



AIRCRAFT ACCIDENT REPORT

NESTOIL/2018/01/25/F

Accident Investigation Bureau

**Report on the Serious Incident involving
Gulfstream G200 Aircraft Operated by Nestoil PLC with
Nationality and Registration Marks 5N-BTF which
occurred at Nnamdi Azikiwe International Airport, Abuja
On 25th January, 2018**



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

The report is based upon the investigation carried out by 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.

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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.

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GLOSSARY OF ABBREVIATIONS USED IN THIS REPORT

AFM	Airplane Flight Manual
AIB	Accident Investigation Bureau
AOC	Air Operator Certificate
ARFFS	Aircraft Rescue and Fire Fighting Services
ATC	Air Traffic Control
ATIS	Automatic Terminal Information Services
ATPL (A)	Air Transport Pilot License (Aeroplane)
ATS	Air Traffic Services
BITE	Built-in Test Equipment
CPL	Commercial Pilot License (Aeroplane)
CRM	Crew Resource Management
CVR	Cockpit Voice Recorder
DH	Decision Height
DME	Distance Measuring Equipment
DNAA	International location Identifier for Abuja Airport
ECU	Electronic Control Unit
FAAN	Federal Airports Authority of Nigeria
FAR	Federal Aviation Regulations
FDR	Flight Data Recorder
IAI	Israel Aircraft Industry



IFR	Instrument Flight Rules
ILS	Instrument Landing System
IMC	Instrument Meteorological Conditions
JAR	Joint Aviation Requirement
LED	Light Emitting Diode
LLWAS	Low Level Wind Shear Alert System
LPC	Line Proficiency Check
LRU	Line Replaceable Unit
MDA	Minimum Descent Altitude
Nig.CARs	Nigeria Civil Aviation Regulations
NSC	No Significant Cloud
OPC	Operator Proficiency Check
PIC	Pilot in Command
QRH	Quick Reference Handbook
RLG	Right Landing Gear
SARPs	Standard and Recommended Practices
SOP	Standard Operating Procedure
T/R	Thrust Reverser
VHF	Very High Frequency
VOR	Very High Frequency Omnidirectional Radio Range
WOW	Weight on Wheel



Aircraft Accident Report No.: Nestoil/2018/01/25/F

Registered Owner and Operator: Nestoil PLC

Aircraft Type and Model: Gulfstream G200

Manufacturer: Gulfstream Aerospace LP

Year of Manufacture: 2007

Registration Mark: 5N-BTF

Serial Number: 180

Location: Runway 22, Nnamdi Azikiwe
International Airport, Abuja

Date and Time: 25th January, 2018 at 15:20 h

*(All times in this report are local time,
equivalent to UTC+1 unless otherwise
stated)*

SYNOPSIS

Accident Investigation Bureau (AIB) was notified by Abuja ATC at 15:28 h on 25th January, 2018 of an accident involving a Nestoil Plc Gulfstream 200 (G200), with nationality and registration marks 5N-BTF on Runway 22 of Nnamdi Azikiwe International Airport, Abuja.

Air Safety Investigators were dispatched to the scene of the accident and investigation commenced immediately. All stakeholders were duly notified.



The aircraft was operating a charter flight, on an Instrument Flight Rules (IFR) flight plan, with four passengers and three flight crew members onboard.

The Captain was the Pilot Flying (PF) and the Co-pilot was the Pilot Monitoring (PM).

At 14:28 h, the Gulfstream 200 (G200), with nationality and registration marks 5N-BTF, took off from Murtala Muhammed International Airport, Lagos (DNMM). At 15:18 h, it landed Nnamdi Azikiwe International Airport Abuja (DNAA) Runway 22, lost control during the landing roll and came to a stop on the right shoulder of the runway with the right main landing gear broken.

The ATC immediately notified the Aircraft Rescue and Fire Fighting Services (ARFFS), Approach Radar Control and other relevant agencies about the occurrence. All persons on board disembarked normally with no injuries.

The serious incident occurred in daylight.

Causal Factor

The use of improper directional control techniques to maintain the aircraft on the runway.

Contributory Factor

Improper coordination in taking over control of the aircraft by the PM which was inconsistent with the SOP.

Four Safety Recommendations were made.



1.0 FACTUAL INFORMATION

1.1 History of the Flight

On 25th January 2018 at 14:28 h, a Gulfstream 200 (G200) aircraft with nationality and registration marks 5N-BTF operated by Nestoil Plc, departed Murtala Mohammed International Airport, Lagos (DNMM) as a charter flight to Nnamdi Azikiwe International Airport, Abuja (DNAA) on an Instrument Flight Rules (IFR) flight plan. Onboard were four passengers and three flight crew members. The Pilot in command (PIC) was the Pilot Monitoring (PM) and the Co-pilot was the Pilot Flying (PF).

The departure, cruise and approach to Nnamdi Azikiwe International Airport were normal. At 14:45 h, 5N-BTF contacted Abuja radar and was subsequently cleared for Radar vectors ILS approach Runway 22. Abuja Airport Automatic Terminal Information Service (ATIS) Papa for time 14:20 h was monitored as follows; "Main landing runway 22, wind 110/07 kt, Visibility 3,500 m in Haze, No Significant Clouds, Temperature/Dew point 33/-01 °C, QNH 1010 hPa, Trend No Significant Change, End of Information Papa".

