AIRCRAFT ACCIDENT REPORT

ARIK/2018/03/06/F

Accident Investigation Bureau

Report on the Serious Incident involving a Bombardier DHC-8-Q400 aircraft owned and operated by Arik Air Nigeria Ltd with nationality and registration marks 5N-BKX which occurred en route Kotoka International Airport, Accra, Ghana
On 6th March, 2018

This report is produced by the Accident Investigation Bureau (AIB), Nnamdi Azikiwe International Airport, Abuja.

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

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

Safety Recommendations in this report are addressed to the Regulatory Authority of the State (NCAA) 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 THE REPORT

ACC	Accra Area Control
AFM	Airplane Flight Manual
AIB	Accident Investigation Bureau
AMM	Aircraft Maintenance Manual
APP	Approach Control
ARA	Arik Air
AFRS	Aerodrome Fire and Rescue Service
ASAP	As soon as possible
ATIS	Automatic Terminal Information Service
ATPL (A)	Airline Transport Pilot License (Aeroplane)
BKN	Broken
CB	Cumulonimbus Cloud
CPL (A)	Commercial Pilot License (Aeroplane)
CVR	Cockpit Voice Recorder
DGAA	ICAO Location Indicator for Accra Airport
DME	Distance Measuring Equipment
DNMM	ICAO Location Indicator for Murtala Muhammed Airport
FCOM	Flight Crew Operating Manual

FDR	Flight Data Recorder
FL	Flight level
ft	Feet
GCAA	Ghana Civil Aviation Authority
h	hour
HP	High Pressure
hPa	Hectopascal
ICAO	International Civil Aviation Organisation
IFR	Instrument Flight Rules
ILS	Instrument Landing System
IMC	Instrument Meteorological Condition
Inc.	Incorporated
KEDOV	A Reporting Point
Kt	Knot
Km	Kilometre
LP	Low Pressure
MEL	Minimum Equipment List
MSA	Minimum Safe Altitude
NAMA	Nigerian Airspace Management Agency

NCAA	Nigerian Civil Aviation Authority
NDB	Non Directional Beacon
NITS	A type of emergency briefing
NOSIG	No Significant Change
PF	Pilot Flying
PM	Pilot Monitoring
QNH	Altimeter Setting above mean sea level
QRH	Quick Reference Handbook
SCCM	Senior Cabin Crew Member
SEP	Safety Equipment and procedure
Shp	Shaft Horse Power
TWR	Tower
UTC	Coordinated Universal Time
VOR	Very High Frequency Omnidirectional Radio Range

Aircraft accident report number:	ARIK/2018/03/06/F
Registered owner and operator:	Arik Air Nigeria Ltd
Aircraft type and model:	Bombardier DHC-8-Q400
Manufacturer:	Bombardier Aviation, Canada
Year of manufacture:	2014
Serial number:	4470
Nationality and registration marks:	5N-BKX
Location:	En route Kotoka International Airport Accra, Ghana
Date and time:	6th March 2018 at about 1911UTC *(All times in this report are local time, equivalent to UTC+1 unless otherwise stated)*

SYNOPSIS

The Accident Investigation Bureau, Nigeria (AIB-N) was not officially notified of the serious incident involving a bombardier DHC-8-Q400 aircraft with Nationality and Registration marks 5N-BKX which occurred en route Kotoka International airport Accra on 6th March 2018.

The Bureau only became aware of the incident following a post on social media on 8th March, 2018. The Bureau immediately contacted the Ghana Civil Aviation Authority (GCAA), being the state of occurrence for consultation and further clarification.

The Bureau's Investigators were dispatched to the Air force hangar within the Kotoka International Airport Accra, Ghana where the aircraft was parked, and investigation commenced immediately. All relevant stakeholders were duly notified.

On 6th March 2018 at about 1810UTC, the scheduled flight ARA304 operated by Arik Air Nigeria - Bombardier DHC-8-Q400 aircraft with nationality and registration marks 5N-BKX, departed Murtala Mohammed Airport Lagos, Nigeria for Kotoka International Airport Accra, Ghana.

In his statement, which was corroborated by the cabin crew in their individual statements, the Captain stated that, at about 81 Nautical Miles to Accra VOR, smoke was observed in the mid-section of the cabin and seemed to be emanating from the right side air vents.

The Captain immediately declared the emergency to the Approach unit (APP), requested priority landing and evacuation, and instructed the cabin crew to prepare the cabin for an emergency landing.

The Captain stated that while executing the checklist "FUSELAGE FIRE, SMOKE or FUMES" in the aircraft Quick Reference Handbook (QRH), the smoke cleared before the localizer capture during the approach. ARA304 then informed Tower (TWR) that they would no longer evacuate passengers on the runway as initially planned as the smoke had cleared and therefore requested to exit the active runway on landing through taxiway "Y" to "E" bay.

The aircraft landed on Runway 21 at about 1911UTC. All persons on board disembarked without injuries.

The incident occurred at dusk in Instrument Meteorological Condition.

The investigation identified the following:

Causal factor

Engine oil leaked onto the hot surfaces of the engine No. 2 due to a failed seal which produced fumes that mixed with the bleed air supply to the air conditioning system, resulting in smoke in the aircraft cockpit and cabin.

Two Safety Recommendations were made.

1.0 FACTUAL INFORMATION

1.1 History of the flight

On 6th March, 2018 at about 1810UTC a Bombardier DHC-8-Q400 aircraft with nationality and registration marks 5N-BKX operated by Arik Airline Nigeria Ltd as ARA304 departed Murtala Mohammed International Airport Lagos, Nigeria for Kotoka International Airport Accra, Ghana on an Instrument Flight Rules (IFR) flight plan.

On board were 4 crew members (2 cockpit crew and 2 cabin crew) and 35 passengers. The Co-Pilot was the Pilot Flying (PF) while the Captain was the Pilot Monitoring (PM).

According to the Air Traffic Control transcript, ARA304 established initial contact with Accra Area Control (ACC) on 130.9 MHz estimating Accra at 1911UTC. ACC acknowledged and cleared ARA304 direct to KEDOS for ILS approach Runway 21 and further requested ARA304 to report when ready for descent.

Few minutes later, ARA304 requested for descent and was cleared to descend initially to FL160. Thereafter, ACC further cleared ARA304 to FL050 and instructed ARA304 to contact Approach (APP) on 119.5 MHz, ARA304 acknowledged. ARA304 established contact with APP as instructed and was given inbound clearance as follows: Radar contact Descend to FL050 direct KEDOS for ILS approach Runway 21.

