AIRCRAFT ACCIDENT AND INCIDENT INVESTIGATION AND PREVENTION BUREAU (AIB GHANA)

REPORT ON THE FUEL INCIDENTS INVOLVING SOUTH AFRICAN AIRWAYS, A330-300 AIRCRAFT REGISTRATION ZS-SXM

14TH-15TH APRIL 2022.

AIRCRAFT INCIDENT REPORT

AIB/2022/04/14-15/INCID

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This investigation was conducted by the Aircraft Accident and Incident Investigation and Prevention Bureau (AIB Ghana) in accordance with Annex 13 to the ICAO Convention on International Civil Aviation and the Ghana Aircraft Accident and Incident Investigation and Prevention Bureau Act, 2020 (Act 1028).

The sole objective of this investigation is to prevent the occurrence of future incidents. It is not the purpose of this investigation to apportion blame or liability. Furthermore, this report should not be used to assign blame, fault or to determine liability.

NOTIFICATION OF ACCIDENT OR SERIOUS INCIDENT
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CONTENTS

GLOSSARY

AIB Ghana	-	Aircraft Accident and Incident Investigation and Prevention Bureau, Ghana
SAA	-	South African Airways
SACAA	-	South African Civil Aviation Authority
AIID	-	Accident and Incident Investigation Division of SAACA
EWS	-	Electronic Water Sensor
JIG	-	Joint Inspection group
LAT	-	Latitude
FAOR	-	R. Oliver Tambo International Airport Johannesburg
KIA	-	Kotoka International Airport Accra
lpm	-	Liters per minute
CB	-	Circuit Breaker
E&E	-	Electrical and Electronic
km	-	Kilometers
MEL	-	Minimum Equipment List
ppm	-	Parts Per Million
AMM	-	Aircraft Maintenance Manual
APU	-	Auxiliary Power Unit
MCC	-	Maintenance Control Center
OCC	-	Operational Control Center
FCMC	-	Fuel Control and Management Computer
FL	-	Flight Level
MBC	-	Microbiological Contamination
ECAM	-	Electronic Centralized Aircraft Monitor
FDC	-	Flight Deck Crew
Z	-	Zulu time or Universal Time Coordinated (UTC)

AIRCRAFT ACCIDENT AND INCIDENT INVESTIGATION AND PREVENTION BUREAU

AIRCRAFT INCIDENT REPORT NO: 002

Registered Owner and Operator:	South African Airways
Aircraft Type:	A330-300
Nationality:	South Africa
Registration:	ZS - SXM
Location of Incident:	Kotoka International Airport / En-route
Date:	14 – 15 April 2022

INTRODUCTION

Ghana's Aircraft Accident and Incident Investigation and Prevention Bureau (AIB Ghana) was initially notified by the Accident and Incident Investigation Division (AIID) of the South African Civil Aviation Authority (SACAA) on 25 April, 2022 of a serious incident involving SAA Airbus A330-300 registration ZS-SXM on 15 April 2022. (Appendix 1)

In exercise of his powers, the Commissioner of the AIB Ghana initiated an investigation into the incident to be carried out in accordance with the provisions of Aircraft Accident and Incident Investigation and Prevention Bureau Act, 2020 (Act 1028).

The Accident and Incident Investigation Division (AIID) of the South African Civil Aviation Authority (SACAA) assisted AIB Ghana in the investigation.

This report is based on the information collected on the reported contamination, interviews and other relevant information which has then been analysed by the investigators to arrive at the conclusions and safety recommendations made as appropriate. The recommendations are aimed at reducing or eliminating the probability of a repetition of the same type of occurrence, and in general, to increase the overall safety of aviation.

SYNOPSIS

During the refueling of SAA flight SA053 (A330-300 registration, ZS-SXM) in Accra (DGAA) on 14 April 2022, utilizing a PUMA Energy refueling truck (RV01), several automatic interruptions of the process were encountered.

As a final check during troubleshooting to ascertain the cause of the automatic interruptions, sump drain of the aircraft wing fuel tanks was carried out to check for the presence of water. Water was reported to be present in the tanks by the SAA engineer. The water was reported to have been drained and refueling was continued and completed from a fuel hydrant on the same Bay (D1) using a PUMA Energy hydrant dispenser vehicle (HD01).

All water tests carried out on the fuel from the refueling truck (RV01) as well as the hydrant dispenser (HD01) during the refueling process indicated the absence of water in the fuel being supplied. The protracted fueling process resulted in the delay of flight SA053, which departed DGAA on 15 April 2022 at 1508 UTC as flight SA9053.

At about 2000 UTC whilst in cruise at FL410 (approximately 5hrs after departure), the Flight Deck Crew (FDC) received an ECAM message indicating a Right-Wing Fuel Pumps Low Pressure which led to a descent to FL190 to enable gravity fuel feed as per the appropriate published procedure.

At 2018 UTC the FDC received an ECAM message indicating Engine #2 stall. The FDC reduced thrust on Engine #2 as per ECAM actions. Since there was no exceedance of engine parameters, the engine was not shutdown. The FDC increased thrust on Engine #2 twice after the initial Engine #2 stall ECAM message, and on both occasions the FDC received further ECAM messages indicating Engine #2 stall.

The flight continued to Johannesburg (FAOR) with manual thrust control and landed safely without further incidence.

The investigation identified the following causes/contributory factors to the fuel interruptions:

On Ground Incident

- Puma Energy was not the regular fuel supply contractor of SAA. Crew were briefed before the flight on the need to use an alternate fuel company. This could have influenced the crew's judgement by creating doubts about the quality of fuel delivered by the refueller RV01 during refuelling challenges.
- Repeated auto interruptions, multiple aircraft fuel system resets and satisfactory water checks performed on the fuel from the truck, created uncertainty as to the cause of the interruptions for the SAA FDC, Engineer and the Refuellers.
- The Engineer had not experienced such a multitude of fuel auto interruptions previously.
- The resultant delay in fueling and its effect on not meeting an on-time departure put undue pressure on the Engineer, FDC and the Refuelling crew.
- The initial water drained from the aircraft's fuel tanks led to a fixation on a possible water contamination from refueller RV01 even though the water checks indicated otherwise.
- The continuation of fuel drainage beyond the point at which the presence of fuel phase in the sample was observed.

In-flight Incident

- There may have been icing in the right tank pump output pressure sense lines.
- The main fuel pump low-pressure warnings may have been erroneously generated by the possible freezing of fuel pressure switches. The result would be that normally operating fuel pumps would be switched off as per the displayed Electronic Centralized Aircraft Monitor (ECAM) procedure.
- Engine no. 2 failed to respond appropriately at FL190 during fuel gravity feed procedure on the event flight.

Eight safety recommendations have been made.

1.0 FACTUAL INFORMATION

1.1 History of Flight

1.1.1 Fueling in Accra

South African Airways flight SA052 arrived in Accra (DGAA) on 14 April 2022 with 9,040kg of fuel on board (Attachment 5 of Appendix 5). The aircraft parked on Bay (D1) at 2114 UTC. A PUMA Energy Refueling truck (RV01) was used for refueling because the parking position of the aircraft did not allow access to the hydrant on the bay.

Fueling started at 2211 UTC but after pumping about 600 litres, fueling stopped abruptly. The fuel shift supervisor after troubleshooting was satisfied that there was no problem with the fueling truck. The Refueling truck (RV01) was fitted with an Electronic Water Sensor (EWS) System. According to the refuellers, the EWS warning light which was constantly monitored by them did not flash to indicate the presence of free water in the fuel supplied.

It was reported that an ECAM message "AFT TRANSFER FAULT" had been triggered and fuel quantity indications in the cockpit showed amber X (indicating a system inability to compute the fuel quantity). A water detector capsule test was conducted on a sample of fuel from the refueling truck and the result was negative (Appendix 8).

The FDC in consultation with the Engineer reset both FCMCs. Refueling started once again around 2225 UTC but after pumping an additional 1,300 litres, all fuel quantities went amber X and refueling stopped. A second reset of both FCMCs followed with the same result after pumping an additional 500 litres. Two further resets now by CBs in the E&E compartment were carried out. After each reset, refueling was resumed but stopped abruptly.

The aircraft was then down powered for 5 min, refueling was resumed with the same resultant effect. In consultation with South African Airways OCC and MCC, the aircraft was down powered a second time for 10 min. At this time, the total volume of fuel that had been pumped into the aircraft was about 6400 litres.

A new shift of refuellers took over the fueling activity at 2300 UTC and the engineer requested for another water detector capsule test to be performed on a fuel sample from the Refueller RV01. The result of the water test was again negative. The FDC and engineer after consulting the AMM and MEL, ran FCMC diagnostic tests to establish the cause(s) of the fault. Thereafter, the engineer checked the fuel quantity probes for capacitance and as part of the troubleshooting procedure drained fuel from the aircraft fuel tanks to check for the presence of water using the Airbus 330 water drain purge tool with P/N 98A28104000000 (Last page of Appendix 3).

He reported that the first few samples drained was predominantly water followed by a mixture of fuel and water. He determined the presence of water by sight, smell and viscosity based on his experience. The samples drained were transferred into a 20L container (Appendix 4) which was filled to different levels, the contents disposed of and returned to be refilled. Every time the water drain purge tool was used, the engineer checked for the presence of water and disposed of its contents into the 20L container until he believed that there was no more water in the respective fuel tank of the aircraft. He then reset the fuel panel and fueling was resumed at about 0005 UTC.

However, after pumping an additional 2600 litres, refueling was once again interrupted automatically. Fuel was drained from the aircraft's fuel tanks as before and refueling resumed. After pumping an additional 2700 litres, refueling was once again interrupted automatically. A water detector capsule test was once again conducted on a sample from the refueller and the result was once again negative.

A KLM ground technician who was invited to assist with troubleshooting also conducted a water detector capsule test on the sample from the refueller but the result was still negative. The KLM engineer then suggested the issue could be due to low

pressure from the refueller and proposed using a different truck for the fueling. (Appendix 6, page 1)

The Captain then took a decision to continue refueling from the hydrant. The aircraft was therefore repositioned on the same bay (D1) to allow access to the hydrant. A PUMA Energy Hydrant dispenser (HD01) also fitted with an Electronic Water Sensor (EWS) System was connected to the aircraft. A water detector capsule test was conducted on fuel from the hydrant dispenser and the result was again negative.

Without further drainage from the aircraft fuel tanks after the last interruption, refueling resumed at 0158 UTC. After pumping about 2000 litres the aircraft's APU automatically shut down causing refueling to stop due to the power interruption. There was one unsuccessful APU start attempt by the FDC. A ground power unit was then connected to the aircraft. The engineer drained some more fuel from the aircraft's fuel tanks as before to check for the presence of water and the result was negative. The fueling panel was reset again and fueling resumed at about 0225 UTC. Fueling continued successfully and was completed at 0300 UTC with a total volume of 31,587 litres pumped from HD01.

At the end of the refueling, the engineer drained some more fuel to confirm the absence of any residual water. The total amount of fuel uplifted for flight SA053 was 43,255 litres (11,668 litres from the fuel truck RV01 and 31,587 litres from the hydrant dispenser HD01).

The Engineer conducted the entire refueling process using the normal automatic fueling procedure.

Throughout the refueling process, the blue EWS light on the refueling trucks was constantly monitored by the refuellers. At no time (during refueling using RV01 or HD01) did the EWS warning light fitted on the trucks flash to indicate the presence of free water in the fuel supplied.

KIA CCTV footage of the activities on the Bay D1 on the night of 14/15 April, 2022, showed the 20L container being carried eleven (11) times from the right wing and three (3) times from the left wing of the aircraft and its contents disposed of, into an open drain near the perimeter wall west of Bay D1.

1.1.2 Flight SA9053, ACC- JNB

Flight SA9053 (delayed flight SA053) departed Accra (DGAA) to FAOR at 1508Z on the 15 April 2022. The FDC reported that at about 2000Z while cruising at FL410, they had an ECAM message titled "Fuel R Wing Pumps LO PR" (fuel right wing pumps low pressure). The FDC reported that "they followed ECAM actions and descended to FL190 for the Gravity feed procedure".

The FDC further reported that, "at 2018Z ECAM message ENGINE 2 STALL appeared. ECAM actions were applied and thrust was reduced. The engine was not shut down. At the lower altitude with warmer temperatures in the fuel tanks, the condition remained the same. Every time the thrust on Engine #2 was increased, there was an ECAM Stall Indication." Rolls Royce Post Flight Analysis indicates that, "the FDC increased thrust on Engine #2 twice after the initial Engine #2 stall ECAM message, and on both occasions the FDC received further ECAM messages indicating Engine #2 stall." The FDC managed thrust manually for the remaining duration of the flight and landed safely at FAOR. After landing, the "Fuel R Wing Pumps LO PR" fault light remained illuminated. The aircraft taxied to the parking bay.

No passengers or crew were injured, and the aircraft was not damaged.

1.1.3 Sources of Information:

- *Notification of the occurrence from AIID South Africa on 25 April 2022.*
- *PUMA Energy Airport Refueling Investigation Report dated 15 April 2022 and received on 26 May 2022.*
- *SAA Incident Investigation Report dated 27 May 2022.*
- *KIA CCTV footage for 14 / 15 April 2022.*

- *Interviews with PUMA Energy staff.*
- *Interviews with GACL staff.*
- *Interview with SAA engineer.*
- *Site inspection of PUMA Energy Facilities.*
- *Inspection of PUMA Energy records.*
- *Inspection of fuel disposal site.*

1.2 Injuries

Not Applicable

1.3 Damage to Aircraft

No Damage

1.4 Other Damages

Nil

1.5 Personnel Information

SAA Engineer:

- Work Experience – 7(1/2) years
- Experience on Aircraft Type (A330) – 5 years
- License expiry date – 22/01/2024

PUMA Energy Shift Supervisor 1:

- Work Experience – 4 years

PUMA Energy Shift Supervisor 2:

- Work Experience – 8 years

1.6 Aircraft Information

1.6.1 Aircraft

Type:	A330 - 300
Serial No.:	1792
Manufacturer:	Airbus
Year of Manufacture:	2017
Registration Markings:	ZS-SXM

1.6.2 Engine

Type:	Trent 700
Manufacturer:	Rolls Royce PLC
Engine Serial Number:	Not Applicable
Engine Time Since New:	Not Applicable
Fuel:	Jet A1

1.7 Meteorological Information

- Visibility: 10 km
- Temperature: 28ºC
- Relative Humidity: 84%

1.8 Aids to Navigation

Not Applicable

1.9 Communication

Not Applicable.

1.10 Aerodrome Information

Name:	Kotoka International Airport
Location Indicator (ICAO):	DGAA

1.11 Flight Recorders

Not Applicable

1.12 Wreckage and Impact Information

Not Applicable

1.13 Medical and Pathological Information

Not Applicable.

1.14 Fire

Not Applicable

1.15 Survival Aspects

Not Applicable

1.16 Test and Research

Nil

1.17 Organisational and Management Information

Not Applicable

1.18 Additional Information

1.18.1 Post Flight Maintenance Findings and Analysis by SAA Maintenance

Below are the post flight findings of the inspections, tasks and investigative analysis carried out by SAA Maintenance on the subject aircraft:

1. Samples taken from the fuel tanks revealed heavy microbiological contamination (MBC).
2. Fuel filters removed contained MBC.
3. Internal visual inspection of the aircraft fuel tanks after draining showed signs of a brown sedimentary deposit. Samples collected and analysed revealed that it was MBC. Despite the presence of the confirmed MBC, there was no evidence of any foreign material found to have clogged the fuel pumps.
4. Borescope inspection of the number 2 engine revealed no damage nor foreign objects.
5. Maintenance records reflect there was a weekly check carried out three days prior, three fuelings and three flight legs before the fuel contamination incident. During the weekly check as per maintenance requirements a fuel sump drain was carried out and no anomaly was evident.
6. On arrival in Johannesburg the tanks were sumped a few times and SAA reported that no water was found. (Appendix 17)
7. SAA reported having drained 4 to 5 litres of water from the aircraft fuel tanks two days after the event flight.

1.18.2 Rolls-Royce Plc Engine Review

Flight timeline

Taken from:

- Pilot report
- Post Flight Report (PFR)
- R06 exceedance reports
- QAR data

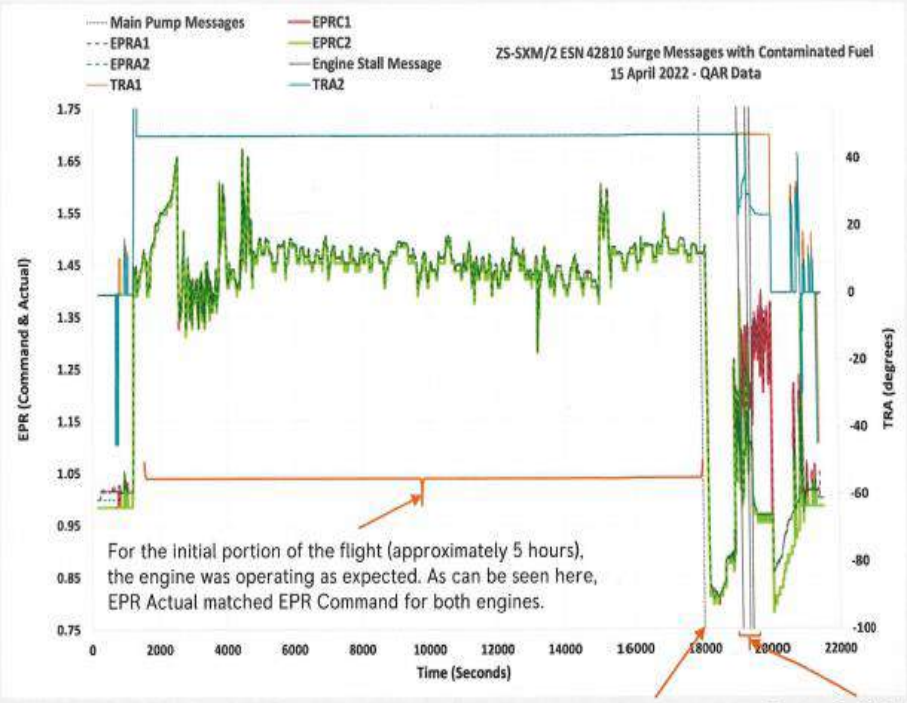
Time (UTC)	Data from PFR/QAR/Pilot Report	Description
15:20	Flight departed from Accra	
20:00	[FUEL AFT XFR FAULT]	Aircraft fuel system advisory
20:00	[FUEL MAIN PUMP 2 (122QA2)]	Main fuel pump system malfunction with aircraft right fuel pump 2
20:00	[FUEL R WING PUMPS LO PR]	All fuel pump systems malfunctioning on right wing
20:03	Aircraft began descending in order to utilise gravity feed	
20:14	Aircraft levelled off at FL200	
20:17	[FUEL PUMP (E2-5050EB) / FUEL LP SW (E2-4075KS)]	Low fuel pressure indication on Engine 2
20:18	[ENG 2 STALL] and R06 Exceedance report: REASON, SURGE	Engine 2 stall/surge message
20:19	Throttle angle reduced from 47deg to 23deg	
20:22	Throttle angle increased to 47deg	
20:22	R06 Exceedance report: REASON, SURGE	Engine 2 stall/surge message
20:22	Throttle angle reduced to 29deg	
20:24	R06 Exceedance report: REASON, SURGE	Engine 2 stall/surge message
20:25	Throttle angle reduced to 23deg	
20:34	Aircraft began final descent	
20:49	Aircraft landed at Johannesburg	

These events will be the main focus of this presentation

EPR Actual v EPR Command – Full Flight

EPR – Engine Pressure Ratio.