At 15:17 h, 5N-BTF reported 4 NM on Instrument approach (ILS) and was requested to report 2 NM because there was a preceding aircraft (Gulfstream 5) on landing roll. Thereafter, 5N-BTF was cleared to land runway 22 with reported wind of 070°/07 kt.

At 15:18 h, the aircraft touched down slightly left of the runway centre line. According to the PF, in the process of controlling the aircraft to the centre line, the aircraft skidded left and right and eventually went partly off the runway to the right where it came to a stop.

In his report, the PM stated that on touchdown, he noticed the aircraft oscillating left and right as brakes were applied. The oscillation continued to increase and [the aircraft] eventually went off the runway to the right where the aircraft came to a stop, partially on the runway.

During the post-crash inspection, the investigation determined that the skid marks on the runway indicated that the aircraft steered in an S-pattern continuously with increasing

amplitude, down the runway. On the last right turn, the aircraft exited the right shoulder of the runway, the right main wheel went into the grass and on the final left turn, the right main landing gear strut detached from its main attachment point after which the aircraft finally came to a complete stop on a magnetic heading of 160°.

The ATC immediately notified the Aircraft Rescue and Fire Fighting Services (ARFFS), Approach Radar Control, and other relevant agencies about the occurrence. All persons on board disembarked with no injuries.

Instrument Meteorological Conditions (IMC) prevailed at the time of the occurrence.

The serious incident occurred in daylight.

1.2 Injuries to Persons

Injuries	Crew	Passengers	Total in the Aircraft	Others
Fatal	Nil	Nil	Nil	
Serious	Nil	Nil	Nil	
Minor	Nil	Nil	Nil	Not Applicable
None	3	4	7	Not Applicable
Total	3	4	7	

1.3 Damage to Aircraft

The aircraft was substantially damaged.

1.4 Other Damages

Nil.



1.5 Personnel Information

1.5.1 Pilot-in Command (Pilot Monitoring)

Nationality:	Nigerian
Age:	37 years
License Type:	ATPL (A)
License Validity:	29 th October, 2018
Medical Validity:	10 th July, 2018
Ratings:	Dash 8, Hawker 900XP/4000, HS-125/800XP, Falcon 7X, Gulfstream 200, SD 360, B737-300/500
Total Flight Time:	5,300 h
Hours on Type:	280 h
Last 90 days:	14:20 h
Last 28 days:	7:10 h
Last 7 days:	3:12 h
Last 24 hours:	1:25 h

This pilot was the PM and had a rest period of 21:00 h prior to reporting for duty. During the post-occurrence interview, the PM reported that he took over control towards the end of the landing roll.

1.5.2 Co-pilot (Pilot Flying)

Nationality:	Nigerian
Age:	42 years



Gender:	Male
License Type:	ATPL (A)
License Validity:	14 th August, 2019
Medical Validity:	7 th January, 2019
Ratings:	Hawker-900 XP, PA-28, HS-125/700/800XP, Gulfstream 200
Total Flight Time:	5,700 h
Hours on Type:	93 h
Last 90 days:	23:58 h
Last 28 days:	7:10 h
Last 7 days:	3:12 h
Last 24 hours:	1:25 h

The PF also holds a command rating on this aircraft and had rest period of 21:00 h prior to reporting for duty.

1.5.3 Observer

Nationality:	Nigerian
Age:	36 years
Gender:	Male
License Type:	ATPL (A)
License Validity:	3 rd December, 2019
Medical Validity:	27 th September, 2019



Ratings:	MD-80, Hawker-900XP, HS-125/800XP, Gulfstream 200
Total Flight Time:	1,970 h
Hours on Type:	24 h (simulator)
Last 90 days:	Nil
Last 28 days:	Nil
Last 7 days:	Nil
Last 24 hours:	Nil

1.6 Aircraft Information

1.6.1 General Information

Manufacturer:	Gulfstream Aerospace LP
Serial No.:	180
Year of manufacture:	2007
Total airframe time:	1,421 h
Total landing cycles:	921
Certificate of Insurance:	1 st February, 2018
Certificate of Airworthiness:	4 th May, 2018

The load sheet recorded that the aircraft weight at landing was calculated to be 12,553 kg and the Centre of Gravity was 35.79.



1.6.2 Engines

	Engine No. 1	Engine No. 2
Manufacturer:	Pratt & Whitney, USA	Pratt & Whitney, USA
Type/Model:	PW306A	PW306A
Serial number:	PCE-CC 0376	PCE-CC 0379
Time Since New:	1,421 h	1,421 h
Cycle Since New:	921	921

1.6.3 Main Landing Gear

Manufacturer:	Israel Aircraft Industry (IAI) Engineering Division Commercial Aircraft Group, Israel
No. of Wheels:	2 on either side
Maximum Landing Weight:	30,000 lb
Maximum Take-off Weight:	35,650 lb
Ramp Weight:	35,800 lb
Safe-Life:	17,500 Landings

1.7 Meteorological Information

DNAA

Time: 15:00 h

Wind: 070°/07 knots



Visibility: 3,500 m
Weather: Haze
Cloud: NSC
Temp/Dew: 33/-01 °C
QNH: 1010 hPa

1.8 Aids to Navigation

The conditions of the navigational aids at the Nnamdi Azikiwe International Airport Abuja on the day of the occurrence were as follows:

VHF 127.05 MHZ ATIS Freq	Serviceable
ABC VOR/DME 116.3 MHZ	Serviceable
IAB ILS/DME RWY 22 109.3 MHZ	Serviceable
IAC ILS/DME RWY 04 111.9 MHZ	Serviceable
LLWAS	Unserviceable
Radar Monitor	Serviceable

1.9 Communication

There was effective communication between the Air Traffic Services (ATS) and the aircraft throughout the duration of the flight.



