AIRCRAFT ACCIDENT REPORT

PAAN/2004/07/26/F

Accident Investigation Bureau

Report on the Accident to a Pan African Airlines Nigeria Ltd Bell 412 EP Helicopter with registration 5N-BDZ which occurred near SEDCO Energy Rig Platform, Off Nigeria's Southern Coastline on 26th July, 2004

This report was produced by the Accident Investigation Bureau (AIB), Murtala Muhammed Airport, Ikeja, Lagos.

The report is based on the investigation carried out by the Accident Investigation Bureau, in accordance with Annex 13 to the Convention on International Civil Aviation, Nigerian Civil Aviation Act 2006, and Civil Aviation (Investigation of Air Accidents and Incidents) Regulations 2016.

In accordance with Annex 13 to the Convention on International Civil Aviation, it is not the purpose of aircraft accident/serious incident investigations to apportion blame or liability.

Readers are advised that the Accident Investigation Bureau investigates for the sole purpose of enhancing aviation safety. Consequently, AIB reports are confined to matters of safety significance and should not be used for any other purpose.

Accident Investigation Bureau believes that safety information is of great value if it is passed on for the use of others hence, readers are encouraged to copy or reprint for further distribution, acknowledging the Accident Investigation Bureau as the source.

Safety Recommendations in this report are addressed to the Regulatory Authority of the State (NCAA). This Authority ensures enforcement.

Printed in Nigeria for the Accident Investigation Bureau (AIB)

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GLOSSARY OF ABBREVIATIONS USED IN THIS REPORT

AIB	Accident Investigation Bureau
AIPB	Accident Investigation & Prevention Bureau
ANR	Air Navigation Regulation
ATPL	Airline Transport Pilot Licence
C of A	Certificate of Airworthiness
CRM	Crew Resource Management
CSO	Cycle Since Overhaul
CVR	Cockpit Voice Recorder
ELT	Emergency Locator Transmitter
FDR	Flight Data Recorder
GPS	Global Positioning System
HF	High Frequency
HLO	Helicopter Landing Officer
hPa	Hectopascal
ICAO	International Civil Aviation Organization
MEL	Minimum Equipment List
N/A	Not Available
NCAA	Nigerian Civil Aviation Authority

NCARs	Nigeria Civil Aviation Regulations
NIMET	Nigerian Meteorological Agency
NM	Nautical Mile
NTSB	National Transportation Safety Board, U.S.A
PAAN	Pan African Airlines Nigeria Ltd
PF	Pilot Flying
PIC	Pilot In-Command
PM	Pilot Monitoring
QNH	The Atmospheric Pressure at Mean Sea Level
TSN	Time Since New
TSO	Time Since Overhaul
UTC	Universal Time Coordinated
VHF	Very High Frequency
VOR/DME	VHF Omni-directional Radio Range/Distance Measuring Equipment

Aircraft Accident Report No.:	PAAN/2004/07/26/F
Registered Owner and Operator:	Pan African Airlines Nigeria (PAAN) Limited
Aircraft Type and Model:	Bell 412 EP
Manufacturer:	Bell Helicopter Textron, USA
Year of Manufacture:	2001
Serial No.:	36278
Registration Number:	5N-BDZ
Location:	Near SEDCO Energy Rig Platform, Off Nigeria's Southern Coastline Co-ordinates: N04°17'6" E004°29'9"
Date and Time:	26th July 2004, Time undetermined *All times in this report are local time, equivalent to UTC+1 unless otherwise stated*

SYNOPSIS

The erstwhile Accident Investigation and Prevention Bureau (AIPB) [1] received notification of the accident on the 26th of July 2004. Investigators were dispatched to the site on 28th of July 2004. All other stakeholders were notified.

[1] Accident Investigation and Prevention Bureau (presently AIB).

On 25th July, 2004 at about 24:00hrs, a Bell 412 EP helicopter with registration 5N-BDZ operated by Pan African Airlines Nigeria Limited, departed Port Harcourt on a medical evacuation flight to SEDCO Energy Rig platform with a reported visibility of 100m in fog. The helicopter landed at SEDCO Rig platform at 01:15hrs and commenced refuelling but was unable to lift the required amount of fuel due to a defective fuel dispenser on the Rig. The helicopter departed SEDCO Rig Platform with two crew members, one patient and one medical attendant, with a plan to make a technical stop in Funiwa to refuel before proceeding to Port Harcourt.

Less than five minutes after the helicopter lifted off from SEDCO Energy Platform, the radio operator received a brief and unclear message from the helicopter. The radio operator tried to establish contact with the helicopter but there was no response. Relevant agencies were immediately notified, and a search and rescue mission launched by Chevron Nigeria Limited, Pan Ocean Limited, and Pan African Airlines.

The estimated time of the accident was 02:30hrs.

Causal Factor

The Accident Investigation Bureau could not conclusively determine the cause of this accident.

One Safety Recommendation was made.

1.0 FACTUAL INFORMATION

1.1 History of the Flight

On 25th July, 2004 a Bell 412 Helicopter operated by Pan African Airlines with registration 5N-BDZ departed Port Harcourt on a medical evacuation mission and landed on SEDCO Rig platform at 01:15hrs the following day to refuel and pick an injured patient back to Port Harcourt. Both the Pilot Flying (PF) and Pilot Monitoring (PM) were captains on the aircraft.

During refuelling, the fuel dispenser became unserviceable after uplifting 430 litres and as such the helicopter was unable to carry the required fuel quantity for the return leg to Port Harcourt. The crew then planned a technical stop in Funiwa to pick up additional 250 litres of fuel.

At about 02:25hrs the helicopter departed SEDCO Rig platform with two crew members, one patient and one medical attendant onboard. According to the radio operator on the rig, three to five minutes after departure, the helicopter made an unclear radio call. Thereafter, the radio operator made several attempts to raise the crew but there was no response.

The medical evacuation flight was conducted to convey the patient who had three right hand fingers severed at about 22:45hrs the previous day.

The exact time of the accident could not be ascertained.

