AIRCRAFT ACCIDENT REPORT

MAL/2019/09/07/F

Accident Investigation Bureau

Final Report on the serious incident involving a Boeing 747-400 aircraft with nationality and registration marks 5N-DBK operated by Max Air Limited which occurred at Minna Airport; Nigeria on 7th September, 2019

This report was produced by the Accident Investigation Bureau, Nigeria (AIB-N), Nnamdi Azikiwe International Airport, Abuja.

The report was based upon the investigation carried out by AIB-N, in accordance with Annex 13 to the Convention on International Civil Aviation, Civil Aviation Act 2006 and Civil Aviation (Investigation of Air Accidents and Incidents) Regulations 2019. In accordance with Annex 13 to the Convention on International Civil Aviation, it is not the purpose of aircraft accident/serious incident investigations to apportion blame or liability.

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

The AIB-N 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 reports for further distribution, acknowledging the AIB-N as the source.

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)

TABLE OF CONTENTS

TABLE OF FIGURES

GLOSSARY OF ABBREVIATIONS USED IN THIS REPORT

°C	Degree Celsius
AGL	Above Ground Level
AIB	Accident Investigation Bureau, Nigeria
AIP	Aeronautical Information Publication
AOC	Air Operator Certificate
AP1	Autopilot number one
AP2	Autopilot number two
AP3	Autopilot number three
ARFFS	Aerodrome Rescue and Fire Fighting Service
ATC	Air Traffic Control/Controller
ATL	Air Transport Licence
ATS	Air Traffic Service
CAT 7	Category 7 (Fire fighting)
CB	Cumulonimbus
CRM	Crew Resource Management
CVR	Cockpit Voice Recorder
DH	Decision Height

DME	Distance Measuring Equipment
DNMN	Minna Airport
FAA	Federal Aviation Administration
FAAN	Federal Airports Authority of Nigeria
FDAU	Flight Data Acquisition Unit
FDR	Flight Data Recorder
FSF	Flight Safety Foundation
ft	feet
hPa	Hectopascal
ICAO	International Civil Aviation Organization
IFR	Instrument Flight Rules
ILS	Instrument Landing System
IMC	Instrument Metrological Condition
IMN	Minna ILS/DME
km	Kilometer
kt	Knot
LOC	Localizer
m	metre (s)

METAR	Meteorological Terminal Aviation Routine Weather Report
MHz	Mega hertz
MNA	Minna VOR
NAHCON	National Hajj Commission of Nigeria
NAMA	Nigerian Airspace Management Agency
NCAA	Nigerian Civil Aviation Authority
Nig. CARs	Nigeria Civil Aviation Regulations 2015
NiMet	Nigerian Meteorological Agency
NM	Nautical Mile(s)
NOSIG	No Significant Change
OEJN	King Abdul Aziz International Airport, Jeddah
OEMA	Prince Mohammad bin Abdulaziz International airport, Medina
OFDM	Operational Flight Data Monitoring
OOT	Out-of-Tolerance
PAPI	Precision Approach Path Indicator
PF	Pilot Flying
PM	Pilot Monitoring
PNF	Pilot not Flying

RA	Radio altitude
RFFS	Rescue and Fire Fighting Services
RNAV	Area Navigation
RWY	Runway
SARPs	Standards and Recommended Practices
SCT	Scattered
SMS	Safety Management System
TDZE	Touch Down Zone Elevation
TEMPO	Temporary (Meteorological Trend)
USA	United States of America
UTC	Coordinated Universal Time
VHF	Very High Frequency
VMC	Visual Meteorological Condition
VOR	VHF Omni Directional Radio Range
V_{REF}	Reference landing approach speed, all engines operating

Definitions

Area Navigation (RNAV): A method of navigation which permits aircraft operation on any desired flight path within the coverage of station-referenced navigation aids or within the limits of the capability of self-contained aids, or a combination of these. (ICAO, 2001).

Calibration Past Due: Calibration past due refers to a situation where an instrument was not checked for calibration at the designated interval.

QNH: Altimeter sub-scale setting to obtain elevation when on the ground (pressure setting to indicate elevation above mean sea level).

Wind shear: It is defined as a sudden change of wind velocity and/or direction. Wind shear may be vertical or horizontal, or a mixture of both types.

Aircraft accident report number:	MAL/2019/09/07/F
Registered owner and operator:	Max Air Limited
Aircraft type and model:	B747-400
Manufacturer:	The Boeing Company, USA
Year of manufacture:	1996
Nationality and registration marks:	5N-DBK
Serial number:	26403
Location:	Runway 05, Minna Airport
Date and Time:	7th September, 2019 at 03:55 h (All times in this report are UTC)

SYNOPSIS

Accident Investigation Bureau (AIB) Nigeria was notified of the incident by the Nigerian Civil Aviation Authority (NCAA) on 7th September, 2019. Investigators were dispatched to the incident site the same day and commenced post occurrence assessments.

On 6th September, 2019 at 23:34 h a Boeing 747-400 aircraft with nationality and registration marks 5N-DBK operated by Max Air Limited as Flight NGL2092 departed King Abdul Aziz International Airport, Jeddah; Kingdom of Saudi Arabia, (OEJN) with returning Hajj pilgrims bound for Minna Airport, Nigeria, (DNMN). There were 18 crew (2 cockpit

crew, 14 cabin crew and 2 maintenance engineers) and 560 passengers with 8 hours 13 minutes endurance. Instrument Flight Rules (IFR) flight plan was filed. The Pilot was the Pilot Flying (PF) and the Co-Pilot was the Pilot Monitoring (PM).

The take-off, climb, cruise and descent phases of the flight were normal.

The flight crew briefed for RNAV approach. At 3:31:21 h, NGL2092 established contact with Minna Tower and was cleared to Minna VOR (MNA) for ILS/DME approach Runway (RWY) 05. At 3:50:23 h, NGL2092 further reported to Minna Tower that there was an accumulation of storms on the final approach path. They requested to deviate left and extend the downwind of RWY 05. Minna Tower acknowledged and instructed NGL2092 to report when clear of weather.

The flight crew stated that at about 2000 ft the autopilot disengaged and then they elected to fly manually.

At 03:55 h, NGL2092 landed on RWY 05. The aircraft touched down on the right of the centerline of RWY 05 with the left main wheels first and the number one engine nacelle impacted the runway and was dragged along the runway centerline. Minna Tower passed the landing time and issued taxi instructions.

The investigation identified the following causal and contributory factors:

Causal factor

Excessive rudder and aileron inputs at short finals phase of the approach.

Contributory factors

1. The decision to continue the ILS approach runway 05 with erratic localizer signals.

2. An un-stabilized approach with a no go-around decision.

Seven safety recommendations were made.

1.0 FACTUAL INFORMATION

1.1 History of the Flight

On 6th September 2019 at 23:34 h, a Boeing 747-400 aircraft with nationality and registration marks 5N-DBK operated by Max Air Limited as flight NGL2092 departed King Abdul Aziz International Airport, Jeddah; Kingdom of Saudi Arabia (OEJN) with Hajj pilgrims bound for Minna Airport; Nigeria (DNMN). There were 578 persons onboard including 18 crew (02 cockpit crew, 14 cabin crew and 02 maintenance engineers), with fuel endurance of 08 hours 13 minutes. Instrument Flight Rules (IFR) flight plan was filed. The Pilot was the Pilot Flying (PF) and the Co-Pilot was the Pilot Monitoring (PM).

The take-off, climb, cruise and initial descent phases of the flight were normal.