1.10 Aerodrome Information

Nnamdi Azikiwe International Airport, Abuja (DNAA) has Aerodrome Reference Point 09°00'15"N 07°15'30"E and an elevation of 1,123 ft (342 m). The aerodrome has a runway with orientation of 04/22. The length and width of the runway are 3,610 m and 60 m respectively, with an asphalt/concrete surface and blast pads of 65 m at both ends.

1.11 Flight Recorders

The aircraft was equipped with a Flight Data Recorder (FDR) and a Cockpit Voice Recorder (CVR). Both recorders were recovered from the aircraft in good condition.

The flight recorders were downloaded and the CVR recordings were transcribed at the AIB Flight Safety Laboratory, Abuja.

1.11.1 Flight Data Recorder (FDR)

Part Number:	980-4710-003
Type:	AR-FDR
Serial Number:	01065
Manufacturer:	Honeywell, USA

FDR Report

Reviewed roll and yaw axis parameters and confirmed correlation and sign conventions. Rudder, Rudder Pedal Position, Rudder Trim, Magnetic Heading (L&R), Aileron Position (L&R), Control Wheel Position, Aileron Trim, Roll Angle (L&R), and Radar Altitude parameters all appear to be functional, correct and valid. It was confirmed that Thrust



Reversers were not used on this incident event. The following are items identified with regards to this incident: -

1. Nose Wheel Angle and Nose Wheel Steering Position during the landing roll do not appear to be recorded.
2. Brake Application (both pilot positions) and Brake Pressure Indications.
 - a) Only 1 left and 1 right brake pedal angle position parameters are recorded. These are combined brake pedal angle position parameters for both Captain and F/O. Therefore, there is no way to determine which of them, whether the Captain, F/O, or both were actuating the brake pedals.

Note: The first 15% of brake pedal travel is a dead band and no brake pressure rise will occur.

- b) About 10 seconds before the first WOW indication, both brake pedal positions began increasing above 0, reaching ~2deg R pedal & ~3deg L pedal approximately 1 second before the first WOW indication. Documentation indicates that 1 degree of brake pedal application is "NO FORCE" braking (0 psi) and 16.5 degrees is max braking (~1600 psi) and brake clamp-up pressure is 180 to 200 psi. However, the R brake pressure parameter increased (to ~180 psi) once left MLG WOW is indicated and then varied between 200 to 500 psi (200 to 500 psi represent light to medium braking). The L brake pressure parameter was not active or valid. It should be noted that the L MLG touched down first and the R MLG approximately one second later.
 - c) Left Brake Pressure Parameter. The Left Brake Pressure parameter is at -1000 psi (the converted value of 0 counts) for the entire recording. This could be due to a failure in the recording system. Documentation indicates that there is one pressure transducer for the left outboard brake and one for the right outboard brake. The inboard brake pressures are not recorded.



1.11.2 Cockpit Voice Recorder (CVR)

Part Number: 1603-02-12
Type: CVR-120
Serial Number: 1925
Manufacturer: Universal Avionics System Corporation, USA

During the post-accident interview, the PM mentioned that he took over control from the PF during the landing roll.

Extract from CVR transcript

P2- Okay my tops

P1- Your tops

P2- My tops, my tops, easy, easy, no, easy, easy, not...

P1- Ugh

P1- uh

P2- Easy, easy

P2- not with the nose wheel, not with the nose wheel

P1-urgh

P2- Not with the nose wheel

P1- argh, okay

P2- Urgh

P2- (deep breathing)

P2- Urghh

P2- Ehh

P2- Argh, argh

1.12 Wreckage and Impact Information

The aircraft fuselage was in one piece, but the landing gear assembly was detached. The nose landing gear tyres were abraded crosswise and the right inboard main wheel tyre was found deflated. Skid marks of the nose landing gear indicate that the aircraft landed 6 m left of the runway centre line, travelled in an S-pattern with increasing amplitude down the runway.

On the last right turn, the right main wheel went into the grass and on the final left turn, the right main landing gear detached from its attachment point and the lower surface of the right wing was abraded. The aircraft came to a stop at a distance of 1,953 m from the threshold of Runway 22. The distance as measured from the detached right main landing gear to the main wreckage was 10.8 m.



Figure 1: Aircraft tyre marks on the runway



Figure 2: Photo showing the Right Main Landing Gear attachment point



Figure 3: Part of the detached Right Main Landing Gear Assembly



Figure 4: Aircraft final resting point



Figure 5: Nose wheel tyre chaffed



Figure 6: Nose wheel steering control and switch

1.13 Medical and Pathological Information

Toxicological examination for alcohol and substance abuse was carried out on the crew, and the result was negative.

1.14 Fire

There was no fire outbreak in-flight or after the impact.



1.15 Survival Aspect

There was no damage to the fuselage. The crew and passengers disembarked normally with no injuries, before the arrival of the ARFFS. The ARFFS responded promptly.

1.16 Test and Research

Not Applicable.