1.2 Injuries to persons

Injuries	Crew	Passengers	Total in the aircraft	Others
Fatal	2	2	4	Nil
Serious	Nil	Nil	Nil	Nil
Minor	Nil	Nil	Nil	Nil
None	Nil	Nil	Nil	Nil
Total	2	2	4	Nil

1.3 Damage to Aircraft

The helicopter was destroyed.

1.4 Other Damage

Nil.

1.5 Personnel Information

1.5.1 Pilot (Pilot Flying)

Nationality: Nigerian

Age: 50 years

Gender: Male

Licence No.: ATPL 3050(H)

Licence Validity: 30th October 2004

Aircraft Rating:	Bell 206, 412, 407
Total Flying Hours:	11,975 as at 3rd May, 2004
Medical Validity:	30th April, 2004
Simulator Validity:	21st December, 2004
Last 90 days:	Not Available
Last 28 days:	Not Available
Last 24hrs:	Not Available

The Pilot sitting on the right was not the rostered Pilot-in-Command (PIC). Both pilots were Captains.

1.5.2 Co-Pilot (Pilot Monitoring)

Nationality:	American
Age:	45 years
Gender:	Male
Licence No.:	ATPL 463114605
Licence Validity:	30th November 2004
Aircraft Rating:	BH 407, BH 206, BH 412
Total Flying Hours:	8025
Medical Validity:	7th May, 2004

Simulator Validity:	30th November, 2004
Last 90 days:	Not Available
Last 28 days:	Not Available
Last 24 hrs:	Not Available

Both pilots had current instrument check-outs and proficiency rides completed in the aircraft type during the month of July.

The Pilot Monitoring was also the Port Harcourt Base Manager. The person who prepared the duty roster was the Manager On-Duty at the time of the accident. The roster that was filed for the Pilot Monitoring was incomplete, but the Pilot Flying had his roster on board. The pilot monitoring was seen at the base earlier in the day and they both resumed night Medical Evacuation (Medevac) coverage at 18:00hrs. The pilots were both in their living quarters at the time of the call out. The Pilot Monitoring received the call and he notified the rest of the crew.

1.6 Aircraft Information

1.6.1 General Information

Type:	Bell 412 EP
Serial No.:	36278
Operator:	Pan African Airlines Nigeria Ltd
Manufacturer:	Bell Helicopters Textron, USA
Year of Manufacture:	2001

C of A Validity:	11th July, 2005
Airframe Time:	1738.5hrs as at 8th July, 2003
Cycles:	5868 as at 8th July, 2003

The fuel pressure switch was changed on the 14th July, 2004. There were no deferred defects and no reported anomalies.

1.6.2 Power Plant

Manufacturer:	Pratt & Whitney Canada
Engine No. 1:	
Date of Manufacture:	28th February, 2001
Engine Model:	PT6T–3D
Serial No.:	CPPS–TH 0445
TSN:	1562.6hrs as at 8th July 2003
TSO:	1242hrs as at 8th July 2003
Engine No. 2:	
Date of Manufacture:	28th February, 2001
Engine Model:	PT6T–3D
Serial No.:	CPPS–TH0445

TSN:	1738.5hrs as at 8th July 2003
TSO:	1242hrs as at 8th July 2003
Type of Fuel used:	Jet A1

1.7 Meteorological Information

Below is the meteorological information as passed to the helicopter by the HLO at the SEDCO oil rig at 00:30hrs:

Wind:	260°/16 knots
Visibility:	7km
Cloud:	Overcast
Temperature:	25°C
QNH:	1014hPa

At 15 knots and above, the possibility of wind shear is high.

Wind shear is defined as a sudden change in wind direction and/or speed. A severe wind shear is one that causes airspeed changes greater than 15 knots or a vertical speed greater than 500 feet per minute.

1.8 Aids to Navigation

Port Harcourt had NDB and VOR-DME navigational aids at the time of the accident. GPS Garmin GNC 420 was installed on the aircraft.

1.9 Communications

The SEDCO Energy Rig platform has a radio room facility manned by a radio operator. The radio operator stated that between three to five minutes after departure, the helicopter made an unreadable radio call. Thereafter, he made several attempts to raise the crew but there was no response.

1.10 Aerodrome Information

SEDCO Energy Rig is a semi-submersible drilling rig owned and managed by Transocean Limited with a rated water depth of 7,500ft and a drilling depth of 35,000ft. It was delivered in the year 2000.

SEDCO Energy Rig Location:	04°19'28.585"N, 04°19'34.564"E
Escravos to SEDCO Energy:	93NM at Bearing 219°
SEDCO to Funiwa:	90NM at Bearing 095°
Funiwa to Port Harcourt:	80NM at Bearing 064°

1.11 Flight Recorders

The Cockpit Voice and Flight Data Recorders (CVR/FDR) were not recovered.

1.12 Wreckage and Impact Information

The larger part of the helicopter wreckage was not recovered. However, some items were recovered including doors, life raft, an un-inflated life jacket, seat cushion and part of the tail rotor with blue paint on the leading edge. Some of the items recovered were sent to NTSB, USA for analysis.

