detached from the engine. All the securing bolts were missing. The missing segments had been consumed by fire. (See photograph 7).

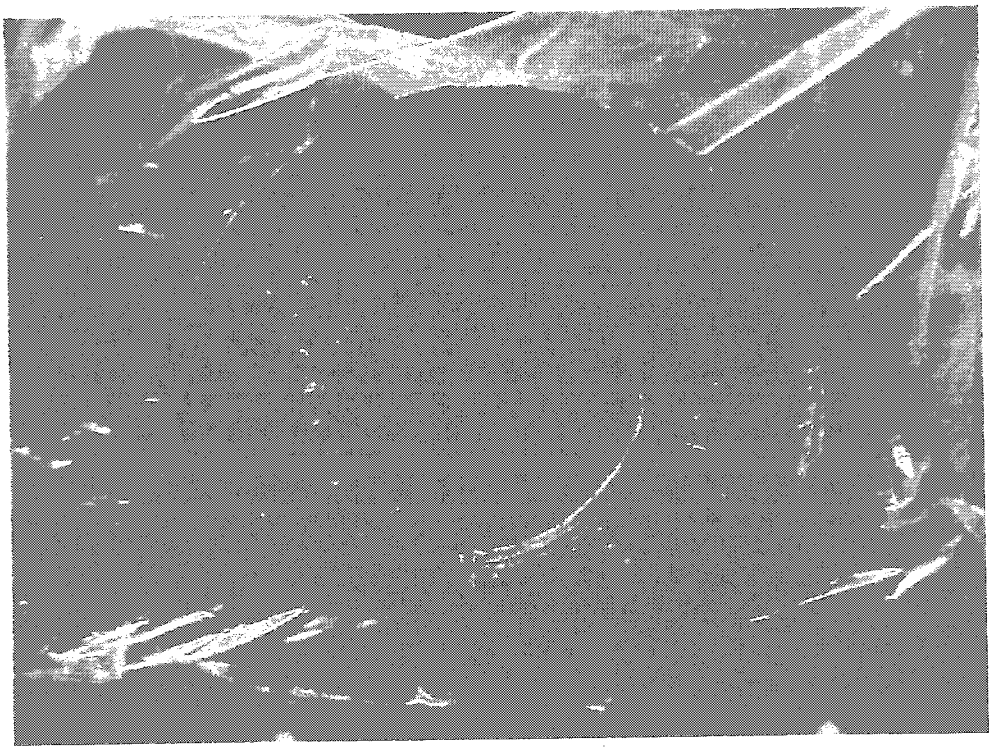


Photograph 3 - Rear of No 1 engine showing left-hand side of free power turbine casing fractured and holed.

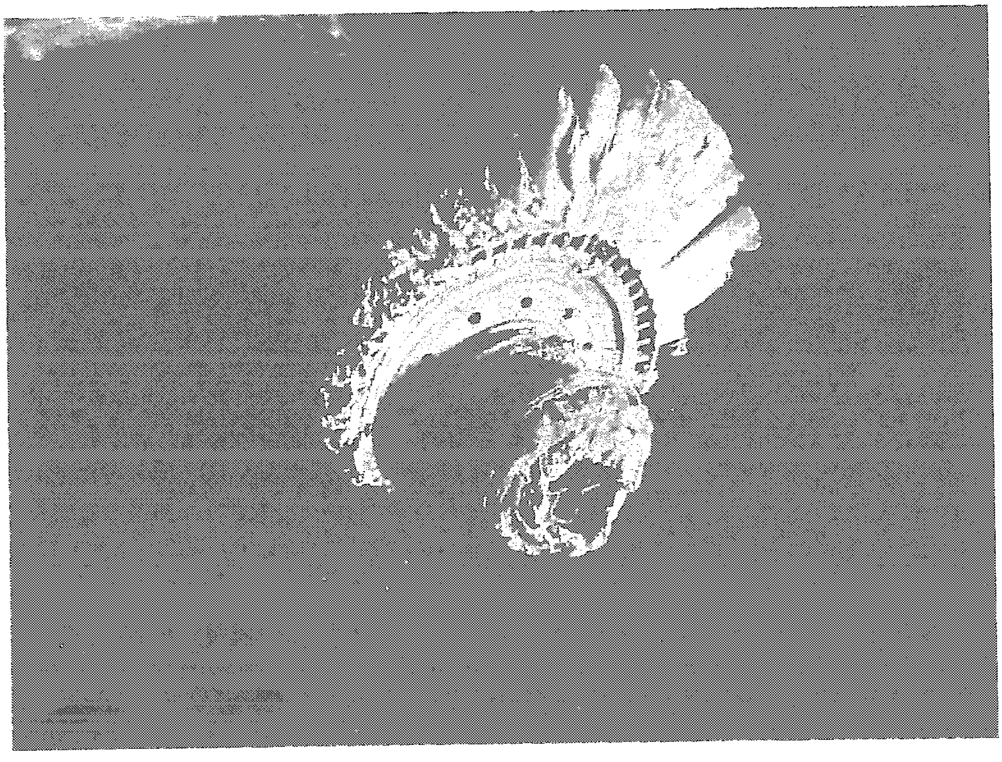
Photograph 4 - Rear of No 1 engine showing left-hand side of free power turbine casing fractured and holed and right-hand side consumed by fire.



Photograph 5 – Rear of No 2 engine showing damage to compressor turbine and stators.



Photograph 6 - Compressor turbine rear stator blade assembly from No 2 engine.



Photograph 7 - Segment of free power turbine including hub.
Believed to have come from No 2 engine.

34. APU

a. The front section of APU had been consumed by fire.

35. Oil Coolers

a. The No 2 engine oil cooler matrix and the main rotor gearbox right-hand side oil cooler matrix were complete.

36. Tail Rotor Drive

a. The No 1 tail rotor drive shaft was missing.

b The No 2 and 3 tail rotor drive shafts, with attached accessory drive gears, were complete.

c. The accessory gearbox casing had been consumed by fire.

d. The No 4, 5, 6 and 7 tail rotor drive shafts were complete. No 5 and 6 sections were slightly bent (non-torsional) and No 7 has been cut for ease of transportation during recovery just forward of the intermediate gearbox.

e. The No 8 tail rotor drive shaft was missing from the tail pylon. Evidence of fresh non-fretting damage to the tail rotor gearbox input splines suggested forced removal from wreckage.

f. The intermediate and tail rotor gearboxes were complete.