1.17 Organisational and Management Information

1.17.1 Nestoil Plc

Nestoil Plc is an NCAA licensed operator, holding an Air Operator Certificate (AOC) on 20th May, 2015 with reference: NOP/AOC/03-15/001 valid till 19th March, 2019 for commercial aircraft charter operations. Nestoil Plc provides flight services in Fixed and Rotary Wing aircraft for internal clients, as well as providing VIP and Utility services to external clients.

The Maintenance base is located in Ikeja, Lagos. Operations started in 2010 as an Aviation department within Nestoil Plc, with one helicopter - a Sikorsky S76. In 2013, two more helicopters, the Agusta Westland AW139, were introduced to the fleet. Nestoil Plc currently has five aircraft (excluding the accident aircraft) in its fleet: three helicopters and two fixed wing aircraft (the Gulfstream GIV-SP and a Hawker Beechcraft HS125 900XP).



1.18 Additional Information

1.18.1 Nose Wheel Steering — System Description (G200 Manual)

The Nose Wheel Steering (NWS) system is an electro-hydraulic servo system controlled by an Electronic Control Unit (ECU). The ECU is located in the right forward radio rack. Access to the ECU is through access panel 223EZ. The NWS system provides the following, a steering angle of 60° either side of center, a towing angle of up to 100° either side of center without manual disconnecting of the nose landing gear torque links[.] +A NWS toggle switch on the left console in the cockpit allows the pilot to activate the NWS system or to switch it off and place the nose landing gear in a free swivel mode for shimmy Damping. The pilot and copilot can control the steering angle 3° either side of center with the rudder pedals or the pilot can control the steering angle of 60° either side of center by a steering handle on the left console. The NWS is a rack and pinion type, actuated by a pair of coaxial hydraulic actuators and controlled and monitored by an electro-hydraulic servo system.

The system consists of the following components; Steering actuators and mechanism, Steering control valve manifold, ECU, Two steering actuator and mechanism feedback, position transducers, Two cockpit pedals command transducers, Two cockpit handle, command transducers, Main landing gear and nose landing gear WOW switches.

1.18.1.2 Failure Detection

Any single failure in the NWS system which may impact aircraft safety is detected by the NWS - ECU monitoring channel. If a hazardous situation is detected, the monitor de-energizes the selector valve. As a result, the system is transferred to bypass mode.

In this case, aircraft directional control is accomplished by means of differential braking and/or rudder control. When the failure condition is corrected, the monitor channel resets the control channel back into normal operational mode. When the steering system is switched ON and the nose landing gear is in the down and locked position, the BIT circuit



performs an initial power up test, checking and verifying all protection circuits capabilities. The self-test is performed by injecting out of range signals to the monitoring circuits. Only when the self-test verifies the proper operation of the monitoring function, the steering system becomes active. Otherwise, the system remains in bypass mode. When the steering system becomes active, the BIT circuit continuously monitors the steering system in a periodic mode. The BIT detects and isolates failures to Line Replaceable Unit (LRU) level or to a failure zone. A LED panel on front of the ECU displays the failed LRU or relevant failure zone.

1.18.2 Extract from Gulf Stream G200 AFM/QRH Section IV Normal Procedure checklist for landing

AFTER TOUCHDOWN

- 1. Thrust levers - IDLE*
- 2. Wheel brakes - APPLY*
- 3. Maintain positive nose contact with runway, using firm push of the control wheel;
READY light - ON*
- 4. T/R latches - Raise, deploy and set as required*

1.18.3 PIC Minimum Qualification and Experience Requirements

(Nestoil Operational Manual Part A, 6.2.1.1)

The minimum qualification and experience requirements for pilots to act as PIC of the Company operated commercial aircraft flights are:

- a. Be at least 21 years old.*

b. An Airline Transport Pilot's Licence with applicable category, class and type rating for that aircraft.

c. A current class 1 medical certificate

d. For IFR flight, or any commercial air transport night operations, a valid instrument rating qualified under Nig.CARs 2.3.7

e. Valid Recurrent checks; LPC (line proficiency check), OPC (operator proficiency check) and aerodrome/heliport competence

f. Successful completion of an appropriate command course if upgrading;

g. Acquired experience requirements appropriate to the aircraft category and class leading to the following flying qualification:

	<i>Aeroplane</i>	<i>Helicopters</i>
<i>• Total Flying Hours -</i>	<i>4,000</i>	<i>3,000</i>
<i>• Hours in Command -</i>	<i>2,500</i>	<i>1,500</i>
<i>• Hours on Type -</i>	<i>100</i>	<i>100</i>
<i>• Attainment of a specified minimum experience level for those pilots upgrading to PIC from within the Company or for those going as direct entry PICs. Captains freshly employed by the Company must have the required total flying hours experience and as PIC, 1000 hours multi-engine aeroplane or 500 hours multi-engine helicopter respectively.</i>		

Until a PIC has 15 flights performing PIC duties in the aircraft type (which included 5 approaches to landing using Category I procedures), he or she may not plan for or initiate an instrument approach when the DH or MDA is less than 100 m (300 ft) and the visibility less than 1.5km (1 statute mile).