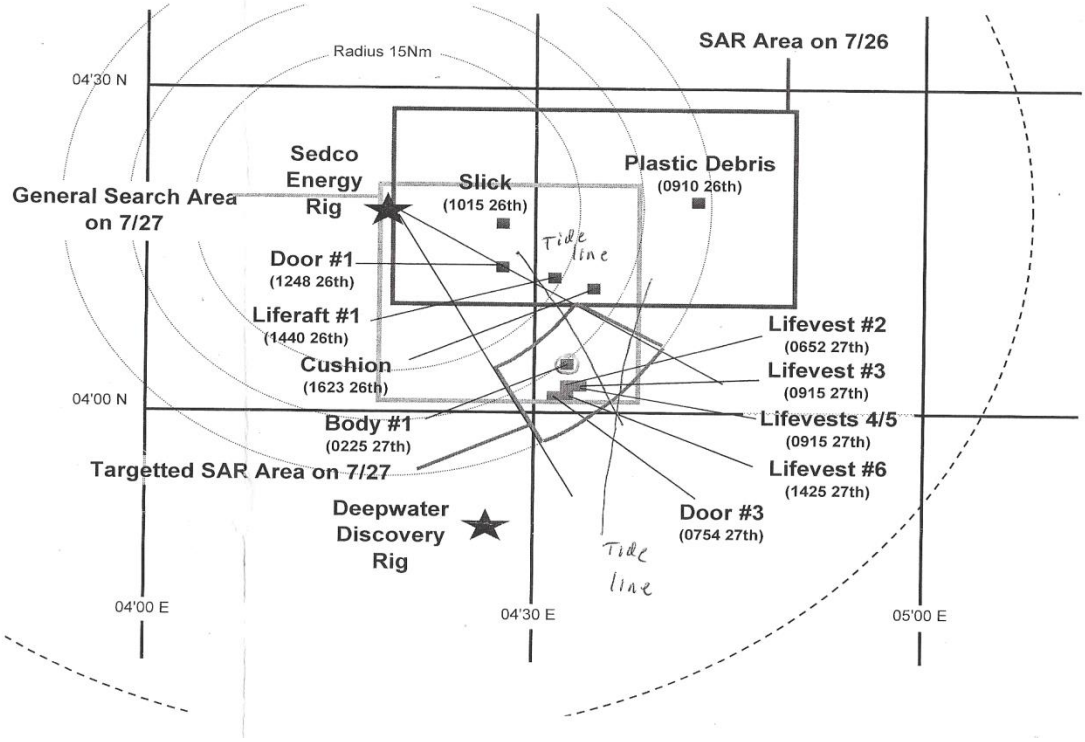


Figure 1: Wreckage distribution during the Search and Recovery Operation

1.13 Medical and Pathological Information

Although one body was recovered, the autopsy report was not available.

1.14 Fire

The main wreckage was not recovered and as such the investigation could not ascertain whether or not there was pre or post impact fire.

1.15 Survival Aspect

The accident occurred over the ocean after take-off from the rig, which was surrounded by the Atlantic Ocean. Extensive Search and Rescue (SAR) turned Search and Recovery Operations commenced same day. Helicopters, floatplanes, boats, special ships and equipment were deployed but these efforts could not locate the main aircraft wreckage.

The aircraft was destroyed and might have submerged under the sea. The medical attendant's body was recovered but the patient and the two crew members were not found.

On Friday, 20th August 2004 at 05:00hrs, the Search and Recovery Operation was terminated.

1.16 Test and Research

1.16.1 Component examination

The following components were sent to NTSB, USA for examination:

1. Major portion of the left passenger door.
2. Major portion of the right passenger door.
3. A piece of a tail rotor blade

See Appendix A for details of the examination.

1.16.2 Fuel Contamination Test Result

A sample of sea water from the vicinity of the oil slick was delivered to the Quality & Safety Department in New Iberia on or about 18 August, 2004 and was presented to Petroleum Laboratories on 19 August, 2004. The sample was submitted along with control samples of Aeroshell 4 Hydraulic Fluid, Aeroshell /Royco transmission fluid, Mobil Jet II Turbine Engine Oil and Jet A turbine engine fuel.

The laboratory used TNRCC method 1006 to measure Total Petrohydrocarbon levels, which gives an indication of the level of refinement for a given product through using carbon chain values ranging from C-6 through C-35.

(Generally, the lower the carbon number, the more refined a product is. For example the major constituents of Jet fuel fall into the C-10 to C-19 range, while those of Mobil Jet II fall into the C-26 to C-35 range.)

The lab results did not indicate any presence of Petrohydrocarbons in the seawater sample taken from the oil slick, these results should not be construed as being conclusive because of variables that may have been involved in collecting the sample and because of the small size of the sample (< 1 Liter)

Sample	**Carbon Chain Values* (in mg/liter – parts per million)**							
	TPH C_6-C_7	TPH C_8-C_9	TPH C_{10}-C_{11}	TPH C_{12}-C_{13}	TPH C_{14}-C_{15}	TPH C_{16}-C_{17}	TPH C_{18}-C_{19}	TPH C_{20}-C_{21}
Sample from Oil Slick	<5	<5	<5	<5	<5	<5	<5	<5
Aero Shell 4	0	0	101	3656	28167	37979	29345	6522
Aero Shell/Royco	0	0	0	0	0	0	0	0
Mobil Jet II	0	0	0	0	0	0	17	55
Jet A	1913	11368	19083	34625	33558	22077	10431	1031
Samples	TPH C_{22}-C_{23}	TPH C_{24}-C_{25}	TPH C_{26}-C_{27}	TPH C_{28}-C_{29}	TPH C_{30}-C_{31}	TPH C_{32}-C_{33}	TPH C_{34}-C_{35}	TPH C_6-C_{35}
Sample from Oil Slick	<5	<5	<5	<5	<5	<5	<5	<5
Aero Shell 4	100	94	214	0	0	4254	5312	115743
Aero Shell/Royco	0	14	172	679	2332	57234	0	60431
Mobil Jet II	0	0	4483	958	16010	68280	10875	100678
Jet A	0	0	4422	25088	1308	4100	0	169076
*Method detection levels are 5 mg/I – ppm								

