AIRCRAFT ACCIDENT REPORT

CHL/2019/02/02/F

Accident Investigation Bureau

Report on the accident involving AgustaWestland AW139 helicopter operated by Caverton Helicopters Limited with nationality and registration marks 5N-CML, which occurred at Kabba, Kogi State on 2nd February, 2019.

This report was produced by the Accident Investigation Bureau (AIB), Murtala Muhammed Airport Ikeja, Lagos. The report was based upon the investigation carried out by AIB, 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.

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Safety Recommendations in this report are addressed to the Regulatory Authority of the State, as well as other stakeholders, as appropriate. The Regulatory Authority is the authority that ensures implementation and 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, Nigeria
AMO	Approved Maintenance Organisation
AOC	Air Operator Certificate
ATC	Air Traffic Control
ATPL	Airline Transport Pilot Licence
ATS	Air Traffic Services
AW	AgustaWestland
C of A	Certificate of Airworthiness
CPL	Commercial Pilot Licence
CVR	Cockpit Voice Recorder
FDM	Flight Data Monitoring
FDR	Flight Data Recorder
IAS	Indicated Airspeed
ICAO	International Civil Aviation Organization
IMC	Instrument Meteorological Conditions
IVSI	Instantaneous Vertical Speed Indicator
LDP	Landing Decision Point
MEL	Minimum Equipment List
MPRF	Multi-Purpose Flight Recorder
NAF	Nigerian Air Force
NAMA	Nigerian Airspace Management Agency
NCAA	Nigerian Civil Aviation Authority

NiMet	Nigerian Meteorological Agency
Nig. CARs	Nigeria Civil Aviation Regulations
NPF	Nigeria Police Force
OM	Operation Manuals
PAF	Presidential Air Fleet
PF	Pilot Flying
PIC	Pilot in Command
PM	Pilot Monitoring
QAR	Quick Access Recorder
QRH	Quick Reference Handbook
RAD ALT	Radio Altimeter
SMS	Safety Management System
SOPs	Standard Operating Procedures
T/O	Take-off
VFR	Visual Flight Rules
VMC	Visual Meteorological Conditions

Aircraft Accident Report number:	CHL/2019/02/02/F
Registered owner and operator:	Caverton Helicopters Limited
Manufacturer:	AgustaWestland
Aircraft type and model:	AgustaWestland AW139
Date of manufacture:	May, 2012
Serial number:	31389
Nationality and registration marks:	5N-CML
Location:	Kabba Football Field
	7°50'31" N 6°04'41"E
Date and time:	2nd February, 2019 at about 14:34 h
	(All times in this report are local time (UTC +1 h) unless otherwise stated)

SYNOPSIS

On 2nd February, 2019 at about 07:26 h, an AgustaWestland (AW139) helicopter with nationality and registration marks 5N-CML operated by Caverton Helicopters Limited departed Lagos for Nnamdi Azikiwe International Airport in Abuja, to conduct a VIP charter flight from Abuja to Okene via Kabba and return to Abuja. The positioning flight to Abuja was normal. The helicopter was refuelled and the flight crew prepared for the VIP charter flight to Kabba.

At about 13:46 h, the helicopter departed Abuja runway 22 for Kabba. On board were 12 persons including the Vice President of the Federal Republic of Nigeria, his entourage and three crew members (Pilot, Co-pilot and an Engineer). The flight crew stated that they sighted the intended landing area as a result of the cloud of residual dust generated by the downwash[1] of a Police helicopter.

After sighting the football field, the flight crew approached with the speed of 20 kt to about a 100 ft, and entered a hover to land. At about 50 ft above ground level, a brownout[2] set in. The flight crew lost visual contact with the ground and external surroundings. The Co-pilot began radio altitude callouts "35, 30, 25, 20 and 15". At about 14:34 h, the helicopter experienced a hard landing on the right main landing gear and rolled over onto its right side. All persons on board were evacuated uninjured.

Causal factor

The causal factor was: The flight crew encountered a brownout condition during the hover to land, which led to the loss of external visual references, spatial disorientation and loss of situational awareness resulting in a misjudgement of distance and ground clearance, as the flight crew tried to control the helicopter's movements for landing. The helicopter landed hard and rolled over on its right side.

Contributory factor

The contributory factors were: Inappropriate landing technique used, non-adherence to company procedures for known or anticipated brownout condition during landing and lack of risk assessment, limited landing site preparation and planning prior to commencement of the flight.

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[1] Downwash is the change in direction of air deflected by the aerodynamic action of an aerofoil, wing or helicopter rotor blade in motion, as part of the process of producing lift.

[2] Brownout in helicopter operations is an in-flight visibility restriction caused by dust or sand in which the flight crew loses visual contact with nearby objects that provide the outside visual references necessary to control the helicopter near the ground.

Eleven days after the accident, the AIB issued two Interim Safety Recommendations, one to the Nigerian Civil Aviation Authority and one to Caverton Helicopters. The required safety actions were initiated and implemented promptly.

Two further Safety Recommendations were issued in the Final Report.

1.0 FACTUAL INFORMATION

1.1 History of the flight

On 2nd February, 2019 at about 07:26 h, an AgustaWestland (AW139) helicopter with nationality and registration marks 5N-CML operated by Caverton Helicopters Limited departed Murtala Mohammed International Airport in Lagos for Nnamdi Azikiwe International Airport in Abuja, to conduct a VIP charter flight from Abuja to Okene via Kabba and return to Abuja. The positioning flight was normal and landed in Abuja at 10:00 h. The helicopter repositioned to the Presidential Air Fleet (PAF) apron for the NGR002 charter flight.

The helicopter was refuelled and the flight crew prepared for the VIP charter flight. At about an hour before the planned departure, the flight crew received the coordinates for the temporary landing sites at Kabba and Okene, and they were thus able to finalize their flight planning for the mission. In the flight plan, the estimated time of arrival to Kabba was 14:30 h.

At about 13:46 h, the helicopter departed Abuja runway 22 for Kabba, Kogi State on a VIP charter flight, call sign Nigeria 002 (NGR002). A Visual Flight Rules (VFR) Flight Plan was filed for the flight. On board were 12 persons including the Vice President of the Federal Republic of Nigeria, his entourage and three crew members (Pilot, Co-pilot and an Engineer). The fuel on board was 1,270 kg. A squawk code of 1301 was assigned to NGR002 by the Air Traffic Control (ATC) for radar monitoring. The Pilot was the Pilot Flying (PF) and the Co-pilot was the Pilot Monitoring (PM).

The Flight Data Recorder (FDR) data showed that the take-off and climb out phase was normal. The helicopter levelled off at a cruising altitude of 5,000 ft above mean sea level, flying with the autopilot engaged. At 14:20 h in cruise, the Multi-Purpose Flight Recorder (MPFR) light came ON and the Crew Alerting System (CAS) displayed “FDR AND CVR FAIL”. According to the flight crew, Caverton Helicopters Quick Reference Handbook (QRH) procedure (pages 50 and 51) was accomplished. According to the

QRH, the flight could continue. The helicopter was monitored on Abuja Approach Radar until 55 NM from Abuja.

The flight approached the landing area and the Pilot stated that he was able to take note of the area and the obstacles outside the landing area (spectators' stands, football field goal posts, a car and people awaiting the arrival of the VIPs). The flight crew stated that on initial approach, they carried out the pre-landing checks which included a landing brief for a ground helipad landing and a Landing Decision Point (or committal point) of 100 ft/20 kt indicated airspeed (IAS) based on the surrounding obstacles.

Another helicopter (Bell 412) with nationality and' registration marks 5N-PEJ operated by the Nigeria Police Force (NPF) conveyed the advance party. Before and throughout the flight, NGR002 was in radio communication with 5N-PEJ on frequency 136.1 MHz. 5N-PEJ landed outside the football field ahead of NGR002 at about 14:30 h.

The flight crew of NGR002 stated that they sighted the intended landing area as a result of the cloud of residual dust generated by the downwash of 5N-PEJ's main rotor. The flight crew further stated that the approach was normal.

After sighting the football field, the flight crew agreed on the selected landing area. NGR002 approached with the speed of 20 kt to about a 100 ft, and entered a hover to land. At about 50 ft above ground level, a brownout set in. The flight crew lost visual contact with the ground and external surroundings. They elected to use the Instantaneous Vertical Speed Indicator (IVSI) and Radio Altimeter (RAD ALT) as references to control the descent. The Co-pilot began radio altitude callouts "35, 30, l25, 20 and 15". After the "15" callout, neither the Co-pilot, nor the Pilot could remember making or hearing further callouts. At about 14:34 h, the helicopter experienced a hard landing on the right main landing gear and rolled over onto its right side.

The Pilot immediately shut the engines and the Co-pilot shut off the fuel. The emergency procedures, which also included switching off the battery and the generators, were carried out.

All persons on board were evacuated uninjured. The accident occurred in day time.

According to the weather report from the Nigerian Meteorological Agency (NiMet), the prevailing weather at the football field was good. However, due to the brownout conditions the visibility was non-existent in the immediate vicinity of the landing area.

1.2 Injuries to persons

Injuries	**Crew**	**Passengers**	**Total in the aircraft**	**Other**
Fatal	Nil	Nil	Nil	Nil
Serious	Nil	Nil	Nil	Nil
Minor	Nil	Nil	Nil	Not applicable
None	3	9	12	Not applicable
Total	3	9	12	Nil

1.3 Damage to aircraft

The helicopter was destroyed.

1.4 Other damage

A parked car had slight damage from flying debris.

Figure 1: Damaged parked car relative to the helicopter

Figure 2: Damage to a parked car from flying debris

1.5 Personnel information

1.5.1 Pilot (Pilot flying)

Nationality:	Nigerian
Age:	34 years
Licence type:	Airline Transport Pilot Licence (Helicopters)
Licence validity:	14th May, 2019
Aircraft ratings:	AgustaWestland AW139
Medical Certificate validity:	14th May, 2019
Simulator validity:	29th May, 2019
Total flying time:	4,044:36 h
Total on type:	3,769:29 h
Total on type (as pilot-in-command):	1,040 h
Last 90 days:	137:35 h
Last 28 days:	27:35 h
Last 7 days:	18:45 h
Last 24 hours:	02:45 h

The Pilot had flown about 50 h VIP charter flights. He had flown 10 h in the past seven days and had two days off before the day of the accident, 2nd of February, 2019.