The Captain stated that at about 81 Nautical Miles to Accra, the First Officer called his attention to misty air coming from the right side air vents. On further observation, they both confirmed it to be smoke. The Senior Cabin Crew Member (SCCM) reported the presence of smoke in the mid-section of the cabin to the cockpit crew. The cockpit crew further stated that they immediately referred to the "FUSELAGE FIRE, SMOKE or FUMES" procedure in the Quick Reference Handbook (QRH). Thereafter, the Captain called Accra Approach requesting immediate descent declaring "MAYDAY" stating "we have smoke in the cockpit and cabin and will like to land and evacuate immediately on the runway".

Accra Approach then responded saying, "Continue Descent to 3900 ft on QNH 1009 and proceed direct KEDOS for ILS approach Runway 21 expedite" and to report back when established on the localizer, which the crew acknowledged. The cockpit crew was further notified by Approach of the activation of the airport emergency services. The crew in turn notified Approach of their intention on landing, to shut down the engines and order an emergency evacuation.

The flight crew stated that while they were executing the checklist in the Quick Reference Handbook (QRH), the Captain gave the SCCM the NITS[1] briefing and thereafter briefed the passengers through the Public Address (PA) System of the situation. The cabin crew members stated that they distributed paper serviettes to passengers to cover their noses and mouths.

The captain further stated that after carrying out the QRH actions, the smoke cleared prior to the localizer intercept.

The crew reported to Accra Approach that the smoke had cleared and were established on ILS approach Runway 21. Approach then instructed ARA304 to contact Tower (TWR) on 118.6 MHz for landing instructions. TWR cleared ARA304 to land Runway 21 with a prevailing wind of 200^{o}/9 kt with a reminder that the Ghana Airports Company Limited (GACL) Rescue and Fire Fighting Services (RFFS) fire truck was on standby.

The crew also informed Tower that they would no longer evacuate on the runway as initially planned, requesting to exit the active runway through taxiway Y (Yankee) on landing, which Tower affirmed and asked ARA304 to park at "E" Bay. The Pilot stated that he then briefed the SCCM of the new intention, instructing that after engine shut

[1] NITS briefing is an emergency briefing defined by the meanings of the acronym vis:
N – Nature of Emergency; I – Intention of Captain; T – Time available; S – Special/Specific instruction

down and seat belts sign off, passengers should leave all bags behind and disembark through the main entry (L1) door.

According to the cockpit crew; the aircraft landed on Runway 21 at about 1911UTC, taxied to the apron and parked.

The Cabin crew opened the main entry door and coordinated the disembarkment. All passengers and crew disembarked without injuries in the presence of the Ghana Airports Company Limited Rescue and Fire Fighting Services (RFFS).

The incident occurred at dusk. Instrument Meteorological Condition (IMC) prevailed at the time of incident.

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	4	35	39
Total	4	35	39

1.3 Damage to aircraft

The aircraft was not damaged.

Figure 1: Photo of 5N-BKX in the maintenance hangar

1.4 Other damage

Nil.

1.5 Personnel information

1.5.1 Captain (Pilot Monitoring)

Nationality:	Antiguan
Age:	42 years
License type:	Airline Transport Pilot License (Aeroplane)

License:	Valid till 20th August, 2018
Aircraft ratings:	Part 1: DHC-8-Q400,
	Part 2: DASH-6, DASH-8, Piper Aztec-34
Medical certificate:	Valid till 4th August 2018
Simulator:	Valid till 20th August 2018
Total flying hours:	6,238 h
On type:	2,360 h
Last 90 days:	100 h
Last 28 days:	42 h
Last 24 hours:	1:12 h

1.5.2 Co-Pilot

Nationality:	Nigerian
Age:	29 years
License type:	Commercial Pilot License (Aeroplane)
License:	Valid till 26th August 2018
Medical certificate:	Valid till 1st August 2018
Simulator:	Valid till 13th May, 2018
Aircraft ratings:	**Part 1:** Piper Aztec-28, Piper Aztec-34,
	Part 2: DASH 8-400
Total flying hours:	1,240 h
On type:	1,040 h

Last 90 days:	89 h
Last 28 days:	26 h
Last 24 hours:	1:12 h

1.6 Aircraft information

1.6.1 General information

The Bombardier DHC-8-402 (also known as Q400) is a twin engine medium–range airliner with 78 passengers seating capacity and a cruise speed of about 360 knots.

Type:	Bombardier DHC-8-Q400
Serial number:	4470
Operator:	Arik Air Nigeria Ltd
Manufacturer:	Bombardier Aviation, Canada
Nationality and registration marks	5N-BKX
Year of manufacture:	10th August 2014
Total airframe time:	4,966.15 h
Total Landings/Cycles:	6,180
Certificate of Insurance:	Valid till 12th April, 2018
Certificate of Airworthiness:	Valid till 17th December, 2018

1.6.2 Maintenance information

1.6.2.1 Last scheduled maintenance inspection check

E-037, completed on 28 February 2018 at airframe hours of 4940:42 and cycles of 6142. Next scheduled maintenance inspection is an E-038 which is due by airframe hours of 5090:42 or 14 April 2018, whichever comes earlier.

1.6.2.2 Outstanding defects as stated in the Deferred Defects log book:

S/N	Description	Tech Log Book Reference	Date opened	MEL Reference	Category
1	ANVS Inop	271774	28 Jan 2018	23-30-4	D
2	Armrest 22c broken	0009324	22 Feb 2018	25-20-58	D
3	Life Jacket	Illegible	Illegible	Illegible	C

1.6.3 Powerplant

	Engine No. 1	Engine No. 2
Manufacturer	Pratt & Whitney Canada	Pratt & Whitney Canada
Engine Type	PW150A	PW150A
Year of Manufacture	5th March, 2014	21st February 2014
Serial Number	P.C.E - FA1056	P.C.E - FA1054
Time Since New	4,976:37 h	4,971:15 h

Engine description

The aircraft is powered by two Pratt & Whitney Canada PW150A gas turboprop engine with a nominal sea level static power output of approximately 5100 shp. It has an axial Low pressure (LP) Compressor, a centrifugal High Pressure (HP) compressor, a two-stage gas generator turbine and a two-stage power turbine. Bleed air for the fuselage air conditioning units is taken from either the LP or HP compressors, depending on the power settings.