At 03:31:21 h, NGL2092 established communication with Minna Tower while descending to FL220 as cleared by Kano Control. Minna Tower acknowledged and cleared NGL2092 to Minna VOR (MNA) for ILS/DME approach Runway (RWY) 05. Tower requested NGL2092 to report released by Kano and then passed the Minna 03:00 h meteorological report to NGL2092 as follows: *surface wind is 030 at 06 kts, visibility is 10 km in nil weather, cloud few at 210 m, QNH is 1013, temperature is 23°C, dew point 22°C*.

Thereafter, NGL2092 requested the ILS frequency from Tower. Tower gave ILS frequency as 110.5 MHz. NGL2092 then requested from Tower: *please these birds on your Runway, is there anything you can do about them?* Tower responded: *Ok we['ll] inform the FAAN Operation to do something about them.*

At 03:37:01 h, NGL2092 reported cleared to FL060 and released by Kano. Minna Tower acknowledged and further cleared NGL2092 to FL050 and instructed NGL2092 to report 20 NM "MNA".

At about 20 NM MNA, NGL2092 reported descending through FL100.

At 03:46:55 h, NGL2092 further reported to Minna Tower that there was an accumulation of storms on the final approach path, then requested to deviate left and extend the downwind leg of RWY 05. Minna Tower acknowledged and instructed NGL2092 to report when clear of weather.

At 03:50:23 h, NGL2092 reported RWY 05 in sight, established on the localizer (LOC) 05 and also clear of the accumulated storm on the final approach path of RWY 05. Minna Tower cleared NGL2092 to land RWY 05 with a reported prevailing wind of 030°/ 07 kt.

During the post incident interview, the PF mentioned that on final approach, while descending through 2000 ft, the ILS signals were erratic and the autopilot disengaged itself. The PF manually flew the aircraft using visual cues to landing. The PF also mentioned applying the rudder and maybe the aileron just before touchdown. The Flight Data Recorder (FDR) showed that just before touchdown, there were significant aileron and rudder inputs.

At 03:55 h, NGL2092 landed on RWY 05. The aircraft touched down on the right of the centerline of RWY 05 with the left main wheels first and the number one engine nacelle impacted the runway and was dragged along the runway centerline. Minna Tower passed the landing time and issued taxi instructions.

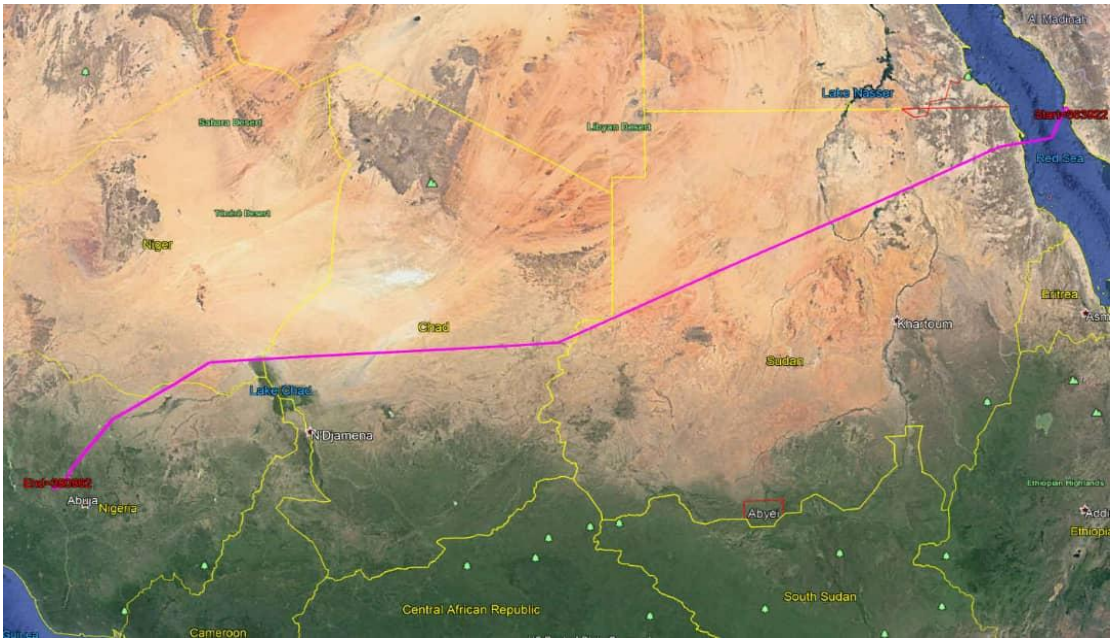

Figure 1: Flight track for NGL2092 imposed on Google Earth

At 03:56:33 h, the flight crew reported to Minna Tower that the localizer on RWY 05 was not calibrated and Minna Tower acknowledged. NGL2092 taxied to the apron and parked.

All passengers disembarked the aircraft normally. Thereafter, Max Air Limited ground personnel informed the crew of the damage to the number one engine nacelle.

The serious incident occurred at dawn.

1.2 Injuries to persons

Injuries	Crew	Passengers	Total in the aircraft
Fatal	Nil	Nil	Nil
Serious	Nil	Nil	Nil
Minor	Nil	Nil	Nil
None	18	560	578
TOTAL	18	560	578

1.3 Damage to aircraft

The aircraft was slightly damaged.

1.4 Other damage

One runway edge light was damaged.

Figure 2: Damaged runway edge light

1.5 Personnel information

1.5.1 Pilot

Nationality:	Indonesian
Age:	63 years
License type:	Airline Transport Pilot License (A)
License validity:	20th September, 2019
Aircraft ratings:	Boeing 747-400, Boeing 747-200, Boeing 737, Fokker 28
Medical Certificate validity:	15th December, 2019
Simulator validity:	17th December, 2019

Total flying time:	25,033:25 h
Total on type:	5,559:55 h
Total on Type (PIC):	5,559:55 h
Last 90 days:	140 h
Last 28 days:	50 h
Last 7 days:	22:50 h
Last 24 hours:	Nil

1.5.2 Co-Pilot

Nationality:	Nigerian
Age:	53 years
License type:	Airline Transport Pilot License (Aeroplane)
License validity:	23rd January, 2023
Aircraft Ratings:	(Part 1) Boeing 747-400 (Part 2) Boeing 747-200/300, Boeing 727, BAC 1-11, Dornier-228, Let 410
Medical Certificate validity:	23rd June, 2020
Simulator validity:	24th October, 2019
Instrument rating validity:	24th April, 2020
Total flying time:	8,446.05 h
Total on type:	1,197.35 h
Total on type (PIC):	656.47 h
Last 90 days:	140 h
Last 28 days:	50 h
Last 7 days:	22:50 h
Last 24 hours:	Nil

The flight crew had flown the last 14 trips to and from Jeddah as a set of crew together and they were in compliance with flight and duty time regulations having rested for over 24 hours in Jeddah prior to reporting for duty.

1.6 Aircraft information

1.6.1 General information

Type:	Boeing 747-4B5
Manufacturer:	The Boeing Company, U.S.A.
Year of manufacture:	1996
Serial number:	26403
Certificate of Airworthiness valid until:	15th November, 2019
Certificate of Insurance valid until:	20th December, 2019
Certificate of Registration:	issued 27th July, 2016
Noise Certificate:	issued 28th July, 2016
Total Airframe Time:	85,009 h
Total Landing Cycles:	13,268

Figure 3: 5N-DBK parked at the Apron after the incident

Figure 4: The aircraft after disembarkation

The aircraft is 70.67 m in length with cabin width of 6.1 m configured with 568 seating capacity.

Maximum takeoff weight of the aircraft is 857,000 pounds and maximum landing weight of 630,000 pounds. The aircraft departed Jeddah (OEJN) with calculated take-off weight of 721,416 pounds and landing weight of 614,616 pounds. The actual landing weight was 604,916 pounds.