1.5.2 Co-pilot (Pilot monitoring)

Nationality:	Nigerian

Age:	22 years
Licence type:	Commercial Pilot Licence (Helicopters)
Licence validity:	6th November, 2019
Aircraft ratings:	AgustaWestland AW139; Aerospatiale AS350
Medical certificate validity:	6th November, 2019
Simulator validity:	15th July, 2019
Total flying time:	800 h
Total on type:	240 h
Last 90 days:	132:10 h
Last 28 days:	25:50 h
Last 7 days:	06:35 h
Last 24 hours:	02:45 h

The Co-pilot had flown 20 h VIP charter flights. He had flown 10 h in the past seven days and had two days off before the day of the accident, 2nd of February, 2019.

1.5.3 Engineer

Nationality:	Nigerian
Licence type:	Airframe and Power plant
Licence validity:	13th January, 2022
Aircraft ratings:	AgustaWestland AW139; Aerospatiale AS350; Socata TB-9 Tampico

1.6 Aircraft information

Manufacturer:	AgustaWestland

Type:	AW139
Date of manufacture:	May 2012
Serial number:	31389
Certificate of Airworthiness:	Valid until 10th August, 2019
Certificate of Insurance:	Valid until 31st March, 2019
Certificate of Registration:	Issued on 27th August, 2014
Noise Certificate:	Issued on 26th January, 2016
Total airframe time:	4,872:16 h

The following Deferred Defects were found:

1 Aft Air Condition Fail (Minimum Equipment List Category D due by 14th April 2019)

2 Environmental Control System (ECS) (Minimum Equipment List Category D due by 28th May 2019).

The helicopter certificated max take-off mass was 6,800 kg. According to the operational flight plan, at departure, the take-off mass was 6,780 kg comprising actual fuel 1,250 kg and zero fuel mass 5,530 kg. The centre of gravity was 5.24.

1.6.2 Power plant

Engines	Number 1	Number 2
Engine model	Pratt & Whitney Canada PT6C Turbo-shaft Engine	Pratt & Whitney Canada PT6C Turbo-shaft Engine
Serial number	KB1004	KB0992
Time since new	5,765:50 h	4,872:16 h
Cycles since new	3,913	3,628

1.7 Meteorological information

According to the weather report from the Nigerian Meteorological Agency (NiMet), the prevailing weather at the football field was good with visibility over 10 km and no clouds below 5,000 ft. There was no current or forecast significant weather, such as precipitation. However, due to the brownout conditions the visibility was non-existent in the immediate vicinity of the landing area.

1.8 Aids to navigation

Not applicable.

1.9 Communications

The helicopter had two-way radio communication with Abuja Tower, Radar Approach and the Police helicopter (5N-PEJ). The air traffic services (ATS) related communications were recorded at the ATS facility in Abuja. The recorded ATS communications were of good quality and were transcribed. The communications were normal with no indications of any problems or concerns.

1.10 Aerodrome information

The Kabba landing area was an unpaved area comprising a football field located in the centre with two spectator stands on each side of the field. The elevation of the area was 1,500 ft (457 m) above mean sea level and the location coordinates were 07°50’31” N 006˚04’41” E. The field surface was characterized by scattered patches of grass and loose fine soil. The Police helicopter (5N-PEJ) landed outside the football field next to one of the spectator stands. The accident helicopter (5N-CML) landed in the football field.

Although the landing area was not an approved heliport, it was suitable as a temporary helicopter landing site.

1.11 Flight recorders

The helicopter was fitted with a Multi-Purpose Flight Recorder (MPFR) that had a combined cockpit voice and flight data recording capability. It offered continuous audio recording for the last 120 minutes and a 25-hour flight data recording capability. The MPFR was manufactured by Penny & Giles Aerospace Ltd, United Kingdom. The part number was D51615-142 Issue 2, serial number A09296-001 and date of manufacture July, 2014.

The recorder malfunctioned 34 minutes into the accident flight, and thus no data from the approach and landing phases were recorded on the MPFR. However, the helicopter was fitted with a Quick Access Recorder (QAR) that recorded data but not audio. The QAR recorded 930 parameters that covered the entire flight. The flight was reconstructed using the QAR data. The QAR was manufactured by Penny & Giles Aerospace Ltd, United Kingdom. The part number was D51640-0001 Issue 1, serial number 387842-015, MOD status 02 and date of manufacture November, 2009.

Figures 3 and 4 below depicts some of the parameters considered in the investigation, which included Avionics Caution - FDR Fail, Vertical Acceleration, Collective Handle Position, Pressure Altitude and Radio Height.

The QAR recorded a vertical acceleration of 1.4 g at the moment of landing. The tri-axial accelerometers, located near the centre of gravity of the helicopter, were the primary source of acceleration data recorded. However, smoothing of the data before recording caused the data to reflect the underlying acceleration trend and not the dynamic accelerations. Hence, it was likely that the landing was significantly "harder" than the 1.4 g recorded.

According to Leonardo Helicopters, the helicopter was delivered equipped with EPIC SW phase 6.2, and Caverton Helicopters did not apply the optional Service Bulletin to upgrade the 5N-CML EPIC system to SW phase 7. Therefore, the normal acceleration was filtered by the EPIC system, which caused some of the fastest acceleration spikes to be smoothed out. The filter on the tri-axial accelerometer was removed from the EPIC SW phase 7 onwards.

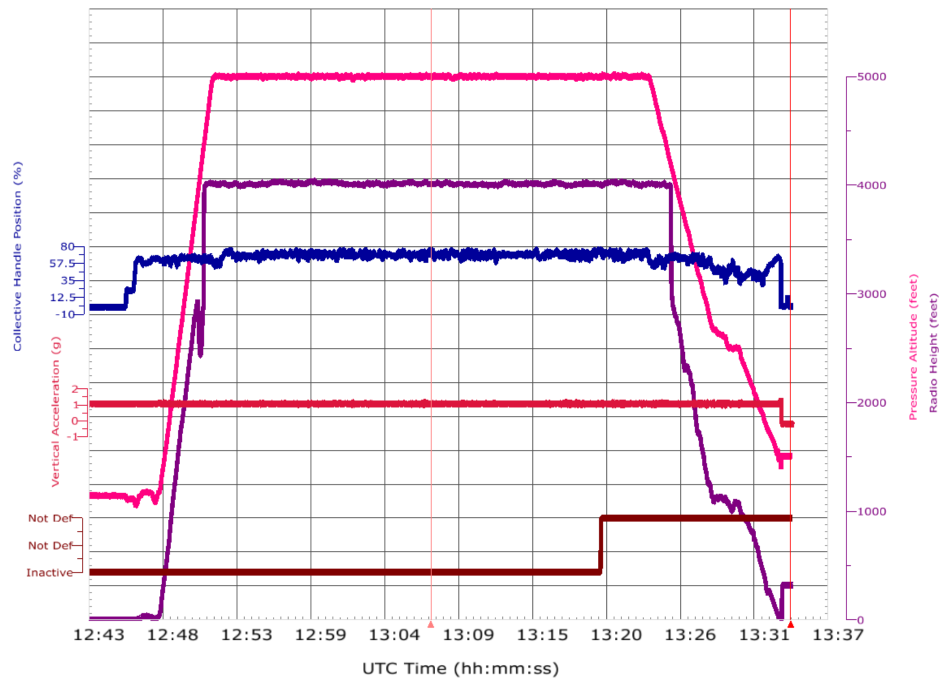

Figure 3: Profile of the flight

Legend
Not Def – MPFR Failed
Inactive – MPFR Functioning

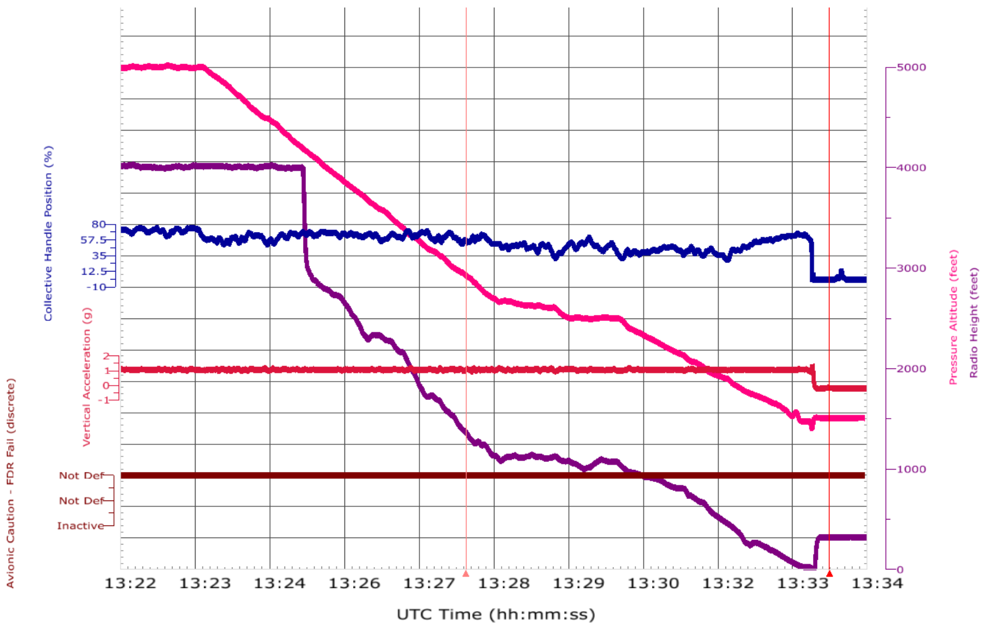

Figure 4: Approach and landing phase

1.12 Wreckage and impact information

The accident occurred on the football field close to one of the goal posts. The helicopter landed hard on the right main landing gear and rolled onto its right side. The five main rotor blades struck the ground and separated from the rotor head.