1.18.4 Main Landing Gear (Extract from Israel Aircraft Industries Doc No 941622)

The G 200 MLG is designed to meet up with specifications of JAR/FAR 25 Airworthiness Regulation (Ref. 1)

The main landing gear system is designed so that if it fails due to overloads during take-off and landing (assuming the overload to act in the upward and aft direction), the failure mode is not likely to cause the spillage of enough fuel from any part of the fuel system to constitute a fire hazard.

Due to the main landing gear location a failure from an upward and aft acting overload will not result in fuselage been directly affected, however it is worthwhile to verify that leakage from the wing is also unlikely. The easiest method to check on this is to calculate the estimated failure loads of the main gear and back up structure under upward/aft loading and to compare the two. If the back-up structure is stronger than the main-gear, compliance with FAR 25.721 is assured. If the back-up structure is weaker than the main gear, further action will be necessary.

1.18.4.1 Failure Mode and Recommendation

It should be noted that the specification for the design of the forward trunnion attachment (which abut a wing fuel tank), was deliberately written to avoid any longitudinal loading from the trunnion axis passing forward. With the failure of the rear trunnion socket of the gear, the upward and aft acting external load can subsequently pull the forward trunnion pin out of its socket and allow the main gear to detach itself from the wing (providing that this has not already occurred).

It is recommended that the strength of the back-up structure be evaluated under these estimated main gear failure loads. If the back-up structure can withstand these loads, compliance with FAR 25.721 is assured. Even if this is not completely met, the above

description of the mode of gear separation following the failure enables this airworthiness requirement to be satisfied.

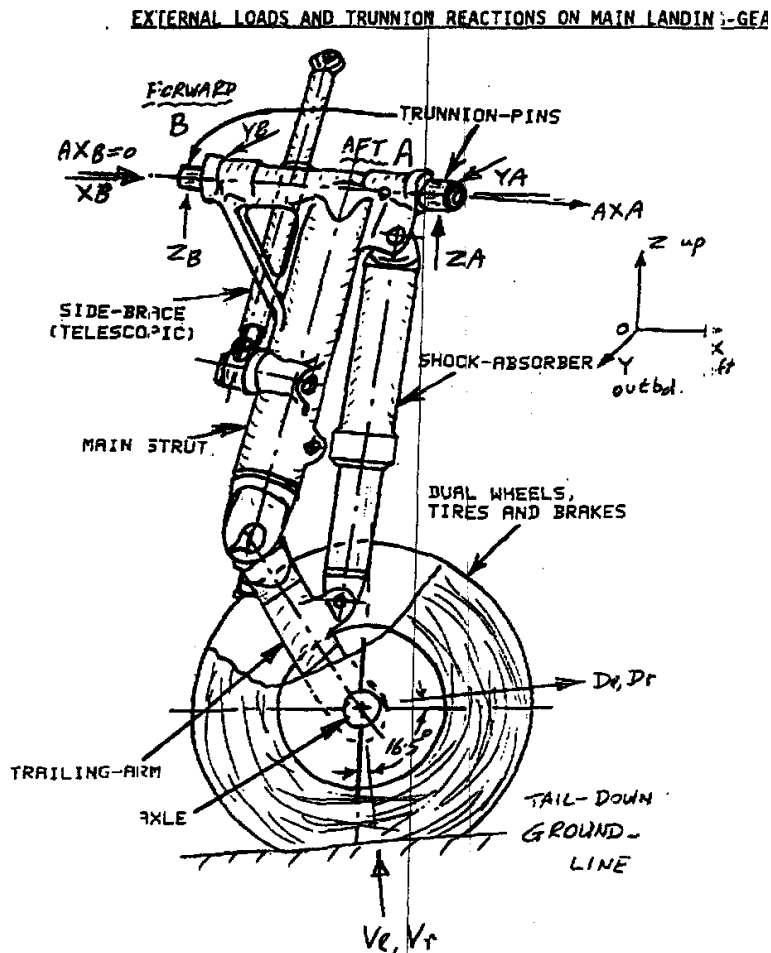


Figure 7: Schematic Diagram of the Main Landing Gear

1.18.5 Wreckage Recovery

Wreckage recovery of civil aircraft will normally be coordinated by Accident Investigation Bureau, occasionally with assistance from other organizations such as the military, airport operator, specialist aircraft recovery contractors or the aircraft operators. The nature of the recovery operation may vary greatly depending on the size of the aircraft, the location of the accident (on-airport or off-airport) and the degree of damage to the aircraft. Where assistance is provided by the operator in the form of personnel, equipment, resources or



hangar facilities, the aircraft or wreckage remains in the custody of the Bureau and access to it will be strictly by permission of the Commissioner/CEO. This is necessary to avoid any intervention which may unintentionally destroy evidence.

When an aircraft is deemed to be salvageable, an operator may wish to conduct the recovery operation with appropriately skilled personnel to minimize further secondary damage. Such steps must not be taken without prior agreement of the Bureau which will continue to oversee the process to ensure the preservation of evidence.

The runway was temporarily closed after the occurrence due to the position of the accident aircraft. The Bureau agreed that the aircraft be removed from the active runway to allow usage of the runway. Consequently, FAAN used its equipment to remove the aircraft from the runway under the supervision of the Bureau. However, the aircraft was moved to a new location the following day without notifying the Bureau.