1.17 Organizational and Management Information

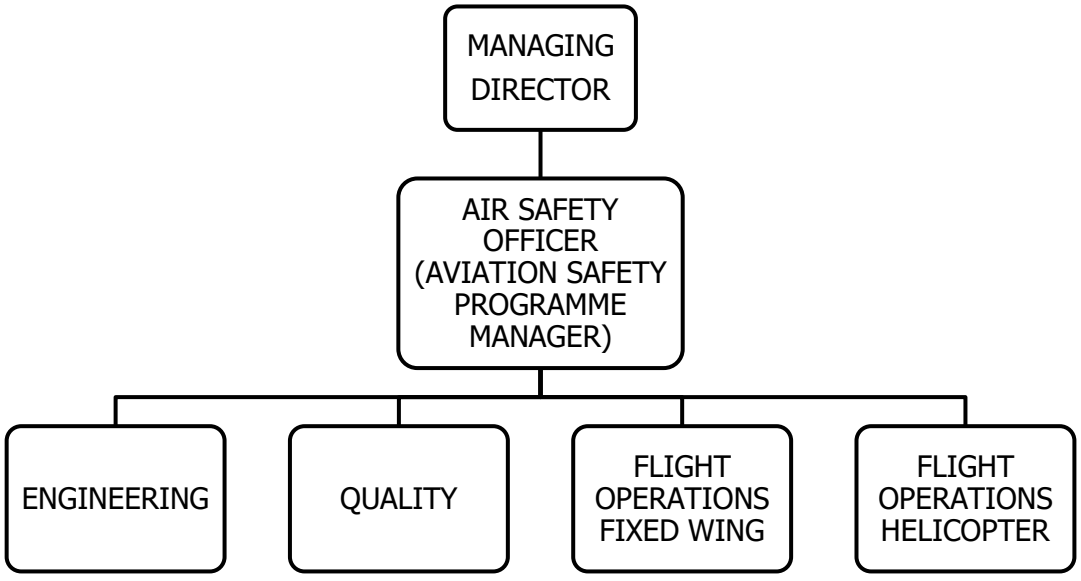
1.17.1 Pan African Airlines Nigeria Ltd (PAAN)

PAAN is an indigenous Nigerian aviation transportation supplier incorporated in April 1961. It operates from customer bases in Warri and Escravos where their helicopters meet the need of the Nigerian oil and gas industries.

The Air Operator Certificate (AOC) granted PAAN by the Nigerian Civil Aviation Authority (NCAA) stipulates that all flights shall be conducted in accordance with an approved operations manual which contains the Standard Operating Procedures (SOP).

It is the policy of the company that all employees be provided with a safe and healthy working environment as is possible with due regard to economic considerations and legal obligations.

Management Structure for Aviation Safety



The following policy statement demonstrates the commitment of PAAN:

1.17.2 Flight and Duty Time Limitation Scheme

1.17.2.1 Aim

The aim of this document is to express the intent behind the published, relevant document, namely NCAA document NAP-009H thereby taking all reasonable precautions to ensure that crew members are adequately rested at the beginning of each flying duty period. The flying duty period shall not be of such duration as to cause excessive fatigue. To meet this aim, due note will be taken of length of duty cycles, periods of time-off, cumulative duty hours and special considerations relevant to Pan African Airlines Nigeria Operations. Any variation in advised limits; take into consideration the compensatory nature of the overall 28 days off work/leave cycle.

1.17.2.2 Applicability

The scheme shall apply in relations to any flying duty carried out at the behest of the company by a member of the flight crew. Other non-flying duties such as training tasks specifically required for the maintenance or upkeep of a professional pilot license required by the NCAA shall also be governed by the scheme.

1.17.2.3 Crew Members

Responsibility for the proper control of flight and duty time does not rest wholly with the company. Crew members have the responsibility to make optimum use of the opportunities and facilities for rest provided. They are also responsible for planning and using their rest period properly. The ANR and NCAR place a further responsibility on crew members. Simply put, crew members shall not act as operating crew if they know

or suspect that their physical or mental condition renders them unfit to operate. Furthermore, they must not fly if they know that they are or are likely to be in breach of this scheme. Crew members not in the regular employment of the company must provide details of their previous 28 day totals of duty periods/flying hour before undertaking a flying duty on behalf of the company.

1.17.2.4 Flying Duty Period (FDP)

Anytime during which a person operates in a helicopter as a member of its crew, it starts when the crew member is required by the company to report for a flight, and finishes at rotors stopped on the final sector plus 15 minutes for post flights duties.

1.17.2.5 Late Finish/Early Start

Any duty that is carried out within any part of the period 2100 to 0600 hours local time.

1.17.2.6 Local Night

A period of 10 hours falling between 2000 hours and 0600 hours local time.

1. Positioning

The practice of transferring crews from place to place as passengers in surface or air transport at the behest of the company.

1.17.2.8 Reporting Time

The time at which a crew member is required by the company to report for any duty.

1.17.2.9 Rest Period

A period of time before starting a flying duty period, which is designed to give crew members adequate opportunity to rest before a flight. A rest period shall include one local night.

1.17.2.10 Medical Emergency Duty (MED)

The period rostered as twin engine, two (2) crew, or co-pilot, commencing at 1815 local time and ending 12 hours later at 0615 local time. The crew member is required to be contactable only for the purpose of acting as crew member of a flight carried out solely for the purpose of medical emergency or prevention of loss of life at a remote client location.

1. Maximum Number of Flying Hours

The maximum number of flying hours which a pilot may be permitted to undertake are:

Single Day:

Any 3 consecutive days	-	*21 hours*
Any 7 consecutive days	-	*39 hours*
Any 3 consecutive 28 days period	-	*270 hours*

1.17.2.12 Standby Duty

A period during which the company places restraints on a crew member for duties associated with commercial air transport who would otherwise be off duty. This period shall not include any time during which the crew member is contactable for the purpose of giving notification of duty, which is due to start 10 hours or more ahead.

1.17.3 Helicopter Refueling

During any refueling operation at an offshore location, the non-handling pilot shall leave the aircraft to monitor refueling operations specifically to supervise:

1. *Water detection capsule check.*
2. *Fuel delivery quantity matches requirement.*
3. *Ensure that the refueling cap is replaced securely.*
4. *Ensure that earth cable is removed.*
5. *Complete the required paper work.*

1.17.4 Emergency locator Transmitter (ELT) Offshore Operations

Company aircraft when flying over water on commercial air transport operations beyond 10 minutes flying time from land in a hostile environment shall be equipped with an emergency locator transmitter (ELT) for non hostile environment. (See the relevant MEL in part B of this manual).

Each aircraft shall be equipped with an airframe mounted gravity activated ELT.

1.17.5 Night Offshore Take-off procedures

All flights off-shore at night including inter-rig flights are to be conducted under Instrument Flight Rules (IFR) in accordance with the procedures in Escravos supplement chapter 9. Night take-offs and departures from helidecks are to be carried out using the procedure described in part B2.1.3.