The blades were scattered around the fuselage as follows:

1. Main rotor blade piece – 62.4 m from the main wreckage, 210° and coordinates 07°50'33" N and 006°4'42" E.
2. Main rotor blade piece – 29 m from the main wreckage, 226° and coordinates 07°50'32" N and 006°4'42" E.
3. Main rotor blade piece – 24 m from the main wreckage, 270° and coordinates 07°50'33" N and 006°4'42" E.
4. Leading edge of one of the main rotors – 70 m from the main wreckage, 240° and coordinates 07°50'32" N and 006°4'44" E.
5. Main rotor blade piece – 60 m from the main wreckage, 285° and coordinates 07°50'31" N and 006°4'43" E.
6. Main rotor blade piece – 67.8 m from the main wreckage, 330° and coordinates 07°50'30" N and 006°4'43" E.
7. Main rotor blade piece – 67.5 m from the main wreckage, 002° and coordinates 07°50'29" N and 006°4'41" E.
8. Main rotor blade piece – 55.7 m from the main wreckage, 10° and coordinates 07°50'29" N and 006°4'41" E.
9. Main rotor blade piece – 61.5 m from the main wreckage, 28°and coordinates 07^{0}50'29" N and 006^{0}4'40" E.
10. Parked Toyota Camry 29 m from the main wreckage, 210° and coordinates 07°50'30" N and 006°4'41" E.
11. Main rotor blade leading edge piece – 50 m from the main wreckage, 82^{0} and coordinates 07°50'31" N and 006°4'40" E.

See wreckage plot below

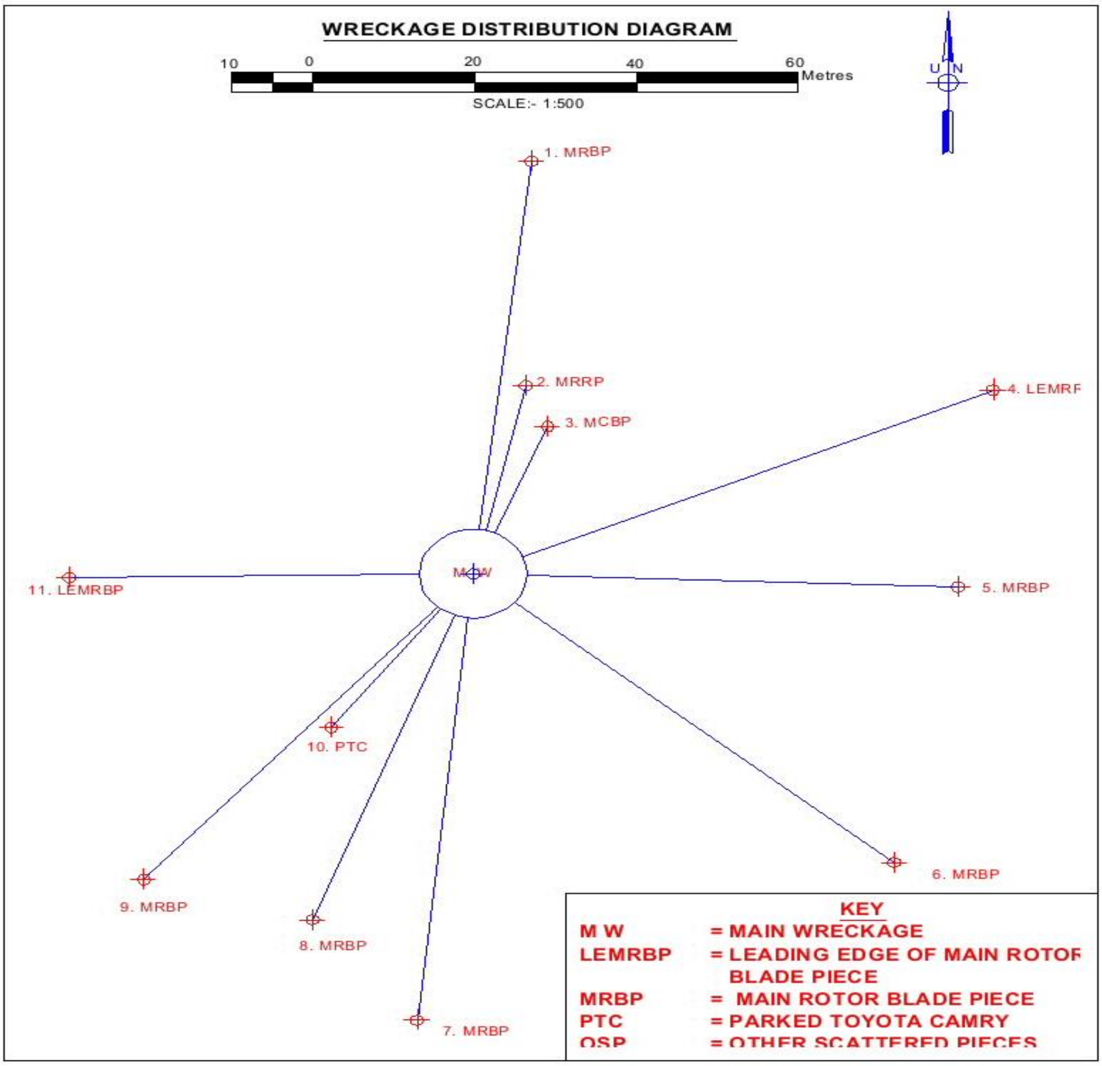

Figure 5: Wreckage distribution diagram

The right main landing gear broke and the right horizontal stabilizer was damaged. The tail rotor blades suffered damage, but the tail rotor assembly remained intact. The life raft deployed, and the left and the right floatation devices did not deploy.

Figure 6: The underside of the helicopter

Figure 7: The helicopter

Figure 8: Damaged right main landing gear

Figure 9: Damaged right horizontal stabilizer

Figure 10: Deployed life raft

Figure 11: Damaged tail rotor blades

1.13 Medical and pathological information

No medical tests were conducted. Reasonable efforts were made to submit the flight crew to alcohol testing, which was the normal procedure in aircraft accident investigations. Due to the absence of suitable testing facility in the vicinity of Kabba, the efforts were unsuccessful.

1.14 Fire

There was no pre- or post-impact fire.

1.15 Survival aspects

The accident was survivable. The seats and the restraints were intact. There was no fire. The rescue and evacuation from the helicopter was prompt.

The Engineer on board opened the left emergency window and all persons evacuated the helicopter safely with assistance provided by the police and security agents present on the football field.

1.16 Test and research

In the landing sequence, the right main gear broke off. The breakage occurred in the horizontal profiled beam structure to which the gear was attached. The profiled beam was perpendicular to the helicopter forward direction. The upper surface of the profiled beam had twisted forward and the lower surface backwards. The beam part containing the breakage surfaces were dismantled from the helicopter and submitted for metallurgical examination in an effort to determine details of the mode of breakage.

The result of the examinations will be added to this report when available and if relevant to the findings and conclusion to this report.

1.17 Organizational and management information

1.17.1 Caverton Helicopters Limited

Caverton Helicopters Limited was established in 2002 as a provider of charter, shuttle and maintenance services. It obtained an Air Operator Certificate (AOC), with authorization to conduct passenger and cargo flights, aerial work and charter flight operations. The company also obtained an Approved Maintenance Organisation (AMO) certificate from the Nigerian Civil Aviation Authority (NCAA) in accordance with the requirements of Nigerian Civil Aviation Regulations. Caverton Helicopters' principal base of operations was at Murtala Muhammad International Airport Ikeja, Lagos.

Caverton Helicopters operated a fleet of 27 aircraft comprising AgustaWestland AW139, Bell 407GXP, Bell 412, de Havilland DHC-6 Twin Otter, Sikorsky S-76C and Airbus H125 (AS350) aircraft.

Caverton Helicopters was initially set up to serve the onshore helicopter sector. Since then, Caverton Helicopters has expanded by providing logistics support to the major enterprises in the offshore oil and gas industry along the West African shelf.

1.17.2 Excerpts from the Caverton Operations Manual Part A (OMA)

The following contains excerpts from the Caverton Helicopters Operations Manual, Part A on issues which were considered relevant to the investigation.

8.4.3. Enhanced Operational Controls (EOC) for Heliports/ Airports not listed in the OM Part C (Unlicensed Heliports — Airports / New Heliports — Airports)

a. Aerodromes not listed in the OM Part C may be used on occasion; providing that the Director of Operations or Chief Pilot has authorised the operation and the following EOCs are in place and documented:

b. (The PIC must have completed a fly by assessment of the site by day /procedures laid out in Part A 13.1).

1. *No dispatch without contact with the aircraft operator and confirmation (by phone or email) that the destination heliport is open and the FATO is clear;*
2. *A site that has not been surveyed or assessed by day must not be used by night*
3. *No dispatch without contact with the Heliport /Airport operator and, as far as practicable, confirmation of met conditions at the helipad;*
4. *The minima for VFR flight are in place. Special VFR Flight is not permitted;*
5. *The flight shall carry an Air Quartermaster (AQM);*
6. *Fuel Requirements. No refueling is to be planned for at the unlicensed site;*
7. *The Flight Crew and AQM must be satisfied, on arrival, that the nature of the site is as expected and that, as far as can be ascertained from the air, nothing would prevent a successful approach, landing and subsequent departure from the site. Confirm and record (in the flight plan) the positive agreement of both pilots and the AQM; that the site is clear and it is safe to land;*
8. *If picking up at unlicensed heliports; no substantive changes to the outbound manifest (passengers, baggage, cargo or DG) are permitted;*
9. *Voyage Reporting. Each operation to these heliports / Airports shall raise a Voyage Report for review by the Caverton FSO.*
10. *Crew must complete form OPS -006A once Landed, (Completed form shall be send to the Chief pilot for review and possible inclusion to OMC, and the LSSR. (shall be included if more the [sic] 2 Flight per year).*

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8.31.16 Brownout conditions

When operating in known or anticipated brownout condition during takeoff and landing, where recirculating dust may seriously impair visibility, the takeoff and landing techniques should slightly be adapted.