1.6.4 Propeller

	Propeller 1	**Propeller 2**
Manufacturer	Dowty Propellers, UK	Dowty Propellers UK
Propeller type:	R408/6-123-F/17	R408/6-123-F/17
Model number:	DAP 1053	DAP 1052
Year of manufacture:	28th March, 2014	27th March, 2014
Number of blades:	6	6

1.7 Meteorological Information

1.7.1 Lagos (DNMM) at 1800 UTC

Wind:	190°/10 kt
Visibility:	8 km
Weather:	Nil
Cloud:	FEW 2,000 ft CB, BKN 1,400 ft

Temperature/Dew point:	34°C/24°C
QNH:	1010 hPa
Trend:	NOSIG

1.7.2 Accra (DGAA) at 1800 UTC

Wind:	180°/10 kt
Visibility:	10 km or more
Weather:	Nil
Cloud:	FEW 3,000 ft CB
Temperature/Dew point:	31°C/23°C
QNH:	1009 hPa
Trend:	NOSIG

1.8 Aids to navigation

The airport is equipped with Non-Directional Beacon (NDB), Very High Frequency Omni-Directional Radio Range (VOR), Distance Measuring Equipment (DME), Instrument Landing Systems (ILS), and Automatic Terminal Information Service (ATIS). All were serviceable at the time of the occurrence. Relevant Maps, Aeronautical Charts and Approach plates were all on-board the aircraft.

1.9 Communications

There was effective communication between Accra ATC unit and the aircraft at the time of the occurrence.

1.10 Aerodrome information

Kotoka International Airport, Accra with ICAO location indicator DGAA has two runways designated 03/21. It is asphalt coated with a dimension of 3,403 metres by 61 metres. It is located on the Latitude of 5.6061° N and Longitude of 0.1681° W with elevation of 205 ft.

1.11 Flight recorders

5N-BKX was fitted with both flight data recorder and the cockpit voice recorder in accordance with the existing regulations. Both recorders were retrieved in good physical condition.

The FDR was downloaded by the operators and the RAW data sent to the Accident Investigation Bureau's Safety Laboratory for analysis. The CVR was overwritten due maintenance action carried out before it was retrieved by the investigators.

The particulars of the recorders are given below:

	Flight Data Recorder (FDR)	**Cockpit Voice Recorder (CVR)**
Manufacturer	Universal Avionics Systems Corporation USA	Universal Avionics Systems Corporation USA
Part Number	1607-00-00	1606-00-01
Serial Number	727	781

1.12 Wreckage and impact information

Not Applicable.

1.13 Medical and Pathological Information

Not Applicable.

1.14 Fire

There was no fire.

1.15 Survival aspect

The occurrence was survivable as the aircraft came to a complete stop, the seats and the restraints were intact.

1.16 Test and research

The procedure for the removal of smoke, odour and mist from the cabin was carried out in accordance with Aircraft Maintenance Manual (AMM) 05-50-04-160-802, this includes detailed visual inspection of the Engines, APU and the Air conditioning system.

Visual inspection carried out on engine No. 2 by the Arik Maintenance Engineer shows traces of oil in the Air conditioning compartment (tail section). The engine No. 2, P2.2 inter-stage valve exhaust was full of oil and also, there were signs of wetness and oil contamination in the Generator case, low and high pressure compressors, Air intake ducts and P2.2 and P2.7 bleed air ducts.

Due to the above observations, and in accordance with Aircraft Maintenance Manual 72-00-00-290-809, a Borescope inspection of the compressor inner support (CIS) and inter-compressor case strut was requested and carried out by Aero Contractors Nigeria Ltd, which revealed evidence of oil stains on the strut and its vicinity, oil stains within the vicinity of LPC stage 1 blade, evidence of oil stains on LPC stage 3 blade, signs of wetness on the impeller and its vicinity. **See Appendix A**.

1.17 Organizational and management information

1.17.1 Arik Air Nigeria Limited

Arik Air started operations in 2006 and is a privately and wholly Nigeria-owned commercial airline operating both domestic and international flights.

Arik Air operates from two hubs at Murtala Muhammed Airport Lagos and Nnamdi Azikiwe International Airport in Abuja. Arik Air head office is the Arik Air Aviation Center on the grounds of Murtala Muhammed International Airport in Ikeja. Arik Air serves a network of regional and mid-haul destinations within Africa.

The Arik Air fleet consists of Boeing and Bombardier aircraft, including Boeing 737-700, Boeing 737-800, Bombardier CRJ1000 and Bombardier Dash 8 Q400.

1.17.1.1 Flight Crew Operation Manual (FCOM) checklist

The 'FUSELAGE FIRE OR SMOKE – SMOKE' Checklist in the operator's FCOM had the following memory items

- *Oxygen Masks …….. On/100%*
- *Smoke Goggles (if applicable)…….. On*

- *Mic switch…….. Mask*
- *Recirc Fans …….. OFF*

1.17.1.2 Airplane Flight Manual

- FUSELAGE FIRE, SMOKE OR FUMES EMERGENCIES

  NOTES:

  In the event of smoke or fire, prepare to land the aircraft without delay while completing fire suppression and/or smoke evacuation procedure. If it cannot be visually verified that the fire has been completely extinguished, whether the smoke has cleared or not, land immediately at the nearest and suitable airfield or landing site

  GENERAL PROCEDURES

  1. *Oxygen mask – On 100% oxygen selected*
  2. *Goggle – On*
  3. *BOOM/MASK switch – MASK and establish communication*
  4. *RECIRC fan switch - OFF*

- *UNKNOWN SOURCE OF SMOKE*

  BLEED SOURCE OR AIR CONDITIONING SUSPECTED

  1. *BLEED 1 Switch – OFF.*
     Wait up to one minute, if no improvement:
  2. *BLEED 1 switch –BLEED 1.*
  3. *BLEED 2 switch – OFF.*
     Wait up to one minute, if no improvement:

4. *BLEED 2 switch – BLEED 2.*
5. *FLT COMP PACKS switch OFF.*

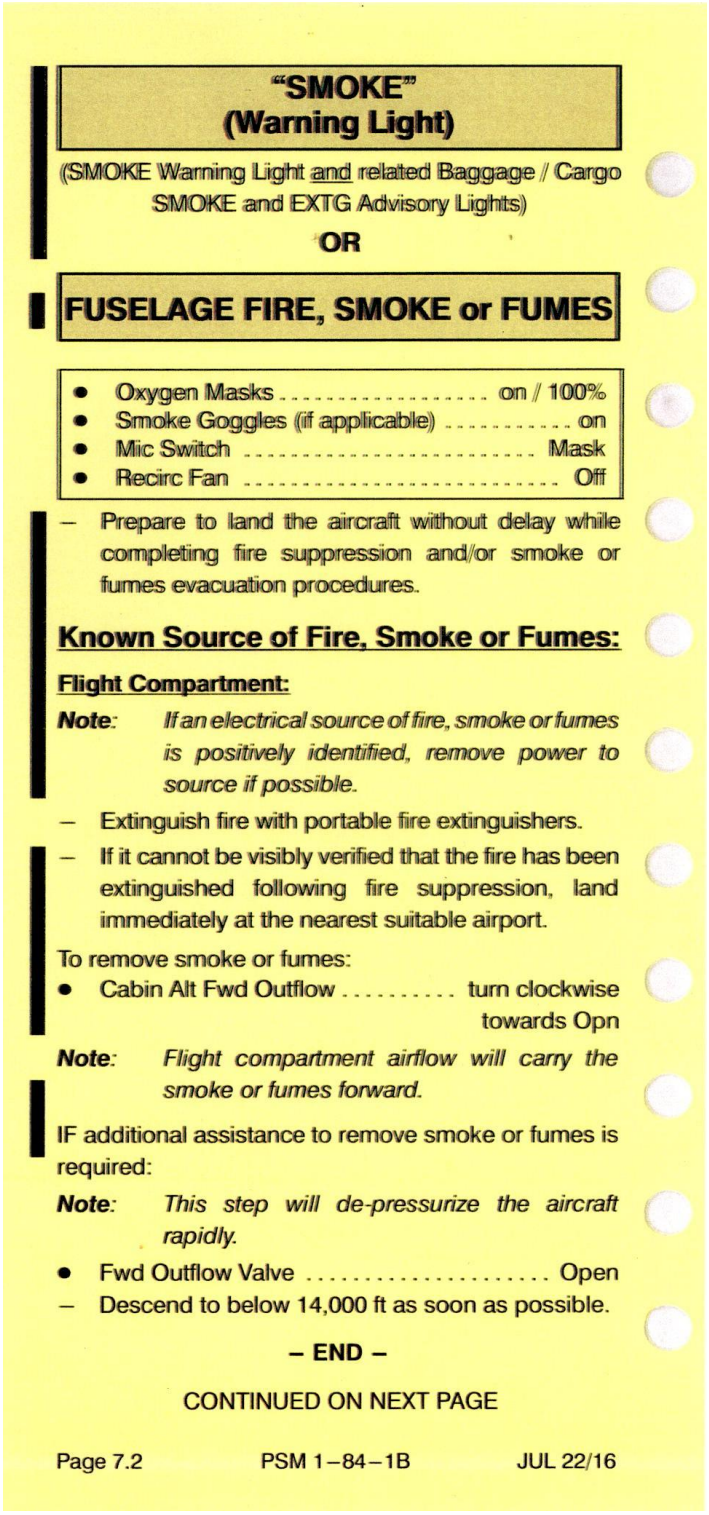
   Wait up to one minute, if no improvement:
6. *FLT COMP PACKS switch – AUTO or MAN.*
7. *CABIN COMP PACKS switch OFF.*

   Wait up to one minute, if no improvement:
8. *CABIN PACKS switch – AUTO or MAN.*

- *SOURCE OF FIRE OR SMOKE CANNOT BE IDENTIFIED:*
  1. *DC CONTROL GEN switches – OFF.*
  2. *AC CONTROL GEN switches – OFF.*
  3. *MAIN BATT, AUX BATT and STBY BATT switches – OFF.*
  4. *EMER LIGHTS switch – OFF*

     If emergency lights are required:
  5. *EMER LIGHTS switch – ON*
  6. *See paragraph 3.7.6.6 for powered services.*
  7. *Land immediately at the nearest suitable airport.*

1.17.1.3 QRH procedure for fuselage fire, smoke or fume



"SMOKE"
(Warning Light)

(SMOKE Warning Light and related Baggage / Cargo SMOKE and EXTG Advisory Lights)

OR

FUSELAGE FIRE, SMOKE or FUMES

- Oxygen Masks ..... on / 100%
- Smoke Goggles (if applicable) ..... on
- Mic Switch ..... Mask
- Recirc Fan ..... Off

– Prepare to land the aircraft without delay while completing fire suppression and/or smoke or fumes evacuation procedures.

Known Source of Fire, Smoke or Fumes:

Flight Compartment:

Note: *If an electrical source of fire, smoke or fumes is positively identified, remove power to source if possible.*

– Extinguish fire with portable fire extinguishers.

– If it cannot be visibly verified that the fire has been extinguished following fire suppression, land immediately at the nearest suitable airport.

To remove smoke or fumes:

- Cabin Alt Fwd Outflow ..... turn clockwise towards Opn

Note: *Flight compartment airflow will carry the smoke or fumes forward.*

IF additional assistance to remove smoke or fumes is required:

Note: *This step will de-pressurize the aircraft rapidly.*

- Fwd Outflow Valve ..... Open

– Descend to below 14,000 ft as soon as possible.

– END –

CONTINUED ON NEXT PAGE

Page 7.2 PSM 1–84–1B JUL 22/16

Cabin:

- Emergency Lights ..... if req'd
- Evacuate passengers from affected area.
- Extinguish fire with portable fire extinguishers.

Note: *If a pilot is required to fight the fire, protective breathing equipment must be donned prior to exiting the flight compartment.*

- If it cannot be visibly verified that the fire has been extinguished following fire suppression, land immediately at the nearest suitable airport.

IF assistance to remove smoke or fumes from the cabin is required:

Note: *This step will de-pressurize the aircraft rapidly.*

- Auto / Man / Dump ..... Dump
- Descend to below 14,000 ft as soon as possible.

– END –

Baggage / Cargo Compartment:

- Illuminated SMOKE / EXTG switch ..... press

Note: *The second Baggage compartment FIRE BOTTLE LOW Advisory Light may illuminate after the first bottle has been discharged.*

- Land immediately at the nearest suitable airport.

– END –

Unknown Source of Fire, Smoke or Fumes:

Note: *To prepare for and manage an immediate landing, the Unknown Source of Fire, Smoke or Fumes procedure may be terminated prior to completion.*

Bleed Source or Air Conditioning Suspected:

- Bleed Air 1 ..... Off

Wait up to 1 minute.