For all take-offs a straight ahead climb shall be maintained until a minimum of 500 feet prior to turning into a circuit if training or onto the departure track if IFR.

1. **Off-shore Operations-Intermediate Refueling**

Off-shore flight will normally carry round trip fuel with appropriate reserves. On operation where intermediate refueling is available, the requirement to maintain maximum pay load in both directions may necessitate carrying out point of no return (PNR) flight.

1.18 Additional Information

The Helicopter landing officer (HLO), a Transocean employee, stated that he secured the passengers in their life vests and seat belts on departure from the SEDCO Rig. He also secured the door.

1.19 Useful or Effective Investigation Techniques

Not Applicable.

2.0 ANALYSIS

2.1 The Flight

The helicopter departed Port Harcourt on medical evacuation flight to SEDCO Rig. It landed on the rig with reported visibility of 100m in fog and commenced refuelling immediately. During refuelling, the fuel dispenser became unserviceable and as such the helicopter was unable to carry the sector fuel for the return leg to Port Harcourt. The crew then planned a technical stop in Funiwa to refuel. 5N-BDZ later lifted off at 02:25hrs on 26th July, 2004 for Port Harcourt en-route Funiwa Rig. Between 3 to 5 minutes after take-off, the radio operator at the SEDCO Rig observed that the pilots made an attempt to call. The radio operator made several attempts to call the crew back but there was no response. The estimated time of the accident was at about 02:30hrs.

The Certificate of Airworthiness (C of A) was valid at the time of the accident.

Due to the circumstances of the crash, it was practically impossible to get any valuable account of the accident, coupled with the fact that it happened in the ocean during the early hours of the day, when it was still dark.

2.2 Personnel (Crew)

The flight crewmembers had valid licenses at the time of the accident. The PF, a Nigerian, kept his hour log in order. There were no ambiguities in his hour log. The American was a training pilot with a good record, as evident in his NCAA personnel file. The PM on the incident flight had been rostered as the PIC and hence should have been the PF. However, the HLO asserted that the reverse was the case as the PIC had refuelled the aircraft and was also seated on the left-hand side in the cockpit.

PAAN policy is that the PM will do the refuelling and other jobs while the PF will take care of the aircraft in case of emergency on the deck. It is of utmost importance to identify the PF and PM.

2.3 Prevailing Weather conditions at 00:30hrs

The meteorological information showed that the wind was at 16 knots. The possibility of wind shear is higher when the wind speed is above 15 knots.

Visibility of Seven kilometre shows a good visibility but the cloud at Eight Oktas meant that there was overcast or that the sky was obscured. The cloud base would have been used to determine if the weather was good for departure or not but was not available.

3.0 CONCLUSION

3.1 Findings

1. The crew were certified to conduct the flight.
2. The rostered PIC was not the Pilot Flying. The Pilot Flying (PF) was rostered as the Pilot Monitoring (PM).
3. The helicopter had a valid Certificate of Airworthiness at the time of the occurrence.
4. The helicopter was unable to carry the sector fuel on the Rig due to defective fuel dispenser.
5. The pilot departed SEDCO Energy Rig with the intention of taking more fuel in Funiwa.
6. The meteorological information did not include the cloud base.
7. Only the body of the medical attendant was recovered.
8. The CVR and FDR were not recovered.
9. Some parts of the helicopter were recovered while the main wreckage was not found.

3.2 Causal Factor

The Accident Investigation Bureau could not conclusively determine the cause of this accident.

4.0 SAFETY RECOMMENDATIONS

4.1 Safety Recommendations 2018-007

NCAA should ensure that heliport operators provide full weather report for helicopter operations.

RESPONSES TO SAFETY RECOMMENDATIONS

NCAA Response to AIB Safety Recommendations

The NCAA responded to Safety Recommendation Section 4.1 (2018-007):

NCAA agrees with and has implemented this Safety Recommendation. Nig.CARs Part 12.13.12 (b) requires Heliports operators to provide at least one final approach and take-off area (FATO), one touch down and lift-off area (TLOF), helicopter clearway where necessary, safety area, helicopter ground taxiways, air taxiways, air transit route and apron with particular attention to the following: *(b)* local conditions such as elevation, temperature/visual or *general meteorological conditions.*

APPENDIX

Appendix A: Wreckage examination results

NATIONAL TRANSPORTATION SAFETY BOARD
Office of Research and Engineering
Materials Laboratory Division
Washington, D.C. 20594

March 28, 2005

MATERIALS LABORATORY FACTUAL REPORT — Report No. 05-006

A. ACCIDENT

Place : Atlantic Ocean, Nigeria.
Date : July 26, 2004
Vehicle : Bell 412 EP, 5N-BDZ
NTSB No. : WAS04WA010

B. COMPONENTS EXAMINED

1. Major portion of the left passenger door.
2. Major portion of the right passenger door.
3. Piece of a tail rotor blade.

C. DETAILS OF THE EXAMINATION

Reportedly, the helicopter took off from an oil platform off the coast of Nigeria and contact was lost after 3 minutes. The components received for examination were the only structural items reportedly recovered from the water. The sketch in figure 1 illustrates the aircraft with the left passenger door and the tail rotor located and identified. The direction of rotation of the main rotor, as indicated by the blue arrows, is counterclockwise when viewed from above. The direction of rotation of the tail rotor, as indicated by the green arrow, is counterclockwise when viewed from the right side of the aircraft. The forward (FWD) direction is also indicated.

The sketch in figure 2 illustrates a left passenger door, viewed from the inside of the aircraft, with the forward and up directions indicated. The door components that interact with the fuselage are identified and consist of the four upper guide rollers, the upper latch, the lower latch, the "J" track along the lower edge, the rear lower guide, the rear upper roller guide and the stop bracket.