1.6.2 Engines

Engine	**Number 1**	**Number 2**	**Number 3**	**Number 4**
Manufacturer	Pratt and Whitney, USA	Pratt and Whitney, USA	Pratt and Whitney, USA	Pratt and Whitney, USA
Type/Model	PW4056-3	PW4056-3	PW4056-3	PW4056-3
Serial number	P729053	P729134	P729135	P727813
Time since new	52642:27 h	49677:10 h	51344:30 h	72218:13 h
Cycles since new	10687	10235	10649	12436

Fuel Used: Jet A1

1.7 Meteorological information

Minna airport Meteorological Terminal Aviation Routine Weather Report (METAR) for 7th September, 2019 as obtained from Nigerian Meteorological Agency (NiMet) is as follows

DNMN	**03:00 UTC**	**04:00 UTC**	**05:00 UTC**
Wind	030°/06 kt	010°/14 kt	00000 kt
Visibility	10 km	10 km	10 km
Weather	Nil	Light Rain	Nil
Cloud	Few 210 m	Sct 240 m	Few 210 m
Temp/Dew point	23°C/22°C	24°C/22°C	23°C/22°C
QNH	1013 hPa	1014 hPa	1014 hPa
Trend	Nosig	Tempo Few 540 m Cb	Tempo Few 510 m Cb

The pre-departure meteorological information available to the crew: TAF DNMN 061700Z 0618/0724 23010KT 9999 SCT012 FEW021CB PROB30 TEMPO 0619/0701 08015G30KT 5000 – TSRA BKN009 FEW018CB BECMG 0701/0703 VRB02KT (Terminal aerodrome forecast for Minna for 7th September at 0000 UTC: Wind 230° at 10 kts, visibility 10 km with cloud scattered at 1200 ft, Few Cumulonimbus Clouds at 2100 ft, 30 % probability of temporary wind 006° at 19 kts. At 0100 UTC: wind 080° at 15 kts gusting to 30 kts, visibility 5000 m in light thunderstorm and rain with broken clouds at 900 ft, few cumulonimbus clouds at 1800 ft, wind becoming between 0100 and 0300 UTC variable at 2 kts).

1.8 Aids to navigation

The conditions of the navigational aids as logged by Minna Tower on 7th September, 2019 were as follows:

1. Wind sock serviceable
2. Wind direction and speed indicator serviceable
3. "MNA" VOR/DME (115.1 MHz) serviceable
4. "IMN" ILS/DME (110.5 MHz) serviceable
5. Runway edge light (solar) serviceable
6. Approach lights serviceable
7. Precision Approach Path Indicator (PAPI) serviceable

The conventional runway edge lights and the Transmitter two (Tx 2) for the localizer RWY 05 were unserviceable.

Each edge light (solar) unit is a standalone, having the solar cells, battery, circuitry and the light unit. As at the time of this investigation, 20% of the units were no longer serviceable.

Aeronautical Information Publication (AIP) Supplement S38/2019 dated 10th September 2019 indicated that Minna airport VOR/DME was last calibrated on 10th March, 2018 and due for calibration in March 2019 while ILS/DME was last calibrated on 6th January, 2019 and was due for calibration in July, 2019. See Appendix 1: AIP Supplement S38/2019 issued on the 10th September, 2019.

Information available to the flight crew in the flight planning stage was:

1. REF AIP SUPPLEMENT S30/2019
2. VOR/DME Approach procedures for RWY 05 See Appendix 2: MNA VOR/DME approach chart.

3. RNAV (GNSS) Approach procedures for RWY 05 See Appendix 3: MNA RNAV (GNSS) approach chart.
4. Jeppesen NAVDATA change notice indicating that ILS RWY (05) approach procedure was not included in the NAVDATA.

1.9 Communication

There was two-way communication between the aircraft and the tower.

1.10 Aerodrome information

Minna airport has aerodrome reference point 09°39'08.3996" N, 006°27'44.4033" E and an elevation of 834 ft (254 m). The aerodrome has an asphalt/concrete, un-grooved surface runway with orientation 05/23 (049°/229° magnetic). The length and width of the runway are 3,400 m and 45 m respectively.

The airport caters mostly for charter flight operations. However, it serves as an international airport during Hajj operations.

Minna airport is owned by the Federal Government of Nigeria and managed by the Federal Airports Authority of Nigeria (FAAN). FAAN manages operations at the terminal and airside. FAAN personnel were posted from other airports to manage the wild life around the airport during the 2019 Hajj operations.

Air Navigation Services are provided by Nigerian Airspace Management Agency (NAMA).

The AIP published November, 2016 by NAMA indicated that the airport fire fighting

category was Category 8. Two fire fighting engines and one water tanker were available at the time of this investigation.

Operations at the airport are guided by the Aerodrome Manuals, Aerodrome Emergency Plan (AEP) and other manuals as developed by the operator. According to the documents submitted to the Bureau, these manuals were not endorsed by the Nigerian Civil Aviation Authority (NCAA).

Figure 5: Available fire tenders at Minna airport

1.11 Flight recorders

The aircraft is fitted with Solid-State Flight Data and Cockpit Voice Recorders.

Recorders	**Flight Data Recorder**	**Cockpit Voice Recorder**
Manufacturer	Honeywell	L-3 Communication
Model	SSFDR	A200S
Part Number	980-4700-042	S200-0012-00
Serial Number	12626	01388

The Flight Data Recorder (FDR) and Cockpit Voice Recorder (CVR) were retrieved and downloaded at the Flight Safety Laboratory of Accident Investigation Bureau (AIB), Nigeria in Abuja.

There were no relevant data recorded on the CVR. The last information stored was from an earlier flight.

Data pertinent to the incident flight were captured on the FDR which included: localizer deviation, glideslope deviation, pressure altitude, radio height, vertical acceleration, aileron and rudder inputs. Vertical and lateral flight profiles were recreated using FDR parameters and coordinates of the touchdown point.