37. Tail Pylon and Tail Rotor

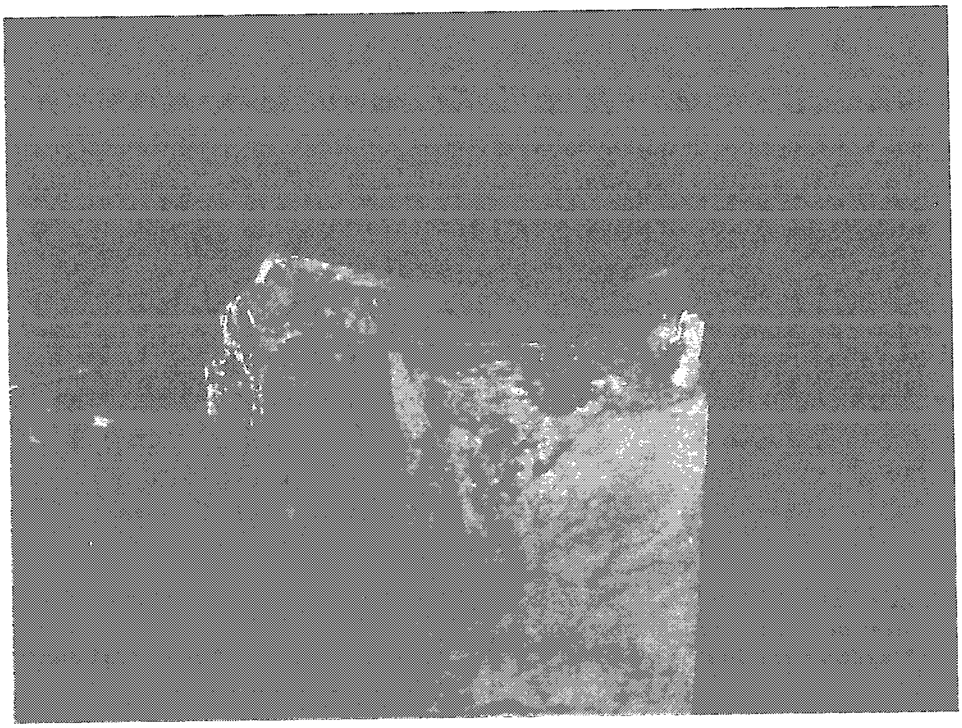
a. The lower section of tail pylon was complete with left and right stabilators and intermediate gearbox. The fibreglass skin was missing from the stabilator trailing edges. This had been removed and had not burnt.

b. The upper section of tail pylon was complete with tail rotor gearbox, tail rotor hub and tail rotor root sections.

c. Outer sections of all 3 tail rotor blades were missing with evidence of a low speed impact. One tail rotor blade had evidence of an overload fracture of its leading edge spar 460mm from the root end. (See photographs 8 and 9). The remaining 2 blade root ends had crude cut marks where they had been hacked off by wreckage plunderers. Photographic evidence taken shortly after the accident showed that these blades were slightly distorted but intact after the crash. (See photograph 10). The fractured blade was later recovered approximately 1 km from the crash site and examination confirmed an overload fracture of its leading edge spar.

d. All the tail rotor hub pitch change linkages appeared undamaged.

Photograph 8 – Tail rotor assembly showing tail rotor blade fractures. Upper blade has overload fracture of leading edge spar.



Photograph 9 – Overload fracture surface on tail rotor leading edge spar.

Photograph 10 – Tail pylon showing tail rotor bladc with low speed impact damage.

38. Misc Wreckage

a. Three main rotor blade leading edge spars were recovered. These were slightly bent along their span length and had overload fractures at the root ends.

b. Twenty two separate main rotor blade trailing edge pockets were recovered. These pockets had crude cut marks where they had been hacked off by wreckage plunderers. (See photograph 11).

39. The following items were also recovered from the wreckage:

a. One empty engine fire bottle.

b. Two stub wing weapon carriers.

c. The burnt out remains of the IR jammer.

d. Two armour plated cockpit skin panels.

e. Two empty GPMG magazines.

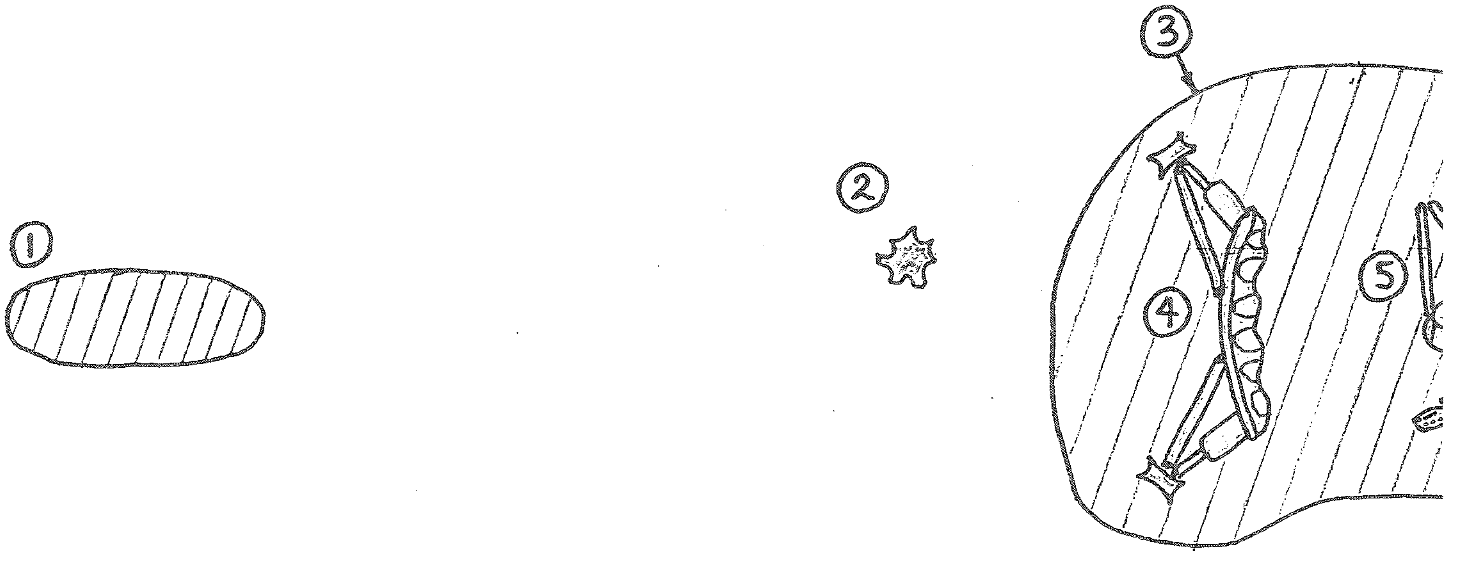
Photograph 11 – Main rotor blade leading edge spars and trailing edge pockets.

Inspection of Crash Site

40. On inspection of the crash site 25 days after the accident the impact ground marks made by the aircraft were still apparent, as were some items of wreckage. These ground marks verified the written statements made by the helicopter's passengers and crew, and supported the analysis made during the examination of the wreckage in the Freetown tobacco warehouse.

41. Whilst on site, a limited survey was carried out. (See figure 3).

CRASH SITE SURVEY CARRIED OUT ON 13TH



KEY:-

1 - INITIAL BOUNCE GROUND MARK.

2 - TREE STUMP (POSSIBLE TAIL ROTOR STRIKE MARK).

3 - AREA OF SCORCHED GROUND AND MINOR DEBRIS.

4 - MAIN UNDERCARRIAGE.

5 - MAIN ROTOR HEAD AND GEARBOX.