- *T/O*

The danger from loss of visual reference is greater than that from the lesser chance of an engine failure. The takeoff profile must maximize separation from ground rather than slavishly following techniques designed to minimize the consequences of an engine failure. The recommended profile is to apply power for a no hover takeoff, getting vertical speed before lowering the nose to start into flight, known as the towering takeoff.

- *Landing*

Landing may be one of these methods depending on the conditions and the discretion of the commander.

1. *Make a no hover landing, reducing to zero ground speed exactly at the point of landing*
2. *Make a running landing, but only if the surface is known to be level and firm the pilot should seek a small object on the ground that he can land near so that it can be good visual reference throughout the landing.*

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13.1.3 ASSESSMENT PROCEDURES FOR UNLICENSED HELIPORTS

The following paragraphs outline the procedures for the assessment of an Unlicensed Heliport (HLS).

13.1.3.1 Personnel — HLS Assessment

Specific training is required for the assessment and authorisation of HLS. This training will be carried out during Initial Line Training by the relevant Line Training Captain.

13.1.3.2 Personnel — HLS Authorisation

Only the Chief Pilot can authorise the use of congested and/or Hostile Area HLS. Non-Hostile HLS that are not located inside a congested area may be authorised by the Assessing Pilot.

13.1.3.3 Initial Assessment of Unlicensed Heliports (HLS)

An initial assessment of the HLS shall be carried out using a 1:50,000 scale map or detailed plans of the site to determine

(a) if it is situated in a congested area.
(b) If the HLS is situated in a hostile environment.

13.1.3.4 Assessment of the HLS — Congested Area Criteria

During the assessment of the site the criteria detailed in Table 1 — Serial O1 above shall be used to determine whether the site is located inside a congested area. If the site is located inside a congested area operating restrictions may be applicable and therefore the procedures detailed in para 13.1.3.7 shall be carried out.

13.1.3.5 Assessment of the HLS — Hostile Environment Criteria

During the initial assessment of the site the criteria described in Table 1 — Serial 07 above shall be used to determine if the site is located within a hostile environment. If the site is in a congested area then in order to be deemed "Non- hostile" there must be adequate safe routes into and out of the site that would support a safe forced landing. If it is determined that the HLS is situated in a Hostile Environment, then the site is only suitable for Performance Class 1 or Performance Class 2 types of operations which automatically rules out the use of single engine helicopters. As the site is located in a hostile environment operating restrictions may be applicable and therefore the procedures detailed in para 13,1.3.7 shall be carried out.

13.1.3.6 Uncongested Non-Hostile HLS — The Simple Case

TABLE 2 - PERFORMANCE REQUREMENTS

Congested?	*Hostile?*	*Performance Requirements*
Congested	*Hostile*	*Performance Class 1*
Congested	*Non-Hostile*	*Performance Class 1, 2 and 3*
Congested	*Hostile*	*Performance Class 1*
Congested	*Non-Hostile*	*Performance Class 1, 2 and 3*

If it is determined that the site is neither in a Congested area nor in a hostile environment, then the flight may take place pending an aerial reconnaissance upon arrival by the pilot and no further procedures will be necessary other than to record the place of landing in the Helicopter Technical Log.

13.1.3.7 Determining the Applicable Operating Restrictions

13.1.3.7.1 Determining the Performance Requirements

Table 2 shall be used to determine the performance requirements of the site

13.1.3.7.2 Determining Additional Operating Restrictions/Criteria

Table 3 requires additional restrictions to be applied based on the quality of the information supplied to the assessing pilot.

TABLE 3 - DETERMINING ADDITIONAL OPERATING RESTRICTIONS		
Quality and/or Type of the Information Available to Assessing Pilot	***Type of Site***	***Operating Restrictions/ Criteria Applicable***

*A site which has been surveyed by the Company and for which a HLS Directory Entry exists, **or,*** *A Site which has been surveyed by another AOC/PAOC holder and for which a HLS Directory Entry exists and the information is presented to pilot in such a manner that it* *is possible to determine the relevant performance requirements, **or,*** *A site which has been accurately measured using suitable equipment and the information is presented to pilot in such a manner that it is possible to determine the relevant performance requirements.*	*SURVEYED*	*The site may be used by Night provided:* *(a) adequate lighting is available in accordance with para 13.1.4.1.5 below.* *(b} When a HLS Directory Entry exists: there is no night prohibition stated on the entry.* *The survey must be less than 12 months old at the time of the flight otherwise the operating restrictions for a MEASURED site shall apply.*
*A site which has been measured to an accuracy less than that of a SURVEYED site, e.g. paced out, differential GPS readings taken, **or*** *The site is assessed using a current large scale map (1:50,000 or 1: 25,000), **or*** *The site is assessed using area plans or a detailed drawing supplied by a responsible person.* *Obstacle heights may be determined from comparisons to known objects such as a standard two-storey house or "Spot heights" taken from map.*	*MEASURED*	*The site may be used by Day only.* *All dimensions shall be factored by 10%.* *Where the site is clearly located in an open area, e.g. a car park, then it need not be measured provided that its available length clearly exceeds the distance required for the helicopter to* *Reach 50ft in still air at the WAT limiting* *weight and there are no obstacles greater than 15ft located at that distance.*
No reliable information is available but a reasonable estimate of the site size and obstacle heights has been provided. For example, "It is an open field with a length equivalent to about 3 football pitches with trees 25ft high at the end".	*ESTIMATED*	*The site may be used by Day only.* *An ESTIMATED site may not be located inside a congested area.* *An estimated site may not be located inside a hostile environment.* *Fuel to an alternate site shall be carried.* *The minimum acceptable dimensions for an estimated site shall conform to the LOA requirements of the helicopter when operated in Performance Class 3 (Group B Landing Distance).*

13.1.4 HLS OPERATIONAL PROCEDURES

13.1.4.1 Pre-Departure Procedures

Before operating to an unlicensed site the following procedures shall be carried out by the Commander or nominated responsible person:

(a) Carry out an initial assessment in accordance with para 13.1.3.3 above.
(b) If the site is clearly in an un-congested non-hostile environment, then the flight may depart a aerial reconnaissance in accordance with para 13.1.3.3 above.
(c) Determine the applicable performance requirements from Table 2 at para 13.1.3.9 above.
(d) Determine any additional operating restrictions/criteria based on the quality/availability of the information supplied in accordance with Table 3 at para 13.1.3.9.2 above
(e) Calculate the required performance criteria in accordance with the relevant OM-B-Para 4.
(f) Ensure that permission in writing to use the site has been obtained from the local land owner
(g) Inform the local police of intended flight(s)
(h) Complete the HLS Assessment form and submit it to an authorizing officer as appropriate. (Note: it is acceptable for the assessing pilot and the authorizing pilot to be the same person)
(i) Carry out the flight as required

13.1.4.2 Procedures for Estimated Sites

The Commander must be satisfied on arrival that the nature of the site is as expected and that as far as can be ascertained from the air, nothing would prevent a successful approach, landing and subsequent departure from/to the site. He must also be satisfied that the LDA is not less than that required for the helicopter to land form 100ft.To achieve the aforesaid he should consider:

(a) Size: That the FATO is adequate
(b) Shape: Accommodates the approach, go-around, TLOF and departure route with due regard to the appropriate performance class.
(c) Surroundings: That any obstacles and wires etc have been identified and do not infringe the approach and departure flight paths.
(d) Surface: That the surface appears satisfactorily and is free from debris which may damage the helicopter
(e) Slope: That any slope appears to be within limitations for the specific helicopter.

No performance credit may be taken for wind and no approach is permitted with a tailwind component.

The helicopter must be shut down on arrival at the site and site measured or surveyed with the equipment specified in para 13.1.4.3 below. Unless the site is measured to the standard required of a SURVEYED site, horizontal dimensions should be reduced by a factor of not less than 10%. Obstacle heights should be increased by a factor of at least 10%.

The site is limited to use by day only.

13.1.4.3 Procedure for Measured Sites

The Commander must be satisfied on arrival that the nature of the site is as expected and that as far as can be ascertained from the air, nothing would prevent a successful approach, landing and subsequent departure from/to the site. He must be satisfied from the LDA is not less than required for the helicopter to land form 100ft.

No performance credit may be taken for wind and no approach is permitted with a tailwind component.

The helicopter need only be shut down on arrival if the Commander believes the dimensions to be less than what was assessed. In such circumstance he should follow the procedure as for the ESTIMATED site 13.1.3.5 above.

Sites are limited to use by day only.

13.1.4.4 Procedures for Surveyed Sites

The Commander must be satisfied on arrival that the nature of the site is as expected and that as far as can be ascertained from the air, nothing would prevent a successful approach, landing and subsequent departure from/to the site. He must be satisfied that the site has not changed in respect of size and obstacles environment since the last survey.

No approach is permitted with a tailwind component.

Where appropriate lighting is provide, surveyed sites may be used by night in twin engine helicopters only.

13.1.4.5 *Site Departure Procedures*

Prior to departing form an unlicensed site the Commander shall satisfy himself that for the ambient conditions, the helicopter can depart within the limitations of the required performance category as detailed in relevant Part B-Section 4.

13.1.4.6 Post flight Procedures

After the flight has taken place the Commander shall ensure that the post-flight section of the HLS assessment form has been completed and that any use of an exemption /permission is duly recorded on the form.

1.17.3 Caverton Helicopters Safety Management System Manual

1.0 Overview:

Caverton Helicopters Safety Management System (SMS) is the formal structure that is used to manage safety risks associated with all areas of operations (Flight, Ground, Maintenance, and Industrial safety (HSE) conducted by and in the name of Caverton Helicopters.

The SMS is based upon a systematic approach to hazard identification and risk management, which is intended to improve the organisations overall safety performance, reduce costs and maintain the integrity of the organisation.

Furthermore, in order to be a successful SMS, it aims to go beyond compliance with regulatory requirements such as the Nig. CARs 2015 and managed as an integral part of the overall business. Furthermore, this document prescribes how safety is managed in both Caverton's commercial air transport and approved maintenance organizations.