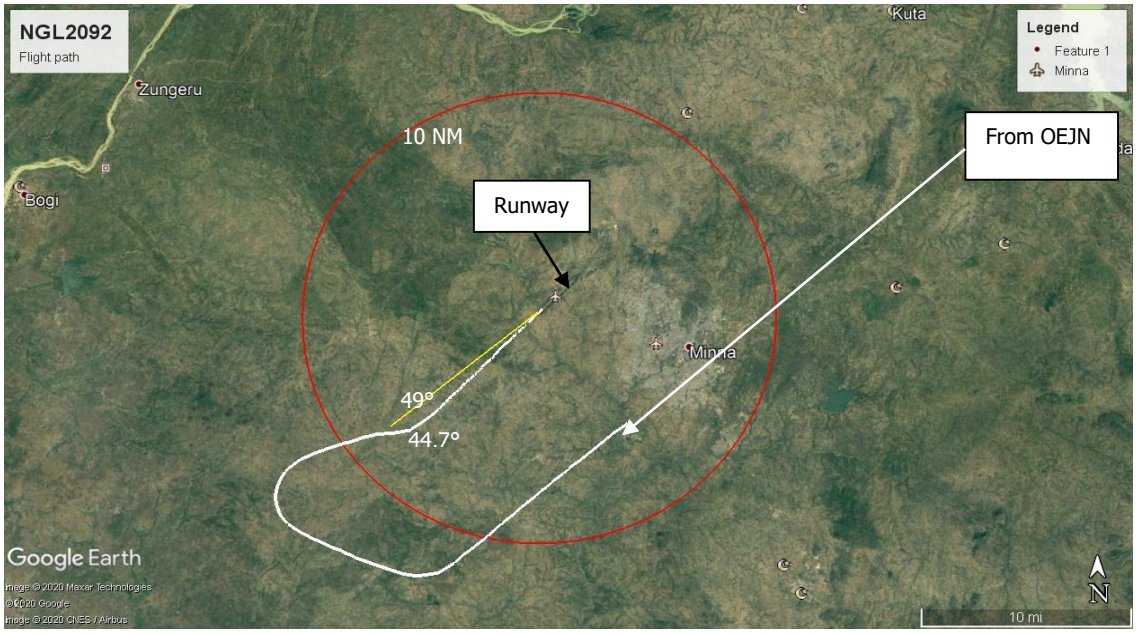

Figure 6: Lateral descent/approach profile of NGL2092 to touchdown

Figure 7: NGL2092 approach track

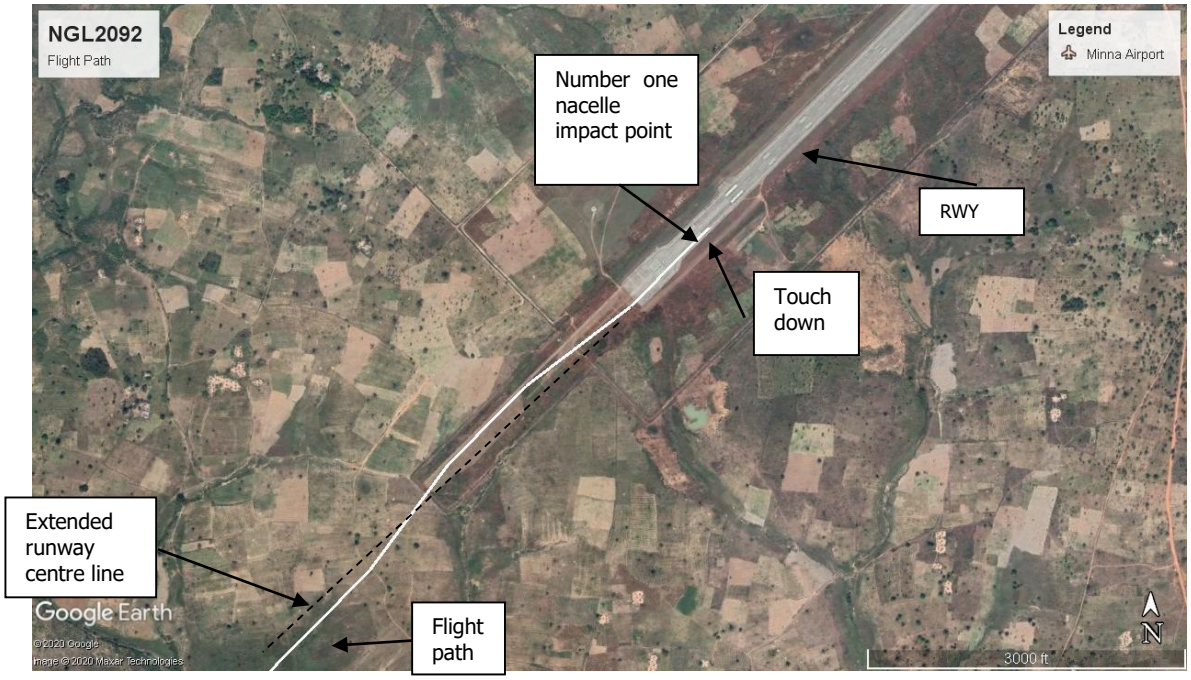

Figure 8: NGL2092 final approach track

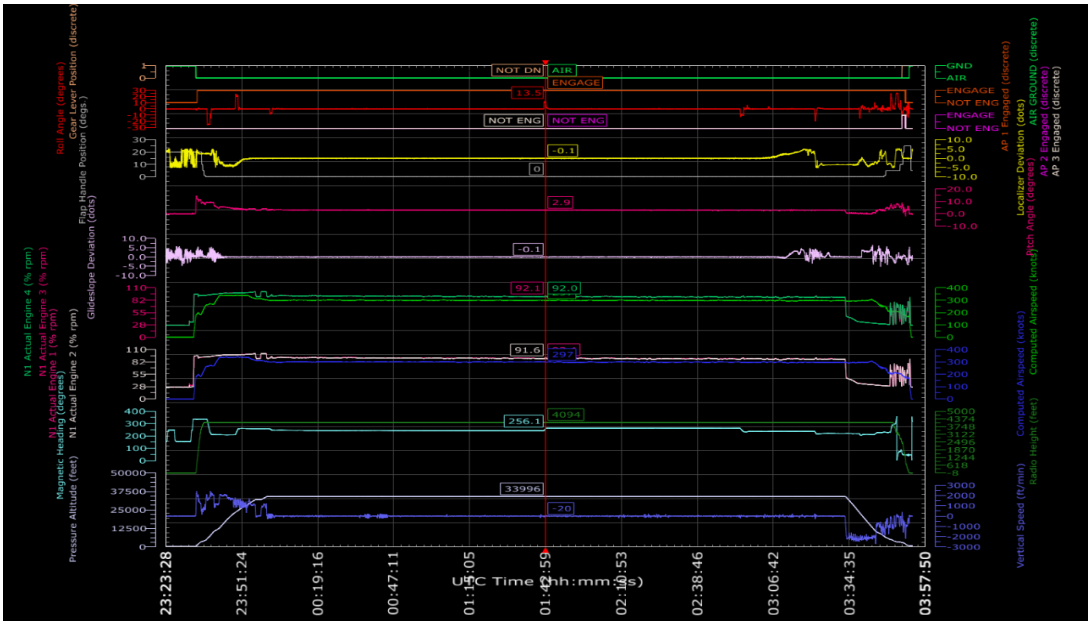

Figure 9: Selected FDR parameters from flight NGL2902

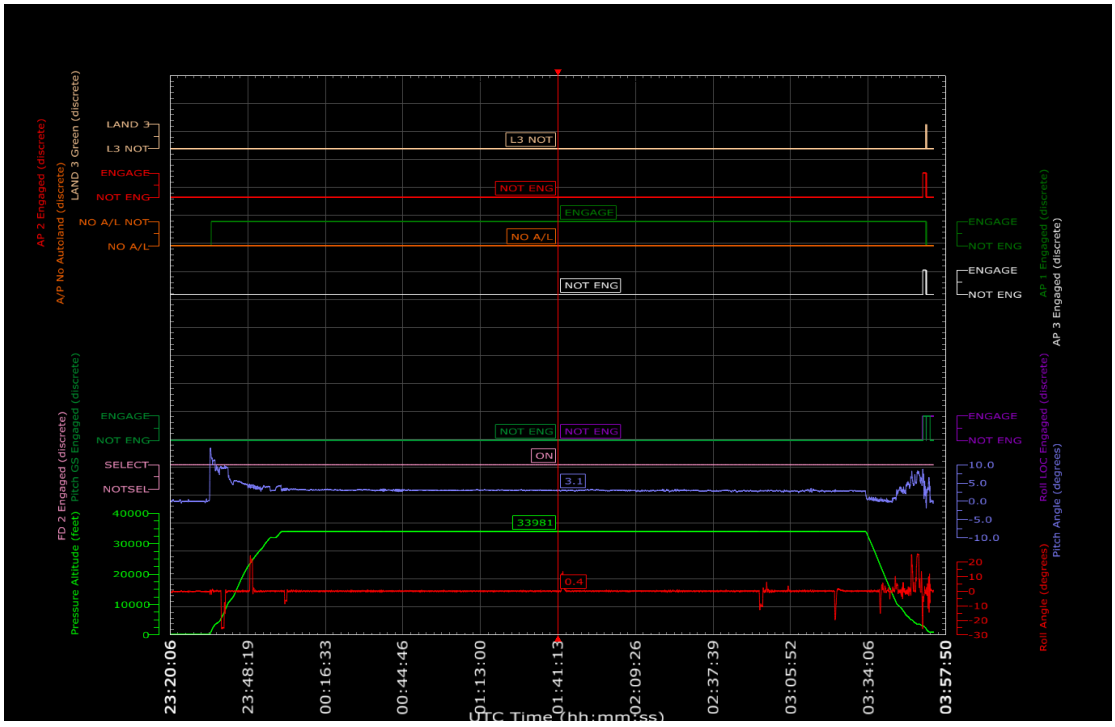

Figure 10: Selected autopilot related parameters

1.12 Wreckage and impact information

The aircraft crossed the threshold right of the centerline in a left bank, the left main wheels touched down, the number one engine nacelle impacted the runway on the center line, 203 m from the threshold, and was dragged on the runway along the center line for approximately 44 m as the aircraft was steered to the center line.