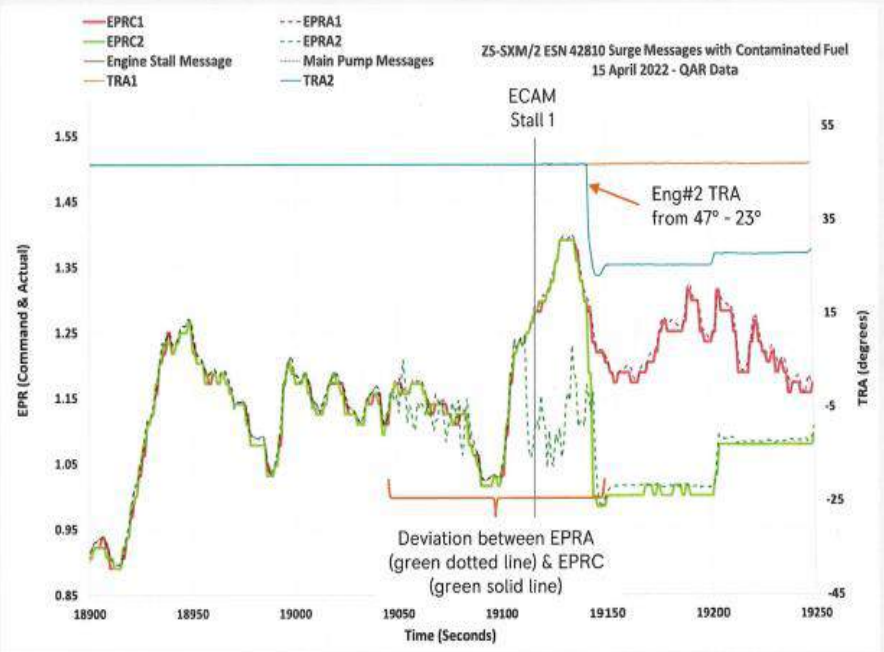
The ratio between intake pressure and LPT exit pressure (P50/P20) and is indicative of engine thrust.



EPR Actual v EPR Command – 1st Stall Warning

EPR – Engine Pressure Ratio.

The ratio between intake pressure and LPT exit pressure (P50/P20) and is indicative of engine thrust.

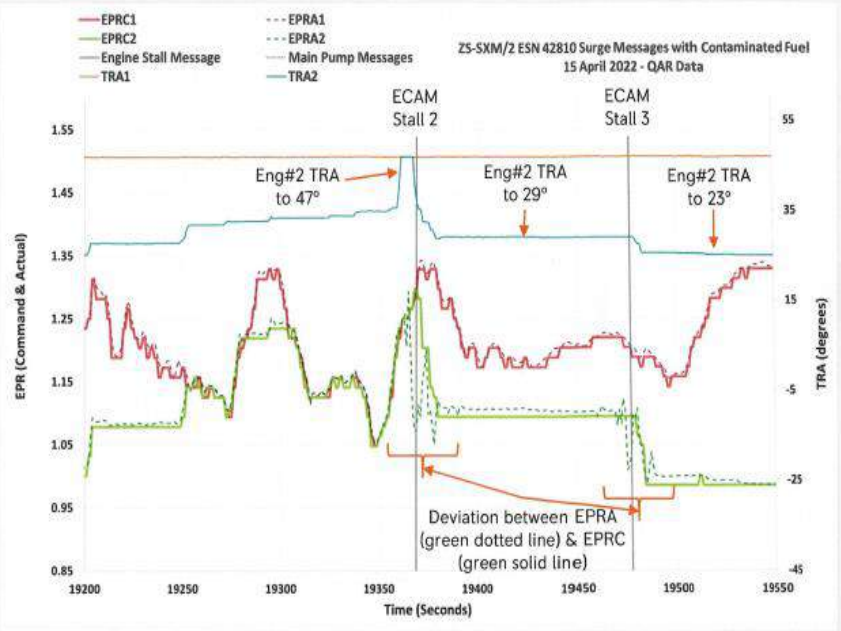


Approximately 3 minutes after levelling off at FL200, EPR Actual starts to deviate from EPR Command. This continues until the throttle is reduced from 47° to 23°, The first ECAM Stall warning occurred within this period.

EPR Actual v EPR Command – 2nd & 3rd Stall Warnings

EPR – Engine Pressure Ratio.

The ratio between intake pressure and LPT exit pressure (P50/P20) and is indicative of engine thrust.

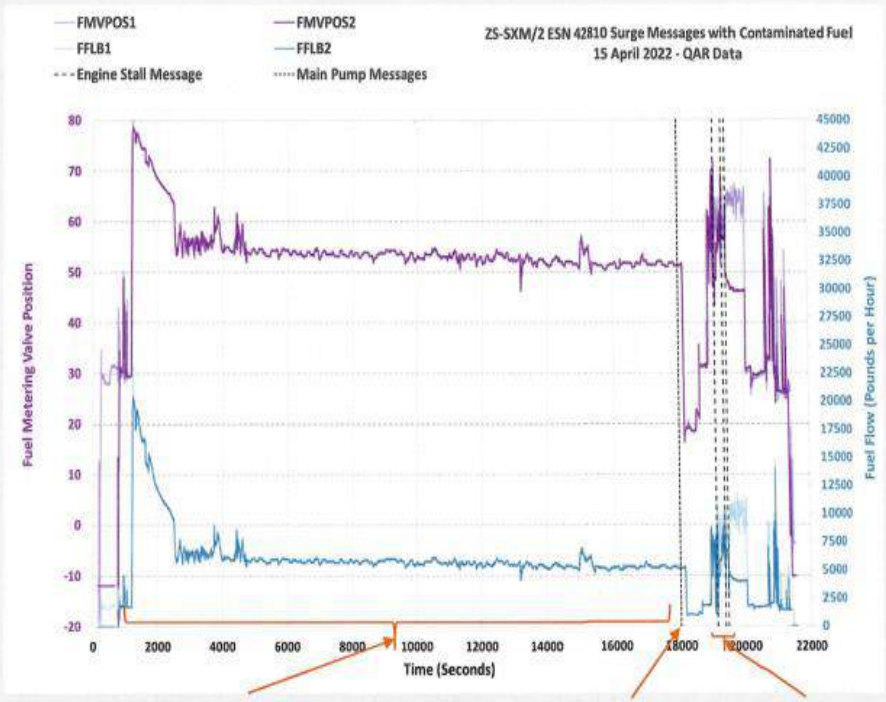


Approximately 4 minutes after the first Stall Warning, the throttle is advanced back to 47° and EPR Actual again starts to deviate from EPR Command. This continues until the throttle is reduced to 29° but deviation can again be seen to occur approximately 2 minutes later. These deviations coincide with ECAM Stall Warnings 2 and 3. The throttle is then retarded to 23°, and EPRA can be seen to match EPRC once again.

FMVPOS & FFLB – whole flight

FMVPOS - Fuel Metering Valve Position

FFLB – Fuel Flow (pounds / hour)



Similarly to EPR, FMVPOS and FFLB behave as expected for the initial portion of the flight. Although not a 1:1 ratio, the trends of FMVPOS and FFLB should be similar, as the Fuel Flow should be proportional to the position of the Fuel Metering Valve.

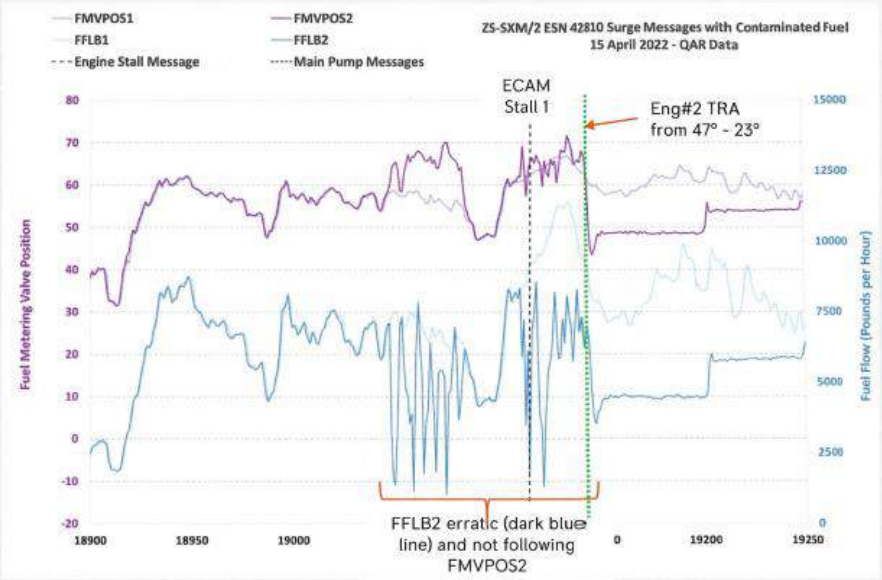
Fuel Main Pump 2 ECAM warning

Engine Stall ECAM warnings (see slides 8 & 9 for details)

FMVPOS & FFLB – 1st Stall Warning

FMVPOS - Fuel Metering Valve Position

FFLB – Fuel Flow (pounds / hour)

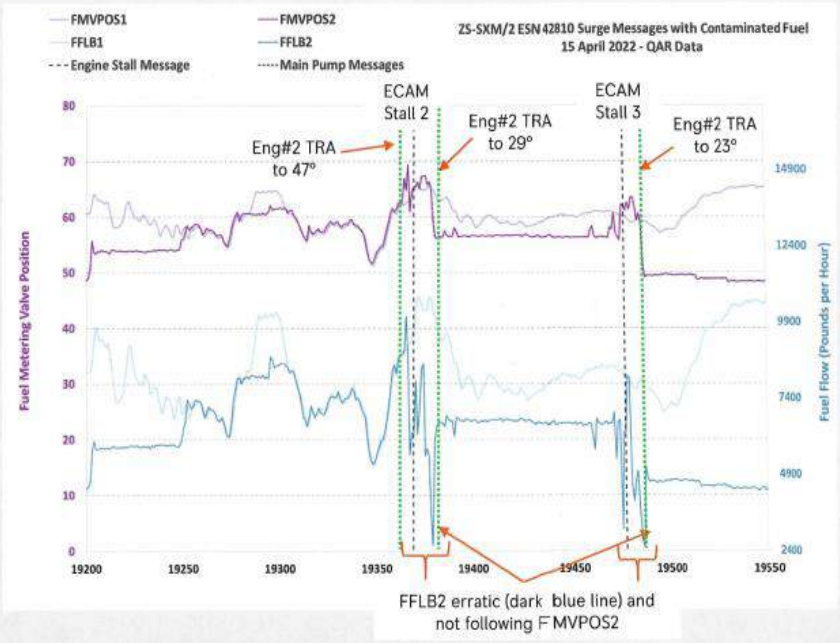


At the same time that EPR Actual starts to deviate from EPR Command, the Fuel Flow becomes erratic and stops following the trend of FMVPOS. FMVPOS can be seen increasing as the engine tries to get more fuel to achieve EPRC. Similarly to EPR, this continues until the throttle is reduced from 47° to 23°. The first ECAM Stall warning occurred within this period.

FMVPOS & FFLB – 2nd & 3rd Stall Warnings

FMVPOS - Fuel Metering Valve Position

FFLB – Fuel Flow (pounds / hour)

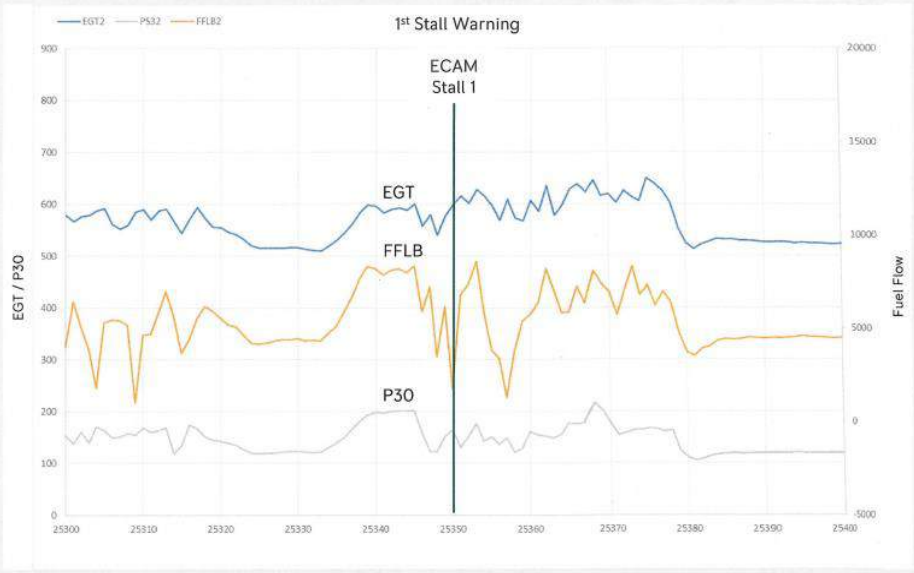


The trends shown on slide 8 are repeated for the second and third Stall Warnings, where Fuel Flow becomes erratic and deviates from the trend of FMVPOS until the throttle is retarded.

P30 / EGT / FFLB

A Stall/Surge would be indicated by a rise in EGT with a drop in P30 & fuel flow

The data from this event does not follow this trend.



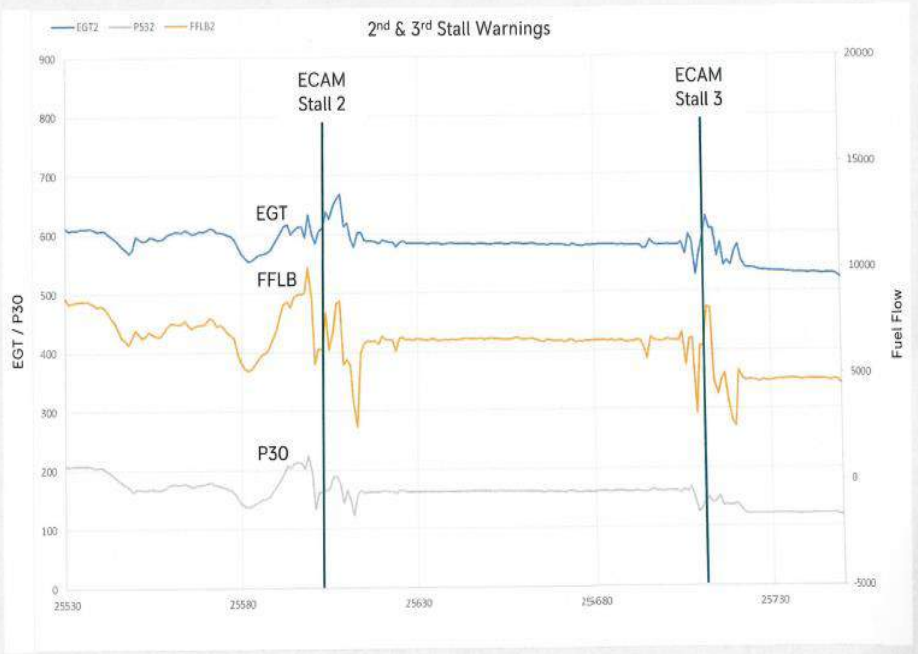
Review of the engine data for the first Stall Warning could not confirm if the engine stalled or if the Surge/Stall Detection Logic was triggered erroneously due to the highly dynamic and abnormal fuel flow experienced during the event (see slide 12 for details of the Surge/Stall Detection Logic).

Note: time stamp is different to charts of EPR & Fuel Flow

P30 / EGT / FFLB

A Stall/Surge would be indicated by a rise in EGT with a drop in P30 & fuel flow

The data from this event does not follow this trend.



Review of the engine data for the second and third Stall Warnings could also not confirm the presence of surge/stall.

Note: time stamp is different to charts of EPR & Fuel Flow

ECAM Stall/Surge Warnings

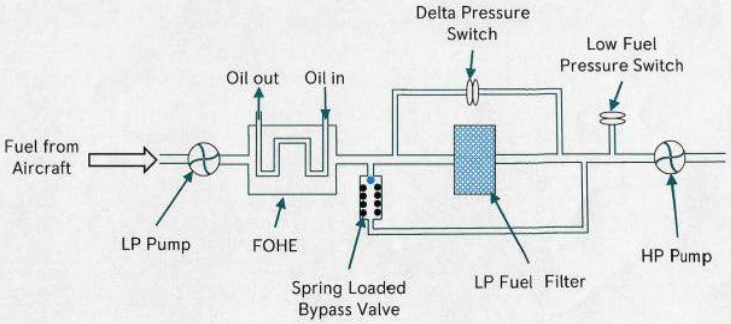
Surge detection logic

- The surge detection logic is a P30dot Vs. P30/P20 threshold on the Trent 700
- There is a bias applied on P30 and P30dot which is factored by the rate of change of fuel flow. This is to take transient manoeuvres into account and shift the above threshold in a way that there is more detection margin during a fuel flow reduction than during a fuel flow increase
- Based on how the biases are set it needs less change of P30 to trigger when rate of change of fuel flow is positive high
- Whole Engine System analysis concluded sudden change in fuel flow such as that observed in the event flight, could cause compressor surge, but this can not be confirmed.

Engine LP Fuel System

Engine LP Fuel System

- Fuel is fed from the aircraft to the engine Low Pressure (LP) fuel pump.
- From here it passes through the Fuel Oil Heat Exchanger (FOHE) before reaching the LP fuel filter.
- The LP fuel filter has a spring loaded bypass valve to enable continuous fuel flow if the filter were to become blocked.
- A pressure sensor reads the pressure across the LP filter and triggers a cockpit and Post Flight Report (PFR) message to indicate an impending bypass (this is in advance of the filter going into bypass in order to provide maintenance crew the opportunity to replace the filter prior to bypass).
- There is a Low Fuel Pressure Sensor downstream of the LP filter prior to the High Pressure fuel pump.



Summary and Conclusion

Summary

- All engine parameters were within expectations until shortly after gravity feed was initiated.
- From this point, engine #2 was trying to achieve thrust but was unable to at higher throttle angles (EPR Actual could not achieve EPR Command).
  - The Fuel Metering Valve can be seen opening in order to try and achieve the commanded EPR, but fuel flow did not match.
- Fuel Flow was erratic at the point of surge warning, spiking between ~1500lbs/hr and ~8000lbs/hr during the first surge warning.
- It is not clear if the engine actually surged, or if the surge detection logic was triggered due to the abnormal conditions.
- No evidence of LP fuel filter blockage – there was no impending filter bypass message in the PFR and no filter bypass was reported by the operator.

Conclusion

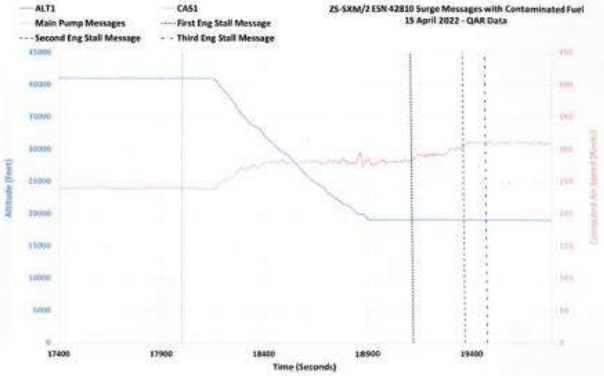
- Engine was unable to provide required thrust due to fuel starvation.

1.18.3 Airbus Post Flight Report (PFR) Analysis

Airbus Amber

PFR ANALYSIS

- 19:33 - Fuel Right Inner Collector Cell Temp Sensor Fault
- 2 20:00 – Fuel Aft XFR Fault
- 1 20:00 - Fuel Main Pump 2 LO PR
- 3 **20:00 - Right Wing Pumps LO PR**
- 20:17 - Low pressure on Engine 2
- **20:18 - Engine Stall**
- 20:22 & 20:24 - Further Engine Stalls



- After the low pressure detected on Fuel Main Pump 2 and then on the 3 pumps, the gravity feed procedure was applied following the applicable FCOM Abnormal Procedure. A/C descent was initiated from FL410 to FL200.
- First Eng Stall message triggered shortly after reaching FL200 and starting the gravity feed.