The overriding purpose of our SMS is to ensure Caverton Helicopters conducts safe and secure operations on behalf of its clients. Implementation of the SMS also provides the following benefits:

- *Guards against the direct and indirect costs of accidents and incidents*
- *Markets the safety standards of the organisation*
- *Improves communication, morale and productivity of staff*
- *Meets legal responsibilities to manage safety in accordance with Nigerian Civil Aviation Authority, ICAO requirements & Client requirements*

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Section 2 – Safety Risk Management

2.0 The SMS forms a part of the organisation's risk management activity, providing a specific framework for the identification of safety hazards and subsequent assessment, control and monitoring of all safety related risks.

2.1 Hazard Identification & Risk Management

It is important to clarify the definition of the terms hazard and risk in the context of the SMS:

Hazard: Condition, object or activity with the potential of causing harm (injuries to personnel, damage to equipment or structure, loss of material or reduction of ability to perform a prescribed function).

Risk: the chance of injury to personnel, damage to equipment or structures, loss of material, or reduction of ability to perform a prescribed function, described and measured in terms of likelihood and impact severity.

There are three layers of risk assessment within Caverton Helicopters organisation

Basic Safety Assessment of reported occurrences *Safety Assessment of individual reported occurrences and non-conformances*
Hazard Identification and risk Assessment *Safety Risk Assessment of operational activity*
Management of Change *Risk management of all business activity including projects & changes to the operations*

2.1.1 Basic Safety Assessment and Occurrence Report Handling

Basic Safety Assessment refers to the ongoing safety assessment of all occurrence reports entered in the company's Safety and Quality Database – Proactive Reactive Integrated Management System (PRISM).

The purpose of the Basic Safety Assessment is to enable the Safety and Quality Department to categorize reports entered in PRISM into their respective area of interest viz, Flight Operations ("FLT") Maintenance ("MXE") and Health and safety related reports ("HSE"). In addition, the software allows keywords to be attached to reports submitted, thereby facilitating trending. The supporting software system (Prism) is normally used to record all safety related events and to determine the level of review, reporting and investigations.

In cases where specific actions are required to address a short fall identified in a report, Corrective Action Required (CARs) are raised and sent to responsible post holder. Response to CARs shall be responded to within the defined dates agreed upon, otherwise the CAR will be deemed overdue. Responsible department shall be required to record the actions taken in Prism and subsequently validated by members of the Quality and Safety team at each location. Request for closure will then be sent to either the Quality or Safety Manager. Although PRSIM has the ability to risk assess Corrective Action request (CAR), CH S&Q does not use this capability to prioritize or determine the level of action required. CARs are normally ascribed due dates, within which respondents are expected to provide their feedback.

Trends and prioritized safety concerns identified through safety occurrence reports shall be escalated to the relevant Safety Action Group and/or the safety Review Board by the Safety & Quality Department where appropriate.

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2.4 Hazard Identification, Risk Assessment Process and Mitigation

The process of hazard identification and risk assessment within Caverton Helicopters SMS is known as HEMP (Hazard and Effect Management Process) and is conducted and managed principally through PRISM. Assessment of the following information supports the process of hazard and risk identification:

- *Occurrence reports*
- *Investigation reports & recommendations*
- *Non compliances raised during audits and inspections*
- *Flight data Monitoring (FDM) trend data*
- *Issues raised at SAG/ SRB meetings*
- *Proposed operational changes/new activities/projects (MOC)*
- *External sources such as Accident Investigation Bureau, NTSB, and other relevant organizations*

The purpose of this process is to reactively, proactively and generatively identify and control hazards that may impact upon operational activity-whether current or proposed – and evaluate the likelihood and impact severity of existing or potential safety risks arising from such hazards and to manage them accordingly.

2.5 Management of Change

A proposed change or existing activity shall be evaluated for significance and inter-departmental impact by management of the initiating department. It will be discussed at the SRB/SAG and may require coordination of specific steering committee.

Hazards identified during the Management of Change (MOC) process shall be risk managed using the Caverton Helicopters Risk management tool (PRISM) or similar formats designed to meet important requirements contained under the MOC tab in PRISM. Hazards identified together with their related controls may be transferred onto the hazard register if the need arises. Whenever this is done, detailed description of all the major hazards/threats and their respective controls with assigned responsible individual/post holder(s) forms what is referred to as a "Safety Case" for the proposed change / activity

2.6 Risk Evaluation

Risk ratings are determined using agreed criteria to evaluate the combination of the potential impact severity (Consequence) of an occurrence and the likelihood of the occurrence arising (Probability).

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2.10 HAZARD EFFECT AND MANAGEMENT PROCESS (HEMP)

The CH SMS uses Bow-tie methodology as a core part of her generative hazard and Effect Management Process (HEMP). The Bow-tie is a pictorial approach to Hazard Identification & Risk control and involves a detailed analysis of hazardous event and associated threats and controls of major aviation hazards peculiar to CH operations....

2.11 HAZARD MANAGEMENT PROCESS INTERRELATIONSHIP

At CH the Hazard Management Process is designed and linked to the Management Of Change, Safety reporting, investigations and the QA system. This guarantees that the hazard management Process is kept alive and made an integrated process which is continuously updated through various safety related activities such as incident reporting, MOC etc. The process shall be subjected to periodic evaluations and effectiveness of remedial actions plans (RAP), etc. reviews typically will comprise all concern Bow-tie owners, and facilitation will be conducted by S&Q personnel.

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1.17.4 The Presidential Air Fleet (PAF)

PAF was a unit of the Nigerian Air Force. Its base of operation was Nnamdi Azikiwe International Airport, Abuja.

One of the activities of PAF was the provision of air transport for the President and the Vice President. The protocol unit of the Vice President's office liaised with PAF for VIP missions/flights when using PAF air assets.

For the flight in question, PAF informed the AIB that the protocol unit of the Vice President's office had not involved PAF when this transport was planned and required.

1.18 Additional information

1.18.1 The extracts below relate to approach and landing in brownout conditions with medium and large helicopter. Source reference: North Atlantic Treaty Organization (NATO), AC/323 (HFM-162) TP/400; RTO Technical Report TR – HFM – 162 Published January, 2012.

1.18.2 Pertinent orientation information for helicopter take-offs and landings

For safe helicopter landings the main source of information available to the pilots is visual contact with the environment. Focal vision uses the central 30 degrees or so of the visual field; it is concerned with object recognition and identification. It involves relatively fine detail (high spatial frequencies). The information processed by focal vision is well represented in our consciousness. Therefore, it contributes to the conscious perceptions of orientation. During flights in Visual Meteorological Conditions (VMC), central vision allows distant judgment, depth perception employing binocular cues of stereopsis, vengeance, motion parallax and accommodation. On the other hand, ambient vision involves broader areas of the visual field (including the visual periphery). It sub-serves spatial localization and orientation and is primarily involved with the position, motion and attitude of the individual/airframe in the environment. Under good visual environment, ambient vision provides motion cues and position cues such as the horizon. In summary, focal vision orients the perceived object relative to the individual, whereas ambient vision orients the individual relative to the perceived environment.

1.18.3 Inadequacies of current landing approach during brownout

A common landing technique is to choose noticeable features on the ground (rocks, bushes, trees, fences, etc.) in order to set up the approach and land at the designated landing zone.

These external ground-based features provide the pilot with necessary and valuable information for landing. However, the sudden loss of visibility or degraded visibility abolishes visual guidance references (pre-identified landmarks as stated above), other moving targets, distance and height perception that are essential to control the aircraft near the ground.

There is little tolerance for error and inherent correction delay since brownout occurs close to the ground. Although the sudden loss of visual references would necessitate the transition from VMC (Visual Meteorological Conditions) to IMC (Instrument Meteorological Conditions), there remains an inadequacy between task requirements (landing in a non-visual environment) and the lack of feedback for drift and height above the terrain, especially in legacy aircraft equipped with only standard flight instrumentation. By the time when lateral drift is detected, corrective actions might not be implemented on time.

During flights under Instrument Flight Rules (IFR) in Instrument Meteorological Conditions (IMC), pilots should be able to read the instrument displays that provide the necessary, yet basic, spatial awareness information with confidence. Pilots who are trained to trust their instruments will most likely ignore the physiological inputs during landing even if external visual cues are available in order to concentrate on the flight instruments. Therefore, the instrument displays should be functioning properly in order to provide veridical flight parameters. However, in good visual environment, peripheral (ambient) vision facilitates the detection of drift and height above terrain which are the most critical information required during take-offs and landings.

The helicopter, by nature is an unstable platform. Pilots have to "work" persistently with their controls in order to gain and maintain stability. Without inputs to the controls *through either the Automated Flight Control System (AFCS) or hands-on control, the position of the helicopter in three-dimensional space can only be maintained for a very short period of time. Usually, it is much shorter than the time that it takes to land the helicopter. This time period depends on the specific airframe and the environmental conditions.*

The landing procedure itself is challenging. In order to descend and land from hovering, the helicopter pilot must reduce the torque (force). The reduction of force immediately (within a fraction of a second) requires a change of tail rotor power. The amount of tail rotor power change is determined by the amount of main power reduction (the torque) and is in turn determined through visual information obtained by the pilot. The impact of a change in tail rotor power is to create drift, which is compensated by moving the cyclic, in order to influence the requirement of power. This process requires "working" of the controls by the pilot in order to maintain stability. Moreover, as the helicopter is closer to the ground, the rotors are further influenced by the turbulence of air impacting the ground and the subsequent reflection off the ground surface. If mission requirement dictates that the landing procedure were to be sped up (i.e. a quick reduction in power), it would create a greater disturbance.

The fidelity of current helicopter instrumentation is not sufficient to execute instrument landing in remote and unfamiliar landing zones in degraded visual environment. Therefore "brownout landing" in current helicopters relies on hand-on control and may be supported by AFCS in some legacy airframes. The requirement of external (or virtual) visual cues is an important factor for safe take-offs and landings. Therefore, additional technological aids are required to support the aircrew in situations of limited visibility due to rising and re-circulating loose particulates (sand/snow) in order to avoid the spatial disorientation trap of brownout/whiteout.