Physical examination of the aircraft revealed that the lower surface of the nacelle was abraded, thereby releasing the cowl latches resulting in the fan cowls being blown-off the engine.

The following were also observed:

1. Damage to the lower intake of number one engine
2. Damage to fan cowl (left and right) on number one engine
3. Damage to thrust reverser cowl on number one engine
4. Torn fairing on the left wing
5. Damage to transfer tube between angle gear box and main gear box
6. Evidence of bird strike on the lower part of the radome

Figure 11: Damaged cowling of engine number one

Figure 12: Tyre marks indicating the touchdown point

Figure 13: Number one engine nacelle impact point on the runway

Figure 14: Torn flap fairing on the left wing

Figure 15: Evidence of bird strike on the lower radome

1.13 Medical and pathological information

No medical tests were conducted.

1.14 Fire

There was no pre- or post-impact fire.

1.15 Survival aspect

Not applicable

1.16 Test and research

Nil.

1.17 Organizational and management information

1.17.1 Federal Airports Authority of Nigeria (FAAN)

FAAN is a service organization statutorily charged to manage all Commercial Airports in Nigeria and provide service to both passenger and cargo airlines. Generally, to create conditions for the development in the most economic and efficient manner of air transport and the services connected with it. The agency has its head office on the grounds of Murtala Muhammed International Airport in Ikeja, Lagos State.

Minna airport is owned by the Federal Government of Nigeria and managed by the Federal Airports Authority of Nigeria (FAAN). FAAN manages operations at the terminal and airside. In addition, it provides other facilities and services, such as medical clinic, ambulance, fire trucks etc. Also, FAAN maintains the airfield lightings at the aerodrome.

1.17.2 Max Air Limited

Max Air Limited (Max Air), a registered airline with head office and main operational base located in Kano holds an Air Operator Certificate (AOC) with number: MAX/AOC/06-13/01 issued in accordance with the requirements of the existing Nigeria Civil Aviation Regulations (Nig. CARs). It is authorized to conduct passenger and cargo, scheduled operations and charter flight operations. The airline operates a fleet of Boeing 747 and Boeing 737 aircraft.

National Hajj Commission of Nigeria (NAHCON) had granted licenses to Max Air Limited for airlift of pilgrims from Nigeria to Saudi Arabia (return) from 2008. The airline operated a fleet of three Boeing 747 for this operation. It also engages a mix of foreign and domestic personnel for this annual exercise which lasts for about 40 days.

The Hajj operations involved movement of pilgrims from designated airports in Nigeria to Prince Mohammad bin Abdul-Aziz International airport, Medina (OEMA) and King Abdul-Aziz International airport, Jeddah (OEJN). The return flights were from OEJN to designated Nigerian airports. In the 2019 Hajj operations, Nigerian pilgrims airlifted numbered above 50,000, of which Max Air Limited had more than half of the total number.

NGL2092 destined for Minna from Jeddah was among the last flights for the airline in the 2019 Hajj operation.

The operations of Max Air Limited are guided by its Operations Manual ISSUE: 01 10/06/2017. Other activities are guided by the relevant manuals which include the Safety Manual, Reliability Program Manual, Quality Manual, Security Manual, Flight Dispatch Manual, Cabin Crew Manual etc. Max Air Limited used aeronautical charts from Jeppesen for its flights.

1.17.3 Nigerian Airspace Management Agency (NAMA)

The Nigerian Airspace Management Agency (NAMA) is responsible for the provision of air navigation services to ensure safe, efficient, expeditious and economic flight operations in Nigeria. It is tasked with developing the Nigerian airspace infrastructure to a level consistent with the requirements of the International Civil Aviation Organization (ICAO) Standards and Recommended Practices (SARPs).

1.17.3.1 Air Traffic Control (ATC) Service

Air Traffic Control (ATC) Service, presently referred to as Air Traffic Management (ATM) is one of the most important services provided by Nigerian Airspace Management Agency (NAMA).

Air Traffic Control (ATC) Service is a service provided for the purpose of preventing collisions between aircraft; on the maneuvering area, between aircraft and obstructions; and to expedite and maintain an orderly flow of air traffic. ATC service is sub-divided into area control service, approach control service and aerodrome control service.

1.17.3.2 Aeronautical Information Services (AIS)

AIS is a unit responsible for the collection, collation and delivery of accurate, current and timely aeronautical information necessary for the safety, efficiency and regularity of international air navigation with the most minimum delay.

Extracts from NAMA Air Traffic Safety Engineering Manual of Operations and Standard Operating Procedures.

3.9 CALIBRATION POLICY

3.9.1 All CNS facilities shall be calibrated as at when due in line with ICAO specifications.

3.9.1 All Instrument Landing System and Glide Slope shall be ground- checked once in three months and flight calibrated once every six months.

3.9.1 All conventional Very High Frequency Omni-directional Radio range shall be ground checked and flight calibrated once every 12 months.

3.9.1 All Doppler Very High Frequency Omni-directional Radio range shall be ground checked once every 12 months and flight calibrated once every three years.

3.9.1 All surveillance equipment shall be calibrated once every three years.

3.9.1 In the event of a major modification, repairs or accident, calibration shall be carried *out as soon as possible.*

MAINTENANCE OF INSTRUMENT LANDING SYSTEM (ILS)

4.8.1 The ILS and DME shall comply fully with ICAO specifications in Annex 10 and provide the required services the operators need in the current Air Traffic Control (ATC) environment. The ILS must provide accurate course and glide path information for approach and landing aircraft, while the co-located DME must provide slant range distance information to the aircraft with reference to the touch down point.

1.17.4 Nigerian Civil Aviation Authority (NCAA)

NCAA is the government agency saddled with the regulation and oversight of aviation activities in Nigeria. The NCAA is set up by the Civil Aviation Act (2006) which empowers the Director General of NCAA to make regulations in aviation. The current regulations are as enshrined in the Nigeria Civil Aviation Regulations 2015 (Nig. CARs). Relevant sections of the Nig. CARs guide activities of personnel and service providers in the aviation industry. Oversight activities are achieved by continuous and periodic audits by inspectors of the NCAA.

1.17.4.1 Extracts from the Civil Aviation Act (2006)

1.17.4.2 Extracts from the Nig. CARs

Continued Serviceability and Inspection of Flight Recorder Systems

7.8.1.4—*(a) The operator shall conduct operational checks and evaluations of recordings from the flight recorder systems to ensure the continued serviceability of the recorders.*

IS: 7.8.1.4— (a) The operator shall, prior to the first flight of the day, monitor the built-in test features for the flight recorders and flight data acquisition unit (FDAU), when installed, by monitored by manual and/or automatic checks.