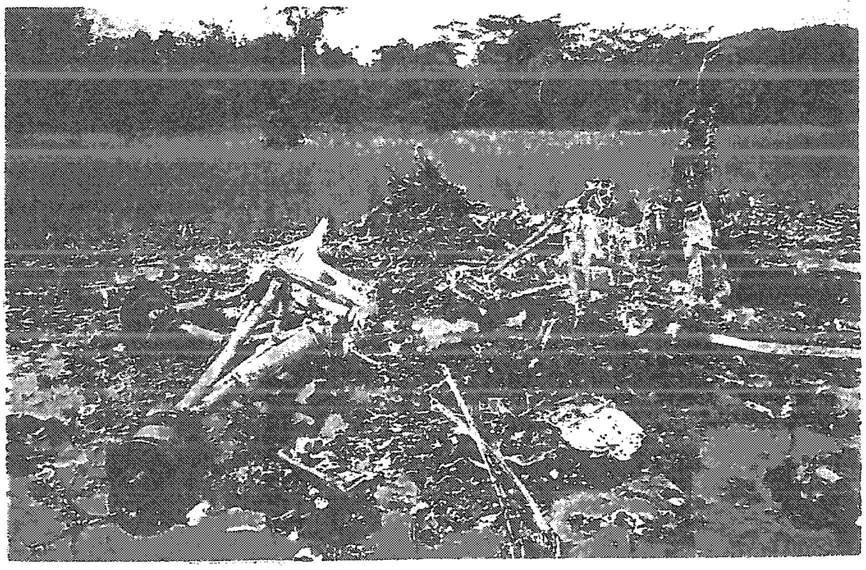
6 - COCKPIT RIGHT HAND SIDE PANEL, NOSE UNDERCARRIAGE AND NOSE GUN TURRET.

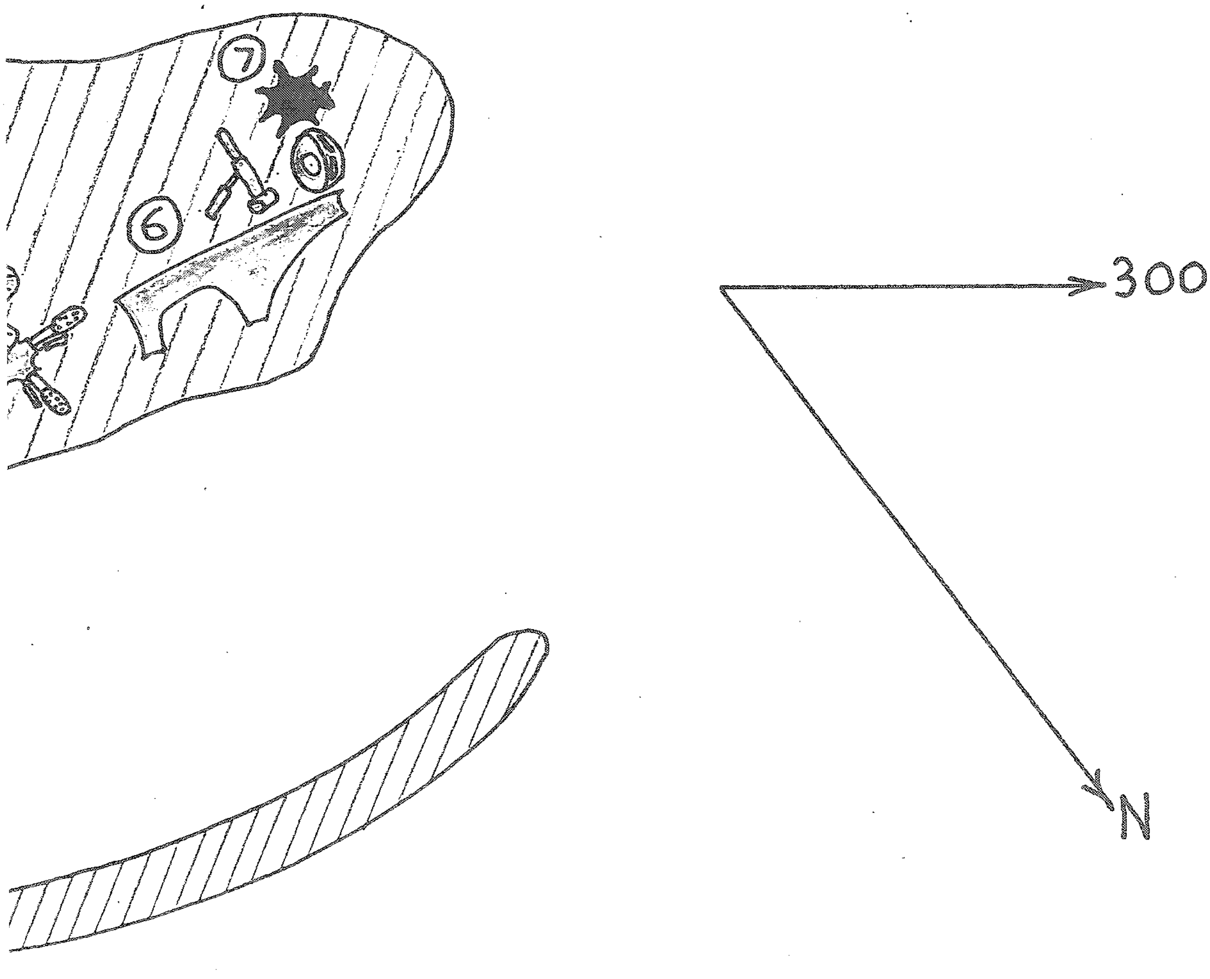
7 - BURNT TREE STUMP.

8 - GROUND MARKS FROM MAIN ROTOR BLADE STRIKES.

Figure 3

VEMBER 2001





SCALE:- 0 1 2 3 4 5 METRES

Aircraft Operation and Maintenance

42. General. The Government of Sierra Leone (GOSL) owns 2 Hind Mi24V helicopters. Jesa Air West Africa is contracted by the GOSL to operate and maintain these aircraft. This contract also tasks Jesa Air West Africa to advise the GOSL on the procurement of helicopter spare parts and other technical issues pertaining to the operation of the aircraft.

43. Operating History. The Hind aircraft in Sierra Leone are used in helicopter gunship and utility roles in support of the SLA and IMMAT. [redacted]

44. Maintenance History. The aircraft (SL202) had been correctly serviced and authorized for flight prior to the departure from Cockerill Barracks on 18 October 2001. There were no overdue maintenance operations, limitations or acceptable deferred faults that would have affected the role or performance of the aircraft for the planned sortie. [redacted]

45. Engineering Personnel. Engineering and support routines were discussed with Jesa Air West Africa's Director and the Chief Engineer. Their engineering team consisted of 5 technicians including the Chief Engineer. Four of these technicians were very experienced on the Hind aircraft, having worked on the type for many years whilst in the Ethiopian Air Force and subsequently in Sierra Leone. The fifth technician, although not experienced on the Hind, was skilled on other rotary wing aircraft types including the Puma. The technicians covered the following 3 trades:

a. Airframes and Engines.
b. Electrical and Avionics.
c. Armament.