In order to secure safe landing, mission related visual cues that will provide drift, height above terrain, descent rate, ground speed, attitude, slope, terrain features, landing zone location, obstacle clearance and moving obstacle detection must be available.

Specifically, drift is the most crucial information prior to touchdown as mentioned above. Ground speed refers to the horizontal speed in the final phase of the approach. The attitude of the aircraft refers to roll, pitch and yaw information. The priority and importance of this information depends on the helicopter type.

1.18.4 Risks management strategies to counter brownout

Landing techniques

Landing is the most hazardous of all transitions in degraded visual environment particularly within low light conditions and a non-permissive environment. The mission commander should risk assess the sortie prior to departure, and balance the tactical, environmental, aircrew and platform risks against the operational imperative. Appropriately constituted crews, systematic planning and thorough preparation are essential prerequisites. A marked and surveyed landing zone should be used wherever possible. Over-flight, noting obstructions, surface material, hover reference markers, overshoot options, actual landing zone height (Radio Altitude – Barometric Altitude comparison) and wind direction is desirable in all cases, although the tactical situation may be a constraining factor. Approaches are always conducted into wind where possible. The aircraft must always have sufficient power to initiate an overshoot should the crew become disorientated or lose essential references. Finally, crews should be alert to potential illusions of scale (e.g., stunted trees) and ground aberrations (e.g., irregular sand ridges).

Potential techniques for landing in degraded visual environment are as follows:

- *Zero speed landing – the most commonly used approach, balancing the time in recirculation against the risks of unseen obstructions or an unknown surface.*

- *Short running landing – aircrew must be confident about the surface but can expect reduced exposure to recirculation and improved aircraft stability. If the surface is known to be smooth (e.g., dirt landing strip) then a faster run-on landing may be used thus avoiding all recirculation until after touchdown.*

• Low hover and land – whilst this enable a final survey of the landing zone, aircrew must expect significant recirculation.

• High hover and vertical descent – this technique requires hover out of ground effect power. It is the preferred option in benign conditions especially if the aircrew are uncertain of surface conditions or obstructions; the technique is ideally supported by automation and/or synthetic orientation cues, unless the landing zone has only a thin layer of dust or snow.

2.0 ANALYSIS

2.1 General

The flight crew were certified and qualified for the flight in accordance with the Nigeria Civil Aviation Regulations (2015) and Caverton Helicopters requirements. No evidence indicated any pre-existing medical or behavioral conditions that might have adversely affected the flight crew's performance.

The accident helicopter was properly certified, equipped and maintained in accordance with the Nigeria Civil Aviation Regulations (2015) and the approved procedures of Caverton Helicopters. The mass and the centre of gravity of the helicopter were within the prescribed limits. No evidence indicated pre-existing engine, systems or structural failures that could have contributed to the accident.

This analysis focused primarily on the Caverton Helicopters safety management system (SMS), coordination, preparation and conduct of the flight, as well as the flight crew's performance. The unavailability of the MPFR audio recording covering the period of the accident sequence, prevented some details of the events from being fully resolved.

2.2 Coordination and preparation of the flight

Normally, flights for the Vice-President were conducted by the Presidential Air Fleet (PAF) using its own aircraft and helicopters. However, for this VIP flight a helicopter operated by a private company was chartered. Nevertheless, it could be discussed whether the PAF should coordinate the preparation of VIP flights in accordance with the PAF's requirements and standards. Such preparation may include site assessment; possibly advance flights and select a suitable landing area for planned VIP flights. Thus, the flight crew of the charter company could then be briefed appropriately. Such oversight would have eliminated some of the risk factors that were believed to have contributed to the accident.

In the case of the accident flight, the AIB was informed that PAF was not involved in the planning and preparation of the chartered VIP flight.

2.3 Conduct of the flight

The helicopter departed Murtala Mohammed International Airport in Lagos, for Nnamdi Azikiwe International Airport in Abuja, to conduct a chartered VIP flight first from Abuja to Kabba, and then onwards to Okene. From Okene, the flight was to return to Abuja. The positioning flight to Abuja was uneventful.

About an hour before departure from Abuja, the flight crew received the coordinates for the landing sites in Kabba and Okene. The flight crew was then in a position to finalized the flight planning for the departure, the flight, and landings at the unlicensed (temporary) landing sites in Kabba and Okene, which had not been previously surveyed.

The helicopter departed Abuja and en-route maintained an altitude of 5000 ft. The flight crew was in radio communication on frequency 136.1 MHz with the Police helicopter 5N–PEJ. 5N-PEJ was transporting an advance party of officials and was flying about five minutes ahead of 5N-CML. The VIP flight (5N-CML) was normal until about 10 minutes to landing when the CVR/FDR fail indicator light came ON. The flight crew consulted the company Quick Reference Handbook (QRH) and determined from the QHR that the failure was such that the flight could continue.

On approach to the intended landing site in Kabba, the flight crew carried out the landing checks, and based on the surrounding obstacles, the Pilot elected 100 ft/20 kt IAS as the Landing Decision Point.

At about 50 ft to the ground a brownout occurred. The flight crew lost visual contact with the ground and elected to use the Instantaneous Vertical Speed Indicator (IVSI) and radio altimeter to control the descent. The Co-pilot began calling out (in feet) heights using the radio altimeter as follows: 35, 30, 25, 20 and 15. After the "15" callout, neither the Co-pilot nor the Pilot could remember making or hearing further callouts.

At about 14:34 h, the helicopter experienced a hard landing on the right main landing gear and rolled over to the right. Even if the flight crew had contemplated a go- around, they had passed their Landing Decision Point. Considering the confinement of the area with a goal post ahead of the helicopter, the flight crew may have felt committed to land. Although the Pilot was significantly experienced as regards helicopter flight hours, his experience and training in brownout conditions was limited. Having lost the visual references, the Pilot lowered the collective to bring the helicopter down, which resulted in a hard landing on the right main gear.

The flight crew executed the emergency procedures, which included shutting off the engines and the fuel, and switching off the battery and the generators. The immediate emergency procedure actions significantly contributed to the successful evacuation of the occupants from the helicopter.

2.4 Risk assessment by Caverton Helicopters

Kabba football field was the first intended helicopter landing site. As an unlicensed heliport, the landing site came under the Special Operations category as contained in the Approved Operations Manual Part A of Caverton Helicopters. An assessment for unlicensed heliports (temporary helicopter landing sites) was required to be conducted by authorized personnel of Caverton Helicopters in accordance with OMA/CAV/01, Section 13.1.3 – 13.1.3.3 - "Assessment of Unlicensed Heliports". The Special Operations requirements by Caverton Helicopters required a risk assessment to be performed on the intended landing area (unlicensed) prior to departure. A classification was to be made to determine whether the temporary landing site was congested or uncongested, and hostile or non-hostile. Such classification may have resulted in a determination of uncongested – non-hostile temporary landing site. The flight crew was required to be briefed on the environmental and platform risks against the operational imperatives. The AIB investigation concluded that there were company shortcomings in the preparation of the flight:

- No risk assessment of the flight; and
- No evidence of a classification of the intended temporary landing site as uncongested - non-hostile before the flight.

As a reason why a risk assessment of the flight and a classification of the intended landing sites could not be done, Caverton Helicopters reported that because of Governmental security arrangements, the locations and coordinates of the landing sites were conveyed to the flight crew only an hour before the departure from Abuja.

An aerial reconnaissance was required to be performed by the pilot on arrival to the destination, in accordance with OMA/CAV/1, Section 13.1.3.6 - "Uncongested Non-Hostile HLS". No reconnaissance flight of the landing site was made. However, the Pilot stated that when he approached the landing area, he was in a position to observe and take note of the landing area and the obstacles outside the landing area. In addition, the Pilot was in radio communication with the flight crew of the police helicopter that had landed four minutes earlier.

Furthermore, the flight crew was required to be briefed on the environmental and platform risks against the operational imperatives. In this case, this was a task for the flight crew to accomplish during the reconnaissance flight.

2.5 The Brownout phenomenon in this accident

The brownout phenomenon occurs in arid terrain. Intense, blinding dust cloud is stirred up by the helicopter rotor downwash during flight close to the ground. In a brownout, the pilot cannot see nearby objects, which provide outside visual references necessary to control the helicopter near the ground. The brownout may result in a complete loss of visual references, and may cause spatial disorientation and loss of situational awareness.

During the descent, the helicopter hovered near to the ground at relatively low airspeed, the downwash made contact with the surface terrain and created a cushion of air in between the helicopter and the ground (ground effect). The start of brownout occurred when the helicopter began to hover at low altitude when it entered ground effect. The brownout transformed the prevailing Visual Meteorological Conditions (VMC) to Instrument Meteorological Conditions (IMC) in the immediate vicinity of the intended landing site. Caverton Operations Manual OMA/CAV/1, section 8.31.16 states that when operating in known or anticipated brownout condition, during landing, where recirculating dust may seriously impair visibility, the appropriate landing techniques should slightly be adapted as follows:

- "Make a no hover landing, reducing to zero ground speed exactly at the point of landing
- Make a running landing, but only if the surface is known to be level and firm; the pilot should seek a small object on the ground that he can land near so that it can be good visual reference throughout the landing."

2.6 Training in brownout conditions

The AIB noted that the Caverton Helicopters did not have a formal training programme for its pilots on take-offs and landings in brownout conditions, and the pilot and the co-pilot did not have formal training on flights in brownout conditions.

Therefore, in its Preliminary Report issued on 13th February 2019, the AIB recommended that the NCAA should issue an Advisory Circular to all helicopter operators flying in Nigeria to be alert to the possibility and the effect of brownout. Appropriate procedures should be put in place to mitigate its effects.

On 6th March 2019, the NCAA addressed the AIB Safety Recommendation (2019-002) and issued an all operators letter (FSG 002) to all helicopter operators on the subject of "Alert on possibility and effect of brownout during helicopter landing". The letter described the background to brownout conditions and the loss of visual references during landing, which may cause disorientation and loss of situational awareness. The letter included requirements for training in brownout conditions as follows:

"All helicopters operators are required to amend the flight crew training programme to include training and checking of pilots on:

a. Procedures for helicopter landing in flat-light, whiteout and brownout condition; and
b. Recovery from inadvertent instrument meteorological conditions (IMC)."