(b) The operator shall carry out annual inspections as follows:

(1) an analysis of the recorded data from the flight recorders shall ensure that the recorder operates correctly for the nominal duration of the recording;

….

(5) an annual examination of the recorded signal on the CVR shall be carried out by replay of the CVR recording. While installed in the aircraft, the CVR shall record test signals from each aircraft source and from relevant external sources to ensure that all required signals meet intelligibility standards;

….

(c) Flight recorder systems shall be considered unserviceable if there is a significant period of poor quality data, unintelligible signals, or if one or more of the mandatory parameters is not recorded correctly.

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Cockpit Voice and Flight Data Recorder Records.

9.2.2.6—(a) Each AOC holder shall retain:

(1) The most recent flight data recorder calibration, including the recording medium from which this calibration is derived; and

(2) The flight data recorder correlation for one aircraft of any group of aircraft operated by the AOC holder—

(i) That are of the same type;

(ii) On which the model flight recorder and its installation are the same; and

(iii) On which there is no difference in type design with respect to the original installation of instruments associated with the recorder.

Note: The flight data recorder calibration and the flight data recorder correlation will be kept as part of the maintenance records for aircraft and its components.

12.4. *AERODROME MANUAL*

12.4.1.—(a) The operator of a certified aerodrome shall have a manual to be known as the Aerodrome Manual for the aerodrome.

….

12.4.4.—(a) To maintain the accuracy of the Aerodrome Manual, the Authority shall issue a written directive to an aerodrome operator requiring the operator to alter or amend the manual in accordance with that directive;

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Aerodrome Operator's Safety Management System.

12.6.5.—(a) The aerodrome operator shall implement a safety management system acceptable to the Authority as prescribed in Nig.CARs Part 20;

….

12.6.15.1.—(a) After consultation with representatives of the air operators that use the aerodrome and with community organisations that may be of assistance during emergency operations at the aerodrome or in its vicinity, the aerodrome operator shall develop and maintain an emergency plan for the purpose of identifying:

(1) the emergencies that can reasonably be expected to occur at the aerodrome or in its vicinity and that could be a threat to the safety of persons or to the operation of the aerodrome;

(2) the measure to activate the emergency plan for each type of emergency;

(3) the community organisations capable of providing assistance in an emergency; and

(4) any additional resources available at the aerodrome and in the surrounding area.

(b) The aerodrome operator shall establish a degree of supervision and control sufficient to manage the size and complexity of an emergency.

(c) The aerodrome operator shall maintain at the aerodrome, in the format of a manual, a copy of an updated version of the emergency plan; and provide a copy to the Authority on request.

(d) The aerodrome operator shall:

(1) update the emergency plan as necessary to ensure its effectiveness in emergency operations; and

(2) review the plan and make any required updates at least once a year after consultation with a representative sample of the air operators that use the aerodrome and the community organisations identified in the plan.

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Rescue and Fire-Fighting at Aerodromes

12.6.16.1. The aerodrome operator shall provide the aircraft fire-fighting vehicles and the personnel that correspond to the critical category for firefighting and published in the Aeronautical Information Publications (AIP) to respond to an aircraft emergency at the aerodrome.

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Aircraft Category for Fire Fighting.

12.6.16.3. An aircraft category for fire-fighting set out in column I of an item of the table below to this subsection shall be established for an aircraft based on the aircraft overall length set out in column II of the item and the aircraft maximum fuselage width set out in column III of that item.

TABLE 1

Column I Aircraft Category for Fire Fighting	*Column II Aircraft Overall Length*	*Column III Aircraft Maximum Fuselage Width*
1	*0 up to but not including 9 m*	*2 m*
2	*9 m up to but not including 12 m*	*2 m*
3	*12 m up to but not including*	*3 m*
4	*18 m up to but not including 24 m*	*4 m*
5	*24 m up to but not including 28 m*	*4 m*
6	*28 m up to but not including 39 m*	*5 m*
7	*39 m up to but not including 49 m*	*5 m*
8	*49 m up to but not including 61 m*	*7 m*
9	*61 m up to but not including 76 m*	*7 m*
10	*76 m up to but not including 90 m*	*8 m*

Where the fuselage width of an aircraft that has an overall length within the range set out in column II of an item of the table to paragraph (a) is greater than the aircraft maximum fuselage width set out in column III of the item, the aircraft category for fire fighting for the aircraft shall be one category higher than the category set out in column I of that item.

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12.6.26. The Aerodrome operator shall ensure the implementation of its approved Environmental Management Plan. The Plan shall include:

(a) measures of handling of all types of wastes: oil and grease spills, air, noise and water pollution;

(b) regular environmental audit by independent qualified experts to ensure the appropriateness and compliance with the environmental management plan; and

(c) records showing compliance with extant environmental protection laws, regulations, guidelines and directives of relevant government agencies. The Aerodrome Operator shall make such records available to the Authority whenever requested.

******

14.1.49. FACILITIES, EQUIPMENT, MAINTENANCE AND CALIBRATION.

14.1.49.1. An ATS provider shall, at all times, make available for the use by its personnel, the equipment and facilities necessary for providing air traffic services covered by its certificate.

14.1.49.2. The ATS provider shall include in the Operations Manual a list of facilities from which ATS will be provided as contained in IS 14.1.49.2.

14.1.49.3. The equipment shall meet with the requirements and calibration standards specified in these Regulations.

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1.17.4.3 Extracts from the Aerodrome Standards Manual Issue 3: May 2015

13.2.2.41 The minimum number of rescue and fire fighting vehicles provided at an aerodrome shall be in accordance with the following tabulation:

Aerodrome Category	Rescue and fire fighting vehicles
1	1
2	1
3	1
4	1
5	1
6	2
7	2
8	3
9	3
10	3

Note — Guidance on minimum characteristics of rescue and fire fighting vehicles is given in the ICAO Airport Services Manual (Doc 9137), Part 1.

1.18 Additional Information

1.18.1 ILS calibration

Calibration is a process that ensures the safety of air navigation by conducting regular flight inspection, calibration of test equipment/avionics system, surveillance of airspace systems, certification and navigation aids/associated facility in accordance with stipulated procedures as recommended in ICAO DOCUMENT 8071, annexes 10 (vol. I &II) and 14.

Calibration, in its most basic form, is the measuring of an instrument against a standard to assure accuracy. A key concept for organizational understanding in a regulated environment is the out-of-tolerance ("OOT") condition, its detection and avoidance. When an instrument's performance is outside its specifications, it is considered OOT, and requires an adjustment to bring it back within acceptable tolerances. An OOT instrument opens the door to the risks. These risks are best avoided by an uninterrupted application of a rigorous calibration program.

1.18.1.1 Calibration Interval

The period of time during which calibration can be expected to remain within specified limits is referred to as the "calibration interval". Intervals are based on numerous factors including manufacturers' data, historical performance, operating environment and calibration frequency. Due to critical accuracy requirements, calibration intervals in aerospace are generally shorter and more closely monitored than in aerospace other industries. Calibration of instrument landing system (ILS) are done twice a year, every six-month interval because of the level of accuracy required, while the very high frequency (VHF) and Omni Directional Range VOR is calibrated once in year. If there is a repair work on any of the navigational equipment, or total replacement, it has to be calibrated. (Techni-Tool: Instrument Calibration in the instrument and aerospace).

2.0 ANALYSIS

2.1 General

The analysis is based primarily on evidence gathered from the Flight Data Recorder (FDR), Air Traffic Control recordings and transcripts, witness interviews; and documentation from the operator, Regulator, Manufacturer and other service providers including evidence gathered from incident site during post incident inspection and assessment.

However, it is important to note that cockpit voice recorder (CVR) recordings for the flight were not available.