46. Servicing Procedures. Flight Servicing and Scheduled Maintenance Operations were carried out in accordance with the following Mi35 publications:

a. Operating Instructions, Books 1-4.
** Aircraft Maintenance Manual, Topic 1.*
b. Helicopter Maintenance Schedule, Parts 1-4.
** Master Servicing Schedule, Topic 5A1.*
c. Flight Preparation and Scheduled Maintenance Procedures, Books 1-4.
** Flight Servicing Schedule Topic 5B1 and Basic Servicing Schedule, Topic 5C.*

** Denotes the British military aircraft servicing publication equivalent.*

47. Flight Servicing. The Jesa Air West Africa technicians carry out Pre-flight (Before Flight), Repeated Flight (Turn Round) and Post-flight (After Flight) Inspections as detailed in the Maintenance Schedule in accordance with Flight Preparation and Scheduled Maintenance Procedures Books 1-4. These inspections are not recorded when complied with. When the aircraft is detached, the technicians normally travel with the aircraft to carry out any flight servicing requirements. [redacted]

48. Scheduled Maintenance. Periodic Inspections are carried out on a flying hour and calendar basis in accordance with the Operating Instructions, Maintenance Schedule, Flight Preparation and Scheduled Maintenance Procedures books. These inspections are forecast, recorded and signed for in the Aircraft Documentation Book. Every 2 years a Ukrainian team from the Konotop Factory carries out a complete aircraft and system test and repair package. This maintenance work takes approximately 3 weeks to complete. This repair package (carried out on both the SLA Hinds SL201 and SL202) was most recently completed on the 23 February 2001. Although engine and transmission magnetic plugs are inspected for abnormal wear debris, routine oil samples are not taken and no facility exists for routine or suspect oil samples and magnetic plug wipes to be taken for laboratory analysis.

49. Lifed Item Component Replacement. Lifed items are forecast in the Aircraft Documentation Book and the operators have the capability to remove and install all major components when required.

50. Fault Recording, Rectification and Documentation. [redacted]

51. [redacted] The Mod Form 700 series of forms, as used to record maintenance on British military aircraft, was given as an example of the type of documentation that could be utilized. The Director is familiar with the 700 series as he used a similar system during his time with the South African Air Force. A more improved and auditable fault recording, rectification and documentation regime could be implemented reasonably quickly at Jesa Air West Africa if the funding was made available.

52. Modifications and Technical Instructions. [redacted]

53. Tool Control. A tool control system is in place. All tools are checked before use and on completion of maintenance work. [redacted]

[redacted] . There is no facility to check and calibrate torque wrenches before use.

54. Publications. The publications held by the operators (translated from Russian into English) were generally in a good state of repair : [redacted]

55. [redacted]

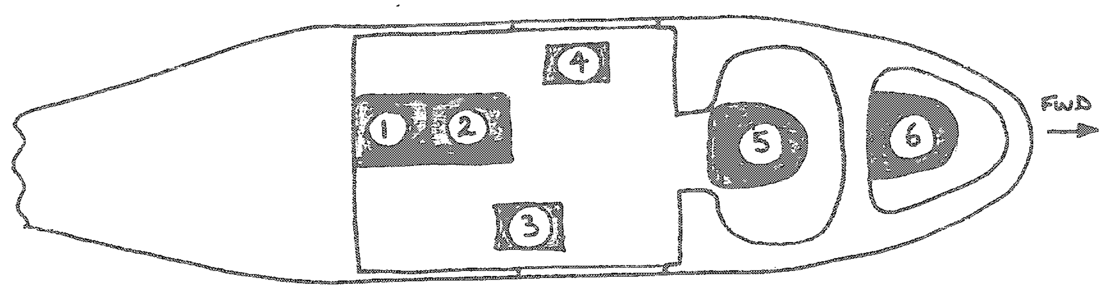
56. Quality Assurance Checks. A clause in the operator's contract allows for an internationally recognized classification society to inspect the aircraft, on a six monthly basis, to ascertain the serviceability of the aircraft in accordance with internationally recognized standards. This clause also allows for the internationally recognized classification society to inspect the aircraft and ascertain its serviceability in accordance with internationally recognized flying safety standards should any dispute on the serviceability or airworthiness arise.

Safety Procedures

57. Passenger Safety Briefings. Although the co-pilot gave the passengers a basic safety briefing before departing Cockerill Barracks on the 18 October 2001, [redacted]

58. Seating Positions. Both the pilot and co-pilot occupied their normal crew positions in their cockpits and were fully strapped into their respective seats with a 4-point harness. [redacted]

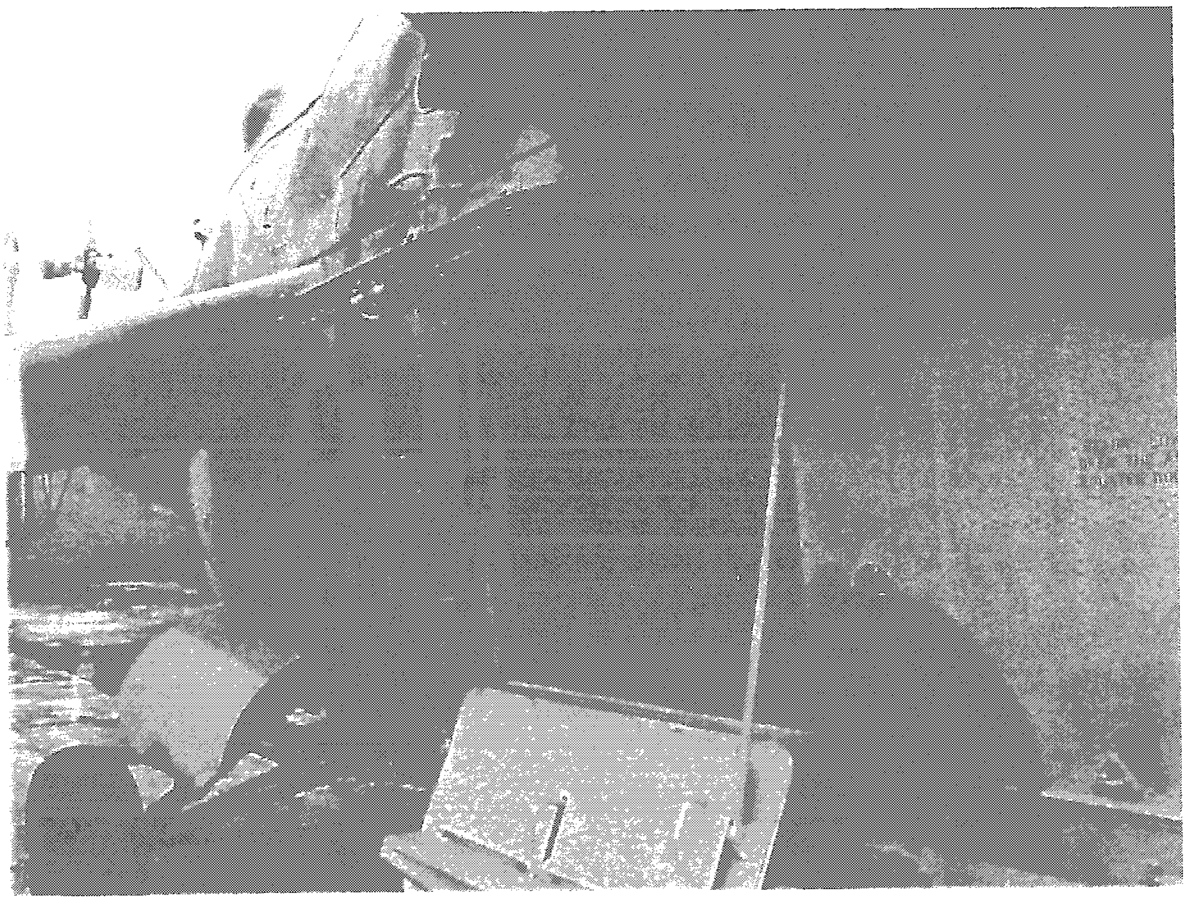
59. Safety Equipment. [redacted] .