15

AIRBUS

Airbus Amber

PFR

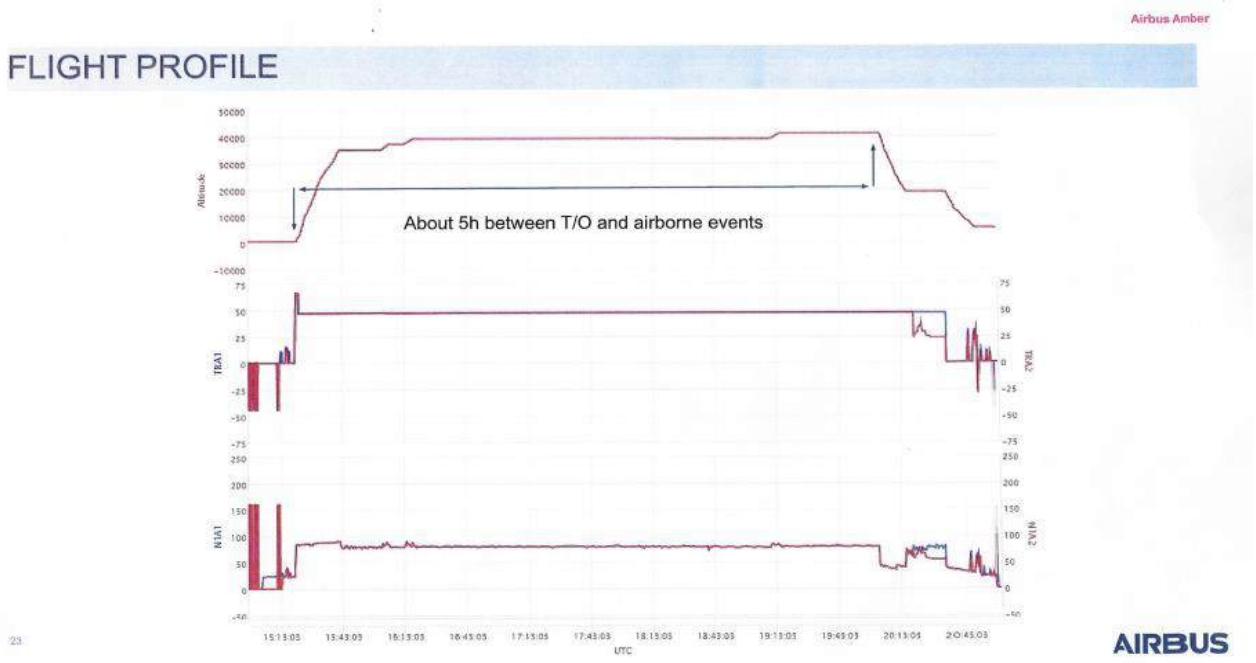
Title: Flight Details

Leg	-99	Flight Number	SA9053	A/C ID	ZS-SXM
From	ACC	First Event Date	15 Apr 22 - 15:08		
To	JNB	Last Event Date	15 Apr 22 - 20:59		

Fault Tracking	Phase	Date Time	ATA	Source	Title	Class	Occurrence History	Priority	Work	Note
	06-CRUISE	15 Apr 22 - 19:33	284915	FCMC1	[FUEL INR TK TEMP SNSR (2QR2)]	1	 x			
					[null]					
	06-CRUISE	15 Apr 22 - 20:00	2827		[FUEL AFT XFR FAULT]		 x			
					[null]					
	06-CRUISE	15 Apr 22 - 20:00	282151	FCMC1	[FUEL MAIN PUMP2 (122QA2)]	1	 x			
	06-CRUISE	15 Apr 22 - 20:00	2821		[FUEL R WING PUMPS LO PR]		 x	High		
					[null]					
	06-CRUISE	15 Apr 22 - 20:17	731241	EEC2A	[FUEL PUMP (E2-5050EB) / FUEL LP SW (E2-4075KS)]	2	..... x2			
	06-CRUISE	15 Apr 22 - 20:17	7321		[MAINTENANCE STATUS EEC 2A]		 x			
	06-CRUISE	15 Apr 22 - 20:17	7321		[MAINTENANCE STATUS EEC 2B]		..... x2			
					[null]					
OCCURRENCE	06-CRUISE	15 Apr 22 - 20:18	7100		[ENG 2 STALL]		..... x2			
OCCURRENCE	06-CRUISE	15 Apr 22 - 20:18	710003	EEC2A	[PROPULSION SYSTEM]	1	..... x3			
					[null]					
	06-CRUISE	15 Apr 22 - 20:44	284221	FCMC2	[FUEL INR TK COMP1(39QT1)]	1	..... x2			
					[null]					

22

AIRBUS



1.18.4 Fuel Contamination

Major contaminants of aviation fuel include solid particles (dirt), water and microbiological growth.

Solid contaminant

Solid contaminants include particulate matter from 1 gm dust to coarse grains and flakes; rust, sand, paint flakes and wear debris. The sources are mainly from catalysts from manufacturing processes, loss of material from the surface of tanks and pipelines, detergent action of additives on surfaces, engineering work in the distribution system, and ingress through an open inspection hatch. The effects (dependent on material type) include filter blockage, fuel degradation and engine wear.

Water

The hygroscopic nature of jet fuel refers to its ability to attract moisture from the air and surroundings. Water can be present in fuel in three forms: dissolved, suspended and/ free water. Several different sources contribute to the presence of water in aviation fuel.

Dissolved water

Dissolved water is invisible to the naked eye, and is considered a constituent of jet fuel that vaporises during combustion. Up to 100 ppm of water is soluble at 40 ^{0}C. Water becomes "undissolved" from fuel as the mixture is cooled at about 2 ppm per 1 ^{o}c. Fuel loaded at 10 ^{o}c and an aircraft flying at altitude with fuel at -40 ^{o} c will precipitate about 10 litres for every 100,000 litres of fuel. Dissolved water can only be detected by chemical water detectors such as "Shell water detector".

Suspended water

Suspended water appears as large droplets which are visible however, small droplets have dull, hazy, or cloudy appearance that takes time to coalesce or settle down in the fuel.

Free water

Water is sparingly miscible with hydrocarbon fuel and since water is denser than fuel, any free water within the fuel forms a lower layer separated from the jet fuel upper layer. Given sufficient time, suspended free water will settle under gravity. Surfactants reduce ability to settle by reducing water droplet size. Up to 30 ppm of dissolved water can be permitted at delivery into plane by IATA. The two methods of chemical detection that are commonly used are Velcon Hydrokit and Shell Water detector, which detects down to about 10 ppm.

Water in aircraft fuel tanks

Aircraft tanks will probably contain free water, from the fuel previously loaded, this may be in the form of ice crystals or lumps of ice. Fuel will release dissolved water in flight because of the following:

- Cooling effect of high-altitude low temperature flight; and
- Some dissolved water settles during climb-out & flight but vents also ingest air and thus water vapour.

Aircrafts are designed to cope with some water & ice, but extent to which they can do so varies a lot with aircraft size - bigger aircraft fly longer and create more water & ice but have more sophisticated 'management' systems. Water in fine suspension can form ice crystals and block filters.

Microbiological growths

Microbiological contamination of fuels can cause operational problems, such as corrosion of metallic structures, fuel quantity indication problems, and blocking of the scavenge systems and fuel filters during flight. There are a number of signs that will indicate that fuel tanks are contaminated such as evidence of contamination of fuel filters, discoloration of sump sample, blocking of fuel injectors, erratic/inaccurate fuel level readings. For example, erratic behavior of the fuel quantity gauging system can be a sign of microbiological contamination, as most gauging systems are capacitance based and the micro-organisms have a different capacitance than fuel.

A number of different types and species of microorganisms can cause microbiological contamination of fuel. There are three basic categories: bacteria, moulds, and fungus. All these organisms are present in the environment and therefore can easily access the whole fuel supply chain.

Micro-organisms grow at the fuel/water interface and on internal tank surfaces. Turbulence in the fuel tank will cause the micro-organisms to become suspended and results in contamination of the fuel phase. Water is always present in the fuel tank and can be introduced in the following ways:

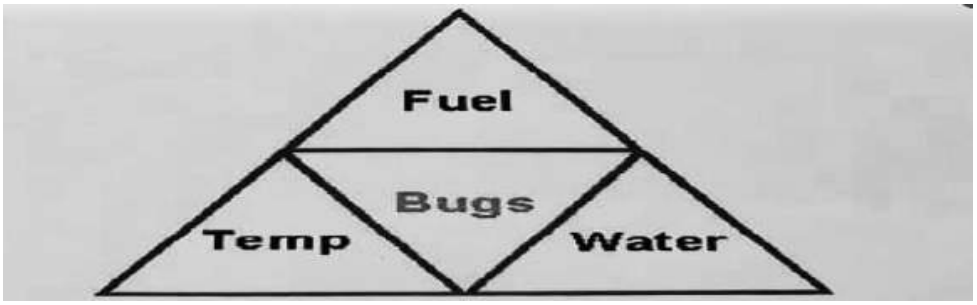
i. Changes in relative humidity.
ii. Changes in temperature which causes dissolved water to become free water.

iii. Failure of the fuel handling procedures. As water collects inside the fuel tank, the possible risk of microbiological growth can increase exponentially. This is why routine water removal (e.g., sumping) is a key factor in the control of microbiological growth. Most modern aircraft are fitted with water scavenging systems to remove water from the aircraft fuel tanks continuously; when these systems fail to operate correctly, then a build-up of water will occur.

Micro-organisms tend to grow at the fuel/water interface in the fuel tanks. However, growth can also take place in other areas such as on the vertical surfaces of the fuel tank and on the convex shapes such as tubes and areas where water condensate forms. If the tanks are wet with fuel, the contamination can appear as a smooth, slimy, transparent to dark coloured gel. When the tanks are dry, the contamination usually appears as a dark solid material on the tank surfaces but can also be present in a variety of colours. Microbiological contamination can cause the tank protective primer coating to appear stained. Microbiological growth may sometimes be associated with a foul, unpleasant odour.

Factors Affecting Growth

Fuel systems are an ideal environment for micro-organisms. Bacteria yeast and fungi need three things to live, food (provided by the fuels hydrocarbons), water (microbes live in water), and a warm environment. All of which are present in aviation fuel systems. The picture below illustrates the relation between these factors and the micro-organisms.



i. **Water**

Since water is essential for microbiological growth, accumulation of water in the tank stimulates microbiological contamination.

ii. Temperature

The optimum temperature for most microbiological growth is 20 to 35°C. Higher temperatures, however, may favour other micro-organisms. Most micro-organisms will grow at temperatures below 20°C but more slowly.

iii. Aircraft design

Microbiological growth is enhanced in:

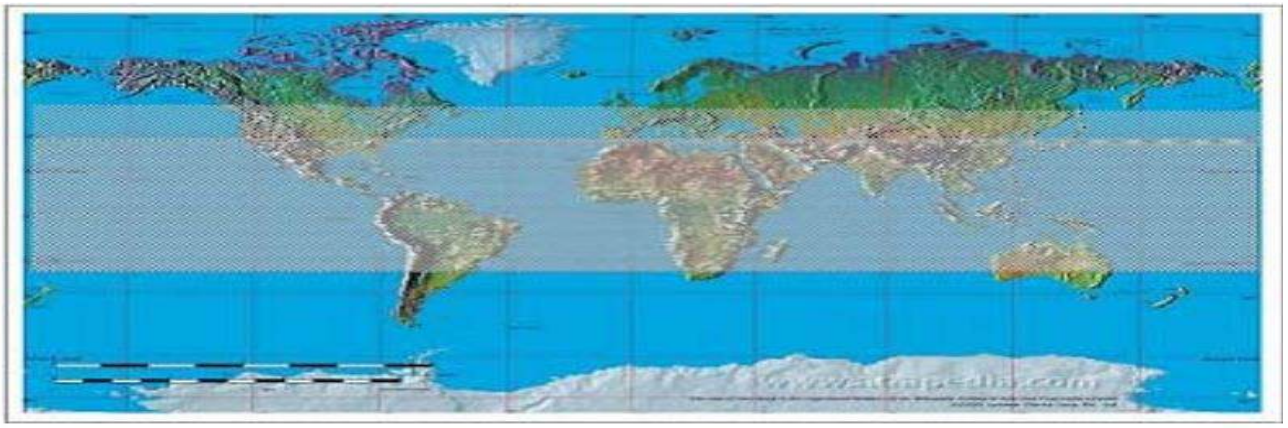
- undrainable water/fuel tanks;
- warm inboard tanks/trim tanks.

iv. Flight Operations

Microbiological spoilage is more likely in aircraft:

- operating transoceanic flights;
- operating at low altitude.
- in warm climates
- low utilisation.
- fuel tanks which are underutilised.
- aircraft parked or in storage.
- uplifting suspect fuel.

The incidence of contamination problems in aircraft is very much influenced by the climate in which the aircraft operates in conjunction with the efficacy of water draining procedures applied by aircraft operators. The area between LAT 30° South and LAT 30° North is considered a high-risk area for operations. In effect since most microorganisms need free water to grow, microbial growth in fuel tanks are most commonly found where water is present.



Areas which are at higher risk of developing microbiological contamination.

Refueling

A Visual Check and water contamination test for the fuel shall be performed before refueling an Aircraft. However, with the consent of the aircraft engineer or representative supervising the refueling operation, water contamination test may be done after 1000 litres has been displaced. After the fuel contained in the vehicle delivery pipework and filter vessel has been displaced (typically 1,000 litres), a 1-litre sample shall be taken downstream (outlet side) of the filter for an Appearance (or Visual) Check. If water is found in the sample, a second sample shall be drawn immediately.

Shell Water Detector Capsules

The Shell Water Detector capsule is the standard industry test for monitoring the level of free or dispersed water in Jet Fuel. It is used in conjunction with a syringe, which draws a 5ml of the fuel through the capsule. If the paper inside the capsule does not change from yellow to green it means that the fuel contains less than the IATA recommended limit of 30ppm water content, and the test is classified a Pass. A strong green colour means that the fuel contains more than 30ppm of water and the test is classified Fail.

What must be done when contamination is suspected/detected?

1. Perform clear and bright test
2. Perform water test
3. If 1 and 2 is positive then, quarantine, investigate and decontaminate/dispose. Ensure no significant contamination gets passed

to aircraft. Finally, report as incident/accident and investigate mitigation to avoid re-occurrence.

Impact on Operations

- Operational disruptions.
- Unscheduled grounding for decontamination and other related issues.
- Increased fuel uplift due to fuel gauging fluctuations.

  In case of contamination, the decontamination and process require defueling and refueling to full with biocide.

References:

- *IATA Guidance Material on Microbiological Contamination in Aircraft Fuel Tanks, edition 4.*
- *Airbus In-Service Information on Microbiological Contamination in Fuel Tanks, Ref. no 28.11.00002. Issue date: 13th September 2021*
- *Aviation Fuel Quality Control and Operating Standards for Into-Plane Fuelling Services (JIG 1) Issue 12, January 2016*
- *Fuel and fuel system microbiology, fundamentals, diagnosis, and contamination control. Frederick J. Passman, editor. ASTM manual*
- *Microbial Contamination and Associated Corrosion in Fuels, During Storage, Distribution and Use. Edward C. Hill and Graham C. Hill*
- *www.aljac.com/pdfs/fuel_testing_consumables.pdf*

1.18.5 Electronic Water Sensor System

All Puma Energy refueling trucks and hydrant dispensers at KIA including RV01 and HD01 are equipped with the EWS system which detects the presence of water in the fuel supply.

The Electronic Water Sensor (EWS) system provides the assurance to refueling operators and airlines that the fuel delivered into aircraft is monitored and prevents water from reaching the aircraft by triggering a Deadman* shutdown. The EWS is used in conjunction with Dirt Defense Filtration (DDF) technology and includes the following components:

- An EWS fitted downstream of filtration.

- A compatible controller
- A sensor warning light (blue)

These systems are connected to the Deadman system to ensure automatic fuel shutdown, under the conditions specified below:

- The EWS measures a free water concentration of 30ppm to 50ppm for more than 10 seconds or
- Free water concentration greater than 50ppm for more than 5 seconds.

EWS Warning Light

The EWS warning light is blue in colour unless local airport regulations require a different colour. The EWS light is permanently displayed on the fueling vehicle exterior, enabling a clear unobstructed view for the fueling operator at all times during fueling, in all-weather/light conditions. The EWS warning light is configured as follows:

- Standby Mode: Before fuel flow commences, the light flashes intermittently in cycles (on and off twice in 0.5seconds and remains off for 2.5seconds and then the cycle repeats).
- Fueling Mode: When fuel flow commences, the light constantly illuminates indicating that the system is operational.
- Check Level: A sensor indication between 15ppm and 30ppm of free water for at least 10 secs will trigger slow flashing of the light to prompt the operator to stop the fueling.
- Alarm Level: A sensor indication greater than 30ppm of free water for at least 10secs or greater than 50ppm of free water for at least 5 seconds will trigger faster flashing of the light and shall automatically shut down the fueling.
- Refueling procedure requires that the blue light be monitored at all times during the refueling process.

Deadman Switch: A Deadman switch is a switch that is automatically operated in case the human operator becomes incapacitated, such as through death or loss of consciousness.

Reference*: Joint Inspection Group (JIG)*

1.18.6 Airbus Fueling System

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S

Fuel is stored in the:

- Wings
- Centre section
- Trimmable Horizontal Stabilizer (THS).

DESCRIPTION

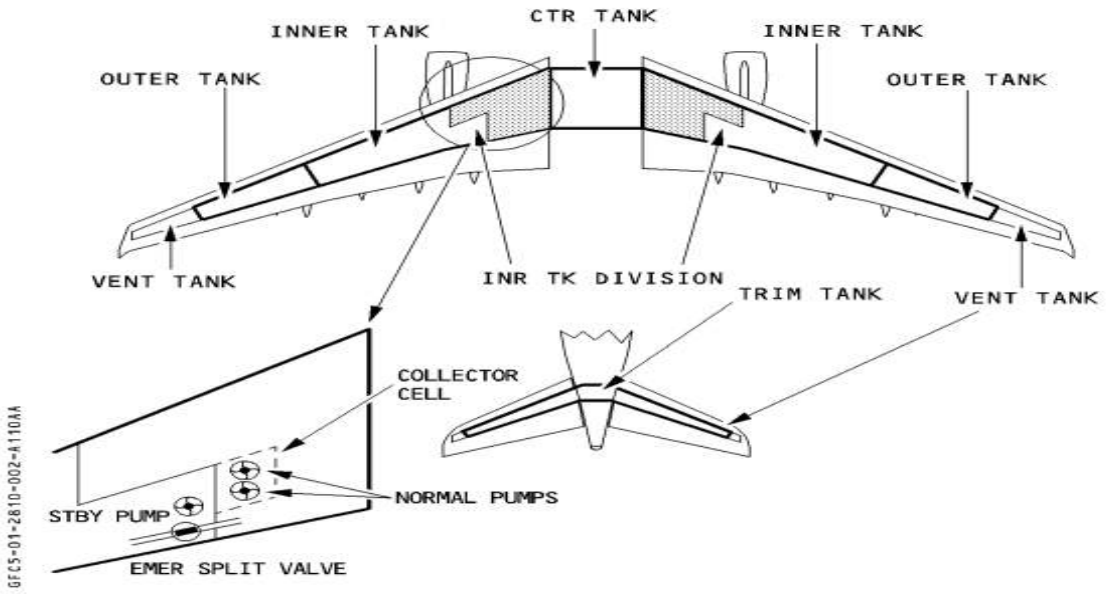
The wings have inner and outer tanks. Each inner tank contains one collector cell that:

- Maintains a fuel reservoir for the fuel booster pumps and provide negative 'g' protection to feed the engines.
- Is maintained full and contains about 1000 kg (2200 lbs) of fuel.

Each inner tank is divided into two parts via a SPLIT valve that normally remains open. The inner tank is used as a single tank and, if tank damage is suspected (i.e. FQI data is lost or there is a rapid FQI decrease following an engine failure), the SPLIT valve can be manually closed by using the dedicated pushbutton on the overhead panel.

In each wing, and on the right of the THS trim tank, there is a vent surge tank outboard of the outer tank. After refueling to maximum tank capacity, fuel can expand by 2% (20º temperature increase) without spillage. There is an overpressure protector in each wing surge tank, in the trim surge tank, and between the center and the right inner tanks

TANK ARRANGEMENT



FUEL CONTROL AND MONITORING SYSTEM (FCMS)

GENERAL

The fuel system is controlled by two Fuel Control and Monitoring Computers (FCMC). The FCMCs:

- Measure the fuel quantity and indicate it on the ECAM.
- Calculate the aircraft's Gross Weight and Center of gravity, based on the Zero Fuel Weight and the CG entered by the crew.
- Control transfer of fuel to the inner tanks for engine feed.
- Control transfer of fuel to and from the trim tank for CG control.

  Magnetic level indicators are fitted in the lower surfaces of the center and wing tanks to allow the manual measurement of each tank's fuel quantity.

FUEL QUANTITY INDICATION AND LEVEL SENSING

FUEL QUANTITY INDICATION

One FCMC is active and the other is on standby. If the first FCMC fails, then the other FCMC takes over. Each FCMC calculates the fuel quantity by using the:

- Fuel volume from the fuel probes.