The analysis focuses on these five areas:

1. Conduct of the flight.
2. The calibration of the ILS/DME at Minna airport.
3. The aerodrome rescue and fire fighting service capabilities at Minna airport.
4. NCAA regulatory oversight on FAAN, Max Air and NAMA.
5. Environmental and weather factors at Minna airport during the incident.

The Pilot and Co-Pilot were properly licensed to conduct the flight in accordance with Nig. CARs and Max Air requirements.

There was no evidence of any mechanical malfunction prior to the incident. The aircraft load sheet indicated that the aircraft was loaded within the prescribed centre of gravity (C of G).

The flight crew had in excess of 33,000 hours combined flying experience, 6757.30 hours of which was on the aircraft type. They had flown the last 14 trips to and from Jeddah as a set of crew together.

The flight crew had valid medical certificates and they were in compliance with flight and duty time regulations having rested for over 24 hours in Jeddah prior to reporting for duty.

2.2 Conduct of the flight

The take-off, climb, cruise and initial descent phases of the flight were normal.

ATC initial clearance to NGL2092 was for ILS approach RWY 05 at Minna. ATC should have been aware that ILS was two months past due for calibration (as mentioned in AIP supplement S38/2019). Moreover, the flight dispatch documents indicated that VOR/DME and RNAV approach RWY 05 were available.

The flight crew of NGL2092 had access to the NOTAM which had detailed information about the status of Jeppesen NAVDATA change notice indicating that ILS RWY (05) approach procedure was not included in the NAVDATA.

Had it been the flight crew had gone through the flight plan all the way to the Jeppesen information they could have been alerted on the status of the ILS procedure which was not in use.

Therefore, the flight crew could have rejected the ILS approach clearance given by ATC.

NGL2092 cleared the weather, joined final approach path and reported established on the ILS. However, on short finals the flight crew realized that the aircraft was not aligned with

RWY 05 centre line indicating that the aircraft deviated right of the centre line and a go-around should have been executed. However, the flight crew attempted to correct the deviation to align the aircraft back to centre line by using the combined inputs of aileron and rudder. The inputs applied were excessive in trying to align the aircraft with the runway centre line before touchdown.

2.3 Calibration past due of ILS/DME at Minna airport

According to the AIP supplement (S38/2019), ILS/DME RWY 05 at Minna airport was calibration past due since July, 2019.

Recall that after landing, ATC was informed by NGL2092 about the erratic signal of the localizer, this was corroborated by the FDR information. This is an indication of the unreliability and out of tolerance (OOT) of the localizer which might not be unconnected with its calibration status.

2.4 NCAA regulatory oversight on Minna airport

Nig. CARs section 12.4 states that *the operator of a certified aerodrome shall have a manual to be known as the Aerodrome Manual for the aerodrome. In addition, the aerodrome manual should be update[d] to reflect changes that are pertinent.* The Aerodrome Manual serves as a reference document agreed between the aerodrome operator and regulator with respect to the standards, conditions and the level of service to be maintained at the aerodrome.

In compliance with Nig. CARs section 12.6.5, an acceptable SMS as prescribed by relevant

sections of the Nig. CARs is to be implemented by aerodrome operators.

The investigation determined that Minna airport neither has an approved aerodrome manual nor a safety management system manual. Minna airport Aerodrome Emergency Plan (AEP) and ARFFS Operating Manuals respectively, were effective from 2014.

The AIP 2016 categorizes Minna airport as Category 8. Hajj operators like Max Air Limited use Boeing 747 and other wide body aircraft for their operations. Therefore, Minna airport meets the published minimum requirement to accommodate the aircraft as shown in AIP 2016. Section 13.2.2.41 of NCAA Aerodrome Standards Manual (ASM) stipulated three fire fighting vehicles for Category 8 aerodromes and ICAO doc 9137 identified the type of vehicle to be used for operations at Category 8 airports. Minna airport presently has only two fire fighting vehicles. This is in contravention of the provisions of the ASM and ICAO SARPs.

Wildlife control policy at Minna airport was not approved by the NCAA. Consequently, there were no qualified personnel to man Wildlife Planning and Management stationed permanently at Minna airport.

The conventional runway edge lights installed on the runway were no longer serviceable. However, a solar powered system was installed and serviceable at the time of the occurrence. The solar powered system might prove useful in providing back-up lighting when the conventional systems are down. The investigation found that 20% of the batteries of the solar powered system were not serviceable.

2.5 Environmental and weather factors at Minna airport during the incident

Information from NiMet indicated that one hour before, during and one hour after the incident the weather forecasts were indicating averagely calm winds, clear visibility with temperature and dew point being the same. The pressure (QNH) was also averagely standard. These indicated that there was no expectation of either terrestrial rainfall or wind shear.

The METAR information received in the flight release document for NGL2092 indicated that sometime during the previous night, there was a forecast of thunderstorms in rain around the airport. The thunderstorm must have passed the station before the incident. The cumulonimbus clouds around the station reported by the flight crew could be the remnants of the storm. However, the wind was relatively light through-out that period. There was no expectation of gusty winds that might have emanated wind shear. Therefore, the investigation determined that weather was not a factor in this occurrence.

3.0 CONCLUSIONS

3.1 Findings

1. The Pilot and Co-Pilot were properly licensed to conduct the flight.
2. The flight crew were in compliance with the duty time as required by the regulations.
3. The aircraft had a valid Certificate of Airworthiness.
4. There were no cockpit voice recordings for the incident flight.
5. The aircraft centre of gravity (CG) was within the prescribed limits.
6. The aircraft was cleared for ILS/DME approach RWY 05 by ATC.
7. The flight crew requested from ATC to ensure that no birds were present around the runway.
8. After the flight crew noticed that the ILS signals were erratic they reverted to visual approach using the localizer for guidance.
9. The aircraft crossed the threshold right of the centre line in a left bank.
10. The aircraft touched down with the left main wheels first and the number one engine nacelle impacted the surface of RWY 05 centre line, 203 m from the threshold.
11. The aircraft was steered to the centre line after touchdown.
12. The aircraft sustained damage to the number one engine, its fan and reverser cowlings.

13. One runway edge light was damaged.
14. There was evidence of bird strike at the edge of the lower part of the radome.
15. Minna Airport does not have an approved Aerodrome Manual.
16. Minna Airport does not have an approved Aerodrome Rescue and Fire Fighting Service (ARFFS) manual.
17. Minna Airport does not have approved Aerodrome Emergency Plan (AEP).
18. Minna Airport does not have approved Wild Life Control Program.
19. Minna Airport ARFFS had less than adequate number of fire fighting vehicles required for CAT 8 fire fighting operations.
20. The Minna ILS/DME RWY 05 was due for calibration in July, 2019; two months prior to the incident.
21. The Minna VOR/DME RWY 05 was due for calibration in March, 2019; six months to the incident.
22. Localizer transmitter two (Tx 2) was unserviceable.
23. Solar powered runway edge lighting was serviceable at the time of the incident.
24. Conventional runway edge lighting was not serviceable.

3.2 Causal factor

Excessive rudder and aileron inputs at short finals phase of the approach.

3.3 Contributory factors

1. The decision to continue the ILS approach runway 05 with erratic localizer signals.

2. An un-stabilized approach with a no go-around decision.

4.0 SAFETY RECOMMENDATION

4.1 Safety Recommendation 2021-008

Federal Airports Authority of Nigeria (FAAN) should ensure that the Aerodrome Manuals including Safety Management System (SMS) manuals are updated and submitted to Nigerian Civil Aviation Authority (NCAA) for approval.

4.2 Safety Recommendation 2021-009

Federal Airports Authority of Nigeria (FAAN) should ensure that all airfield lightings are properly maintained and kept serviceable.