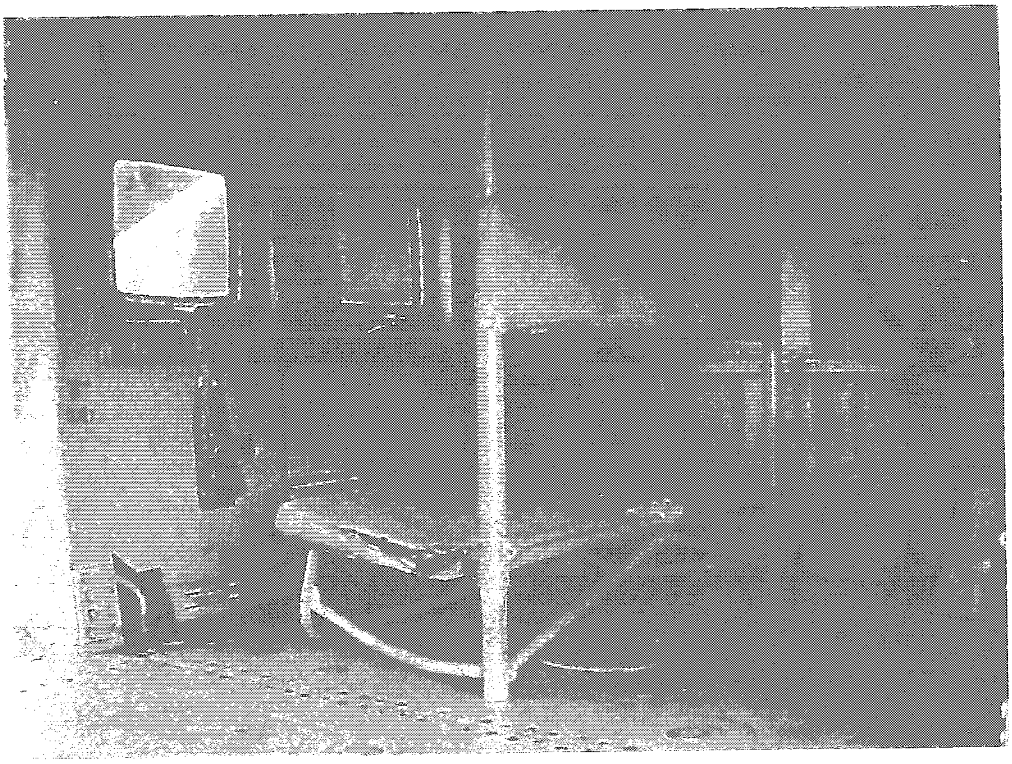
Key:

1. Australian Major.
2. Female Major.
3. L/Cpl medic.
4. Air gunner.
5. Pilot.
6. Co-pilot.

Figure 4 – Crew and passenger seating positions.



Photograph 12 – 2-Man seat installed facing right as fitted to Hind SL201.



Photograph 13 – 2-Man seat installed facing right as fitted to Hind SL201.

Egress

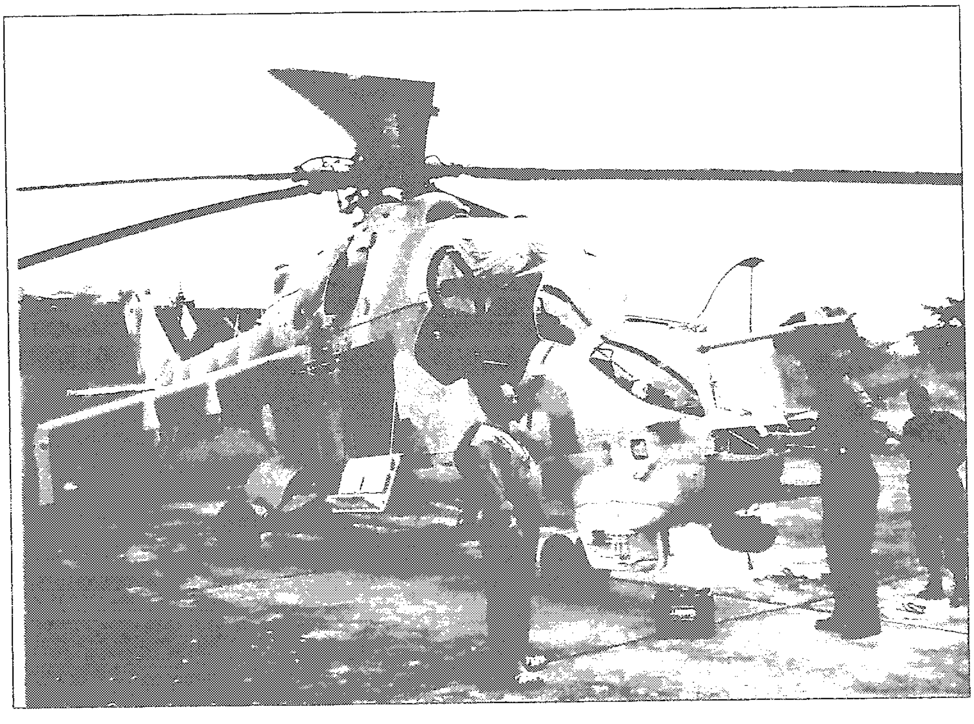
60. Once the air gunner was made aware that there was a problem with the aircraft and that the pilot was going to attempt an emergency landing, he unloaded and removed the general purpose machine gun (GPMG) from its mounting on the cabin left-hand side door forward window and placed it in front of him on the cabin floor. He then looked upwards and to the rear of the aircraft through the window and noticed flames coming from the No 1 engine's exhaust. He closed the window and [redacted]. During this time in an attempt to get into a brace position, the 2 Majors rotated their legs and torsos to the right towards the front of the aircraft and bent their upper bodies forward to get as low as possible whilst still remaining seated in the 2-man seat. The Australian Major also had his right arm placed protectively around the female Major's torso. Immediately before impact, the air gunner opened the cabin right-hand side door and [redacted]

61. After the aircraft had come to rest, the co-pilot immediately opened his cockpit canopy (which hinges on the right-hand side and opens upwards on the left-hand side of the aircraft, (see photograph 14) climbed out of his cockpit and ran out to the front left away from the aircraft for a distance of approximately 5 metres. He then stopped and looked back towards the aircraft and noticed that the damaged main rotor blade root ends were still turning very slowly and the area around both main engines and the front of the main rotor gearbox was on fire. He shouted a warning to get out of the aircraft to the other aircraft occupants. Almost immediately afterwards, the air gunner and the L/Cpl medic climbed out through the cabin's open right-hand side door. The air gunner and the medic

crawled away to the front right of the aircraft for a distance of approximately 7 metres. The medic then stood up and ran for a further 3 metres away from the aircraft. The air gunner went back towards the aircraft and opened the pilot's cockpit canopy (which hinges at the rear and opens rearwards on the right-hand side of the aircraft (see photograph 14). At the same time the Australian Major guided the female Major to the cabin's open right-hand side door, he then climbed out through the door, crawled under the rear of the fuselage and moved away to the left of the aircraft for a distance of approximately 15 metres. The Australian Major then circled around towards the front of the aircraft maintaining his distance from the wreckage.