1.18.5.1 Extract from Part 5 Section 11, Civil Aviation (Investigation of Air Accidents and Incidents) Regulations 2016

Removal of Damaged Aircraft, Custody and Preservation of Evidence

(1) Subject to paragraph (2) below and regulation 14 where an accident or a serious incident which results in the withdrawal from service of an aircraft occurs in or over Nigeria no person, other than an authorised person, shall have access to the aircraft involved and neither the aircraft nor its contents shall, except under the authority of the Commissioner, be removed or otherwise interfered with. Where it is necessary to move aircraft wreckage, mail or cargo, sketches, descriptive notes, and photographs shall be made, if possible, of the original positions and condition of the wreckage and any significant impact marks.

(2) The Bureau shall take all reasonable measures to protect the evidence and to maintain safe custody of the aircraft and its contents for such a period as may be necessary for the purposes of an investigation. Protection of evidence shall include the



preservation, by photographic or other means of any evidence which might be removed, effaced, lost or destroyed. Safe custody shall include protection against further damage, access by unauthorised persons, pilfering and deterioration. (3) Subject to the provisions of Customs and Excise Management Act— (a) the aircraft may be removed or interfered with so far as may be necessary for the purpose of : (i) extricating persons or animals ; (ii) removing any mail, valuables or dangerous goods carried by the aircraft for the purpose of preservation ; (iii) preventing destruction by fire or other cause ; (iv) preventing any danger or obstruction to the public, air navigation or other transport ; or (v) removing any other property from the aircraft under the supervision of an Investigator or with the agreement of an Investigator or of a Police Officer.

1.18.6 Extract from Disable Aircraft Recovery Manual NAIA Abuja

Chapter 3 Removal Instructions

ACTIONS TO BE TAKEN

(a) Ensure that the aircraft is not approached or removed until the Accident Investigation Bureau (AIB) has given permission to do so (with the exception of firefighting or lifesaving procedures or where the safety of other aircraft is compromised).

(b) Where the aircraft is required to be removed for safety reasons prior to permission being granted by the Accident Investigation Bureau (AIB), or if the AIB will not be at the site, the coordinator will ensure the following actions:

(i) Take photographs of the aircraft and where relevant to include photographs of the flight deck showing position of all switches and controls.

(ii) Mark the location and position of the aircraft and any other major components. (iii) Draw a diagram of the incident site where necessary.

(c) Meet with the aircraft operator or its handling agent to discuss how to remove the aircraft as quickly as possible.



(d) Make available all relevant information including equipment which the airport can supply or source to the aircraft operator.

(e) If the aircraft operator's intended actions may result in a delay to successful recovery then the procedures detailed in chapter 1, paragraph 1.3 should be followed.

(f) If the aircraft is required to be removed, ensure the operator signs and completes the Indemnity Form (Appendix 1).

(g) Agree on the appropriate access route for the equipment and arrange escort vehicles and any relevant security passes.

(h) Agree with the aircraft operator on an area where the aircraft should be moved to.

(i) Arrange for fire cover to be provided by the ARFFS.

1.18.7 Flight Deck Crew Incapacitation and Disorientation

Nestoil Plc Operations Manual Part A General/Basic Manual Crew

Section 5.2.1.1a

In the context of pilot incapacitation it is essential that crew members closely monitor the aircraft's flight path in the critical stages of takeoff, initial climb, final approach and landing, and immediately question any deviation from the norm. Incapacitation and disorientation includes the following: - Loss of consciousness - Sickness to the extent of incapacitation - Subtle incapacitation (vertigo, non-awareness, irrational actions) Incapacitation can be gradual or sudden, subtle or overt, partial or complete and may not be preceded by any warning. a. Partial or gradual incapacitation These symptoms include severe pain (especially sudden severe headache or chest pain), dizziness, blurring or partial loss of vision, disorientation, vomiting or diarrhea. b. Sudden or complete incapacitation may be subtle or overt, and may not be preceded by any warning. While incapacitation may occur at any stage of flight, fatal collapse among flight crew has most commonly occurred in the critical stages of approach and landing when ground proximity

presents a direct hazard. Where the pilot handling the aircraft is incapacitated an accident is inevitable, unless the other pilot detects the collapse and is able to assume control in sufficient time. When incapacitation occurs, it is essential to act before the situation becomes operationally critical. Should any aircrew member become ill, consideration shall be given to declaring an emergency to ATC. It is stressed that in the event of illness, the Crew have absolute authority to divert, or take all necessary action to achieve medical attention. The Cabin Crew (if carried) will normally undertake the safe securing of an incapacitated Pilot, and assist with check list duties subject to there being no urgent requirements in the cabin Pilots will, as part of their base check, be required to display their ability to continue the flight and complete a landing or go-around without the aid of their fellow Flight Crew member.

1.18.7.1 General Crew Procedures in the Event of Incapacitation

The following procedures are to be used if a pilot suffers any medical symptoms inflight, which might impair his ability to handle the aircraft such that he would hand over control. The procedures must be followed even if the pilot has apparently recovered, as temporary symptoms are often a warning of more severe illness to follow, and self-diagnosis is notoriously unreliable. If the affected pilot is handling the aircraft, he is immediately to inform the other pilot and hand over control to him. The destination, base or appropriate agency, is to be informed of the problem and a diversion made to the nearest suitable landing place, bearing in mind the nature and severity of the symptoms and the availability of medical facilities. Normal crew duties require that during all stages of the flight, pilots and other crew members call the handling pilot's attention to any deviation from the normal flight path or ATC clearance. The recovery from a detected incapacitation of the handling pilot shall follow the sequence below: a. Recognition: It is important to recognize the condition of incapacitation or disorientation as soon as possible. Flight Crew must be familiar with the early recognition of Pilot incapacitation symptoms, which may occur at any stage of flight. Sudden or progressive incapacitation should be suspected when a pilot begins to deviate from normal procedures, makes