Left Passenger Door

Examination of the left passenger door (see figures 3 and 4) revealed that it was mostly intact. The two windows were missing but the elastomeric retainers and fillers for both windows were present. No fragments of glazing material were observed in the retainers of both windows. A portion of the structure at the rear edge was also missing, as

indicated by the red arrow in figures 3 and 4. The "J" track at the bottom of the door displayed two distinct indentations, as indicated by the yellow arrows. The green arrow in figure 3 indicates the exterior door handle, and the green arrow in figure 4 indicates the interior door handle, which were in their "closed" position.

In figure 4, the blue arrows indicate the upper guide roller assemblies, which were attached to the door, rolled freely, and appeared to be undamaged. In contrast, the rear upper guide, also a roller assembly, was missing along with a portion of the door structure at the position indicated by the red arrow.

In figure 4, the lower latch hook, which was present and appeared undamaged, is hidden from view by the lower latch guard. The upper latch hook was also present, and appeared undamaged, but the guard for this hook was missing. Attempts were made to rotate the exterior and interior door handles from their "closed" position but the mechanism was found to be too stiff to operate manually. Examination showed that the latches, the adjacent mechanism visible inside the door, and the area around the latches appeared to be undamaged although the guard plate at the upper latch was missing. The door handles displayed significant surface corrosion. The lower guide assembly, at the location indicated by the black arrow in figure 4, is illustrated in the left view of figure 5 with the interior surface identified. A blue arrow indicates where the lower square groove on the plastic slide had been torn in an inwards direction, and the black arrows indicate the inward bending that had been applied to the normally flat slide retainer, features consistent with the door being forced outwards. The stop bracket assembly, at the location indicated by the white arrow in figure 4, is illustrated in the right view of figure 5. The normally vertical portion of the stop bracket, with the seal attached, had been partially straightened out, and the aft part of the horizontal portion of the bracket had been deformed outwards and upwards, as if the bottom of the door had moved outward while the vertical portion of the stop was retained.

The missing portion of the left passenger door is illustrated in the two views of figure 6. The left view illustrates the exterior surface at the location indicated by the red arrow in figure 3. The missing portion was a rectangular shape with three fractured edges that were mostly straight and well defined. The edge of the lower fracture had propagated further forward as indicated by the red arrow. The right view illustrates the interior surface at the location indicated by the red arrow in figure 4, with the rectangular shape, illustrated in the left view, in the background. The missing rectangular shape would correspond with the location of the rear upper guide, which probably remained in its guide channel on the fuselage. A significant amount of the interior surface material above the rectangular shape was missing. Smaller amounts of interior surface material were missing from below and forward of the rectangular shape. The red arrows indicate the fractured edges of the material missing from the interior structure.

Right Passenger Door

Examination of the right passenger door, shown in figures 7 and 8, revealed that it was also missing the two windows a significant portion of the upper rear structure

(indicated by red arrows) that was contained within the darkest of the blue diagonal stripes on the door at and above the upper latch hook, and structure from the upper forward corner. Although the upper rear corner structure was missing, the retainer of the rear window remained and was still attached to the forward half of the window frame. No fragments of glazing material were observed in the rear window retainer, suggesting that the window left the door intact (or in a few large pieces) before the impact event that removed the missing structure. The "J" track displayed two distinct indentations (yellow arrows in figures 7 and 8) that were in similar locations from the forward end of the door, to those on the left door. The door handle (green arrow in figures 7 and 8) was positioned between the "closed" position (horizontal with the body of the handle forward of its center of rotation) and the "open" position (vertical with the body of the handle below its center of rotation). The upper and lower latch hooks were present on the door. The lower latch hook is obscured in figure 8 by the lower latch guard; the upper latch guard was missing.

The white arrow in figure 8 indicates a crack on the interior surface that terminated at the outer edges of the upper and lower portions of the channel section, adjacent to the outer skin. The portion of structure forward of the crack was retained only by the exterior skin and was very flexible when the door was manipulated. Above the interior door handle was a small white sign, with black letters, warning that the "DOORS MUST BE KEPT CLOSED DURING FLIGHT". The blue arrows indicate the remaining two upper guide roller assemblies, which were undamaged. The upper guide roller assembly, originally located on rear corner of the door, and the upper roller assembly, originally located on the forward corner of the door, were missing along with the structure in these areas. Attempts were made to rotate the inner and outer door handles from their received position but the mechanism was found to be too stiff to operate manually. The door handles displayed significant surface corrosion. The lower latch hook, the visible mechanism behind it, and the area around it appeared to be undamaged. The upper latch, and the area above it, was mechanically damaged and the guard plate was missing.

The black arrow in figure 8 indicates the lower guide assembly (the upper guide assembly was missing as it was also located on the missing portion of structure indicated by the red arrows). A closer view of the lower guide is illustrated in figure 9. The red arrow indicates the inward bending that had been imparted to the normally flat guide support plate. The black arrows indicate the inward bending that had been applied to the normally flat slide retainer, similar to that on the left door and also consistent with the door being forced outwards.

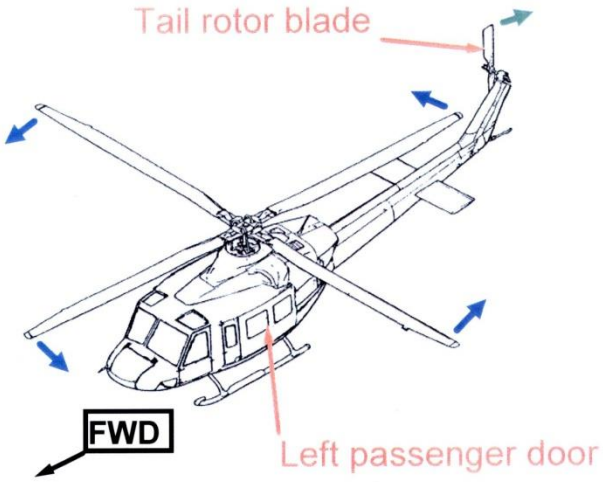
Examination of the area around the upper latch revealed material that had been displaced outwards. A view of the upper latch assembly, from the inner rear, is illustrated in the left view of figure 10. The underlying material and the latch hook spring had been displaced in the direction of the red arrow in this photograph. The edge of the latch hook between the blue arrows had been mechanically deformed. A view of the upper latch, from the rear, is illustrated in the right view of figure 10. As in the left view, the red arrow indicates the direction of the displaced material and the blue arrows indicate the deformed edge of the latch hook. The yellow line is a continuation of the edge of the latch hook, adjacent to its pivot point, to illustrate the significant amount of bending that had been

applied to it. The initiation of the bending was centered in the area between the blue arrows, which, as in the left figure, indicate the deformed edge of the latch hook.