62. Just after the aircraft had come to rest, [redacted] he discovered that his cockpit canopy was partially open (having been opened by the air gunner). Because the aircraft was lying at an angle of 45° on its right-hand side and the canopy opened on the right-hand side of the aircraft, the door was prevented from opening fully by the ground. The pilot attempted to operate the fire extinguisher buttons, ensured that both engine fuel shut off levers were retarded (LP cocks) and possibly operated the rotor brake. With the severely damaged main rotor blades stationary, the pilot unfastened his 4-point harness and with difficulty exited through the partially open cockpit canopy. The pilot made his way towards the front of the aircraft for a distance of approximately 10 metres.

63. It was soon noted that the female Major was not clear of the aircraft and that she was crouching on her hands and knees on the ground next to the right-hand side of the cabin doorway. The air gunner closely followed by the pilot and the Australian Major, ran to her assistance and pulled her clear to the right-hand side of the aircraft for a distance of approximately 15 metres. By now the aircraft fire had intensified causing the ammunition from the GPMG and the nose gun to "cook off". All the personnel took cover in their various locations around the crash site.



Photograph 14 – Hind SL201 showing opened cockpit and cabin doors.

64. Once the explosions, caused by the ammunition, had stopped it was noted by the Australian Major and the air gunner that the female Major was not moving. They carried her to the edge of the paddy field onto firmer ground where, having established that she had stopped breathing, the medic and the Australian Major gave her Cardio Pulmonary Resuscitation (CPR). The female Major was transported via HQ 3 Brigade, by a combination of pickup truck and ambulance to Kenema hospital where she was pronounced dead. Identifying the cause of her death did not form part of this investigation.

ANALYSIS

The Flight

65. The crew was correctly constituted for the intended mission. They were fit to fly but the weather posed some constraints on the sortie. Safety briefings were given to the passengers who departed with the aircraft from Cockerill Barracks the day before the accident; [redacted] The aircraft was manned without incident and the take-off and initial 12 minutes of flight were uneventful.

66. When the initial indication that something was wrong occurred (loud screeching noise from the No 1 engine), the pilot continued to fly the aircraft up through the cloud (IFR), as there were no warnings or abnormal indications from his cockpit instruments. Once clear of the cloud, the pilot levelled the aircraft, reduced its speed to 180 km/hr and set a course to return to the airfield at Kenema.

67. Shortly afterwards, the No 2 engine vibration warning light flickered on the pilot's CWP, but other cockpit indications were still normal. When he further reduced the aircraft's speed to 150 km/hr, the flickering No 2 engine vibration warning stopped.

68. Almost immediately afterwards, when there was a loud bang, events happened very quickly. The loud bang was closely followed the No 1 engine's chip warning indication accompanied by an increase in the No 1 engine's oil temperature, a rapidly reducing No 1 engine oil pressure and audio confirmation that the No 1 engine had failed. The pilot immediately selected each separate engine throttle control lever to its maximum power setting to confirm that the problem was with the No 1 engine, to ensure that the No 2 engine was functioning normally and also to prevent NR droop once the No 1 engine had been shut down. Once this was confirmed the pilot then shut the No 1 engine down by selecting the HP cock to 'off' and closing the LP cock. The pilot had no fire indication on his cockpit instrument panel at this time but reflections of a fire in the area of the No 1 engine could be seen on the left-hand side stub wing by the aircraft passengers and the air gunner could see flames coming from the No 1 engine exhaust as he looked upwards and to the rear of the aircraft through the cabin's open left-hand side forward window. Both these observations confirmed that the No1 engine was actually on fire and that the pilot had shut down the correct engine.

69. By now the pilot was aware that the aircraft could not maintain its NR with just the No 2 engine running and having selected a suitable landing site elected to put the aircraft into autorotation. Whilst in autorotation, the pilot transmitted a 'Mayday' and lowered the aircraft's undercarriage in preparation for the landing. Moments later there was a second loud bang and all the cockpit instrumentation indication that the No 2 engine had failed (chip warning, increase in oil temperature, rapidly reducing oil pressure and audio confirmation). The pilot had no option but to shut down the No 2 engine as well.

70. Faced with this unusual and difficult emergency, the pilot carried out a safe engine off landing into the only available landing site. The aircraft made a relatively firm landing into the paddy field with a nose up attitude of approximately 10° and its wings level. Immediately after landing the aircraft bounced once with forward inertia and came to rest with the left-hand side of its nose resting on a ½ metre high tree stump, which caused the aircraft to lean over in the soft ground onto its right-hand side stub wing at an angle of 45°. The fire in the No 1 engine spread rapidly to the rest of the aircraft. The impact was survivable.

Survival Aspects

71. After the aircraft had come to rest, all of the aircraft occupants had remained in the same position that they had been in prior to impact. The co-pilot immediately released his 4-point harness, opened his cockpit canopy and exited the aircraft on its left-hand side. He did not wait for the main rotor blades to stop turning before making his escape. Fortunately because the aircraft was leaning over on its right-hand side and he'd exited from its left-hand side, he was not struck by any of the rapidly decelerating blades.

72. [redacted]. Immediately before impact, the air gunner opened the cabin right-hand side door and then returned to his [redacted]. Once the aircraft had come to rest, the air gunner climbed out through the cabin's open right-hand side door, closely followed by the medic. They were both aware that the main rotor blades could still be turning and crawled away from the right-hand side of the aircraft to what they considered to be a safe distance (approximately 7 metres) before standing up and running for a further 3 metres. They were both in fact very fortunate that 3 of the main rotor blades had already struck the ground on the aircraft's right-hand side causing them to fracture approximately one metre from their respective root end and depart the aircraft. Their impact with the ground had caused the remaining 2 main rotor blades to decelerate and to stop very quickly.

73. The Australian and female Majors were both sitting on the 2-man troop seat during the accident. [redacted], they both adopted a brace position by rotating their legs and torsos to the right towards the front of the aircraft and bending their upper bodies forward to get as low as possible whilst still remaining seated. The Australian Major also had his right arm placed protectively around the female Major's torso. They both remained in their seats during the impact and once the aircraft had come to rest, the Australian Major guided the female Major to the cabin's open right-hand side doorway and climbed out. He was not aware of any problems with the female Major. Also aware that the main

rotor blades could still be turning, and noting that the aircraft was leaning over on its right-hand side, he crawled under the rear of the aircraft and then moved away from the aircraft's left-hand side. The female Major remained just outside the aircraft crouched on her hands and knees on the ground next to the cabin's right-hand side doorway. She was later pulled clear to the right-hand side of the aircraft by the air gunner, pilot and Australian Major.