As described in the excerpts from a NATO 2012 report presented in 1.18.1 to 1.18.4 above, specific training in brownout conditions was considered essential for safe operations with helicopters.

2.7 The flight crew performance during approach and landing

The recommended landing technique in brownout was to make a running landing and choose a noticeable feature on the ground in order to set up the approach and land at the designated landing zone the (Caverton Operations Manual OMA/CAV/01, Section 8 sub-section 31.16) - "Brownout condition". Such external ground-based features would have provided the flight crew with the necessary visual clues to control the helicopter for landing.

The flight crew adapted a landing technique of "hover to land". As the brownout occurred close to the ground, the sudden loss of visual references would have necessitated a transition from visual flying to flying on instruments (Instrument Meteorological Conditions). The sudden degradation of visibility eliminated the visual guidance references, as well as distance and height perception. It was likely that the brownout and the loss of visual references caused flight crew spatial disorientation and loss of situational awareness. As a result, the helicopter attitude may not have been level and a lateral movement may have taken place, which may have contributed to the hard landing and the breakage of the right landing gear.

2.8 Safety management system (SMS)

Caverton Helicopters used a Safety Management System (SMS) as a formal structure to manage safety risks associated with all areas of its operations. The SMS was based upon a systematic approach to hazard identification and risk management, which was intended to improve the organization's overall safety performance, reduce costs and maintain the integrity of the organization. Reports of all occurrences were fed into the company's Safety and Quality database known as Proactive Reactive Integrated Safety Management (PRISM). Basic safety assessment of reported occurrences, safety risk management and management of change activities were carried out on the PRISM.

In accordance with the Caverton Helicopters SMS Manual, a Management of Change process shall be carried out prior to any new activity that could significantly affect the existing company operational risk controls. All identified hazards associated with the proposed change shall be assessed using the company's Hazard and Effect Management Process. A detailed description of all the major hazards/threats and their respective controls were transferred into a hazard register of the respective location where the change was anticipated. Also, the company's Operations Manual Part A (OMA) contained policies, guidelines and procedures to ensure conduct of safe flight operations. Specifically, OMA 4.9.3, OMA 8.4.3 and OMA 13.1 contained some of the prerequisite information required to guide the company Flight Operations Management in the selection of the appropriate crew composition for such missions, conduct of the flight, planning for the mission and assessment of the landing site. The company's policies, guidelines and procedures enumerated above constitute the company's safety barriers to prevent accidents.

However, during post-accident interviews and further correspondence with the company, it was established that Management of Change process had neither been carried out at the time when the company-initiated VIP charter flight operations, nor when the company was already conducting VIP flight operations. Furthermore, neither Caverton Helicopters Management, nor the flight crew conducted risk assessment of this VIP flight to identify associated hazards that may pose safety risk to the flight, taking into account that the intended landing site at Kabba was an unprepared, temporary and unlicensed landing site.

Consequently, the safety barriers put in place by Caverton Helicopters did not work, as the required assessments were not done in this instance.

Similarly, the AIB noted that the failure of the Multi-Purpose Flight Recorder (MPFR) enroute between Abuja and Kabba was not a single isolated occurrence. The maintenance documentation showed that MPFR failures had occurred a few times before. In each failure instance, the MPFR component had been replaced, the system had been tested and found functional. However, the reasons for the failures had not been determined. The AIB believes that efforts should have been made to determine the reasons for such failures within the Caverton Helicopters SMS programme. By establishing the reasons for such failures, preventive actions could have been considered in order to prevent future similar MPFR failures.

3.0 CONCLUSION

3.1 Findings

1. The helicopter had a valid Certificate of Airworthiness (C of A) and had been maintained in compliance with the regulations.
2. The mass and the centre of gravity of the helicopter were within the prescribed limits.
3. A risk assessment and classification of the Kabba landing site was not done by Caverton Helicopters prior to this flight. Due to Governmental security arrangement, the locations of the planned landing sites were released only an hour before the flight.
4. The flight crew were certified and qualified for the flight.
5. The Pilot was the Pilot Flying (PF) and the Co-pilot was the Pilot Monitoring (PM).
6. The take-off, climb out, cruise and approach phases were normal.
7. During cruise at 5,000 ft and at about 10 minutes to touchdown, the Multi-Purpose Flight Recorder failed.
8. Nigeria Police Force Bell 412 helicopter (5N-PEJ), which conveyed the advance party landed four minutes ahead of NGR002 (5N-CML).
9. During the approach, the flight crew briefed for an expected landing in brownout.
10. The landing technique adopted by the flight crew was hover to land with 100 ft/20 kt as landing decision point.
11. The Caverton Helicopters landing procedures in anticipated brownout conditions were not followed.
12. The brownout occurred at about 50 ft to touchdown when the flight crew lost visual contact with the ground.
13. The flight crew lost all visual cues, relied on instruments and Radio Altimeter callouts from 35, 30, 25, 20, 15 ft and no more until the helicopter hit the ground.

14. At about 14:34 h, the helicopter touched down hard on the right main wheel and rolled over onto its right side.
15. All occupants of the helicopter were evacuated uninjured.
16. Risk assessment of the mission was not conducted prior to commencement of the flight.
17. The intent of the requirement for an aerial reconnaissance was considered to have been met, as the flight crew observed the landing site and the obstacles when approaching the intended landing site.
18. The Pilot was significantly experienced in respect of helicopter flight hours. Although he had flown take-offs and landings in brownout conditions before, he had no formal training in brownout conditions. At the time of the accident, no formal training in brownout conditions was required.
19. The wind at the time of landing was 7 kt south-westerly.
20. The Caverton Helicopters SMS Manual called for an assessment process (Management of Change) of any activity that could significantly affect the existing company operational risk controls. Such an assessment process was not carried out prior to commencement of the VIP Charter operation into the unapproved landing site.

3.2 Causal factor

The flight crew encountered a brownout condition during the hover to land, which led to the loss of external visual references, spatial disorientation and loss of situational awareness resulting in a misjudgement of distance and ground clearance, as the flight crew tried to control the helicopter's movements for landing. The helicopter landed hard and rolled over on its right side.

3.3 Contributory factors

1. Inappropriate landing technique used.

2. Non-adherence to company procedures for known or anticipated brownout condition during landing.
3. Lack of risk assessment, limited landing site preparation and planning prior to the commencement of the flight.

4.0 Safety Recommendations

4.1 Interim Safety Recommendations issued in the Preliminary Report

4.1.1 Immediate Safety Recommendation 2019-002 (issued 13th February 2019)

NCAA should issue an Advisory Circular to all helicopter operators flying in Nigeria to be alert of the possibility and the effect of brownout. Appropriate procedures should be put in place to mitigate its effect(s).

Action taken by the NCAA: On 6th March, 2019, the NCAA addressed Safety Recommendation 2019-002 and issued an All Operators Letter (FSG 002) to all helicopter operators on the subject of "Alert on possibility and effects of brownout during helicopter landing". The letter described the background to brownout conditions and the loss of visual references during landing, which may cause disorientation and loss of situational awareness. In the letter, the "Actions Required" were formulated as follows:

1. All helicopter operators are hereby required to establish and implement appropriate procedures in their Standard Operating Procedures (SOPs) on helicopter handling in flat-light, whiteout and brownout conditions including methods for recognizing and avoiding these conditions. The procedures may include avoiding hovering in brownout or whiteout conditions while adding a little speed, preparing the landing sites before landing, and a quick revert to instrument when inadvertently in that conditions.
2. All helicopter operators are required to amend their flight crew training programme to include training and checking of pilots on:
   a. Procedures for helicopter handling in flat-light, whiteout and brownout conditions; and
   b. Recovery from inadvertent Instrument Meteorological Conditions (IMC).

If the programme already includes the required training, testing, and checking, no further action is required.

3. All helicopter operators are also required to carry out risk assessment in accordance with their Safety Management System (SMS) before dispatching a helicopter for operation into landing pads/areas.

AIB Conclusion: The AIB considers that the action taken by the NCAA meets the intent of the Recommendation 2019-002. The Recommendation is closed as implemented.

4.1.2 Immediate Safety Recommendation 2019-003 (issued 13th February 2019)

Caverton Helicopters Limited should ensure that flight operations are carried out in accordance with the company's approved operations manual, vis-à-vis site survey and proper safety risk analysis are done before dispatching any helicopter to unapproved landing pads.

Action taken by Caverton Helicopters: On 20 December 2019, Caverton Helicopters provided documents and additional information outlining the corrective actions taken to address the Safety Recommendation 2019-003, as well as the NCAA All Operators Letter (FSG 002) and the recommendations from the Caverton Helicopters internal SMS investigation of the accident.

a) As a result of Recommendation 2019-003 and the NCAA All Operators Letter (FSG 002), the Caverton Helicopters initiated numerous improvements to the training programme, introduced a requirement for brownout training (recognition, avoidance and recovery from brownout conditions), reviewed the stabilized approach and un-stabilized approach procedures including amendments to the Operations Manual Part A, Sections 8.17.7.21 and 8.17.7.22. In addition, Operations Manual, Part A, Section 13 was amended with regard to brownout conditions, the conduct of reconnaissance flight, new helicopter landing sites and night operations.

Stemming from the Caverton Helicopters internal SMS investigation of the accident:

- Brownout training was enhanced: Brownout became part of simulator training, and Controlled Flight into Terrain (CFIT) training to include brownout;
- Defined criteria for flight crew experience and crew pairing for high profile VIP flights;
- Operations Manual Part A, Section 13 was reviewed and processes, including a risk assessment procedure, were put in place for temporary unlicensed landing sites and new helipads; and
- The FATO BowTie was reviewed to mitigate the threat associated with "Challenging airfield flight conditions" and two additional barriers were introduced.

AIB Conclusion: The AIB considers that the action taken by Caverton Helicopters meets the intent of the Recommendation 2019-003. According to Caverton Helicopters, the amendments to the Operations Manual have been submitted to the NCAA for approval. Safety Recommendation 2019-003 remains open until Caverton Helicopters obtains NCAA approval of the amendments to the Operations Manual.