Improvement:

Yes

- Leave Bleed Air 1 in the Off position.

IF necessary to assist in removal of smoke or fumes:

- SMOKE or FUMES REMOVAL (Page 7.6) ..... accomplish

– END –

No

CONTINUED ON NEXT PAGE

Unknown Source of Fire, Smoke or Fumes
Bleed Source or Air Conditioning Suspected (cont'd):

No

- Bleed Air 1 ..... on
- Bleed Air 2 ..... Off

Wait up to 1 minute.

Improvement:

Yes

- Leave Bleed Air 2 in the Off position.

IF necessary to assist in removal of smoke or fumes:

- SMOKE or FUMES REMOVAL (Page 7.6) ..... accomplish

– END –

No

- Bleed Air 2 ..... on
- Flt Comp Pack ..... Off

Wait up to 1 minute.

Improvement:

Yes

- Leave Flt Comp Pack in the Off position.

IF necessary to assist in removal of smoke or fumes:

- SMOKE or FUMES REMOVAL (Page 7.6) ..... accomplish

– END –

No

- Flt Comp Pack ..... Auto / Man
- Cabin Pack ..... Off

Wait up to 1 minute.

Improvement:

Yes

- Leave Cabin Pack in the Off position.

IF necessary to assist in removal of smoke or fumes:

- SMOKE or FUMES REMOVAL (Page 7.6) ..... accomplish

– END –

No

- Cabin Pack ..... Auto / Man

CONTINUED ON NEXT PAGE

Source of Fire, Smoke or Fumes cannot be Identified:

- DC Gen 1 and 2 ..... Off
- AC Gen 1 and 2 ..... Off
- Storm/Dome Lights ..... Storm (if req'd)
- Main, Aux and Stby Batteries ..... Off
- Emergency Lights ..... Off (until req'd)

– Land immediately at the nearest suitable airport.

Caution: *Battery duration for operation of essential services is 60 minutes (45 minutes JAA).*

Note: *Engine bleed air flow to ECS packs is lost. The aircraft will de-pressurize.*

IF necessary to remove smoke or fumes from the flight compartment:

Note: *This procedure will de-pressurize the aircraft rapidly.*

- Auto / Man / Dump ..... Man
- Man Diff ..... Incr (50 sec)
- Cabin Alt Fwd Outflow .... fully clockwise (Opn)
- Fwd Outflow Valve ..... Open

Note: *Ram ventilation is most effective above 150 KIAS.*

– Descend to below 14,000 ft as soon as possible.

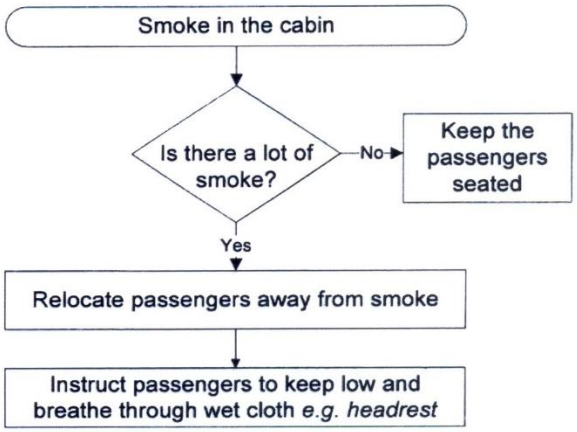
---------- **END** ----------

JUL 22/16 PSM 1–84–1B Page 7.5

1.17.1.4 Cabin Crew SEP Manual (Chapter 4 – Emergency Procedure)

Arik	Cabin Crew SEP Manual	Effective Date: 01FEB16
		Chpt-Page: 4-43
	Chapter 4 Emergency Procedures	Rev. No.: 0
		Issue No.: 2

Fire Drill, continued



1.17.1.5 Operations Manual Part D Training

Arik WINGS OF NIGERIA	**Operations Manual Part D Training**	Effective Date: 01MAR18
		Chpt-Page: 2-32
	Chapter 2 Training Syllabi and Checking Programmes	Rev No.: 0
		Issue No.: 3

The Arik Air SEP recurrent training programme is detailed below:

Frequency		Topic
Every 3 Years	Every Year	Actual donning of a lifejacket Actual donning of PBE Actual handling of fire extinguishers Instruction on the location of emergency and safety equipment carried onboard Instruction on the location and use of all types of exists Security procedures Survival information appropriate to the areas of operation (e.g. polar, desert, jungle or sea) and training in the use of any survival equipment required to be carried. First aid training shall include: unconsciousness, burns, wounds, fractures and soft tissue injuries and techniques of CPR.
		Actual operation of all types of exits Actual fire-fighting using equipment representative of that carried on the aeroplane The effects of smoke in an enclosed area and actual use of relevant equipment in a simulated smoke environment Actual handling of pyrotechnics Demonstration of the use of life-rafts Evacuation of the aeroplane including co-ordination among all crew members A comprehensive drill to cover all ditching procedures will be practised where flotation equipment is carried. This will include practice of the actual donning and inflation of a lifejacket together with a demonstration or film of the inflation of life-rafts and slide-rafts and associated equipment in water.

1.17.2 Nigerian Civil Aviation Authority (NCAA)

The Nigerian Civil Aviation Authority (NCAA) is the apex regulatory body overseeing the activities of all airline operators, crew, engineers, airports, airstrips and heliports, navigation aids and air traffic service providers. NCAA functions include safety oversight on all the above.

1.17.2.1 Nig.CARs (2015) 8.10.1.13

a) No person may serve nor may any AOC holder use a person as a crew member unless that person has completed the initial appropriate initial emergency equipment curriculum and drill for the crew member position approved by the authority for the emergency equipment available on the aircraft to be operated

b) course curriculum requirement as contained in IS:8.10.1.13

1.17.3 Ghana Civil Aviation Authority

Ghana Civil Aviation Authority (GCAA) is the National Aviation Authority and Regulatory Agency of the Republic of Ghana for air transportation in the country. It has its headquarters in Kotoka International Airport in Accra. It also provides air navigation services within the Accra Flight Information Region (FIR), which comprises the airspace over the Republic of Ghana and a large area over the Atlantic Ocean in the Gulf of Guinea.