- Fuel density from the densitometers.
- Horizontal Stabilizer angle.
- Aircraft attitude.
- Fuel electrical characteristic from the compensators

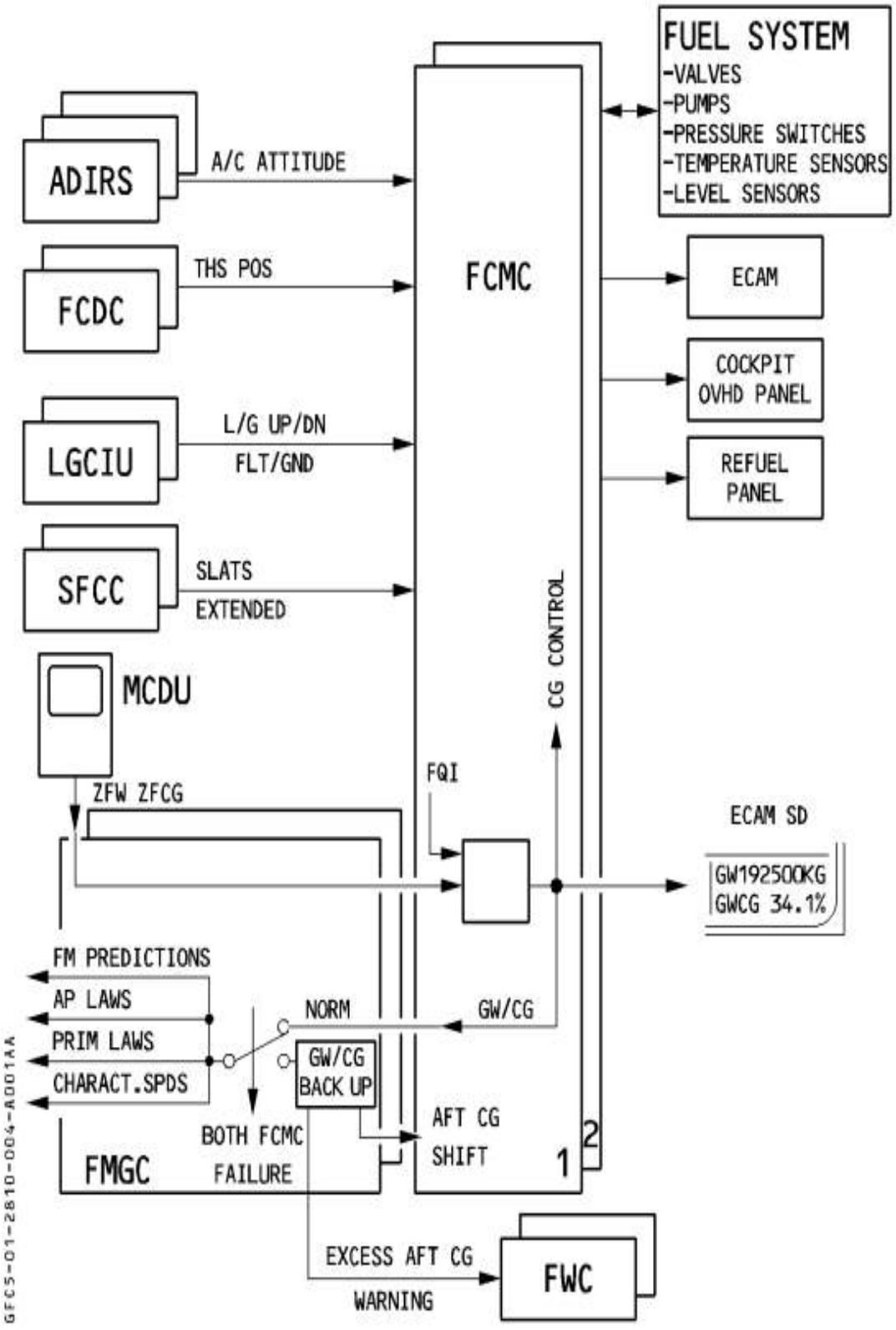
The calculated fuel quantity is indicated on both the ECAM and the refuel control panel.

FUEL LEVEL SENSING

The FCMC also uses information from the following fuel level sensors to control transfers and to provide warnings, independently of the fuel quantity indication:

- Low level sensors:
  - To trigger low level warnings and stop jettison.
  - To control center and trim tank transfers.
- High level sensors: To stop refueling when a tank is full.
- Vent surge tank level sensor: To stop refueling, or fuel transfer, in case of tank overflow.

ARCHITECTURE



ENGIN E FEED

GENERAL

The main fuel pump system supplies fuel from the inner tanks to the engines. In each wing there are three fuel pumps. Two main fuel pumps in the collector cell and one standby pump outside the collector cell. When closed, the cross-feed valve separates the system into two parts, and their associated fuel pumps supply the engines. When open, the cross-feed valve allows any pump to supply any engine.

MAIN COMPONENTS

INNER TANK PUMPS

During normal operation all main pumps run. If a main pump fails, or is switched off, then the standby pump runs. With the cross-feed valve opens, one pump is capable of supplying both engines.

CROSSFEED VALVE

The cross-feed valve enables any pump to supply any engine. The X-FEED valve automatically opens in electrical emergency configuration.

ENGINE LP VALVE

The flow of fuel to an engine can be stopped by closing its respective low pressure (LP) valve via the:

- Engine master switch, or the
- ENG FIRE pushbutton.

NORMAL OPERATION

Fuel is always fed to the engines from the inner tanks.

The fuel transfer sequence is as follows:

1. Centre tank fuel transfers to the inner tanks.
2. Each inner tank empties down to 4000 kg (8830 lbs).
3. Trim tank fuel transfers to the inner tanks.
4. Each inner tank empties down to 3500 kg (7720 lbs).
5. Outer tank fuel transfers to the inner tanks.

Note: If required for CG control, the trim tank may be emptied earlier (refer to CG control).

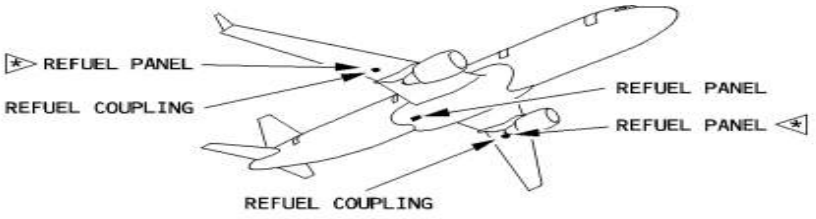
REFUELING - DEFUELING

Two refuel couplings are installed under the wings. These couplings allow refueling from both the right and left sides of the aircraft.

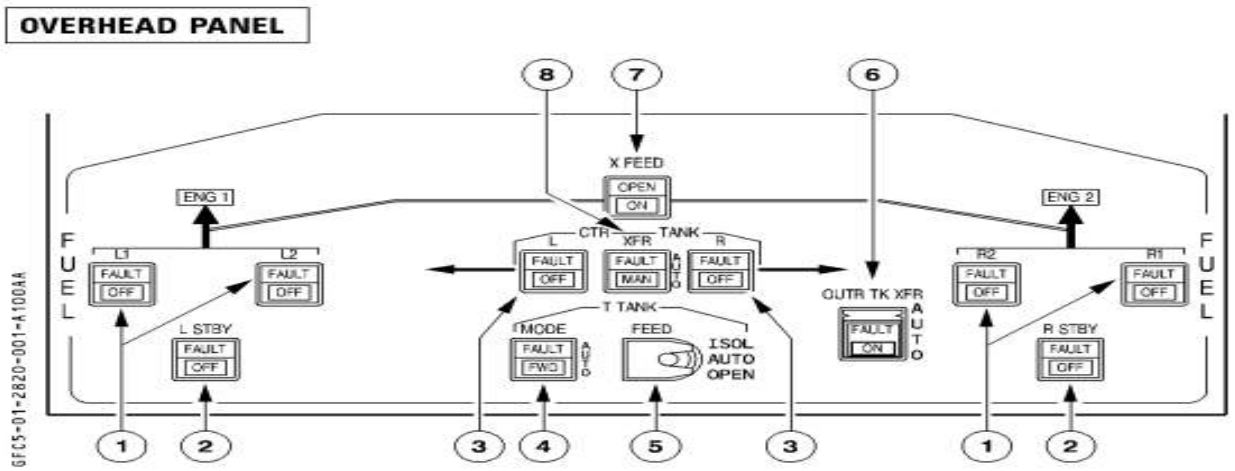
A refuel panel is located on the fuselage side, beneath the right wing.

A second and/or third panel is installed close to the refuel couplings.

A gallery connects the refueling coupling to the fuel inlet valve of each tank



From the cockpit, refueling can be controlled with the refuel pushbutton. Although manual control is possible, it is normally automatic when the required fuel load is set on the preselector. In addition, it is possible to refuel by battery power only. Any tanks that require refueling start to be refueled simultaneously. Refuel valves automatically close either when the required quantity is reached, or when high level is detected. Wing tank gravity refueling is achieved via over wing refueling points. If the FCMC is powered, transfer is possible from any tank (with inner or centre pumps) to outer, inner or centre tanks. When both side couplings are used, refueling time at nominal pressure (50 psi) is approximately 33 minutes for all tanks.



Source: Smart cockpit A330-300 (Fuel)

1.18.7 Airbus Post Event Safety Actions

1.18.7.1 Operators Information Transmission - OIT

CUSTOMER SERVICES DIRECTORATE
2 ROND POINT EMILE DEWOITINE
31700 BLAGNAC FRANCE
TELEPHONE + 33 (0)5 61 93 33 33

AIRBUS

OPERATORS INFORMATION TRANSMISSION - OIT

SUBJECT: ATA 28 – Fuel shortage and associated fuel quality risks

AIRCRAFT TYPE: A300, A300-600, A310, A318, A319, A320, A321, A330, A340, A350, A380, AST

OUR REF.: 999.0044/22 Rev 00 dated 02-JUN-2022

OIT CATEGORY: **Advice**

NOTICE: This OIT provides recommendations on Maintenance and Engineering issues/information. It is left to each Operator's discretion whether to distribute this OIT, or to distribute the information contained in this OIT, to all of their applicable Maintenance and Engineering organizations for information or application of the recommendation.

REFERENCED DOCUMENTS:

Ref. 1: Consumable Material List CML 01ABA1 dated May 2022
Ref. 2: ISI 28.11.0002 MICROBIOLOGICAL CONTAMINATION IN FUEL TANKS dated May 2022

1. PURPOSE

This OIT is dedicated to inform operators of the increasing risk of fuel supply shortage across the globe. This is considered to represent a risk of degraded fuel quality to be uplifted to the aircraft with a potential impact for the Airframe & the Systems which includes but may not be limited to, the Fuel Quantity Indication System (FQIS) and the Engines and Auxiliary Power Unit (APU). By the present OIT, Airbus would like to raise awareness of the above and remind some best practices for fuel handling and quality control.

2. BACKGROUND

Airbus has been made aware of several operators having faced difficulties to refuel the aircraft with reports of multiple refuel interruptions, FQI faults, filter clog alerts and/or APU/Engine malfunction. For the majority of these events, a significant volume of water (several hundreds of litres) was drained out of the fuel tanks and a visual check of the fuel sampling revealed the fuel was not clear and bright as normally expected. Together with these observations, Engines and/or APU uncommanded shutdowns or impossibility to start and eventually loss of FQI have been reported with the aircraft on the ground.

Considering the volume of water removed from the fuel tanks and the fact that no issues were reported in the previous flights, it is highly suspected that the contaminated fuel was uplifted during one refuel rather than resulting from an accumulation during aircraft operation.

3. DESCRIPTION

CUSTOMER SERVICES DIRECTORATE
2 ROND POINT EMILE DEWOITINE
31700 BLAGNAC FRANCE
TELEPHONE + 33 (0)5 61 93 33 33

AIRBUS

OPERATORS INFORMATION TRANSMISSION - OIT

Quality of jet fuel is a key contributor to ensure the reliability of the fuel gauging system and the efficiency of the engines and APU operation among other functions. Therefore, contaminated fuel represents a threat to the efficiency of these systems.

Along the production and the supply chain and until it reaches the fuel tanks and it is burned through the engines or the APU, fuel must always remain compliant with the approved specifications. The specifications approved by Airbus are listed in the Consumable Material List (Ref.1). It is the responsibility of the operators to ensure that the fuel uplifted to the aircraft complies with these specifications, especially that it is free from any contamination such as water or biological material.

Regular fuel tank water drainage activity is highly recommended to reduce the risk of microbiological contamination and to minimize operational/maintenance disruptions due to contamination in the fuel tanks. However, such planned maintenance and housekeeping effort can be jeopardized in case of contaminated fuel being directly uplifted to the aircraft.

The current worldwide situation has led several regions to face difficulties and shortage in fuel supply. Due to this shortage, the risk of poor quality fuel being uplifted to the aircraft is considered to be higher than previously.

To mitigate this increasing risk, Airbus recommends operators to take particular care with the aircraft refuel operations, especially in the remote locations which may be facing fuel supply challenges. It is thus recommended to take local measurements (nearest upstream the aircraft) on a regular basis in order to verify the good quality of the fuel before it is uplifted to the aircraft. Visual inspection of the fuel sampling should be performed to confirm the fuel is clear and bright and free from water or any other contaminants. Presence of visible particles in the fuel or a cloudy fuel sample are signs of potential contamination and should alert the operator that the fuel may be contaminated (Ref. 2).

Any of these proactive measures will contribute to reducing the risk of significant operational disruptions, extensive grounding time and associated expensive corrective actions that may be needed if contaminated fuel is uplifted to the aircraft.

Should operators suspect fuel which is out of specification, having been uplifted to the aircraft, Airbus Engineering Support can be contacted using details in Section 4. CONTACTS for support and/or for reporting the event.

4. CONTACTS

Questions about the technical content of this OIT are to be addressed to Airbus Customer Services through TechRequest on Airbus World, selecting Maintenance & Engineering Domain, Engineering Section and ATA 28

Best Regards,

Stephen MONTGOMERY
Head of Propulsion Systems
In Service Engineering – Customer Care Center

1.18.7.2 Troubleshooting Manual – Tank Quantity and FOB Qty Shown Amber XX

AIRBUS	TSM - SAA - A330	REV DATE: Oct 01/2022
	Tail Number - MSN - FSN: ZS-SXM - 01792 - 505	
	28-42-00-810-951-A - Fuel - Tank Quantity and FOB Quantity Shown Amber XX	

***** ON A/C FSN ALL***

TASK 28-42-00-810-951-A
Fuel - Tank Quantity and FOB Quantity Shown Amber XX

1. Possible Causes:

-unserviceable fuel probe

2. Job Set-up Information

A. Referenced Information

REFERENCE	DESIGNATION
Ref. AMM 28-51-00-740-801	FCMS BITE (System) Test
Ref. AMM 45-10-00-860-815	Procedure to get access to the SYSTEM REPORT/TEST FUEL page

3. Fault Confirmation

SUBTASK 28-42-00-710-059-A
A. Test
(1) Do a BITE test of the FCMC 1 and FCMC 2 Ref. AMM 28-51-00-740-801.
(2) At the MCDU:
(a) Get access to the SYSTEM REPORT/TEST FUEL page Ref. AMM 45-10-00-860-815.
(b) Set the applicable FCMC Main Menu.
(c) Set the Class 3 FAULTS:
- if a fuel probe maintenance message is shown, do the fault isolation procedure in Para. 4.A.
- if there are no fuel probe maintenance messages shown, no more maintenance work is necessary.

NOTE: The FOB fuel indication can show XX when the two probes in a collector cell are unserviceable. If the probes in a collector cell are unserviceable, the inner tank indication will also show XX. If a fuel tank quantity shows XX, the FOB quantity can not be calculated.

4. Fault Isolation

SUBTASK 28-42-00-810-194-A
A. Procedure
(1) If a Class 3 maintenance message identifies an unserviceable fuel probe, do the applicable trouble shooting procedure.
(2) Do the test in Para. 3.A.(1).

1.18.7.3 Troubleshooting Manual -Fuel – Refuel Will Not Start or Cannot Be Completed

***** ON A/C FSN ALL***

TASK 28-25-00-810-821-A
Fuel - Refuel Will Not Start or Cannot Be Completed

WARNING: **OBEY THE FUEL SAFETY PROCEDURES. THIS CAN PREVENT INJURY AND DAMAGE.**

WARNING: **WHEN YOU DO WORK ON THE FUEL SYSTEM WIRING, YOU MUST USE TEST EQUIPMENT THAT IS APPROVED (REFER TO INTERNATIONAL OR NATIONAL SPECIFICATIONS FOR INTRINSICALLY SAFE TEST EQUIPMENT: EN60079, UL913 OR EQUIVALENT). TEST EQUIPMENT THAT IS NOT APPROVED CAN CAUSE FIRE OR AN EXPLOSION.**

1. Possible Causes:

-CONTROL LEVER LANDING GEAR (6GA)
-SW-FUEL ISOL, TRIM TANK (13QN)
-P/BSW-CENTER XFR, OVERRIDE (15QL)
-FCMC
-surge tank sensor/overfull sensor
-high level sensor
-trim line restrictor valve
-refuel isolation valve
-fuel tank isolation valve
-fuel tank inlet valve
-loss of fuel quantity accuracy on any fuel tank
-fuel probe
-total loss of fuel indication
-compensator
-densitometer
-trim line fault
-Ground conditions not set

2. Job Set-up Information

A. Referenced Information

REFERENCE	DESIGNATION
Ref. 28-51-00-810-833-A	Fuel - Ground Conditions Not Set
Ref. AMM 28-25-00-869-801	Ground Fuel Transfer Procedure
Ref. AMM 28-51-00-710-801	FCMS Fuel Valves Test
Ref. AMM 28-51-00-710-802	FCMS Level Sense Test
Ref. AMM 28-51-00-740-801	FCMS BITE (System) Test
Ref. AMM 28-51-00-740-803	Interrogation of the FCMS Input Parameters Pages
Ref. AMM 28-51-00-740-806	Interrogation of the FCMS Refuel Parameters Page
Ref. ASM 28-51-11	

Ref. ASM 28-51-12	
Ref. AMM 32-31-11-000-801	Removal of the L/G Control Lever
Ref. AMM 32-31-11-400-801	Installation of the L/G Control Lever

3. Fault Confirmation

SUBTASK 28-25-00-700-050-B

A. The faults that follow can cause the refuel to:
   - not start
   - stop before end of refuel.

   (1) An unserviceable CONTROL LEVER LANDING GEAR (6GA)
   (2) An unserviceable FCMC.
   (3) A surge tank sensor/overfull sensor wet or faulty wet.
   (4) A high level sensor wet or faulty wet.
   (5) An unserviceable trim line restrictor valve.
   (6) An unserviceable refuel isolation valve.
   (7) An unserviceable fuel tank isolation valve.
   (8) An unserviceable fuel tank inlet valve.
   (9) A loss of fuel quantity accuracy on any fuel tank. This can be caused by a number of fuel probe faults.
   (10) A total loss of fuel indication, this can be caused by a compensator or densitometer fault.
   (11) A trim line fault.
   (12) Ground conditions not set.

      (a) If the ground conditions are not set do the Ref. TSM TASK 28-51-00-810-833 Fuel - Ground Conditions Not Set procedure.

   (13) To find the fault, go to Para. 4.A.

      NOTE: For additional information you can interrogate the FCMS, refer to the AMM 28-51-00 P. Block 501.

4. Fault Isolation

SUBTASK 28-25-00-810-073-A

A. Procedure

   (1) Do the interrogation of the FCMS refuel parameter page procedure Ref. AMM 28-51-00-740-806 .

      (a) If an applicable fault is shown on the refuel parameters page:

         1 Do the applicable troubleshooting procedure.

      (b) If an applicable fault is not shown on the refuel parameters page:

         1 Do the next step.

   (2) Do a check of the aircraft wiring from the landing gear control lever to the FCMC Ref. ASM 28-51-11 and Ref. ASM 28-51-12.
   (3) Repair all the unserviceable wiring and connectors.
   (4)

Do a check of the landing gear control lever CONTROL LEVER LANDING GEAR (6GA) to make sure it transmits correctly Ref. AMM 28-51-00-740-803.

(5) If the signal is not correct, replace the landing gear control lever Ref. AMM 32-31-11-000-801 Ref. AMM 32-31-11-400-801.

(6) If the signal is correct, do the next step.