4.3 Safety Recommendation 2021-010

Federal Airports Authority of Nigeria (FAAN) should ensure that Aerodrome Emergency Plan (AEP) is operational and test run as required by the Nig.CARs 12.6.15.1.

4.4 Safety Recommendation 2021-011

Federal Airports Authority of Nigeria (FAAN) should ensure that Aerodrome Rescue and Fire Fighting Service (ARFFS) equipment are of the appropriate standard and minimum requirements for the category of aircraft expected to land at Minna airport.

4.5 Safety Recommendation 2021-012

Nigerian Airspace Management Agency (NAMA) should ensure that all navigational aids are maintained and calibrated in accordance with the standards prescribed in Nig. CARs 14.1.49.3.

4.6 Safety Recommendation 2021-013

Nigerian Civil Aviation Authority (NCAA) should ensure that all relevant programs and their attendant manuals for Minna airport are reviewed and subjected to the approval procedures.

4.7 Safety Recommendation 2021-014

Max Air Limited should ensure that its flight crew are encouraged to consider executing go-around procedure when not stabilized on final approach.

APPENDICES

Appendix 1: AIP Supplement S38/2019 issued on the 10th September, 2019

Federal Republic of Nigeria
Nigerian Airspace Management Agency
Aeronautical Information Services Headquarters
P. M. B. 21084, Ikeja – Nigeria.

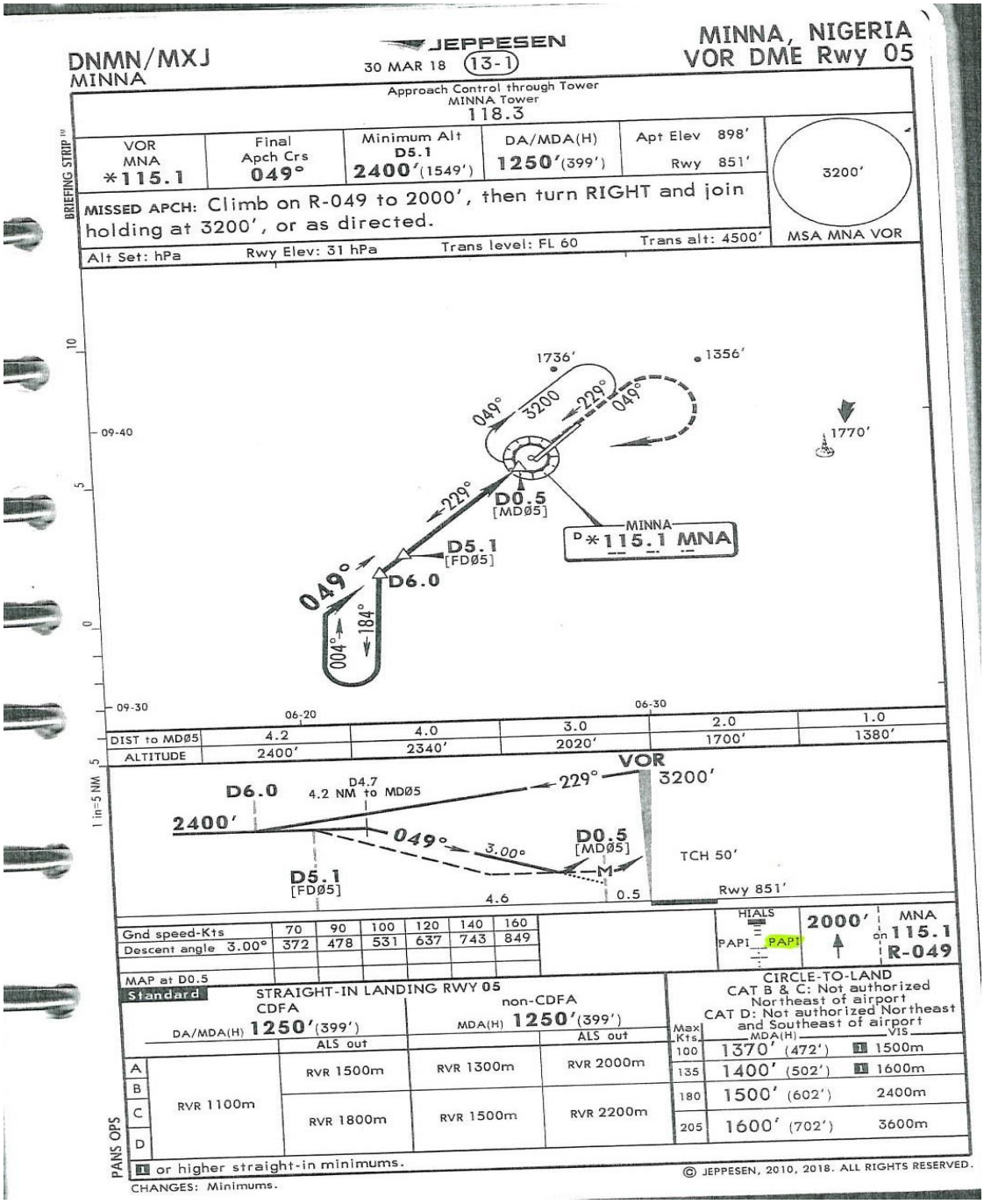
AIP Supplement
S38/2019
10 Sep 2019

NAVIGATIONAL AIDS WITH THEIR CALIBRATION STATUS WITHIN KANO FIR

Below are Navigational Aids with their calibration status within Kano FIR. Pilots are advised to exercise caution and discretion on their usage.

S/N	STATION	FACILITY	DATE LAST CALIBRATED	NEXT DUE DATE	CALIBRATION STATUS
1.	LAGOS	VOR/DME ILS/DME 18R ILS/DME 18L	17/12/2018 17/12/2018 06/12/2018	DEC 2019 JUNE 2019 JUNE 2019	CURRENT DUE DUE
2.	ABUJA	VOR/DME ILS/DME 04 ILS/DME 22	10/03/2018 12/12/2018 12/12/2018	MAR 2019 JUNE 2019 JUNE 2019	DUE DUE DUE
3.	KANO	DVOR/DME ILS/DME 06 ILS/DME 24	08/03/2018 10/01/2019 14/12/2018	MAR 2021 JULY 2019 JUNE 2019	CURRENT DUE DUE
4.	PORT HARCOURT	VOR/DME ILS/DME	07/12/2018 06/12/2018	DUE JUNE 2019	DUE DUE
5.	ENUGU	VOR/DME ILS/DME	07/12/2018 07/12/2018	DEC 2019 JUNE 2019	CURRENT DUE
6.	CALABAR	VOR/DME ILS/DME	05/01/2019 05/01/2019	JAN 2020 JULY 2019	CURRENT DUE
7.	SOKOTO	VOR/DME ILS/DME	07/01/2019 07/01/2019	VOR DUE JULY 2019	DUE DUE
8.	MINNA	VOR/DME ILS/DME	10/03/2018 06/01/2019	MAR 2019 JULY 2019	DUE DUE
9.	KATSINA	VOR/DME ILS/DME	20/03/2009 10/01/2019	OCT 2009 JULY 2019	DUE DUE
10.	OWERRI	VOR/DME ILS/DME	16/12/2018 05/01/2019	VOR DUE JULY 2019	DUE DUE
11.	ILORIN	VOR/DME ILS/DME	26/02/2018 04/01/2019	DUE JULY 2019	DUE DUE
12.	BENIN	VOR/DME ILS/DME	21/12/2018 03/01/2019	DEC 2019 JULY 2019	CURRENT DUE

Appendix 2: MNA VOR/DME approach chart



Appendix 3: MNA RNAV (GNSS) approach chart