1.18 Additional information

1.18.1 Bombardier DASH 8 - Q400 Air Conditioning System

Introduction

The air conditioning pack conditions the bleed air to the proper temperature and humidity and delivers it to the air distribution system for environmental control of the cabin and flight deck.

General

The air conditioning pack is part of the Environmental Control System (ECS). It uses bleed air from the engines or Auxiliary Power Unit (APU) to supply conditioned air to the cabin. Two air cycle machines (ACM), are integrated with a single primary heat exchanger and a single secondary heat exchanger. They are located in the AFT fuselage (AFT equipment bay) and cool the hot bleed air coming from the two engines or from the APU. This configuration provides the redundancy of two packs while allowing access to a much larger dual heat exchanger during operation with a single ACM.

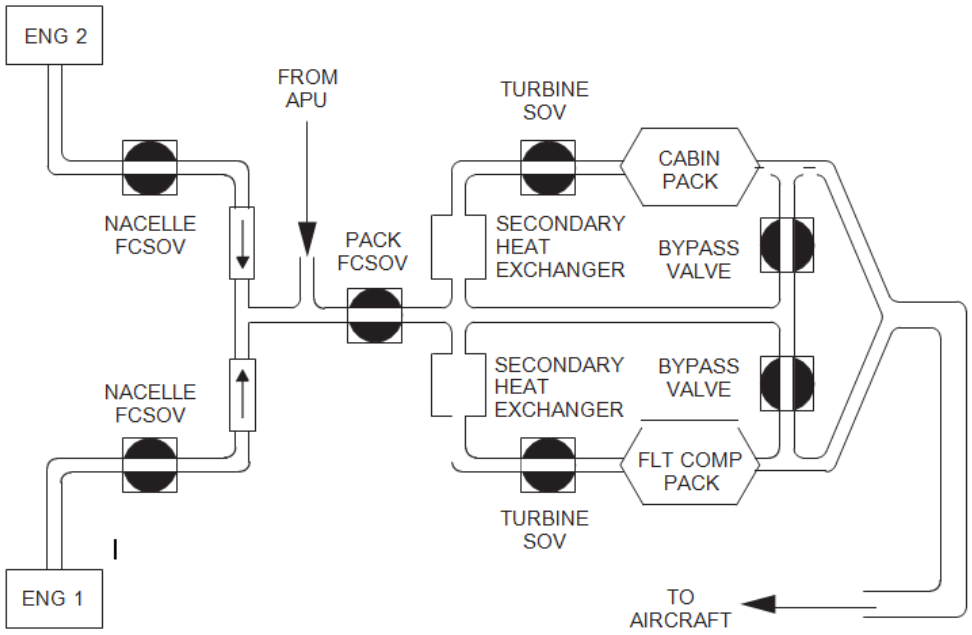
Air Conditioning System

The air conditioning system receives bleed air when the BLEED switches on the AIRCONDITIONING control panel, or the BLAIR switch light on the APU CONTROL panel, are turned ON.

The air conditioning system is controlled by turning the CABIN and FLT COMP PACKS switches to the MAN or AUTO positions, and then adjusting the temperature using the TEMP CONTROL knobs.

These switch settings determine the bleed air source, manual or automatic Environmental Control System (ECS) operation, and the air flow temperatures for the flight and passenger compartments.

Schematic Diagram Of Dash 8 – Q400 Air Conditioning And Pressurization



The ECS Electronic Control Unit (ECU) controls the two Nacelle Shut Off Valves (NSOV) to regulate the air flow to the air conditioning packs. The ECU receives bleed air pressure and temperature data from the pack inlet absolute pressure and inlet temperature sensors. The ECU uses these data to control bleed airflow through the

pack Flow Control Shut-off Valve (FCSOV). The ECU also uses this data to control bleed air flow rate when APU bleed air is selected ON.

1.18.2 Pratt & Whitney Canada (Service Bulletin and Oil Analysis Technology)

Incidents involving cabin air contamination by engine oil have been known to occur in turbine and turboprop-powered aircraft.

The engine manufacturer, Pratt & Whitney Canada (P&WC), released Service Bulletin (SB) 35342 on the 6th October 2016 detailing a repair modification for the 2.5 bearing carbon seal – one of the sources of such oil leaks, as well as a revised Service Bulletin (SB) 35342R1 on the 24th January 2018 (installation of an upgraded seal). All these were made available to the operators.

P&WC rated the Service Bulletin's compliance urgency as category 6 under which it recommends that operators comply with the SB "when the subassembly (i.e engine, module, accessories or component) is disassembled and access is available to the necessary parts when the engine is sent to shop".

Further to the Service Bulletin SB 35342 R1 P&WC also made available to operators who have not yet carried out the recommended overhaul , an Oil Analysis Technology Program to detect chemical element or alloys in the engine oil. The program also enables the analysis of its concentration to determine the source and/or kind of material.

P&WC Oil Analysis Technology Program provides improved precision and sensitivity, compared to that of the traditional Oil Debris Analysis used to monitor the health of oil wetted engine component such as bearings, gears and carbon bearing seals.

This Oil Analysis Technology Program has been available to operators on a trial basis since 2016.

1.19 Useful or effective investigation technique

Nil.

2.0 ANALYSIS

2.1 General

Records available to the Bureau indicate that the aircraft was certified, equipped and maintained in accordance with existing regulations and approved procedures.

This analysis focuses on the conduct of the flight, and crew training.

2.2 Conduct of the flight

2.2.1 The crew actions

The presence of smoke or fire within the airplane can quickly develop into a serious and life-threatening situation. Smoke can be carried into the fuselage via the air conditioning and pressurization system, or it can occur within the airplane by overheated surfaces, burning electrical equipment and wiring.

The crew stated that they executed the 'FUSELAGE FIRE, SMOKE or FUMES' Checklist in the Quick Reference Handbook (QRH)/Smoke checklist in the FCOM which had the following memory items:

- *Oxygen Masks……On/100%*
- *Smoke Goggles (if applicable) ……. On*
- *Mic switch……MASK*
- *Recirc Fans……OFF*

Investigation revealed that there was an incomplete checklist execution.

The *'Oxygen Mask….On/100%' and 'Smoke Goggles…On'* items on the checklist were omitted by the crew thereby risking incapacitation or exposure to unhealthy smoke/fumes. The crew's assertion of not smelling anything offensive or irritating,

describing the smoke as "mere mist" was an inappropriate judgment, as the nature of the smoke/fumes can only be assessed by chemical analysis or special equipment, neither of which is practicable in flight.