(7) If the refuel has not started, do the steps that follow to find the fault:

(8) If there are any of the conditions that follow, they must be corrected before the refuel can be completed:

- if the refuel has stopped at high level (maximum fuel on board) with the pre-selected fuel quantity set to more than 200kg (440lb) above maximum fuel capacity, set the correct fuel quantity
- if the automatic refuel has stopped and there is a fuel quantity imbalance between the left and right wing tanks, correct the fuel imbalance Ref. AMM 28-25-00-869-801
- make sure that all the refuel/defuel valve switches (at panel 990VU) are set to NORM
- make sure that the refuel/defuel MODE SELECT switch (at panel 990VU) is set to REFUEL
- make sure that the SW-FUEL ISOL, TRIM TANK (13QN) (at panel 245VU) is set to AUTO
- make sure that all manual transfer P/BSWs (at panel 245VU) are set to AUTO.

(9) If the refuel cannot be started again or the fault continues:

(a) Set the MODE SELECT (3QU) to the OFF position.

(b) Do the reset of the FCMC that is in control Ref. AMM 28-51-00-740-801.

(c) Continue with the refuel procedure, refer to AMM 12-11-28 page block 301.

NOTE: Para. (1) and (2) can be repeated to complete the refuel.

(10) If the steps in Para. (1) and (2) do not supply the solution and the refuel cannot be completed:

(11) Set the MODE SELECT switch (3QU) to the OFF position.

(12) Do the reset of the FCMC that is not in control Ref. AMM 28-51-00-740-801. This will make that FCMC the master.

(13) Continue with the refuel procedure, refer to AMM 12-11-28 page block 301.

NOTE: The FCMC that has been set to master can be reset more than once to complete the refuel. Before each FCMC is reset, the MODE SELECT switch (3QU) must be set to OFF.

(14) If the refuel has not started again or is still not complete. Do the actions that follow to find the fault:

- if during the following tests the message ground conditions not set is shown on the MCDU, do the ground conditions not set procedure Ref. TSM TASK 28-51-00-810-833.

(a) FCMC bite test Ref. AMM 28-51-00-740-801.

(b) FCMC level sense test Ref. AMM 28-51-00-710-802.

(c) FCMC valves test Ref. AMM 28-51-00-710-801.

NOTE: The level sense test must have finished before you start the valves test.

(d) FCMC ground report.

(15) If the fault continues:

1.18.8 Monthly Maintenance Report of Refuellers (RV01 and HD01) - Appendix 10

Relevant monthly reports reviewed by the investigation team include the following:

- Deadman Control Valve Test Record
- Fire Extinguisher Inspection Record
- Fueler Monthly Inspection Record
- Over wing Reel Hose Coupler, Nozzle and Strainer Inspection and Maintenance Record – Hose # 1
- Over wing Reel Hose Coupler, Nozzle and Strainer Inspection and Maintenance Record – Hose # 4
- Over wing Reel Hose Coupler, Nozzle and Strainer Inspection and Maintenance Record – Hose # 6
- Underwing Deck Hose Inspection and Test Record
- Underwing Reel Hose QD And Strainer Inspection and Maintenance Record
- Hose Inspection and Test Record
- Underwing Deck Hoses QD And Strainer Inspection and Maintenance Record
- Fixed and Mobile Ladder Inspection
- Sampling Visual Check Records

1.18.9 Extract from Transportation Safety Board of Canada Aviation Investigation Report Number A08Q0082.

In-Flight Fuel Feed Failure Resulting in Engine Fuel Starvation

Air Canada Airbus A330-343 C-GFAH Montréal, Quebec, 50 nm W. 30 April 2008

Summary

The Air Canada Airbus A330-343 (registration C-GFAH, serial number 0279), operating as ACA418, departed Toronto/Lester B. Pearson International Airport, Ontario, at 1622 Eastern Daylight Time en route to Montréal/Pierre Elliott Trudeau International Airport, Quebec, with 228 passengers and 10 crew

members on board. During the flight, several fuel pump low pressure warnings appeared and the affected pumps were switched off as per the appropriate published procedure. While in descent into Montréal, low-pressure warnings appeared on the remaining functioning fuel pumps; they were switched off and the engines continued to operate normally with gravity fuel feeding. During the level-off at 11,000 feet above sea level, the left engine (Rolls Royce, RB211 TRENT 772B-60) incurred a rollback below idle, generating an engine stall followed by an engine fail message on the electronic centralized aircraft monitor. All fuel pumps were switched back on and the left engine regained power shortly thereafter. An emergency was declared and the aircraft landed without further incident.

Post Flight Activities

The water draining procedure was performed and 4.5 litres of water were found in each inner tank. However, this quantity is considered normal by Airbus.

Findings as to Causes and Contributing Factors

The main fuel pump low-pressure warnings were erroneously generated by the possible freezing of fuel pressure switches. The result was that normally operating

fuel pumps were switched off as per the displayed electronic centralized aircraft monitor (ECAM) procedure.

1.18.10 Extract from Interview with SAA Engineer on Flight SA052/9053 of 14/15 April, 2022

Investigator: Do you recollect how they disposed of the fuel that was drained from the aircraft?

Engineer: Unfortunately, I have no idea. I was on the ladder draining, I handed it down to ground crew. They handed me another container. So

unfortunately, I have no idea what they did with the fuel that was in the containers that I handed to them.

Investigator: Okay. Let me take you a step back, when the refueling truck came, apart from the chemical water check, what other check did you do?

Engineer: Well that is normally the standard check that we do, we don't do any other checks. We just do that water check and then we start fueling.

Investigator: Okay, so just bear with me. How do you do that water check with the refuellers?

Engineer: A container on the truck or on the bowser, is filled with fuel. The refuellers take a syringe, put a chemical test unit on it, pull fuel from the container and they will show it to you. Even if the test is negative, I find water, put it on the chemical unit to see if there is a colour change. If it is actually working, it will then change colour.

1.19 Useful or Effective Investigation Techniques

- Use of CCTV footage of refueling event – *To assist in determining the quantity drained from the aircraft fuel tanks and how it was disposed of.*
- Reference to similar investigation reports - *Seeking information on similar occurrences for the benefit of the investigative process.*

2.0 ANALYSIS

This section discusses the factors which were found to have contributed to the incident, as well as other additional factors identified during the course of the investigation that were also considered to be important. The analysis performed is based on the pieces of evidence collected during the investigation.

2.1 Water Contamination During Refueling in Accra

Quality control checks carried out by PUMA Energy in accordance with JIG procedures on the fuel in the refueling truck (RV01), at 0742 UTC in the morning of 14 April indicated that the fuel was bright, clear and free of water. Maintenance records of the vehicles RV01 and HD01 also indicated proper functioning of all systems with no recorded defects. The post event maintenance inspection of the fueler vehicle (RV01) also confirmed that quality checks on the filter inlets and outlets was bright and clear. The loop test on the EWS also indicated correct functioning (Refer to Appendix 10).

PUMA Energy has a valid JIG certificate of approval (Appendix 7). On the day of the reported incident, there was no report of fuel contamination by any of the fourteen (14) other airlines serviced by PUMA Energy (Appendix 15). Post occurrence inspection of the PUMA facilities and records by the AIB Ghana team of investigators was satisfactory. An ad hoc post event third party inspection by United Airlines on PUMA Energy facilities and operations soon after the incident was also satisfactory (Appendix 16).

From the commencement of fueling and throughout the fueling process, all the results of the water tests conducted on the fuel being supplied was negative. Both trucks were fitted with the EWS system which detects the presence of free water in fuel if the concentration exceeds the IATA permissible limit of 30ppm. The EWS systems on the trucks were serviceable on the day and would also have detected the presence of water in the fuel. The refuellers monitored the warning light of the EWS system during the refueling process as required, and at no time did the light indicate the

presence of water. Additionally, at no time was the Deadman shutdown function automatically activated during refueling. Troubleshooting carried out by the fueling personnel on the truck (RV01) revealed no defects.

2.2 Water in Aircraft Fuel Tanks

Aircraft tanks will probably contain free water from the fuel previously loaded, therefore any water drained from the aircraft's fuel tanks may already have been present in the tanks on arrival in Accra.

According to SAA, the aircraft's maintenance records reflect there was a weekly check carried out three days prior, three fuelings and three flight legs before the refueling incident in Accra. During the weekly check as per maintenance requirements a fuel sump drain was carried out and no anomaly was evident.

Any water drained from the aircraft's fuel tanks in Accra, could have been introduced through the accumulation of water from any of the following:

a) Any or all the three refueling before the contamination incident.
b) In-flight ingestion of water vapour through the fuel tank vents.
c) Fuel uplifted in Accra.

NB: It is unlikely that water was introduced into the aircraft fuel tank in Accra because all the water tests were negative and the EWS system did not detect the presence of water.

2.3 Fuel Drain Procedure and Quantity Drained

Reference: Airbus In-Service Information on Microbiological Contamination in Fuel Tanks, ref. 28.11.00002. Issue date: 13-Sept-2021. Last Checked date: 24-May-2022.
The Airbus recommended guidelines for water drainage includes the following:

- Drain until free water is removed from each drain valve (the presence of fuel phase in the sample indicates that the free water has been drained).

At no time was a chemical water test performed to confirm that the fuel drained was free of water, though the test equipment was available.

The Engineer reported that the first few samples drained using the **1**L drain purge tool was predominantly water followed by a mixture of fuel and water. As per the Airbus recommendation above, the fuel drain should have stopped when the presence of fuel in the sample was observed, as this was an indication that free water had been drained.

Since the presence of water in the aircraft fuel tanks was determined by sight, smell, viscosity and experience, it could also have led to much more fuel being drained than was necessary. Additionally, as the amount of fuel drained was not measured and the containers were filled to different levels (as stated by the engineer), the estimated amount of fuel drained from each tank cannot be determined. CCTV footage of the event showed that the contents of the 20L container was disposed of eleven (11) times from the right fuel tank and three (3) times from the left fuel tank indicating the same amount of fuel could not have been drained from each tank as stated. This contradicts the reported 200L drained from each wing tank.

From the above, the reported amount of water drained can be considered incorrect and excessive.

2.4 Effect of Drainage of Fuel Tanks on Refueling Interruptions

Though it might appear that draining fuel from the aircraft wing tanks resolved the automatic interruptions in refuelling, it did not. When refuelling was resumed after draining fuel for the first time, there was an automatic interruption when an additional 2600 litres of fuel was uplifted. Fuel was drained a second time and refueling resumed. Once again, there was an automatic interruption again after uplifting a further 2700liters. Following this interruption, no further draining was carried out to check for the presence of water, neither was any trouble shooting performed. The refuelling truck was then replaced with the Hydrant dispenser HD01, and refuelling was completed successfully but for the APU automatic shutdown which resulted in the loss of electrical power supply to the aircraft. When electrical power was restored with a ground power unit, the refuelling was continued without any problems. If the last interruption before the HD01 was connected had been

caused by the presence of water in the fuel, it would have had to be drained before refuelling could have continued successfully, however this was not the case. Refuelling was continued successfully without the need to drain fuel. From this it can be inferred that neither the fuel drained nor the trouble shooting activities solved the issue of unexplained automatic interruptions

2.5 Solution to Refueling Challenges

The KLM engineer's suggestion that the issue could be due to low pressure from the refueller (RV01) and his proposal to use a different truck resulted in the use of the hydrant dispenser (HD01) for refueling. This produced the desired result. (Appendix 6, page 1)

Apart from the interruption caused by the automatic shutdown of the APU, there was no other interruption during the use of HD01.

It is likely that the increased flow rate of supply from the HD01 (max operating flow rate of 4140 lpm), as compared to that of RV01 (max operating flow rate of 2300 lpm), contributed to the resolution of the issue of interruptions.

2.6 Confirmation of Quality of Fuel Supplied

At the end of refueling the FDC and the Engineer were satisfied that the fuel on board the aircraft was not contaminated and that any water that may have been present had been drained. This is evidenced by the Engineer signing the fuel ticket and the FDC accepting to fly the aircraft to Johannesburg as fueled.

Airbus In-service Information Ref: 28.11.00002 issue dated 13-SEP-2021 indicates – "When there is water in tanks or contaminate is present, it commonly causes the fuel level sensing capacitance probe to give out of range reading". However, after the completion of refueling and throughout the flight, the fuel level sensing capacitance probes did not give any out-of-range readings indicating that there was most likely no appreciable amount of water present in the fuel tanks.

2.7 Microbiological Contamination (MBC)

The post flight findings of the inspections, tasks and investigative analysis carried out by SAA Maintenance on the subject aircraft indicated that samples taken from the fuel tanks revealed heavy microbiological contamination (MBC). Fuel filters removed contained MBC. Internal visual inspection of the aircraft fuel tanks also revealed the presence of MBC. Despite the presence of the confirmed MBC, there was no evidence of any foreign material found to have clogged the fuel pumps. The engine fuel filters did not clog and the bypass did not activate. MBC is therefore not considered as the cause of fuel starvation.

2.8 In-Flight Event

This was occasioned by a Fuel Right Inner Collector Cell Temp Sensor Fault, followed 27mins later by simultaneous indications of Fuel Main Pump 2 LO PR, Fuel Aft XFR Fault and Right-Wing Pumps LO PR (in that order). Seventeen (17) mins later, after a descent from FL410 to FL190 as required by procedure to gravity feed engine no. 2, there was an indication of ENG Stall on the ECAM. This was followed by two further engine Stall indications within a period of six (6) mins. Post flight analysis suggests that the engine did not Stall but suffered fuel starvation and subsequently responded during the approach to landing.

Since the automatic fueling procedure was used, fuel tanks were fueled simultaneously. Any contaminated fuel during refueling would have affected both the left and the right fuel tanks. Subsequently, if the in-flight engine incident was due to contamination originating from refueling in ACC, it would have affected engine no. 1 also en-route.

2.9 Post Flight Analysis

After landing in Johannesburg, the fuel tanks were sumped a few times and no water was found (Appendix 17). However, two days after the flight, 4 to 5 litres of water were drained from the aircraft fuel tanks.

Despite the presence of the confirmed MBC, there was no evidence of any foreign material found to have clogged the fuel pumps. All fuel pumps were serviceable.

The engine fuel filters did not clog and the bypass did not activate.

Based on the various data recovered and with reference to the Transport Canada Investigation report number A08Q008 of Air Canada A330-343 C-GFAH, the investigation is led to believe that the most likely scenarios are possibly any or a combination of the following:

- that there was icing in the tank pump output pressure sense line,
- the main fuel pump low-pressure warnings were erroneously generated by the possible freezing of fuel pressure switches. The result was that normally operating

  fuel pumps were switched off as per the displayed electronic centralized aircraft

  monitor (ECAM) procedure.

3.0 CONCLUSION

3.1 Findings

a. The airline did not report the suspected fuel contamination to the local authorities in Accra.
b. Puma Energy, Kotoka Airport, Accra was properly certificated to JIG standards for the fueling of aircraft.
c. The inspection records of Fueller vehicle RV01 on the day indicated satisfactory operation of the vehicle and the quality of fuel on board was certified as "water and dirt free and meets the relevant specification" by the SAA engineer. (Appendix 11)
d. Operating procedures of Puma Energy were satisfactory.
e. All the chemical water tests conducted on the fuel supplied were satisfactory.
f. The bright and clear check on the fuel was not conducted.
g. There was uncertainty about what was causing the multiple refueling interruptions.
h. Multiple resets of the aircraft's fuel system did not stop the auto interruptions whilst refueling with RV01.
i. The fuel drain did not stop the automatic interruption whilst refueling with RV01.
j. The fuel drain did not follow the recommended procedure. The determination of water in the fuel drained was by touch, viscosity, smell and experience.
k. The quantity of fuel drained from the aircraft cannot be accurately determined.
l. Different quantities of fuel were drained from each wing tank as observed on the KIA Security CCTV footage.
m. Fuel was disposed of into an open drain near the KIA perimeter wall.
n. No other airline serviced by Puma Energy on the day in question reported any problems with refueling.
o. Apart from the APU auto-shutdown, there was no interruption during refueling using HD01.
p. The pressures of a possible flight delay could have influenced the actions of the SAA FDC, SAA Engineer and the refueling staff.

q. Prior to the fuel occurrence involving the SAA flight and thereafter, several airlines were fuel/refueled daily by PUMA Energy using its Hydrant and Refueling Vehicles with no adverse reports or complaints.

r. The fuel quantity indications remained reliable from the introduction of HD 01 and throughout the flight to Johannesburg.

***Post Flight Maintenance Findings from SAA Incident Report of 25th May 2022*:**

s. The samples taken from the fuel tanks revealed heavy microbiological contamination (MBC).

t. The fuel filters that were removed contained MBC.

u. The internal visual inspection of the aircraft fuel tanks after draining showed signs of a brown sedimentary deposit. Samples collected and analysed revealed that it was MBC. Despite the presence of the confirmed MBC, there was no evidence of any foreign material found to have clogged the fuel pumps.

v. On arrival in Johannesburg, the fuel tanks were sumped and no water was found. However, two days later four to five litres were reported to have been drained from both left- and right-wing tanks.

w. Only Engine Number 2 had an engine stall indication en-route.

x. The borescope inspection of the no. 2 engine revealed no damage nor foreign objects.

3.2 Causes/Contributory Factors

It is the opinion of the Investigation Team that the incident could be attributed to the following:

<u>On Ground Incident</u>

a) Puma Energy was not the regular fuel supply contractor of SAA. Crew were briefed before the flight on the need to use an alternate fuel company. This could have influenced the crew's judgement by creating doubts about the quality of fuel delivered by the refueller RV01 during refuelling challenges.

b) Repeated auto interruptions, multiple aircraft fuel system resets and satisfactory water checks performed on the fuel from the truck, created uncertainty as to the cause of the interruptions for the SAA FDC, Engineer and the refuellers.
c) The Engineer had not experienced such a multitude of fuel auto interruptions previously.
d) The resultant delay in fueling and its effect on not meeting an on-time departure put undue pressure on the Engineer, FDC and the refueling crew.
e) The initial water drained from the aircraft's fuel tanks led to a fixation on a possible water contamination from refueller RV01 even though the water checks indicated otherwise.
f) The continuation of fuel drainage beyond the point at which the presence of fuel phase in the sample was observed.

In-flight Incident

g) There may have been icing in the right tank pump output pressure sense lines.
h) The main fuel pump low-pressure warnings may have been erroneously generated by the possible freezing of fuel pressure switches. The result would be that normally operating fuel pumps would be switched off as per the displayed Electronic Centralized Aircraft Monitor (ECAM) procedure.
i) Engine no. 2 failed to respond appropriately at FL190 during fuel gravity feed procedure on the event flight.

3.3 AIB Ghana Comments on BEA Submission on Final Draft Report (APPENDIX 19)

The statement in the BEA comments that, "***the fuel system was not capable of measuring the fuel quantity in the tanks due to probe capacitance out of range (often indicative of excess water)***" was not captured from the AIB Ghana Draft Final Report.

The BEA comments on the initial AIB Ghana Draft Final Report concludes as follows:

"**Therefore, and taking into account that:**

- **During the previous flight, the aircraft did not experience any FQI XX**

- **The first FQI XX and fueling stop occurred when about 600 litres were uplifted into the aircraft.**
- **Presence of water in the fuel was confirmed after the event flight.**
- **Inspections confirmed that pumps inlet & scavenge were not blocked.**
- **Fuel filters were not clogged, and bypass valve did not activate**

BEA fully supports the Airbus and Rolls-Royce analysis that considers that It is unlikely that the engine fuel starvation was due to the presence of MBC and is more likely due to presence of a high concentration of water in the fuel, which occurred, at least, during the first fueling phase (initial 600 litres).”