4.2 Safety Recommendations issued in this report

4.2.1 Safety Recommendation 2020-001

NCAA should

Conduct a Safety Management System (SMS) audit of Caverton Helicopters. The SMS audit by the NCAA should ensure that Caverton Helicopters has implemented the Immediate Safety Recommendation 2019-003, the NCAA All Operators Letter (FSG 002), and the recommendations documented in the Caverton Helicopters internal SMS investigation of this accident. The NCAA audit should also ascertain that the Caverton

Helicopters internal SMS processes in the maintenance activities require the establishment of the reasons/causes of equipment failure/malfunction (reference is made to the failures of the Multi-Purpose Flight Recorder (MPFR) and the unavailability of the reasons of the failures).

4.2.2 Safety Recommendation 2020-002

The Office of the National Security Adviser (NSA) should

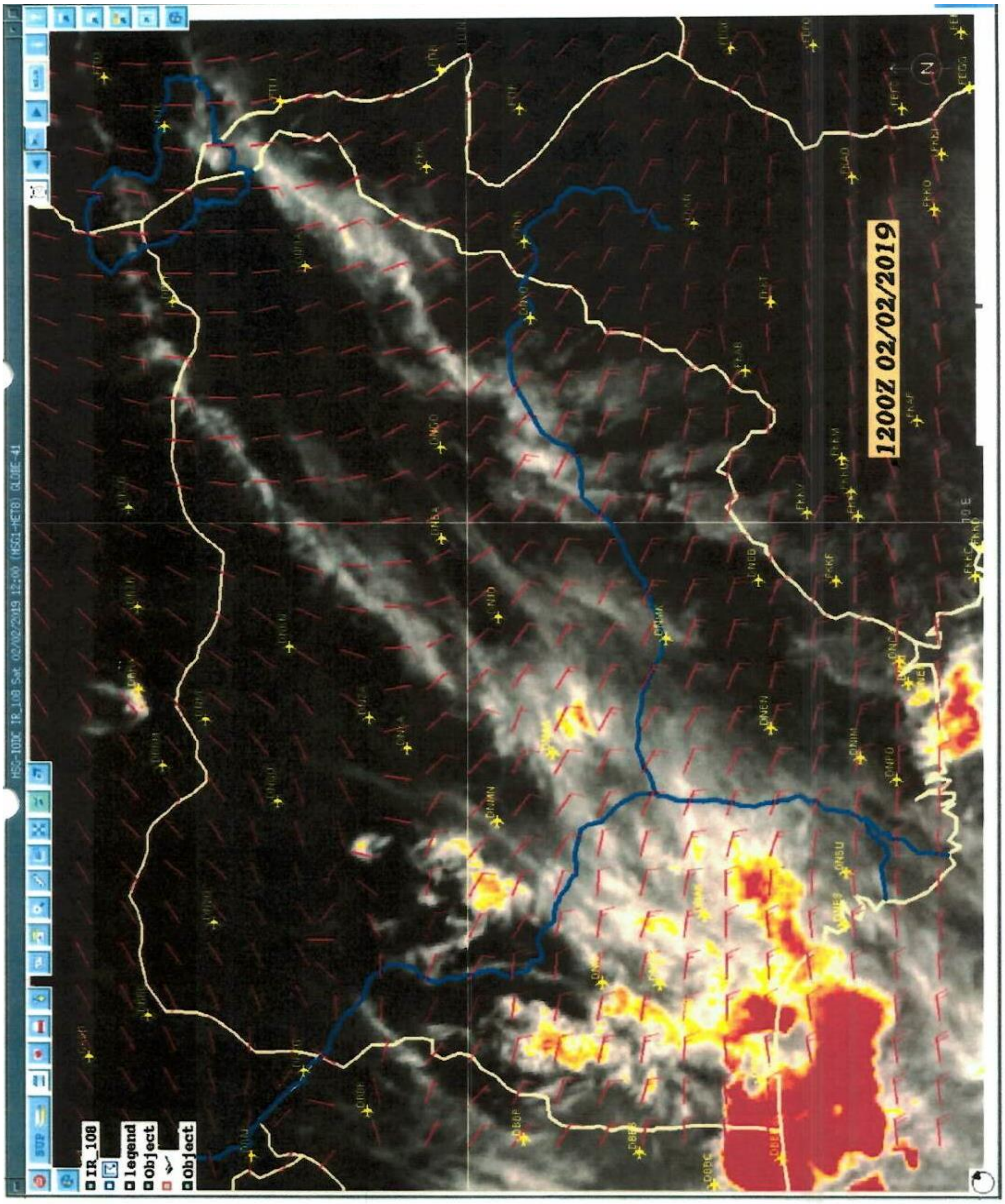
Consider whether the PAF Unit should be involved in the coordination and preparation of all high profile Executive VIP mission (flights) in order to ensure that all Executive VIP flights are conducted in accordance with the PAF Unit's Standards and in line with its approved operating procedures.

LIST of APPENDICES

1. Satellite weather imagery
2. NCAA All Operators Letter (FSG 002)
3. NCAA letter dated 12th March, 2019 to the AIB

APPENDICES

Appendix 1: Satellite Weather Imagery



Appendix 2: NCAA All Operators Letter (FSG 002)

NIGERIAN CIVIL AVIATION AUTHORITY

P.M.B. 21029, 21038, IKEJA-LAGOS.

ALL OPERATORS LETTER (FSG 002)

Ref:	NCAA/FSG/AOL/19/002
Date:	6th March, 2019
To:	All Helicopter Operators
From:	Nigerian Civil Aviation Authority
Attn:	Director of Flight Operations/Quality Manager/Safety Manager
Subject:	**ALERT ON POSSIBILITY AND EFFECTS OF BROWNOUT DURING HELICOPTER LANDING**

The purpose of this FSG All Operators Letter is to alert all helicopter operators on the possibility and effects of brownout during helicopter landing in a dusty environment.

Background

A preliminary investigation into an accident involving an Agusta Westland AW139 helicopter belonging to and operated by a Nigerian operator revealed that after the crew had identified a landing spot within a stadium, they got into a hover to land but at about 50ft above ground level a brownout set in. The crew lost visual contact with the ground and elected to use the Instantaneous Vertical Speed Indicator (IVSI) and Radio Altimeter (RAD ALT) to control the decent. While landing, the helicopter experienced a hard landing on the right main landing gear and went into a dynamic rollover to the right.

Helicopter brownout is a dangerous phenomenon experienced by many helicopters when making landing approaches in dusty environments, whereby sand or dust particles become swept up in the rotor outwash and obscure the pilot's vision of the terrain. An undesirable effect of this interaction may be the lift up of sand or ice particles, that may be entrained in the wake, and affect the pilot's visibility. This is particularly dangerous because the pilot needs those visual cues from their surroundings in order to make a safe landing. This can cause spatial disorientation and loss of situational awareness leading to an accident.

Blowing sand and dust can cause an illusion of a tilted horizon and a pilot not using the flight instrument may instinctively try to level the helicopter with respect to the false horizon resulting in an accident. Helicopter rotor wash also causes sand to blow around outside the cockpit windows, possibly leading the pilot to experience the vection illusion where the helicopter appears to be turning when it is actually in a level hover. This can also cause the pilot to make incorrect control inputs which can quickly lead to disaster when hovering near the ground.

The NCAA has determined that this accident could have been prevented if the pilots were better prepared to cope with encounters such as an Inadvertent Instrument Meteorological Conditions (IIMC), flat-light, whiteout, and brownout conditions.

Actions Required

1. All helicopter operators are hereby required to establish and implement appropriate procedures in their Standard Operating Procedures (SOPs) on helicopter handling in flat-light, whiteout and brownout conditions including methods for recognizing and avoiding these conditions. The procedures may include avoiding hovering in brownout or whiteout conditions while adding a little speed, preparing the landing sites before landing, and a quick revert to instrument when inadvertently in that conditions.

2. All helicopter operators are required to amend their flight crew training programme to include training and checking of pilots on:

   a. procedures for helicopter handling in flat-light, whiteout and brownout conditions; and
   b. recovery from Inadvertent Instrument Meteorological Conditions(IIMC).

   If the programme already includes the required training, testing, and checking, no further action is required.

3. All helicopter operators are also required to carry out safety risk assessment in accordance with their Safety Management System (SMS) before dispatching a helicopter for operation into landing pads/areas.

Please, comply accordingly.

[redacted]

Appendix 3: NCAA letter dated 12th March 2019 to the AIB

NIGERIAN CIVIL AVIATION AUTHORITY

P.M.B. 21029, 21038, IKEJA-LAGOS.

NCAA

OFFICE OF THE DIRECTOR-GENERAL

[redacted]

Reference Number: NCAA/DG/AIB/9/16/071
Date: 12th March, 2019

The Commissioner
Accident Investigation Bureau (AIB)
P.M.B 016, Murtala Muhammed International Airport
Ikeja, Lagos.

RE: PRELIMINARY REPORT ON ACCIDENT INVOLVING AGUSTA WESTLAND AW 139 HELICOPTER OPERATED BY CAVERTON HELICOPTERS LIMITED WITH NATIONALITY AND REGISTRATION MARK 5N-CML WHICH OCCURRED AT KABBA STADIUM, KOGI STATE ON 2ND FEBRUARY, 2019.

Sir, I have been directed to acknowledge the receipt of your letter of transmittal, dated the 13th of February, 2019 on the above subject matter.

I have been further directed to inform the Commissioner that the Authority had reviewed the subject Preliminary Report and addressed the Immediate Safety Recommendation 2019-002 by issuing an All Operators Letter (AOL) Flight Standards Group (FSG) 002, reference number; NCAA/FSG/AOL/19/002, dated the 6th of March, 2019 and titled "Alert on Possibility and Effects of Brownout during Helicopter Landing", to all helicopter operators, detailing the actions required of these entities and ensuring compliance of same.

The subject AOL had been distributed to the relevant organizations and a copy is attached herewith.

The Director General wishes to sincerely thank you for your continuous corporation and to please accept the assurances of his highest regards.

[redacted]