exaggerated responses to flight path disturbances or changes, or fails to maintain assigned heights or headings. Speech may become slurred, and the individual may fail to respond to a question, check item, or radio call. If in doubt, question and observe any response. The 'two communication' rule should be invoked to assist in detecting incapacitation. The 'two communication' rule is introduced in the crew concept to improve the possibility of detecting an incapacitated pilot in accordance with the 'two communication' rule This states that a flight crew member should suspect the onset of incapacitation any time when a pilot does not respond appropriately to a second verbal communication associated with a significant deviation from a standard operating procedure or flight profile. If PF recognizes his own symptoms of disorientation (vertigo or similar), a transfer of control to the PM shall be initiated immediately by saying

"You have control".

PM shall take control over the aircraft and call out distinctly:

"I have control".

1.18.8 Pilot Induced Oscillation

These are sustained or uncontrollable oscillations resulting from efforts of the pilot to control the aircraft and occur when the pilot of an aircraft inadvertently commands an often-increasing series of corrections in opposite directions; each an attempt to cover the aircraft's reaction to the previous input with an overcorrection in the opposite direction. Pilot induced oscillations may be the fault from the aircraft, the pilot, or both. The most dangerous pilot induced oscillations can occur during landing.

1.18.9 Crew Resource Management (CRM)

Crew Resource Management (CRM): Also known as Cockpit Resource Management, is a set of training procedures for use in environments where human error can have

devastating effects. Used primarily for improving air safety, CRM focuses on interpersonal communication, leadership and decision making in the cockpit of an Airline.



2.0 ANALYSIS

2.1 General

The flight crew members were licensed in accordance with the requirement of the Nigeria Civil Aviation Regulations (Nig.CARs). According to records available, the crew members were medically fit, had sufficient rest prior to the flight and were in compliance with the flight and duty time regulations.

The aircraft had a valid Certificate of Airworthiness and had been maintained in accordance with the approved maintenance programme. The aircraft was loaded properly within the regulatory limitations of weight and balance. There was no evidence of pre-impact mechanical malfunction of any structure, flight control systems or engines.

2.2 Approach and Landing

The aircraft was vectored for an ILS approach runway 22. FDR and CVR data indicated that the aircraft was tracking the localizer and glide slope, arrived 1,000 ft AGL in landing configuration with the appropriate speed/rate of descent/engine power and landing checklist completed; thus, the criteria for a stabilized approach was achieved. The approach can be said to be stabilized.

The spot wind given by the Tower before landing, translates to a tail wind of 6 knots and a cross wind from the left of 3 knots which is within the aircraft limitations, and presents a negligible effect on steering/directional controllability on the ground.

The aircraft landed left of the centre line, the left main landing gear touched down first, followed by the right about one second later. After the nose wheel touchdown, a forward pressure was maintained on the control column to keep the nose wheel firmly on the ground. A right rudder input was made to return to the centre line which resulted in induced oscillations that the PF was unable to control. A smoother turn was required to gradually return the aircraft to the centre line without the risk of inducing oscillations.



The resulting induced oscillations, were probably difficult to control due to the limited angle of rudder pedal nose wheel steering of three degrees each side of centre, and the decaying effect of the rudder with reducing speed as indicated by the increasing amplitude of the oscillations.

The FDR shows that the thrust reversers were not deployed and therefore did not affect the controllability of the aircraft.

The PM reported taking over control at the latter part of the landing roll when he saw that the aircraft was out of control. The PM did not announce taking over control, so both pilots were probably having inputs on the rudder pedal and brakes at the same time, counteracting each other and making the situation worse. FDR and CVR data were not available to determine when the PM took over control and to differentiate which pilot was doing what.

The PM also cautioned the PF not to use the Nose Wheel Steering (NWS). During the post incident interview, the PF reported using the NWS during the landing roll but could not recall at what speed. The NWS angle and control wheel position are not recorded on the FDR, and in addition, the speed at which it was used is not verifiable, therefore its effect on the controllability of the aircraft cannot be analysed.

During the post-accident interview all three crew members in the cockpit reported that they did not notice any system malfunctions or warnings during the approach and landing phases.

One of the causes of flat spots on main wheel tires is a locked wheel. On examining the main wheel tires, no flat spots were found, therefore the effects of locked wheels, either before landing or during the landing roll, on this incident, can be ruled out.

An NWS toggle switch on the left console in the cockpit allows the pilot to activate the NWS system or to switch it off and place the nose landing gear in a free swivel mode for shimmy damping. The switch was found to be in the CONNECT (ON) position after the incident. Any single failure in the NWS, which may impact aircraft safety, is detected by



the Failure Detection and System Protection. If a hazardous situation is detected, the system is transferred to bypass mode, and in that mode aircraft directional control is accomplished by means of differential braking and/or rudder control. The activation of this protection system displays a "NWS INOP" message on the Crew Alerting System and in this incident there were no messages on the crew alerting system. In the event that the NWS switch is in the OFF position or the system is transferred to bypass mode due to a failure, the nose wheel will be in a free swivel mode and will castor in the aircraft direction. On examination of the nose wheel tires, transverse abrasions were found indicating that the NWS was being controlled and not in the free swivel mode.