The investigation wishes to comment as follows (AIB Ghana Comments are in Italics):

- **During the previous flight, the aircraft did not experience any FQI XX** - *During the event flight, the aircraft did not also experience any FQI XX indicating that there was no water affecting the computation of the fuel quantity.*
- **The first FQI XX and fueling stop occurred when about 600 liters were uplifted into the aircraft** – *There were also multiple FQI XX indications and fueling stops after the first 600 liters were uplifted. These multiple FQI XX indications and fueling stops continued until 11,668 litres were uplifted. Thereafter, there was no FQI XX indication during refueling with HD01. Additionally, there was no FQI XX indications throughout the flight to Johannesburg which indicates that there was no significant amount of water or equipment malfunction affecting the computation of fuel quantity*.
- **Presence of water in the fuel was confirmed after the event flight** – The *e-mail from SAA states that no water was found in the aircraft fuel tanks on arrival in Johannesburg of the event flight (Appendix 17). SAA also confirms that 4 to 5 liters of water was drained from both fuel tanks 2 days after the event flight. Reference to Transport Canada’s Aviation Investigation Report number A08Q00082, page 7, relating to water drain of the Airbus A330 -343 after its flight the following was stated: “**The water draining procedure was performed and 4.5litres of water were found in each inner tank. However, this quantity is considered normal by Airbus**”. SAA also confirms that a water drain of 5 liters is normal.*

- "**BEA fully supports the Airbus and Rolls-Royce analysis that considers that It is unlikely that the engine fuel starvation was due to the presence of MBC and is more likely due to presence of a high concentration of water in the fuel, which occurred, at least, during the first fueling phase (initial 600 litres)**". *Since the automatic fueling procedure was used, fuel tanks were fueled simultaneously. Any contaminated fuel during refueling would have affected both the left and the right fuel tanks. Subsequently, if the in-flight engine incident was due to contamination originating from refueling in ACC, it would have affected engine no. 1 also en-route.*

4.0 SAFETY RECOMMENDATIONS

The following Safety Recommendations (AIB/SR/2023/09) are made:

1. Airline operators should report incidents promptly to the appropriate local authorities.

2. Technical crew and Refuellers must ensure that the fuel clear and bright check is conducted together with the water test procedure during refueling. It should be thorough and must follow the IATA recommended guidelines.

3. Airline operators should ensure that the regular maintenance water drain checks of aircraft fuel tanks is meticulously adhered to as recommended. Water drain procedures must always follow recommended guidelines.

4. Airport authorities must monitor and ensure that fuel and lubricants drained from aircraft and ground equipment is disposed of at designated safe locations. Airline operators and Service providers should drain fuel and lubricants into special containers for disposal at designated safe locations. The regulator should ensure compliance.

5. Airline operators must conduct due diligence prior to signing on new fuel companies. Quality Audits should be carried out by Airline Compliance departments on fuel companies at all Airports where fuel is uplifted to ensure quality standards are maintained.

6. Airline operators should be familiar with the various special equipment that fuel companies use to ensure the quality of fuel supplied, e.g.: EWS system. Operators should disseminate information on such systems to operating crew and maintenance personnel.

7. Airbus and Rolls Royce Plc should conduct further investigations into the cause of engine no.2 ECAM stall indication at FL190 during fuel gravity feed procedure on the event flight.

8. Airbus and Rolls Royce Plc should conduct further investigations to establish the cause of the failure of engine no. 2, to respond appropriately at FL190 during gravity feed procedure on the event flight.

APPENDIX 1: NOTIFICATION OF SERIOUS INCIDENT

Aircraft Accident and Investigation Bureau

From: Nthabiseng Malumedzha <MalumedzhaN@caa.co.za>
Sent: Monday, 25 April 2022 9:50 PM
To: Aircraft Accident and Investigation Bureau
Subject: ZS-SXM Serious Incident notification
Attachments: Foreign notification_AIB Ghana_ZS-SXM.pdf

Good Day

Kindly find attached an initial notification of an occurrence that occurred on 15 April 2022 at Kotoka Airport Ghana involving an Airbus A330-300 registration ZS-SXM.

Regards

SOUTH AFRICAN CIVIL AVIATION AUTHORITY

Nthabiseng Malumedzha
Aircraft Accident Investigator
Accident and Incident Investigation Division (AIID)
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Follow us on

1

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Standard Letter Number: CA 12-L-002 / 130418

Reference:	CA18/2/3/10027	Telephone number:	(011) 545-1014
Originator:	Nthabiseng Malumedzha	Fax number:	(011) 545-1466
Department:	Accident & Incident Investigation Division (AIID)	Cellular phone number	079 495 7392
Date:	25 April 2022	E-mail address:	malumedzhan@caa.co.za

Aircraft Accident and Incident Investigation and Prevention Bureau
Kotoka International Airport
Accra
Ghana

RE: NOTIFICATION TO FOREIGN STATE OF ACCIDENT

Pursuant to Annex 13 to the Convention on International Civil Aviation, this is to notify you of an aircraft serious incident which has occurred in Accra.

Details of the accident is as follows:-

a.	Identifying abbreviation	INCID
b.	Description of aircraft	
	• Aircraft manufacturer	Airbus
	• Model	A330-200
	• Nationality	South African
	• Registration marks	ZS-SXM
	• Serial number	1792
	• Airframe hours	12 533.07
c.	Name of Owner/Operator	South African Airways
	• Nationality of crew	South African
	• Total flying hours	Unknown
	• Total flying hours on type	Unknown
d.	Date and time of the accident	15/04/2022,
e.	• Last point of departure	Kotoka International Airport Accra (DGAA)
	• Point of intended landing	R Tambo International Airport Johannesburg (FAOR)
f.	• Position of aircraft with reference to GPS	DGAA
g.	• Number of crew and persons on board the aircraft killed or seriously injured.	TBA
h.	• Type of operation	Commercial
	• Serious Incident description and damage	Report as filed by SAA

	to aircraft.	The safety officer reported that on 15 April 2022, Airbus A-330-300 aircraft with registration ZS-SXM, took off from DGAA to O R Tambo International Airport (FAOR) The aircraft departed 1633 hours late after an unscheduled night stop because of fuel contamination. The aircraft was declared serviceable the following day. It departed DGAA at 1508Z. The crew reported that at about 2000Z while cruising at flight level (FL)410 they had an Electronic Centralized Aircraft Monitor (ECAM) message titled "FUEL R Wing Pumps LO PR" (fuel right wing pumps low pressure). They applied ECAM actions which ended with a Gravity feed requirement at FL200. They descended to FL 190 where we could do Gravity fuel feed. The secondary failure that followed was EGINE 2 STALL. They applied ECAM Actions and reduced thrust to stay within Engine parameters. Since there was no exceedance of engine parameters, they did not shut the engine down. At lower altitude with warmer temperatures in the fuel tanks, the condition remained the same. Every time they increased thrust on ENGINE 2, it stalled. The reason why they decided to continue was that. By the time they reached FL190 we were abeam Seretse Kgama (FBSK) International Airport in Botswana, their decision to proceed to destination was informed by the following facts: • Engine 1 parameters were normal • EGINE 2 was at Idle with no exceedances They had fuel Gravity feeding on EGINE 2 with no problems, although we could not increase the thrust. • There was a huge storm covering GBV all the way towards Waypoint Avago. They requested the following from air traffic controller (ATC); direct routing to FAOR RWY and no speed restrictions, so they increased their speed to 310 Kts. They performed a manual landing on Runway 21R at FAOR. After landing the right-wing pumps still indicated FAULT. The aircraft taxied to the parking bay. The crew and passenger were not injured, the

		aircraft was not damaged during this serious incident
i.	Investigation by State of Incident	South Africa
j.	Physical characteristics of the incident site	Final approach runway 07
k.	Contact:	Mrs Nthabiseng Malumedzha Cell: +2779 495 7392 Tel: +2711 545 1014 Email: malumedzhan@caa.co.za
l.	The presence of dangerous goods on board the aircraft.	None
m.	Weather at the time of accident	
n.	Description of any explosions, radioactive material, dangerous articles carried.	Not Applicable.
o.	Addition Information	None
South Africa, being the State of Operator, wishes to report this serious incident to AIB Ghana as the state of Occurrence as per ICAO Annex 13 requirements.		

Yours faithfully

Name: Mrs Nthabiseng Malumedzha
For Executive: Accident and Incident Investigations Division (AIID)

APPENDIX 2: COMMENCEMENT OF INVESTIGATION

Incase of reply, the number and date of this letter should be quoted.

My Ref. No. AIB/2022/04/14-15/SNC(1)

Your Ref. No.:.....

AIRCRAFT ACCIDENT
AND INCIDENT INVESTIGATION
AND PREVENTION BUREAU
TEL: +233 50 239 6070
+233 57 200 0888
TOLL FREE No. +233 80 000 6007

Date: 10th May, 2022

COMMENCEMENT OF INVESTIGATION INTO FUEL CONTAMINATION INVOLVING SOUTH AFRICAN AIRWAYS, A330-200, ZS-SXM THAT OCCURRED ON 14-15/04/2022 AT THE KOTOKA INTERNATIONAL AIRPORT, (DGAA) ACCRA

In accordance with Section 20 (1) of the Aircraft Accident and Incident Investigation and Prevention Act 2022, Act 1028, states "The Bureau shall, at any stage of an investigation of an aircraft accident and incident, recommend in a dated transmittal correspondence to the appropriate authority, including an authority in another state, any preventive action that the Bureau considers necessary to be taken promptly to enhance safety in aviation". Consequently, the Aircraft Accident and Incident Investigation and Prevention Bureau (AIB) has commenced investigation into the serious incident of a fuel contamination involving South African Airways aircraft A330-200 with the registration mark ZS-SXM that occurred on the April 14th-15th, 2022 at the Kotoka International Airport.

2. Accordingly, the AIB has received a notification with reference No. CA18/2/3/10027 dated 25th April, 2022 on the subject matter "Notification to Foreign State of Accident" from the South Africa Civil Aviation Authority on the serious incident which occurred in Accra and has shown its indication of the extent of the investigation to be conducted.

3. In order to ensure an effective management of the process through the Commissioner, Air Cdre Kwame Mamphey (Rtd) has been appointed as Investigator-In-Charge (IIC). To fulfill Section 5 (e), (f) and (h) of Act 1028, the investigation will focus on the preventive and safety measures that the Bureau considers necessary to be taken promptly to enhance safety in the Aviation Industry.

4. The AIB wishes to rely on your provision of support and cooperation for a successful conduct of investigation. This should include the appointment of a focal person from your institution to facilitate the process.

Yours faithfully,

AKWASI AGYEIBI PREMPEH
AG. COMMISSIONER

La-Wireless, Adjacent AU Village
Cantonments-Accra
GPS: GL-032-7631

P. O. Box KA 16112
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3. THE CHIEF EXECUTIVE OFFICER
   SOUTH AFRICA CIVIL AVIATION AUTHORITY
   CAPE TOWN INTERNATIONAL AIRPORT
   SOUTH AFRICA

   ATTN: MRS NTHABISENG MALUMEDZHA
   ACCIDENT AND INCIDENT INVESTIGATION DIVISION (AIID)

4. THE STATION MANAGER
   SOUTH AFRICA AIRWAYS
   NESTER SQUARE
   ACCRA

5. THE MANAGER
   PUMA ENERGY
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   FARNBOROUGH HOUSE
   BERKSHIRE COPSE ROAD
   ALDERSHOT
   HAMPSHIRE
   UNITED KINGDOM

8. **THE HEAD**
HERMANN-BLENK-STR. 16
D-38108 BRAUNSCHWEIG
GERMANY

Cc:

INVESTIGATOR-IN-CHARGE, AIB

EXPERT, INVESTIGATION DIVISION, AIB

APPENDIX 3: SAFETY/OCCURRENCE REPORT

Aircraft Accident and Investigation Bureau

From:	Gloria Yirenkyi <gloriayirenkyi@Flysaa.com>
Sent:	Friday, 13 May 2022 4:10 PM
To:	Aircraft Accident and Investigation Bureau
Cc:	Kwame Mamphey
Subject:	REF: AIB/2022/04/14-15/SINCID
Attachments:	AIRCRAFT ACCIDENT REPORT.pdf; report_67416_1652429335.pdf; 67416 image d39a91e9.jpg

Dear Mr Akwasi Agyeibi Prempeh,

Please find attached the Safety / occurrence report request by your letter referenced in Subject and dated 10th May 2022

Kindly acknowledge receipt of the reports attached for feedback to Head Office.

3rgds

Gloria Wilkinson Mensah | Country Manager (Ghana) | South African Airways
1st Floor Nester Square, Airport City – Liberation Road Accra, Ghana.
Email : gloriayirenkyi@flysaa.com Mobile : +233 (0) 244 344585

1

SOUTH AFRICAN AIRWAYS

Kind of Report :	Hazard
Area of Occurrence :	Hazard (Flight)
Type of Occurrence :	Hazard (Flight)
Event Classification :	Hazard (Flight)

General Information

Please define your name

Reporter :	confidential

In case of an anonymous report please enter 'Anonymous'

Flight Details:

Date & Time of Event (UTC) :	2022-04-14 22:00
Flight Number :	confidential
Departure :	ACC
Destination :	JNB
Diversion :	
Airport of Occurrence :	Departure airport
Aircraft Registration :	ZS-SXM
Aircraft type :	A-330-300
Manufacturer :	AIRBUS
Flight Phase :	Re-Fueling

Crew Information

Crew #1	
Crew Member 1 :	confidential
Position :	confidential
Pension # :	SBH678K
Crew #2	
Crew Member 2 :	confidential
Position :	confidential
Pension # :	
Crew #3	
Crew Member 3 :	confidential
Position :	confidential
Pension # :	
Crew #4	
Crew Member 4 :	confidential
Position :	
Pension # :	

Report Text

Incident / Hazard details

SOUTH AFRICAN AIRWAYS
A STAR ALLIANCE MEMBER

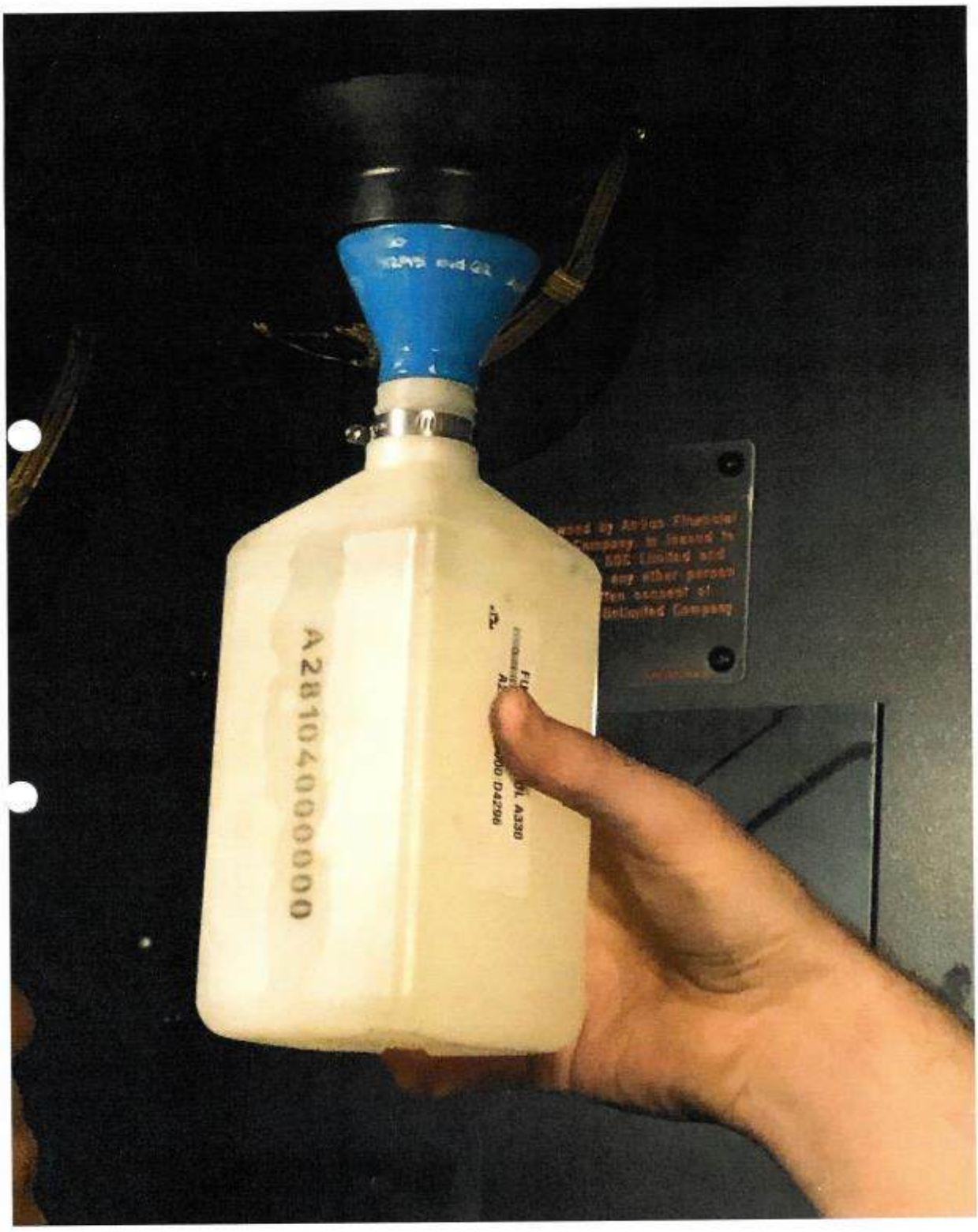
Crew Information

Crew #1	
Crew Member 1 :	confidential
Position :	confidential
Pension # :	SBH678K
Crew #2	
Crew Member 2 :	confidential
Position :	confidential
Pension # :	
Crew #3	
Crew Member 3 :	confidential
Position :	confidential
Pension # :	
Crew #4	
Crew Member 4 :	confidential
Position :	
Pension # :	

Report Text

Incident / Hazard details

Report Text :	Parked at D1 Waited for about 35 min for a truck to arrive. The initial fuelling traffic arrived, and then left. A large bowser subsequently arrived. Refuelling started about 20 min prior to departure time. Within a couple of minutes into the refuelling process, initially an AFT TRANSFER FAULT triggered. Thereafter all fuel quantities went amber X and refuelling stopped. In consultation with the travelling tech both FCMC's reset. Refuelling started once again, and again the quantities amber X and refuelling stopped. A second reset followed with the same result. Two further resets, now by CB in the EE compartment, same result. The aircraft down powered for 5 min, thereafter same result. In consultation with OCC and MCC, downpowered for 10 min. The crew and engineer consulted the AMM and MEL, ran diagnostic tests of FCMC, to establish a prove was causing the fault. Checked the probes for capacitance and considered draining fuel to check for water. The fuel supplier did not have access to a drain, and borrowed one from KLM. The attached photos show the initial samples, showing all water along with bugs a sediment. Containers(25lt) taken from aircraft. Approximately 200 litres from each wing drained. At this stage fuel indications stabilised. Refuelling resumed from a hydrant. During the process the APU shut down, with one start attempt - unsuccessful. At this stage crew were within 15 min of the target time for departure FDP exceedance having already used 3 hours discretionary time. Night stop called. Secondary crew sent to hotel to start required rest period. Primary crew managed disembarkation, hotels, customs and arrived at hotel 3 hours subsequent. Aircraft departed as SA9053 with secondary crew having completed a full rest period at hotel. Photo 1: [i1650187612832.jpg]
Location of the Hazard: :	ramp
Potential Consequence of the Hazard: :	water freezing inflight causing fuel pumps into low pressure state.
Recommendations / Suggestions to Rectify the Hazard: :	Audit refuelling company, even if it's a temporary company.


A2810400000

APPENDIX 4: PICTURE OF THE 20 LITRE CONTAINER

APPENDIX 5: SAA INCIDENT INVESTIGATION REPORT

INCIDENT INVESTIGATION REPORT

Part 1: Information Data

Reference Number: AIR/CQA/22/A330-72-001
Date Compiled: 2022/05/27
Subject: Excessive Water/In-flight engine Surge/Microbiological Contamination

Risk Severity: Before Incident: 3C
After Incident: 3C

Suggested criteria	Assessment risk index	Suggested criteria
Intolerable region	5A, 5B, 5C, 4A, 4B, 3A	Unacceptable under the existing circumstances
Tolerable region	5D, 5E, 4C, 4D, 4E, 3B, 3C, 3D, 2A, 2B, 2C	Acceptable based on risk mitigation. It may require management decision.
Acceptable region	3E, 2D, 2E, 1A, 1B ,1C, 1D, 1E	Acceptable

Flight details:

1. Flight Number: SA09053
2. Route: ACC-JNB
3. Aircraft Type: A330
4. Aircraft Registration: ZS - SXM
5. Date of Incident: 2022/04/15
6. Diversion: NO
7. Delay: YES
8. QA/6 Ref. No. N/A
9. TL/3 Reference Number: SXM100007080

Abbreviations:

JNB	Johannesburg
ACC	Accra
TL/3	Flight & Defect Folio
TL/12	Flight Crew and Technical Irregularity report
AMM	Aircraft Maintenance Manual
W/O	Work Order
TSM	Trouble Shooting Manual
AMP	Aircraft Maintenance Programme
APU	Auxiliary Power Unit
MBC	Microbiological Contamination
ECAM	Electronic Centralized Aircraft Monitor
FCMC	Fuel Control and Management Computer
IAW	In Accordance With
MOP	Manual of Procedures
OEM	Original Equipment Manufacturer
MCM	Maintenance Control Manual
AMO	Aircraft Maintenance Organisation
FDC	Flight Deck Crew
FL	Flight Level
PFR	Post Flight Report
NDI	Non-Destructive Inspection

Part 2: Reported Information:

A) DESCRIPTION OF INCIDENT:

On the 14TH April 2022, during the fueling of SXM, the APU had an auto-shutdown and auto-fueling stopped and the fuel quantity indication disappeared. As a result of troubleshooting, it was discovered that there was a large amount of water in the fuel tank. The water was drained and the fuel indication returned and the aircraft was auto-fueled as normal and subsequently dispatched. Refer attachment 1 and 2.