The interview with the cabin crew further revealed that they failed to properly execute the checklist item in the Cabin Crew Safety & Emergency (SEP) manual (Emergency Procedure) Fire drill; which says that in the event of a lot of smoke in the cabin, passengers should be relocated from the area where there is a lot of smoke and given wet cloth to breathe through.

The cabin crew of 5N-BKX did not relocate any passengers and, instead of the prescribed wet cloth, offered the passengers dry serviette paper to cover their nose and mouth. This action exposed the passengers to a high risk of irritation and suffocation.

2.2.2 The crew's decision

In dealing with smoke in the cabin/cockpit, the flight crew judged that landing was a priority as stated in the QRH/FCOM checklist given their lack of knowledge of the source of the smoke.

Catastrophic in-flight fires have historically given crew very little time to respond. The decision of the flight crew of 5N-BKX not to evacuate passengers on landing and to taxi to Echo bay for passengers' disembarkation might have been a misjudgment on their part, as in the event of smoke in the cockpit or cabin, there is a possibility that an uncontained fire could still be burning somewhere within the aircraft fuselage.

2.2.3 The crew's qualification/training

The crew were properly certified and qualified to conduct the flight in line with the requirements of the Nigerian Civil Aviation Regulations (Nig.CARs).

The smoke in the cockpit/cabin occurrence in a turbine or turboprop aircraft if not properly managed, can lead to flight crew's incapacitation or catastrophic in-flight fire.

In the course of the investigation, crew training records and the company's Operations Manual Part D (Training) showed that the Safety and Emergency Procedure (SEP), recurrent training program on the effect of smoke in an enclosed area and the use of relevant equipment in a simulated smoke environment is covered over a 3-year period.

Therefore, flight crew members should be scheduled more frequently during simulator training for the use of emergency and safety equipment in a smoke environment.

3.0 CONCLUSION

3.1 Findings

1. The aircraft had a valid Certificate of Airworthiness.
2. The flight crew were qualified and certified to conduct the flight.
3. A post occurrence borescope inspection was carried out by an NCAA approved AMO from Aero Contractors Nigeria Limited Fixed Wing Division.
4. Borescope inspection on No. 2 engine showed visible oil stains and wetness on various sections of the gas path, including: inner compressor, LP 1st compressor blades, HP 4th stage axial compressor, inter turbine vanes, accessory gear box and inter compressor case.
5. Traces of oil were also found within the Air conditioning compartment (tail section).
6. The engine No. 2, P2.2 inter stage valve exhaust was full of oil, and there were also signs of wetness and oil contamination in the Generator case.
7. Low oil level was observed in No. 2 engine oil tank.
8. Pratt & Whitney Canada issued a Service Bulletin SB35342 in 2016 on the modification of carbon seals installed on PW150A engines. The service bulletin was revised in 2018 as SB35342R1.
9. Pratt & Whitney Canada had developed a new oil analysis technology programme and made it available to all operators to utilize on engines that are yet to comply with SB35342R1 to detect impending failure of the carbon seal long before it actually fails.

3.2 Causal factor

Engine oil leaked onto the hot surfaces of the engine No. 2 due to a failed seal which produced fumes that mixed with the bleed air supply to the air conditioning system, resulting in smoke in the aircraft cockpit and cabin.

4.0 SAFETY RECOMMENDATIONS

4.1 Safety Recommendation 2021-028

Arik Air Nigeria Ltd should ensure that flight crew execute appropriate checklist items completely in line with the aircraft Flight Crew Operating Manual (FCOM) and Quick Reference Handbook (QRH).

4.2 Safety Recommendation 2021-029

NCAA should ensure that flight crew type-rated on Bombardier DHC-8-Q400 should undergo further training on "The effects of smoke in an enclosed area and actual use of relevant equipment in a simulated smoke environment".

SAFETY ACTIONS

In a letter dated 19th December 2019 (attached below), the NCAA in response to Safety Recommendation 2019-025 stated that from their findings, the new Oil Analysis Technology (SB35342R1) has been accomplished on the fleet of Arik Air Ltd.

Safety Recommendation 2019-025

Nigerian Civil Aviation Authority should monitor that the operators utilize the New Oil Analysis Technology made available by Pratt & Whitney Canada in order to identify impending failure of the carbon seals on PW150A Engines that are yet to comply with SB 35342R1

NIGERIAN CIVIL AVIATION AUTHORITY

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

Reference Number: *NCAA/DG/AIB/9/16/084*

Date: *19th December, 2019*

OFFICE OF THE COMM / CEO
RECEIVED
23 DEC 2019
Accident Investigation Bureau
Lagos

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

RE: DRAFT FINAL REPORT ON THE SERIOUS INCIDENT INVOLVING A DHC-8-Q400 WITH NATIONALITY AND REGISTRATION MARKS 5N-BPU BELONGING TO AEROCONTRACTORS COMPANY, NIGERIA LTD, WHICH OCCURRED AT FL240, 80 NM TO LAGOS ON THE 18th OF APRIL, 2017

I have been directed to acknowledge your letter of transmittal, dated the 23rd of October, 2019 on the above subject matter and also to inform the Commissioner that the Authority had reviewed the subject Draft Report and the under-listed are pertinent;

Section 4.2; Safety Recommendation 2019-025 Page 22: *The Nigerian Civil Aviation Authority (NCAA) fully agrees with this recommendation. Meanwhile it is important that the Authority states the following from its findings:*

- **a.** *Presently, AeroContractors Nig. Ltd does not operate Dash8-Q400 aircraft type as the two aircraft (5N-BPT and 5N-BPU) in its fleet had been deregistered by the Authority. Subsequently, the subject engines are not in their fleet anymore;*
- **b.** *The New Oil Analysis Technology had been incorporated into the AeroContractor's Nig. Ltd Aircraft Maintenance Programme; and*
- **c.** *The NCAA has reviewed the status of accomplishment of the subject Service Bulletin (SB 35342RI) on engines installed on the same aircraft type being operated by other operators (Arik Airline). The following are its findings;*
  - *i. Arik Airlines operate four (4) Dash8-Q400 aircraft in its fleet, of which three (3) are serviceable and One (1) has been grounded for a long time;*
  - *ii. Engines, S/N TM-FA0494 (5N-BKU), TM-FA0495 (5N-BKW), TM-FA1054 (5N-BKW) and TM-FA0491 (5N-BKX) have had this SB accomplished on them;*