For the landing, the nose wheel was firmly on the ground, ground airbrakes were extended, Rudder/Rudder pedal nose wheel steering was used, light to medium braking (with differential braking) was used; all controls were available for controlling the aircraft on the landing roll. The investigation did not find any adverse conditions that might have affected the steering/directional controllability of the aircraft during the landing roll. The handling techniques used, in attempting to bring the aircraft to the centre line and to recover from the resulting oscillations, were inadequate or inappropriate. These can be categorized as proficiency errors leading to additional errors during recovery. Furthermore, during the latter part of the landing roll, both pilots were probably having inputs on the rudder pedal and brakes at the same time, counteracting each other and making the situation worse; the procedure to take over controls is covered in the SOPs, so this can be categorized as a non-compliance error.

2.3 Right Main Landing Gear Strut Detachment

The aircraft touched down left of the runway centre line and in the process of controlling, the aircraft skidded left and right as brakes were applied.

During the post-crash inspection, the investigation determined that the skid marks on the runway indicated that the aircraft steered in an S-pattern with increasing amplitude down the runway. On the last right turn, the aircraft exited the right shoulder of the

runway, the right main wheel went into the grass and on the final left turn, the right main landing gear strut detached from its main attachment point after which the aircraft finally came to a complete stop on a Magnetic Heading of 160°.

This indicated that when the aircraft was making the S-turns there was transfer of load between the main landing gears which might have induced certain stress on the landing gears. On the last left turn, the aircraft exited the right shoulder of the runway when the right main wheel dropped unto the grass from the pavement leading to more stress on the landing gear in addition to the continuous application of brakes by the crew. The Right main Landing Gear (RLG) detached at a point when the entire aircraft loads were momentarily supported by it.

However, the nature of the failure of the landing gear for this particular occurrence is undetermined.



Figure 8: The detached landing gear in relation to the final resting position of the aircraft



2.4 Wreckage Recovery

The aircraft main fuselage was in one piece, but the right landing gear was detached. After preliminary site investigation, the Bureau permitted and monitored the removal of the wreckage from the active runway on the day of the occurrence.

The aircraft was repositioned next day without appropriate notification to the Bureau. This is in contravention of Part 5 Section 11, Civil Aviation (Investigation of Air Accidents and Incidents) Regulations 2016 and Disable Aircraft Recovery Manual Nnamdi Azikiwe International Airport Abuja Chapter 3 Removal Instructions.



3.0 CONCLUSIONS

3.1 Findings

1. The flight crew members were licensed, medically fit and adequately rested.
2. The result of the toxicological examination for substance abuse carried out on the crew was negative.
3. During the post-accident interview, the PM reported that he took over control at the latter part of the landing roll.
4. The aircraft had a valid Certificate of Airworthiness.
5. The weight and Centre of Gravity of the aircraft were within the prescribed limits.
6. There was no evidence of pre-impact mechanical malfunction of any structure, flight control systems or engines.
7. There was no reported adverse weather during approach and landing at Abuja airport.
8. The crew lost directional control during the landing roll.
9. The aircraft veered off and came to rest on the right shoulder of the runway.
10. The aircraft right main landing gear strut detached from its attachment point.
11. The distance from the centre line of runway 22 to the nose wheel skid markings at touchdown was 6 m.
12. The nose landing gear tyres were abraded crosswise.
13. The inboard tyre of the detached right main landing gear was deflated.
14. The response of the airport emergency service was prompt.
15. Thrust reversers were not deployed.
16. The aircraft was repositioned to another location the next day without notifying the Bureau.
17. Inadequate applications of Crew Resource Management (CRM) procedure in accordance with Nestoil Plc SOP during the landing roll.



3.2 Causal Factor

The use of improper directional control techniques to maintain the aircraft on the runway.

3.3 Contributory Factor

Improper coordination in taking over control of the aircraft by the PM which was inconsistent with Nestoil SOP.



4.0 SAFETY RECOMMENDATIONS

4.1 Safety Recommendation 2019-007

Nestoil Plc should ensure that the crew involved in the accident undergo Crew Resource Management training.

4.2 Safety Recommendation 2019-008

Nestoil Plc should review the crew training on handling techniques and characteristics of the aircraft during landing roll.

4.3 Safety Recommendation 2019-009

NCAA should ensure compliance to safety recommendations 4.1 and 4.2 above.

4.4 Safety Recommendation 2019-010

FAAN should ensure that recovery of aircraft wreckage from accident site within the vicinity of the airport is done using appropriate wreckage recovery procedures.



SUMMARY OF COMMENTS TO DRAFT FINAL REPORT

The draft final report was submitted for comments to the Nigerian Civil Aviation Authority, Nestoil Plc, Federal Airports Authority of Nigeria and the National Transportation and Safety Board, USA.

This is in compliance with sub-section 6.3 of Annex 13 to the ICAO Convention.

Nigerian Civil Aviation Authority agreed with the safety recommendations and also proposed editorial suggestions on some aspects of the Factual information.

Nestoil Plc made clarifications on some aspects of the Factual information including the status of the crew pairing and opined on the effect of weather on the controllability of the aircraft.

Accident Investigation Bureau (AIB) Nigeria made necessary amendments to the final report based on the submitted comments.