74. The reason the pilot [redacted] is not known but when he came round, he discovered that his cockpit canopy was already open (having been opened by the air gunner when he returned to the aircraft). Because the aircraft was leaning over to the right at an angle 45°, the pilot's cockpit canopy could not be fully opened due to its contact with the ground. He looked up and to the left-hand side of the aircraft and could see that the area around the No 1 engine was on fire, he then made an attempt to operate the fire extinguisher buttons but because the inertial reel in his harness had locked in the impact, and the angled condition of the aircraft, had difficulty reaching the fire buttons located on the left-hand side of the instrument panel. The pilot however, managed to ensure that both engine LP cocks were closed and possibly operated the rotor brake before, with some difficulty, releasing his 4-point harness and falling out of the right-hand side of the aircraft. With the main rotor blades completely stopped the pilot then made his way towards the front of the aircraft for a distance of approximately 10 metres.

Technical Investigation

75. [redacted] Although the engine magnetic plugs are inspected for excess wear debris as part of the aircraft's routine servicing, no other health monitoring of the engine oil wetted components is carried out and no routine or suspect oil samples are sent for laboratory analysis. Analysis of the sequence of events leading up to the accident indicate that the helicopter's No 1 engine failed closely followed by the failure of the No 2 engine.

76. The physical examination of the No 1 engine revealed that there had been a break-out of the stage 1 free power turbine as the sections of the free power turbine casing were either missing or showing outward deflection marks and rubbing where it had been holed. Supporting this evidence, some of the external dressings and pipelines had been severed at the same axial location as the stage 1 free power turbine rotor. Approximately 50% of the free power turbine casing was missing and the fractured edges revealed no signs of burning or melting. The complete support assembly for the free power turbine bearing housing was missing as was the free power turbine assembly itself. Although the reason for the No1 engine's stage 1 free power turbine to have suffered an uncontained failure cannot be positively determined, the possibility that the engine could have ingested something can be discounted as the inspection of the No1 engine's compressor and compressor turbine revealed that these forward parts of the engine had not been affected by FOD. It is therefore considered probable that the bearing assembly supporting the No1 engine free power turbine assembly had failed, leading to an initial vibration followed by an imbalance of the free power turbine, bearing break up and subsequent catastrophic failure of the free power turbine. Although it was the No 2 engine's vibration warning that was the initial cockpit indication that something was wrong, it is possible that the vibration from the failing No 1 engine free power turbine support bearing was initially so high

that it triggered the adjacent No 2 engine's vibration warning instead. It is also possible that the No 1 engine's vibration warning system was actually unserviceable as the warning light did not illuminate even during the latter stages of the No 1 engine failure.

77. The physical examination of the No 2 engine also revealed that the free power turbine area of the engine was missing with no indications of FOD to the compressor. It is considered most likely that the one-third segment of a stage 2 free power turbine that was recovered originated from this engine as the No 1 free power turbine had suffered an uncontained catastrophic failure and there was no melting of the turbine's casing. The No 2 engine's free power turbine, compressor turbine and combustion chamber casings and the compressor turbine rear stator assembly however, all showed signs of melting as did the segment of stage 2 free power turbine itself (the free power turbine blades are made of a nickel based nimonic ATA alloy that melts at 1400°C and the compressor turbine rear stator assembly is made from an austenitic heat resisting stainless steel that melts between 1400°C and 1500°C).

78. Given that the No 1 engine failed first and that its free power turbine's break up was uncontained, it is considered most probable that some fragments from the No 1 engine's stage 1 free power turbine penetrated the inter-engine fire shield and then the free power turbine casing of the No 2 engine causing the No 2 engine to fail. No remains of the inter-engine fire shield were recovered to support this theory.

79. No evidence from the history of flight and examination of the wreckage would suggest that there had been any problems with the aircraft's rotors and transmission preceding the accident.

Aircraft Operation and Maintenance

80. [redacted]

81. Although the aircraft was being maintained correctly in accordance with the aircraft maintenance schedules by experienced engineering personnel, there was no requirement in the current regulations for minor work to be certified and recorded. Both the Jesa Air West Africa Director and the Chief Engineer stated that a more detailed system of fault recording, rectification and documentation would be desirable and that they were ready and willing to implement one if sufficient funds were available to have the required forms printed. The Director is familiar with the Mod Form 700 series of forms, as used to record maintenance on British military aircraft, as he used a similar system during his time with the South African Air Force. The operation would benefit if a superior and accountable fault recording, rectification and documentation regime were implemented.

82. [redacted]

83. [redacted]

84. [redacted].

85. [redacted]

86. A clause in the operator's contract allows for an internationally recognized classification society to inspect the aircraft, on a six monthly basis, to ascertain the serviceability of the aircraft in accordance with internationally recognized standards. This clause also allows for the internationally recognized classification society to inspect the aircraft and ascertain its serviceability in accordance with internationally recognized flying safety standards should any dispute on the serviceability or airworthiness arise. Under the current contract, these quality assurance checks are now due.

CONCLUSIONS

Findings

87. The Flight:

a. The crew were correctly constituted and fit to fly for the intended mission.

b. The weather conditions posed some constraints on the sortie.

c. Safety briefings were given to the passengers who departed with the aircraft from Cockerill Barracks the day before the accident; [redacted]

d. [redacted].

e. [redacted]

f. The aircraft was manned without incident and the take-off and initial 12 minutes of flight were uneventful.

g. Immediately after the pilot climbed the aircraft from low level a loud screeching noise came from the No 1 engine. The pilot continued to climb the aircraft up through the cloud, as there were no warnings or abnormal indications from his cockpit instruments at this time.

h. Once clear of the cloud, the pilot levelled the aircraft, reduced its speed to 180 km/hr and set a course to return to the airfield at Kenema.

i. Shortly afterwards the No 2 engine vibration warning light flickered on the pilot's CWP. At this time all other cockpit indications were normal.

j. When the pilot further reduced the aircraft's speed to 150 km/hr, the flickering No 2 engine vibration warning stopped.

k. Almost immediately afterwards there was a loud bang closely followed by the No 1 engine's chip warning indication, an increase in the No 1 engine's oil temperature, a rapidly reducing No 1 engine oil pressure and audio confirmation that the No 1 engine had failed.

l. The pilot shut down the No 1 engine using the correct actions.

m. At this time the pilot had no fire indications on his cockpit instrument panel but reflections of a fire in the area of the No 1 engine could be seen on the left-hand side stub wing by the aircraft passengers and the air gunner could see flames coming from the No 1 engine's exhaust.

n. The pilot could not maintain the aircraft's NR with just the No 2 engine running and having selected a suitable landing site elected to put the aircraft into autorotation.

o. The pilot transmitted a 'Mayday' and lowered the aircraft's undercarriage in preparation for the landing.

p. Moments later there was a second loud bang and all the cockpit instruments indicated that the No 2 engine had failed.

q. The pilot shut down the No 2 engine.

r. The pilot positioned the aircraft for an engine off landing.

s. The aircraft made a safe, relatively firm, landing with a nose up attitude of approximately 10° and wings level.

t. Immediately after landing the aircraft bounced once and came to rest with the left-hand side of its nose resting on a tree stump, which caused the aircraft to lean over in the soft ground onto its right-hand side stub wing at an angle of 45°.

u. During the landing one of the tail rotor blades struck a tree stump and fractured at its root end and 3 of the main rotor blades struck the soft ground on the right-hand side of the aircraft causing them to fracture at their root ends.

v. The fire in the No 1 engine spread rapidly to the rest of the aircraft.