Tail Rotor

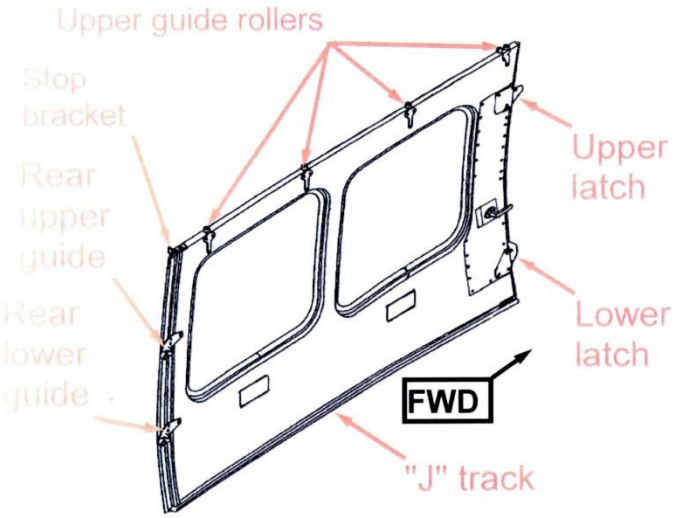
The piece of tail rotor submitted for examination consisted of the outer 16 inches of one blade, as shown in figure 11. Two distinct deformations on the leading edge, indicated by the red and yellow arrows in figure 11, and buckling of the skin behind them (blue arrow) were consistent with an impact event. Closer examination of the impact area indicated by the red arrow in figure 11 revealed multiple dark blue deposits, which are indicated by the red arrows in figure 12. The dark blue deposits matched the dark blue paint in the rearmost stripe on the left and right passenger doors, as illustrated in figures 3 and 7. Closer examination of the impact area indicated by the yellow arrow in figure 11 revealed similar multiple dark blue deposits indicated by the yellow arrows in figure 13. These dark blue deposits also matched the dark blue paint in the rearmost stripe on the left and right passenger doors.

Mechanical Engineer



ImageNo: 0409A01513, Project No:2004080009

Figure 1. Sketch of the accident aircraft type with the left passenger door and the tail rotor blade indicated.



ImageNo:0501A01135, Project No:2004080009

Figure 2. A sketch of the interior surface of the left passenger door.

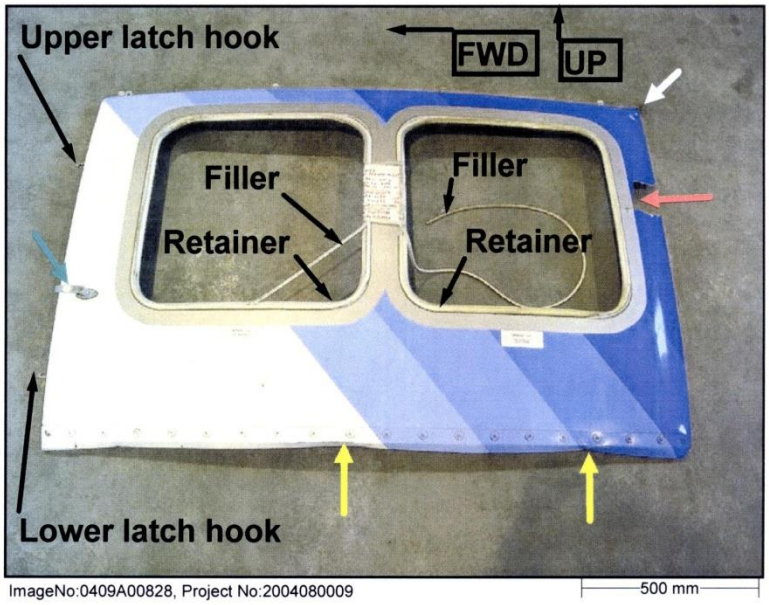


Figure 3. An exterior view of the left passenger door.

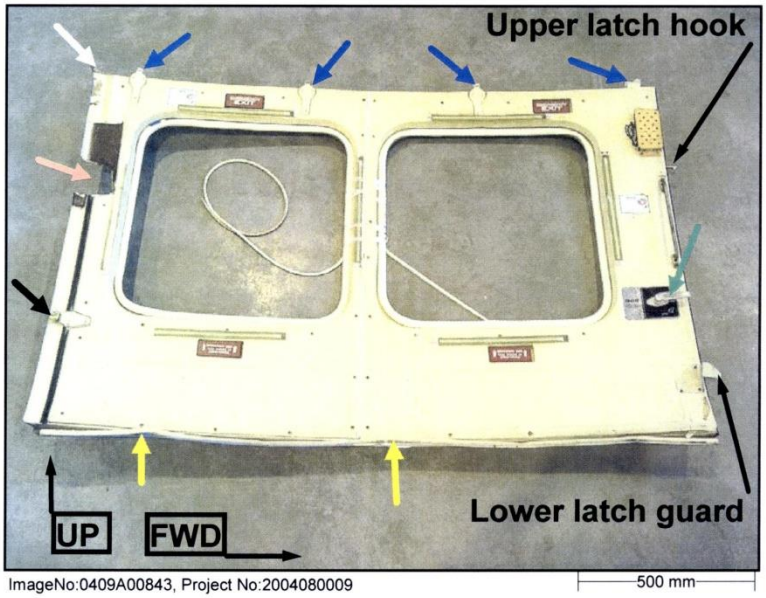
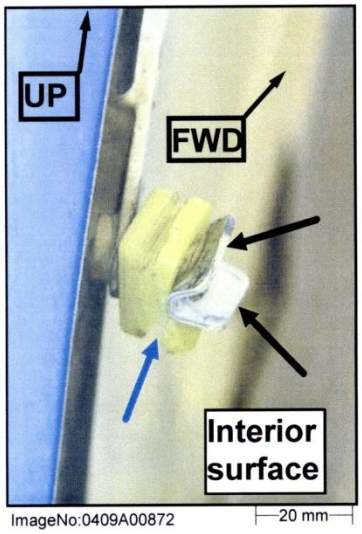


Figure 4. An interior view of the left passenger door.