Corporate Headquarters: Nnamdi Azikwe Int'l Airport, Domestic Wing, Abuja.
Tel: +234 (1) 7610041, +234 (1) 7610042, +234 (1) 7610043, +234 (1) 7610044, **Tel/Fax:** +234 807 729 1113.
Lagos Office: AVIATION HOUSE, Murtala Muhammed International Airport (MMIA) Domestic Wing, Ikeja.
Tel: +234 (1) 4721521 **Fax:** +234 (1) 2790421 **Consumer Protection:** +234 (1) 7607286 (24hrs): **Airworthiness:** +234 (1) 4734482;
Licencing: +234 (1) 7739972; **Operations:** +234 (1) 4714339; **Switch Board:** +234 (1) 7610036, +234 (1) 7610037.
Email: info@ncaa.gov.ng Website: www.ncaa.gov.ng

iii. *Engines, S/N TM-FA1039 (5N-BKU) and TM-FA0488 (5N-BKX) are yet to have the SB accomplished. The SB will be accomplished only during shop visit. However, it is important to state that Arik Airlines is in the process of amending the Aircraft Maintenance Programme to include the new Oil Analysis Technology Programme and implement same for these two engines.*

Appendix A: Borescope inspection report

aero

Borescope Inspection Report

aero contractors nigeria ltd.
Fixed Wing Division

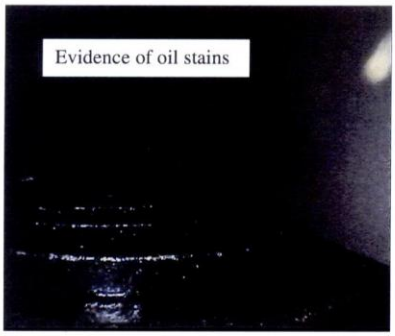
Eng Model:	PW150A	**Report No:**	
Eng S/N:	FA1054	**Manual Reference:**	72-00-00
Date :	09.03.18	**Reason for Inspection:**	SMOKE IN CABIN
Total Hours:		**Total Cycles:**	
A/C Type:	DHC8-Q400	**A/C Reg:**	5N-BKX
Position	#2	**Location**	Accra

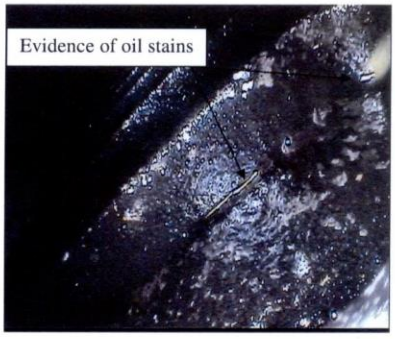
PROPELLER BLADES

Location	Ea	Findings:
		NOT INSPECTED.
In accordance with:	72-00-00	Sign & Stamp:

LPC STAGE 1 BLADES

Location	Ea	Findings:
		Evidence of oil stains found within vicinity of blades.
In Accordance with:	72-00-00	Sign & Stamp:





LPC STAGE 2 BLADES

Location	Ea	Findings:
		No visible discrepancy.
In Accordance with:	72-00-00	Sign & Stamp:

Page **1** of **5**

aero

Borescope Inspection Report

aero contractors nigeria ltd.
Fixed Wing Division

LPC STAGE 3 BLADES

Location	Ea	Findings:
		Evidence of oil stains found on blade.
In Accordance with: 72-00-00		Sign & Stamp:

HP IMPELLER

Location	Ea	Findings:
		Sign of wetness found on impeller and vicinity.
In Accordance with: 72-00-00		Sign & Stamp:

Page **2** of **5**

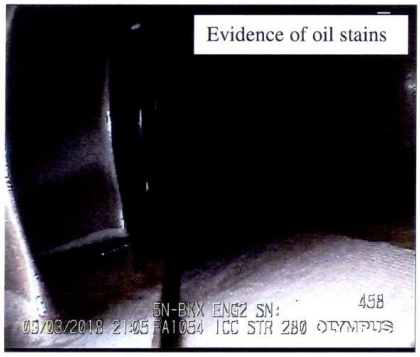
aero

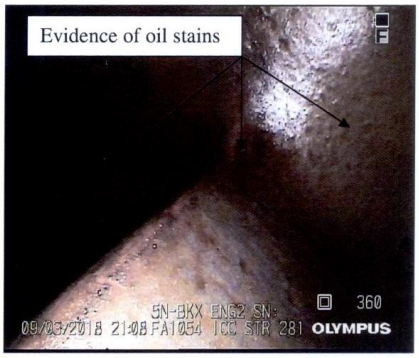
Borescope Inspection Report

aero contractors nigeria ltd.
Fixed Wing Division

INTERCOMPRESSOR CASE STRUT AND COMPRESSOR INNER SUPPORT

Location	Ea	Findings:
		Evidence of oil stains found on struts and vicinity.
In Accordance with:	72-00-00	Sign & Stamp:





aero

Borescope Inspection Report

aero contractors nigeria ltd.
Fixed Wing Division

HPT VANES

Location	Ea	Findings:
		NOT INSPECED.
In Accordance with:	72-00-00	Sign & Stamp:

COMBUSTION CHAMBER

Location	Ea	Findings:
		NOT INSPECED.
In Accordance with:	72-00-00	Sign & Stamp:

HPT BLADES

Location	Ea	Findings:
		NOT INSPECED.
In Accordance with:	72-00-00	Sign & Stamp:

LPT BLADES

Location	Ea	Findings:
		NOT INSPECED.
In Accordance with:	72-00-00	Sign & Stamp:

INTER TURBINE VANE STRUTS

Location	Ea	Findings:
		NOT INSPECED.
In Accordance with:	72-00-00	Sign & Stamp:

PT STAGE 1 BLADES

Location	Ea	Findings:
		NOT INSPECED.
In Accordance with:	72-00-00	Sign & Stamp:

aero

Borescope Inspection Report

aero contractors nigeria ltd.
Fixed Wing Division

PT STAGE 2 BLADES

Location	Ea	Findings:
		NOT INSPECED.

In Accordance with:	72-00-00	Sign & Stamp:	

Date: 09.03.18	Inspector Name:	Sign & Stamp:

The videos and pictures of the inspection are uploaded into Aero W Drive
W:\Engine_Borescope_Videos\DASH8-Q400 (THIRD PARTY)\ARIK AIR\ENG2

Station Date Stamp

Page **5** of **5**