88. Survival Aspects:

a. The pilot and co-pilot were correctly strapped into their cockpit seats.

b. The Australian and female Majors were both sitting on the 2-man troop seat during the flight.

c. [redacted]

d. The Australian and female Majors both adopted a brace position by rotating their legs and torsos to the right towards the front of the aircraft and bending their upper bodies forward to get as low as possible whilst still remaining seated. The Australian Major also had his right arm placed protectively around the female Major's torso during the emergency.

e. [redacted]

f. [redacted]

g. Immediately before impact, the air gunner opened the cabin right-hand side door [redacted]

h. Although the aircraft had come to rest, the co-pilot unstrapped from his seat and vacated the aircraft before the main rotor blades had stopped turning.

i. Once the aircraft had come to rest, the air gunner climbed out through the cabin's open right-hand side door, closely followed by the medic. The main rotor blades were possibly turning very slowly at this time.

j. Once the aircraft had come to rest, the Australian Major guided the female Major to the cabin's open right-hand side doorway and climbed out.

k. The Australian Major, aware that the main rotor blades could still be turning, and noting that the aircraft was leaning over on its right-hand side, crawled under the rear of the aircraft and then moved away from the aircraft's left-hand side.

l. The female Major remained just outside the aircraft crouching on her hands and knees on the ground next to the cabin's right-hand side doorway and was pulled clear to the right-hand side of the aircraft by the air gunner, pilot and Australian Major.

m. The air gunner opened the pilot's cockpit canopy when he returned to assist the female Major. The pilot's canopy would not fully open due to its contact with the ground.

n. [redacted]

o. [redacted] the pilot discovered that his cockpit canopy was already open and that the area around the No 1 engine was on fire.

p. The pilot had difficulty operating the fire extinguisher buttons because his harness inertial reel had locked in the impact and he could not reach the fire buttons.

q. The pilot managed to ensure that both engine LP cocks were closed and possibly operated the rotor brake.

r. The pilot, with some difficulty, released his 4-point harness and fell out of the right-hand side of the aircraft. With the main rotor blades completely stopped, he vacated the aircraft.

s. The female Major died shortly after the accident from causes unknown.

t. The accident was survivable.

89. Technical Investigation:

a. Routine maintenance and documentation for the aircraft for flight were correct [redacted]

b. The No1 engine's stage 1 free power turbine suffered an uncontained failure.

c. The No 1 engine did not ingest FOD prior to its failure.

d. It is considered probable that the bearing assembly supporting the No1 engine free power turbine assembly failed, leading to an initial vibration followed by an imbalance of the free power turbine, bearing break up and subsequent catastrophic failure of the free power turbine.

e. The reason for the No 1 engine free power turbine support bearing failure could not be positively determined.

f. The initial cockpit indication that something was wrong was the No 2 engine's vibration warning.

g. It is possible that the vibration from the failing No 1 engine free power turbine support bearing was initially so high that it triggered the adjacent No 2 engine's vibration warning.

h. It is also possible that the No 1 engine's vibration warning system was unserviceable.

i. The No 2 engine failed shortly after the No 1 engine had been shut down and the aircraft had entered autorotation.

j. The No 2 engine's free power turbine area was missing with its free power turbine, compressor turbine and combustion chamber casings and the compressor turbine rear stator assembly showing signs of melting.

k. The No 2 engine did not ingest FOD prior to its failure.

l. Fragments from the No 1 engine's uncontained stage 1 free power turbine most probably penetrated the inter-engine fire shield and then the No 2 engine free power turbine casing causing the No 2 engine to fail.

90. Aircraft Operation and Maintenance:

a. [redacted]

b. Although the aircraft was maintained correctly in accordance with the aircraft maintenance schedules by experienced engineering personnel, there was no requirement in the current regulations for minor work to be certified and recorded.

c. The aircraft maintenance operation would benefit if an improved and auditable fault recording, rectification and documentation regime were implemented such as the Mod Form 700 series of forms.

d. [redacted]

e. A tool control system is in place but this is not documented.

f. [redacted]

g. There is no facility to check and calibrate torque wrenches before use.

h. Flight Servicing and Scheduled Maintenance Operations are being carried out in accordance with Mi35 maintenance publications. [redacted]

i. [redacted]

j. A clause in the operator's contract allows for an internationally recognized classification society to inspect the aircraft, on a six monthly basis, to ascertain the serviceability of the aircraft in accordance with internationally recognized standards. This clause also allows for the internationally recognized classification society to inspect the aircraft and ascertain its serviceability in accordance with internationally recognized flying safety standards should any dispute on the serviceability or airworthiness arise. Under the current contract, these quality assurance checks are now due.

Causes

91. The investigation identified the following causal factors:

a. The accident was caused following an emergency engine off landing into a paddy field as a result of double engine failure in flight.

b. The No 2 engine failed and was shut down as a result of damage sustained most probably from penetrating fragments from the uncontained failure of No 1 engine.

c. The No 1 engine suffered a catastrophic uncontained failure and fire and was shut down.

d. The No 1 engine support bearing assembly of the free power turbine probably failed following an initial vibration, an imbalance of the free power turbine, bearing break up and subsequent catastrophic breakout of the free power turbine.

e. A contributory cause for the failure of No 1 engine may be the effect of frequently operating the engines above their maximum temperature limitations.

f. [redacted]

SAFETY RECOMMENDATIONS

92. The following safety recommendations are made:

a. [redacted]

b. [redacted]

c. Jesa Air West Africa should be given the opportunity to send routine or suspect oil samples and magnetic plug wipes to a laboratory facility for analysis.

d. Jesa Air West Africa should be funded in order to implement an updated, auditable and improved aircraft fault reporting, rectification and documentation regime such as the Mod form 700 series of forms.

e. [redacted]

f. Jesa Air West Africa should be equipped with the means to download the data from the aircraft's flight data recorder.

g. [redacted]

h. [redacted]

i. Quality assurance checks by an internationally recognized classification society should be carried out on the remaining SLA Air Wing aircraft.

j. [redacted]

k. [redacted]

l. [redacted]

m. [redacted]

n. [redacted]

o. To improve reliability and performance, the remaining SLA Air Wing Hind Mi24V helicopter should be fitted with the uprated TB3-117VMA series 3 version main engines at the earliest opportunity.

p. The cause of death of the female Major should be established separately and any safety feedback should be added to these findings.

Charge Chief Petty Officer
Assistant Investigator

Lieutenant Royal Navy
Investigating Officer