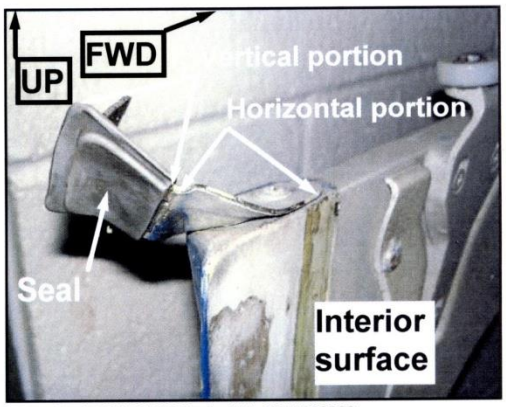


Figure 5. Left photograph shows the left passenger door's lower guide (indicated by the blue arrow in figure 4). Right photograph shows the vertical and horizontal portions of the left door's stop bracket (indicated by the white arrow in figure 4).

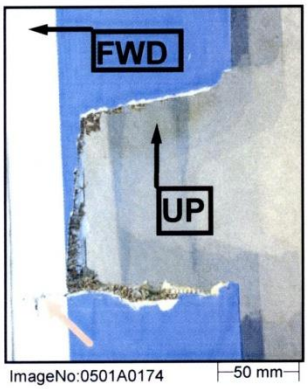
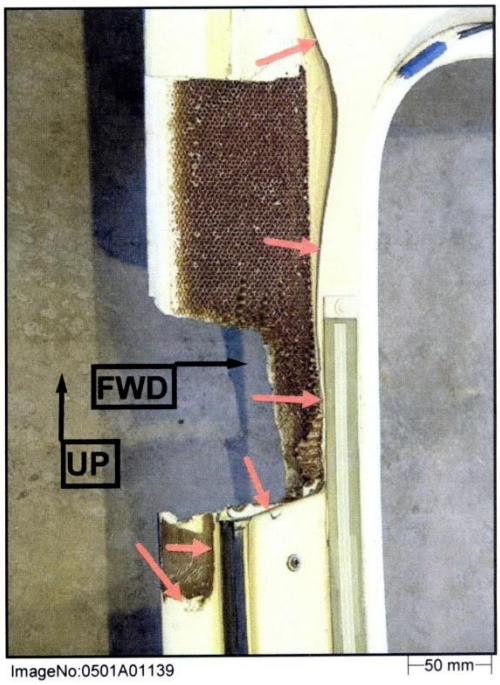


Figure 6. The missing portion of the left passenger door indicated by the red arrow in figures 3 (left) and 4 (right).



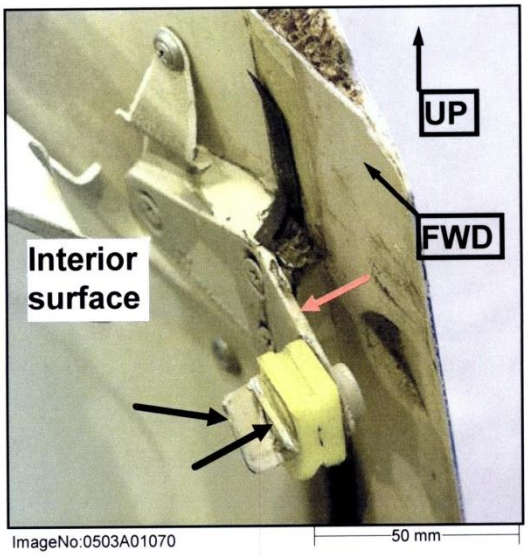
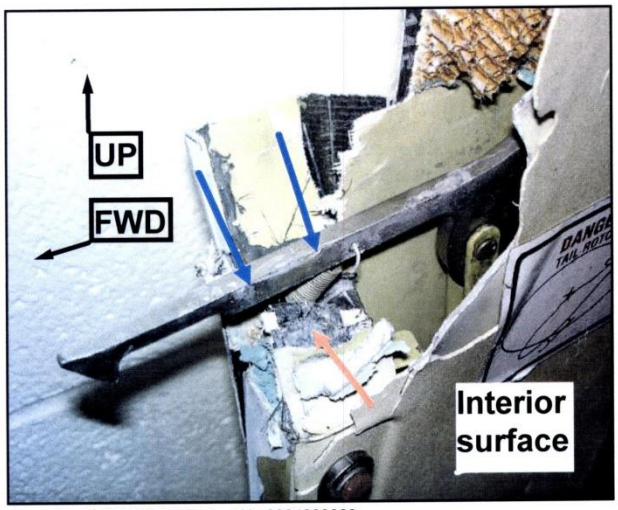


Figure 9. A view, from the rear, of the right passenger door's lower guide indicated by the black arrow in figure 8.



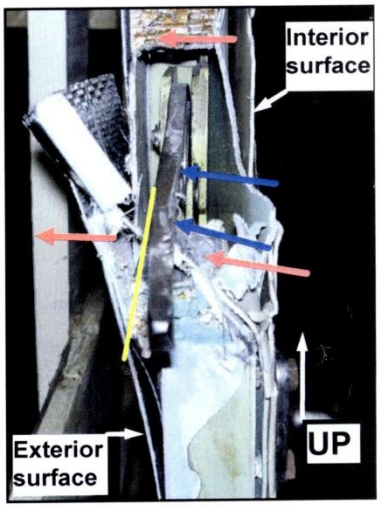


Figure 10. The right passenger door's upper latch, viewed from the inner rear (left) and from the rear (right).