On the 15th April, en-route back to Johannesburg the # 2 engine had a stall pursuant to a fuel pump low pressure message. The engine was not shut down and the aircraft flew back to JNB with engine thrust being manually controlled by the Flight Deck Crew. Refer attachment 3 and 4.

Upon arrival in JNB and as a result of the in-flight stall that was recorded, analysis and inspection actions were taken. Through these actions, it was confirmed that microbiological contamination (MBC) was in the aircraft tanks and fuel system.

B) FACTUAL INFORMATION:

1) Pre-incident Maintenance and Fueling

Preflight Maintenance- Johannesburg
On the 14th April prior to flight SA 052, a Pre-flight Check and an ETOPS Check were carried out in preparation for the flight. During fueling, 38,644 litres were uplifted which equated to the total fuel on board being 42,27 tons. The shutdown fuel after flight SA052 was 9,04 tons. Refer attachment 5

Preflight Maintenance- Accra
When flight SA052 came into Accra at 21H07, the aircraft was to be fueled and a Through Check carried out and signed off in preparation for a 22h35 SA053 departure.
According to the Technician who was handling the aircraft, the following occurred:

> "The Fuel tanker arrived at the aircraft and I requested a standard check for water in the fuel tanks of the tanker, which showed a negative result for water. We started refuelling the aircraft and shortly after starting the fuel quantity indication on the aircraft side became erratic. The aircraft automatically stopped the refuelling procedure. I then lost all indication of fuel quantity in the aircraft.

During troubleshooting I came to a point where I checked for water in the tanks of the aircraft. I removed a sample from the lowest point of the aircraft tanks. It indicated that there was a lot of water in the tanks. I removed all the water from the aircraft fuel tanks. All indication came back normal on the aircraft side.

I requested another water check on the fuel tanker and it also came back negative for water.

The Captain in charge requested that we do not use the fuel tanker to complete the refuelling procedure and we connected to an underground hydrant using a different pump unit. I again requested the standard check for water on the fuel supply from the hydrant before commencing with refuelling the aircraft. It was negative for water in the system.

Auto refuelling procedure was completed with normal indication on the aircraft side.

A water check on the aircraft tanks by taking a sample from the tanks after the refuelling procedure indicated a small amount of water which I also removed.

All fuel quantity indication remained normal and stable."

The aircraft was fueled from two sources, as follows;

1) Puma Fueling Tanker- 11,668 litres.
2) Puma Underground Hydrant- 31,587 litres.

The total uplift in litres was 43,255 litres which equated to the total fuel on board being 40,38 tons. Refer attachment 6.

The APU had the auto-shutdown and there was also a fueling system auto-stop during fueling while using the Puma Fueling Tanker. Refer attachment 2.

2) In-flight surge/stall

On the 15th April, en-route back to Johannesburg, during the cruise phase of flight at 20H00, the following message appeared on the ECAM- FUEL R WING PUMPS LO PR.

At 20H18, the following message appeared on the ECAM- ENG 2 STALL. Refer attachment 7
The FDC reported that they descended to FL200 in order to maximise gravity feed on the #2 engine.

3) Initial AOG Maintenance

The following were the finding of the inspections and analysis tasks that were carried out;

1) The samples taken from the fuel tanks revealed "Heavy Contamination". Refer attachment 8 and 9

2) The fuel filters that were removed contained MBC. Refer attachment 10

3) The visual inspection of the inside of the fuel tank after draining showed visible signs of a brown sedimentary deposit. Samples collected and analyzed revealed that is was MBC. Despite the presence of the confirmed MBC, there was no evidence of any foreign material found to have clogged the fuel pumps. Refer attachment 11 and 12.

4) The borescope inspection of the #2 engine revealed no damage nor foreign objects.

Part 3: Analysis of incident:

Excessive amount of water drained

It can only be speculated as to where the approximately 400 litres of water had come from. As the maintenance record reflects, there was a weekly check carried out 3 days prior, 3 fuelings, and 3 flight legs before the in-flight surge after the Weekly Check. During the Weekly check as per maintenance requirements a fuel sump was carried out as equipment, manpower and downtime were all available and no anomaly was evident.

Fuel Pump Fault message

There is a possibility that the cause of the fuel pump low pressure was ice that formed from the residual water that had precipitated and frozen during the course of the flight. This is supported by the fact that at the time when an internal inspection of the tank had been carried out there was no record that the pump was clogged or obstructed in any way nor did it need to be replaced as a result of failure. Further to this, there

were not any prior defects related to the pump nor since the aircraft has been flying after having been restored to service.

In-flight Surge

As revealed by the engine OEM, the reason for the surge was "unstable fuel flow". At the time of the surge the fuel pump had been low pressure and the supply switching into gravity feed to sustain the engine. Refer attachment 13
When the fuel filters were removed and visually inspected, they were found to have microbiological contamination.
In line with the evidence that had been gathered it can be said that the engine fuel gravity feed situation at normal engine power, coupled with the presence of microbiological contamination in the filter impaired the fuel flow and caused the surge. The reduction in power and altitude enabled the engine to stabilize at the impaired gravity feed rate and no further surges occurred.

Part 4: Conclusions:

a) Findings as to the cause:

It can be stated that the reason for the in-flight stall/surge was erratic and low fuel pressure as reported by the engine OEM. The origins of the two possible contributing factors cannot be definitively traced nor pin-pointed. All compliances, processes and procedures were carried out and proven to be in order. It can be stated that this occurrence was indeed an isolated incident.

b) Recommendation:

It is the recommendation of the Operator that fuel uplifts away from base only be done using hydrant fueling. In exceptional cases where hydrant fueling is not available, thorough inspections must be done and conformations be received regarding the quality of the fuel supplier and tanker.

Part 5: Attached appendices:

Attachment No.	Document name/no.	Brief description
1	TL/3 SXM 100007077	Fuel indication lost/ excessive water drained
2	TL/3 SXM 100007078	APU auto shutdown during fueling
3	TL/3 SXM 100007080	Fuel pump low press/engine stall in flight
4	TL/12 SXM dated 15 April	Fuel pump low press/engine stall in flight
5	TL/6 SXM2033	14 April fuel uplift in JNB

6	TL/6 SXM2034	14 April fuel uplift in ACC
7	SXM Airman PFR	Real- time report
8	GT/92G Sample Report	Tank sample NDI analysis results 20 April
9	GT/92G Sample Report	Tank sample NDI analysis results 25 April
10	Fuel filters pictures	Stripdown/ disassembly pictures
11	Fuel tank picture #1	After draining tank internal visual inspection
12	Fuel tank picture #1	After draining tank internal visual inspection
13	Rolls Royce analysis	Email trail and engine performance graph

Report compiled by:

Date: 2022/06/03

Name: *John Nicholson*
Title: *Specialist*
Tel: *(O) +27 11 978 1608*
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Recommended by:

Date: 2022/06/09

Name: *Rakesh Deeplal*
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Approved by:

P.M Mereotlhe

Date: 2022/06/10

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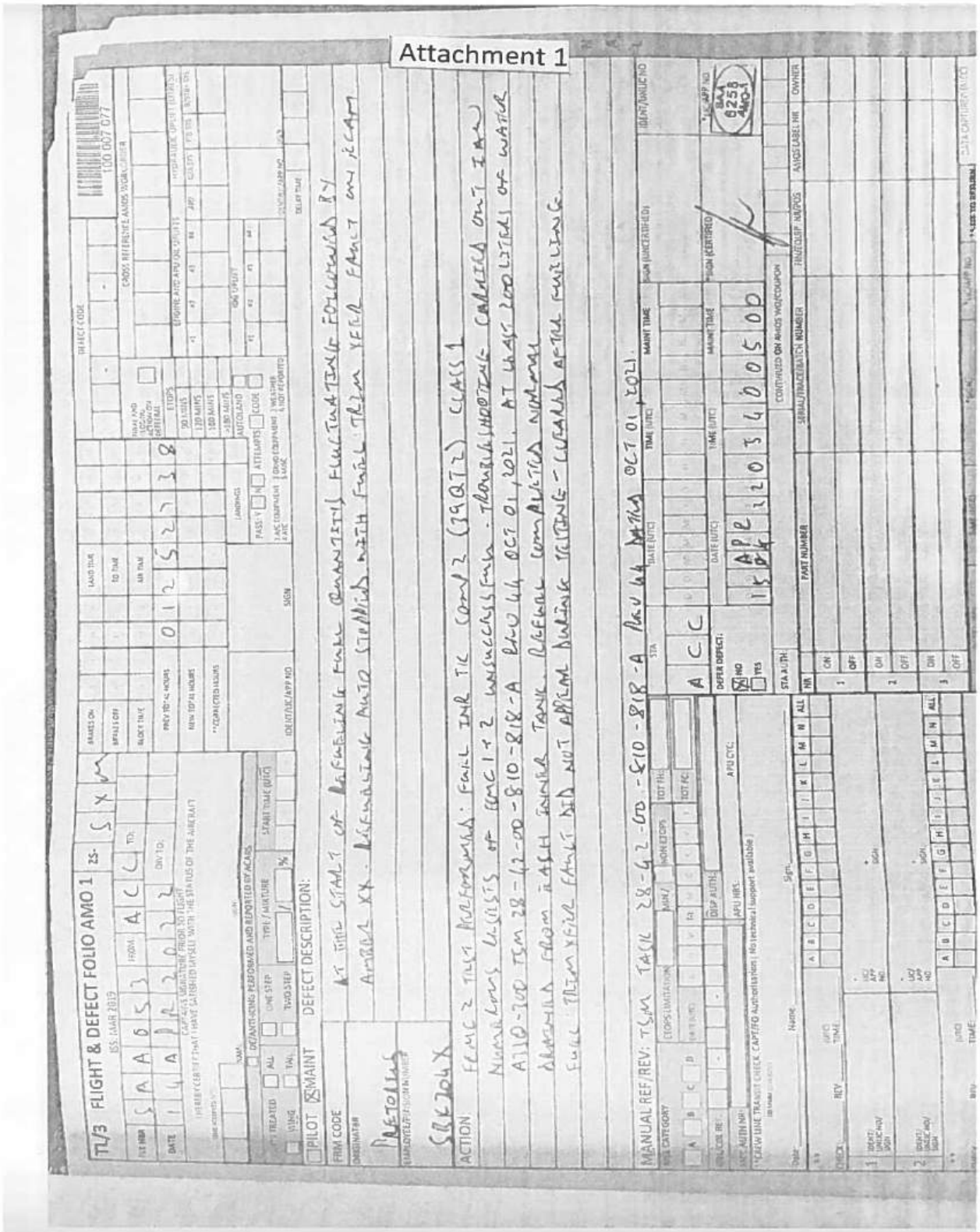
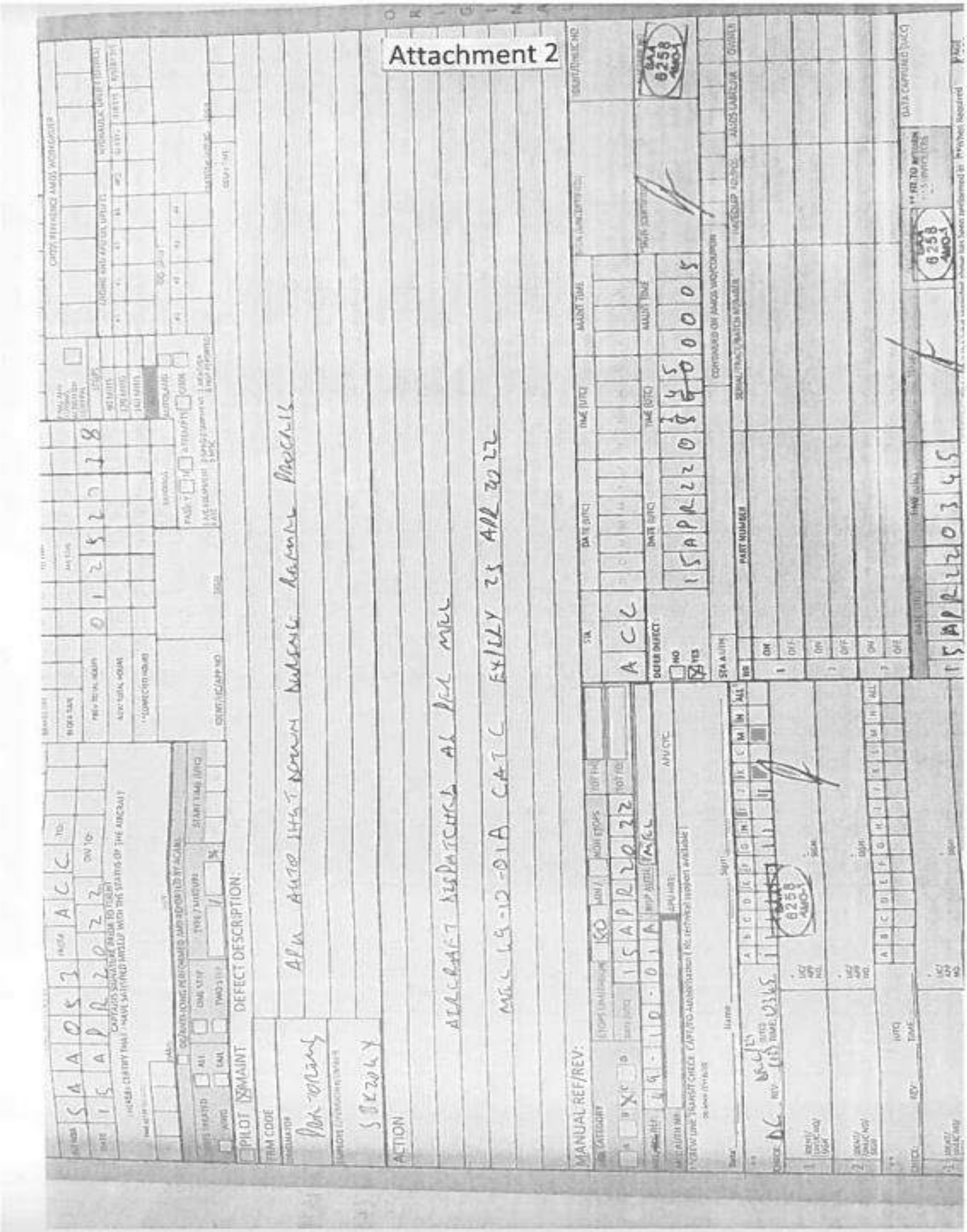
(C) +27 60 583 4737
E-mail: *princemereotlhe@flysaa.com*

APPENDIX 5: ATTACHMENTS (1-13c)

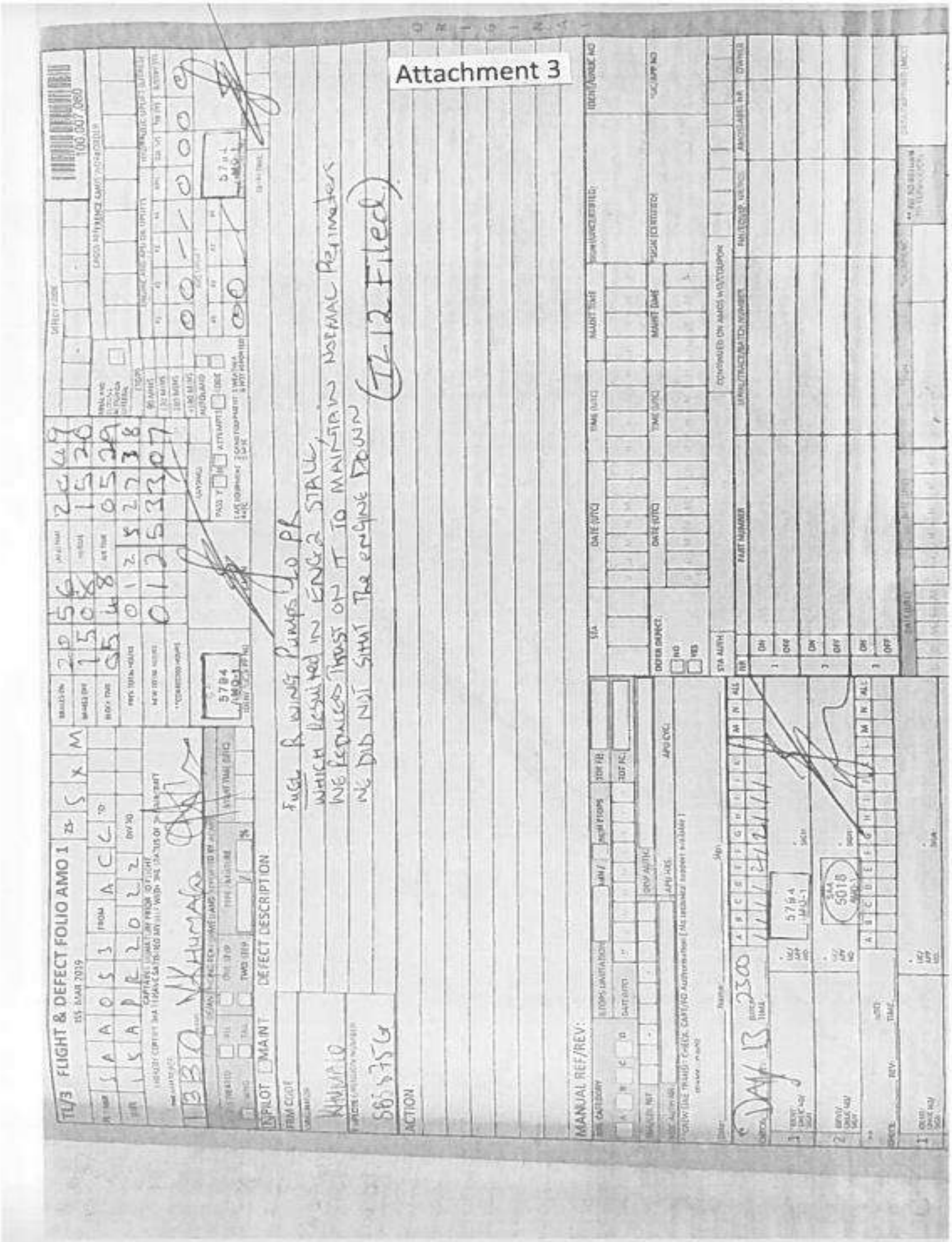


Attachment 2


DEFECT DESCRIPTION:

ACTION

MANUAL REF/REV:



Attachment 3

TL/3 FLIGHT & DEFECT FOLIO AMO 1

ZS- S X M

FLT NBR: S A A 0 5 3 FROM: A C C

DATE: 1 5 A P R 2 0 2 2

BRAKES ON: 20 56 | BRAKES OFF: 15 08 | BLOCK TIME: 05 48

LANDING: 20 49 | AIRBORNE: 15 20 | AIR TIME: 05 29

PREV TOTAL HOURS: 0 1 2 5 2 7 3 8

NEW TOTAL HOURS: 0 1 2 5 3 3 0 7

CAPTAIN'S SIGNATURE PRIOR TO FLIGHT: 1 3 3 0 ... KHUMALO

100,007,080

PILOT / MAINT — DEFECT DESCRIPTION

FUEL R WING PUMPS LO PR
WHICH RESULTED IN ENG 2 STALL,
WE REDUCED THRUST ON IT TO MAINTAIN NORMAL PERIMETERS
WE DID NOT SHUT THE ENGINE DOWN
(TL12 Filed)

ORIGINATOR: KHUMALO

5855875G

ACTION

MANUAL REF/REV:

DAY 13 — 2300

5784 AMO-1

SAA 5018 AMO-1

TL/12 REV. : AUG/90 (8) FLIGHT CREW AND TECHNICAL IRREGULARITY REPORT AMO 1

TL/36 REF. SXM | REF/AIR/OFA : | REF/COMPUTER ENTER DATE : MCC/SXM/022 | T.O.C. FAULT CODE : 28-00

1. DATE	2. FLT. NO.	3. A/C TYPE	4. DEP. STA	5. ARR STA	6. ORIGINATOR CAPT FEO ENG
15-04-2022	SNB9053	330-300	ACC	JNB	CAPT KHUMALO

7. PHASE: D

A. GATE B. PUSHBACK C. CLIMB D. CRUISE E. LANDING F. TAXI IN G. TAXI OUT H. T/O RUN/CLIMB I. DESCENT J. APPROACH K. PARKED L. HANGAR

8. RUNWAY	9. INTERMEDIATE STOP	10. OCCURRED WHERE	11. TIME (Z)	12. ALTITUDE
21R		CRUISE	2003	41000

13. GWT	14. TEMP/DEW POINT	15. AIRSPEED (IAS or MACH)	16. HEADING (Mag or True)	17. FUEL REMAINING

18. WINDS DIRECTION/SPEED	19. SKY CONDITION	20. SEAT BELT SIGN ON/OFF	21. VIS/RVR	22. TURBULENCE L.M.S.
210/22	PARTLY CLOUDY	ON	CLEAR	L

23. IRREGULARITY

A. MECH. FAILURE B. ENG. FAILURE C. BIRDSTRIKE D. NEAR MISS E. SABOTAGE F. LIGHTNINGSTRIKE G. PAX ILLNESS/DEATH K. PAX DISTURBANCE (I) ACCIDENT J. CREW ILLNESS/DEATH K. HARD/OVERWEIGHT LANDING L. HIGH ENERGY STOP M. OTHER N. INCIDENT O. FUEL SPILLAGE

COMPLETE ONLY THE APPROPRIATE SECTION(S) BELOW

24. DELAY CAUSE

10 PASSENGER
20 CARGO
30 AIRCRAFT HANDLING
40 TECHNICAL
50 DAMAGE TO AIRCRAFT
60 FLIGHT OPERATION
70 WEATHER
80 ATC
90 REACTIONARY

25. AIRCRAFT SYSTEM

21 AIR CONDITIONING
22 AUTOPILOT
23 COMMUNICATIONS
24 ELECTRICAL POWER
25 EQUIP/FURNISHINGS
26 FIRE PROTECTION
27 FLIGHT CONTROLS
28 FUEL
29 HYDRAULICS
30 ICE AND RAIN
31 INSTRUMENTS
32 LANDING GEAR
33 LIGHTS
34 NAVIGATION
35 OXYGEN
36 PNEUMATICS
38 WATER/WASTE
49 A.P.U.
51 STRUCTURES GEN
52 DOORS
71 POWER PLANT

USE THIS SECTION (ITEMS 26-31) FOR ENGINE POWER INTERRUPTION AFFECTED ENGINE

26. (2) ENGINE AVAILABLE FOR FURTHER USE (Y, N)

27. ATC EN ROUTE DELAYS (Y, N)

28. MECHANICAL DIFFICULTIES IF FLIGHT CONT'D (Y, N)

29. TERRAIN FEATURES EN ROUTE

30. FAMILIAR W/LANDING AIRPORT (Y, N)

31. REASON FOR OVERFLYING NEAREST SUITABLE AIRPORT TO BE EXPLAINED IN DESCRIPTION

USE THIS SECTION (ITEMS 32-35) FOR DEPRESSURIZATION

32. MAXIMUM CABIN ALTITUDE REACHED

33. DURATION A. MOMENTARY B. _____ MINS

34. PAX O_2 MASKS DEPLOYED (Y, N)

35. DEPLOYED HOW A. AUTOMATIC B. MANUAL

FOR ILLNESS/INJURY OR DEATH OF PAX OR CREW MEMBER INCLUDE THE FOLLOWING IN DESCRIPTION SECTION :

- FULL NAMES OF SFO, FEO & ALL C/W's.
- NAMES, ADDRESSES, TELEPHONE NUMBER, SEAT NUMBER OF 3 WITNESSES AND CORONER OR ATTENDING PHYSICIAN.
- NAME, ADDRESS, AGE, SEAT NUMBER OF STRICKEN PERSON.
- A/C's EXACT LOCATION (NAME OF VOR, RADIAL DME)
- CABIN & A/C's RATE OF CLIMB OR DESCENT AND A/C's CABIN ALTITUDE.
- USE OF OXYGEN, DRUGS OR OTHER PROCEDURES ADMINISTERED.

ACTION TAKEN - CIRCLE ALL APPROPRIATE LETTERS BELOW

36.
A. ABORTED AT _____ KTS
B. RETURNED DEPARTURE STATION
C. UNSCHEDULED LANDING
D. ENGINE SHUTDOWN (FLT/GRD)
E. ENGINE THRUST REDUCED
F. FUEL QUANTITY DUMPED _____
G. EVASIVE ACTION TAKEN
H. EMERGENCY DESCENT
I. EMERGENCY EVACUATION
J. REQUIRED FIRE EQUIPMENT
K. REQUIRED MEDICAL ASSISTANCE
L. REQUIRED LAW ENFORCEMENT
M. FOLLOWED EMERGENCY PROCEDURE Page _____
(N) FOLLOWED ABNORMAL PROCEDURE Page _____
O. EMERGENCY DECLARED

DESCRIPTION OF OCCURRENCE

~~WE GOT FUEL R PUMP LO PRESSUR~~ WHICH LEAD TO ENGINE 2 STALL ~~BUT WE MANAGED TO CONTROL~~ The Thrust ~~AND~~ STOPPING IT FROM STALLING BY REDUCING THRUST ON IT.

~~WE~~ were required to descend below FL 200 TO GET GREATER feed OF THE fuel ON RH WING.

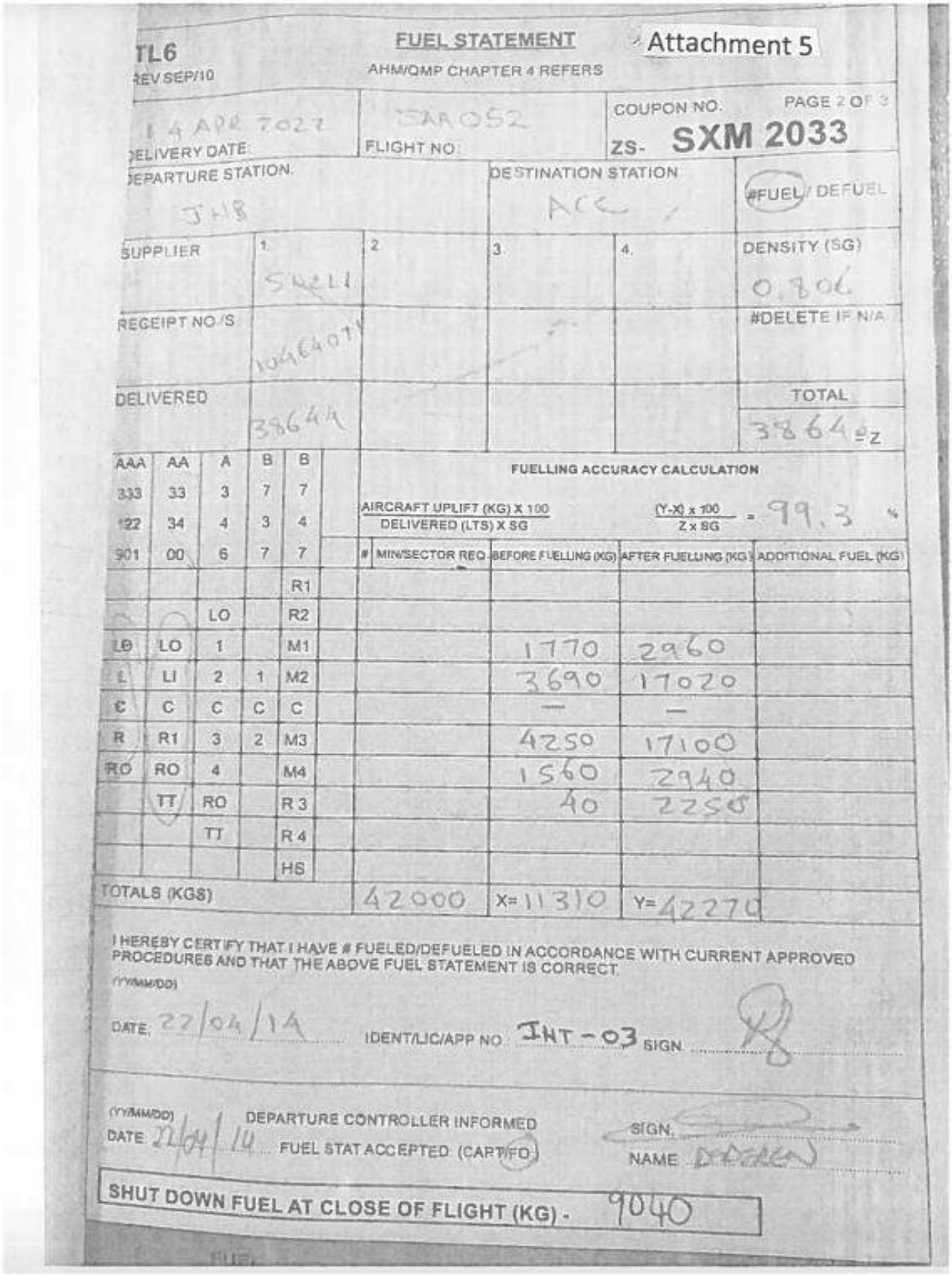
WE MANUALLY CONTROLLED ~~The~~ THRUST TILL LANDING USING ILS Rwy 21R ~~FAOR~~.

W/O: #100007080

Attachment 4

Maintenance Action Telex : FAX : | Orig. Sign.

Date : _____ Stamp :



TL6
REV SEP/10

FUEL STATEMENT — Attachment 5

AHM/QMP CHAPTER 4 REFERS

DELIVERY DATE: 14 APR 2022	FLIGHT NO: LIA052	COUPON NO. ZS- SXM 2033	PAGE 2 OF 3
DEPARTURE STATION: JNB	DESTINATION STATION: ACC	#FUEL / DEFUEL	

SUPPLIER	1.	2	3	4.	DENSITY (SG)
	SHELL				0.806
REGEIPT NO /S	10464071				#DELETE IF N/A
DELIVERED	3864				TOTAL 3864 KG

AAA	AA	A	B	B	FUELLING ACCURACY CALCULATION
333	33	3	7	7	AIRCRAFT UPLIFT (KG) X 100 / DELIVERED (LTS) X SG — (Y-X) x 100 / Z x SG = 99.3 %
922	34	4	3	4	
901	00	6	7	7	

					#	MIN/SECTOR REQ	BEFORE FUELLING (KG)	AFTER FUELLING (KG)	ADDITIONAL FUEL (KG)
				R1					
		LO		R2					
LO	LO	1		M1			1770	2960	
LI	LI	2	1	M2			3690	17020	
C	C	C	C	C			—	—	
R	R1	3	2	M3			4250	17100	
RO	RO	4		M4			1560	2940	
	TT	RO		R 3			40	2250	
		TT		R 4					
				HS					
TOTALS (KGS)						42000	X= 11310	Y= 42270	

I HEREBY CERTIFY THAT I HAVE # FUELED/DEFUELED IN ACCORDANCE WITH CURRENT APPROVED PROCEDURES AND THAT THE ABOVE FUEL STATEMENT IS CORRECT.

(YY/MM/DD)

DATE: 22/04/14 IDENT/LIC/APP NO: INT-03 SIGN:

(YY/MM/DD)

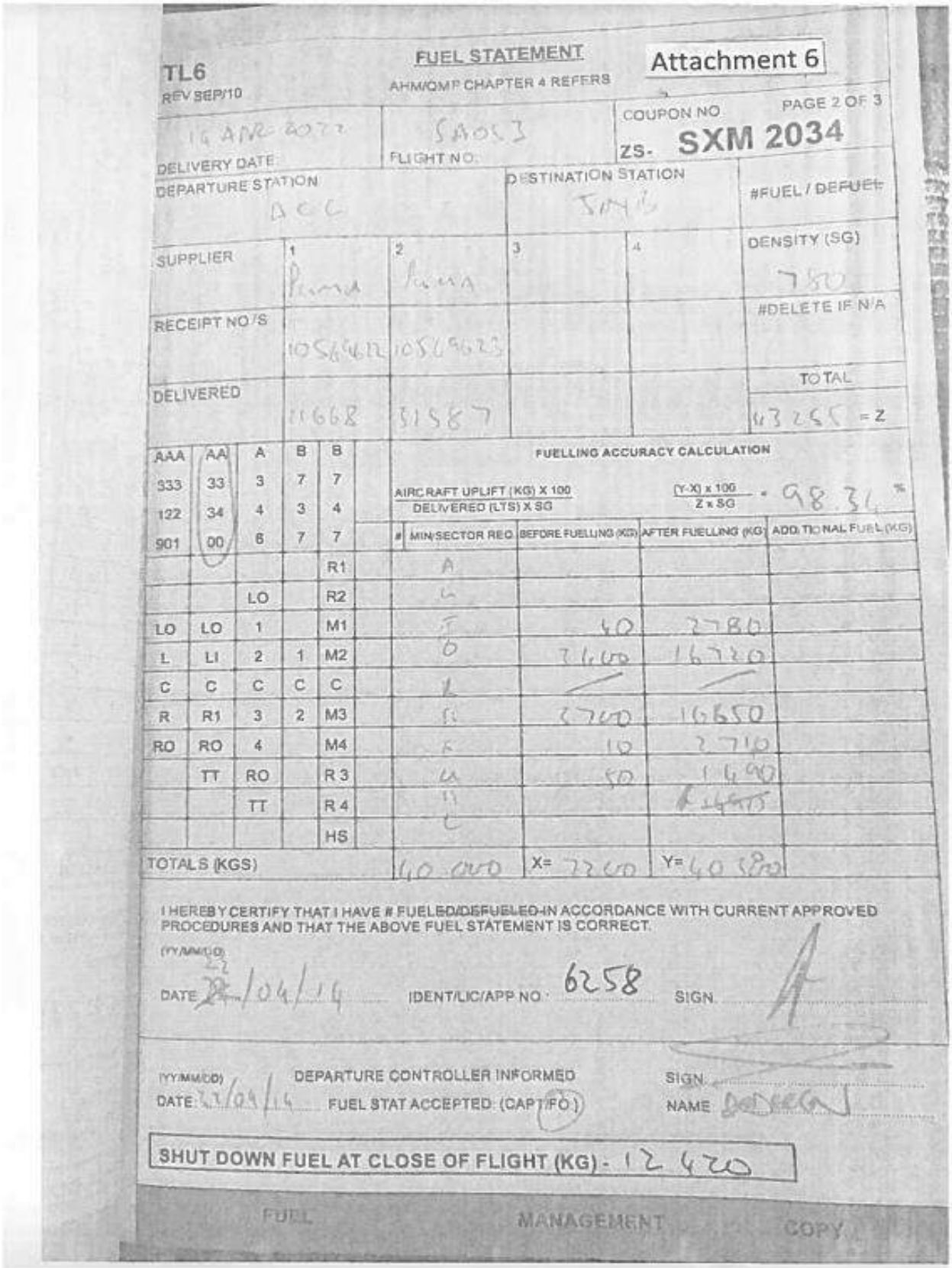
DATE 22/04/14 DEPARTURE CONTROLLER INFORMED

FUEL STAT ACCEPTED (CAPT/FO)

SIGN:

NAME:

SHUT DOWN FUEL AT CLOSE OF FLIGHT (KG) - 9040



TL6
REV SEP/10

FUEL STATEMENT
AHM/OMP CHAPTER 4 REFERS

Attachment 6

PAGE 2 OF 3

DELIVERY DATE: 14 APR 2014	FLIGHT NO: SA053	COUPON NO. ZS- SXM 2034	
DEPARTURE STATION: ACC	DESTINATION STATION: SXM		#FUEL / DEFUEL

	1	2	3	4	
SUPPLIER	Puma	Puma			DENSITY (SG): 780
RECEIPT NO/S	10586422	10589623			#DELETE IF N/A
DELIVERED	11668	31587			TOTAL: 43255 = Z

AAA	AA	A	B	B
333	33	3	7	7
122	34	4	3	4
901	00	6	7	7

FUELLING ACCURACY CALCULATION

AIRCRAFT UPLIFT (KG) X 100 / DELIVERED (LTS) X SG = (Y-X) x 100 / Z x SG = 98.3 %

					#	MIN/SECTOR REQ	BEFORE FUELLING (KG)	AFTER FUELLING (KG)	ADDITIONAL FUEL (KG)
				R1		A			
		LO		R2		L			
LO	LO	1		M1		F	40	2780	
L	LI	2	1	M2		O	12600	16720	
C	C	C	C	C		L	/	/	
R	R1	3	2	M3		R	2760	16650	
RO	RO	4		M4		F	10	2710	
	TT	RO		R3		U	50	1490	
		TT		R4		E		1485	
				HS		L			
TOTALS (KGS)						40 000	X= 7260	Y= 40 280	

I HEREBY CERTIFY THAT I HAVE # FUELED/DEFUELED IN ACCORDANCE WITH CURRENT APPROVED PROCEDURES AND THAT THE ABOVE FUEL STATEMENT IS CORRECT.

(YY/MM/DD) DATE 22/04/14 IDENT/LIC/APP NO: 6258 SIGN:

(YY/MM/DD) DATE 22/04/14 DEPARTURE CONTROLLER INFORMED FUEL STAT ACCEPTED (CAPT/FO) SIGN: NAME:

SHUT DOWN FUEL AT CLOSE OF FLIGHT (KG) - 12 420

FUEL MANAGEMENT COPY

Attachment 7a

Printed: 19/04/2022

Title: Flight Details

Leg	0	Flight Number	SA9053	A/C ID	ZS-SXM
From	ACC	First Event Date	15 Apr 22 - 15:08		
To	JNB	Last Event Date	15 Apr 22 - 20:59		

CMS:RAW_TAB

Fault Tracking	Phase	Date Time	ATA	Source	Title	Class	Occurrence History	Priority	Work	Note
	02-ENG START	15 Apr 22 - 15:07	270000	AFS	[EFCS]	1	X			
					[null]					
	02-ENG START	15 Apr 22 - 15:07	233334	CIDS1	[PES CTRL (8MK)/ DIR1 (101RH)]	1	X			
					[null]					
	02-ENG START	15 Apr 22 - 15:07	228300	AFS	[RLY PWR SPLIT (22CB)]	1	XX			
					[null]					
	02-ENG START	15 Apr 22 - 15:11	732134	AFS	[EEC(E2-4000KS)]	1	X			
					[null]					
	02-ENG START	15 Apr 22 - 15:11	732534	DMC3	[EIVMU2(1KS2)/DMC3(1WT3)]	1	X			
					[null]					
	02-ENG START	15 Apr 22 - 15:13	240000	DMC2	[POWER SUPPLY INTERRUPT]	1	XX			
					[null]					
REPETITIVE	02-ENG START	15 Apr 22 - 15:17	341234	WXR1	[ADIRU1(1FP1) IR BUS/ WXR1(1SQ1)]	1	......X..XX.XX			
					[null]					
	02-ENG START	15 Apr 22 - 15:17	252735	CIDS1	[IPCU AFT(16DS)]	1	X			
					[null]					
	06-CRUISE	15 Apr 22 - 16:37	454122	AFS	[PRINTER(2TP)]	1	........X.....X			
					[null]					
	06-CRUISE	15 Apr 22 - 19:33	284915	FCMC1	[FUEL INR TK TEMP SNSR (2QR2)]	1	X			
					[null]					
	06-CRUISE	15 Apr 22 - 20:00	2827		[FUEL AFT XFR FAULT]		X			
					[null]					
	06-CRUISE	15 Apr 22 - 20:00	282151	FCMC1	[FUEL MAIN PUMP2 (122QA2)]	1	X			
	06-CRUISE	15 Apr 22 - 20:00	2821		[FUEL R WING PUMPS LO PR]		X	High		
					[null]					
	06-CRUISE	15 Apr 22 - 20:17	731241	EEC2A	[FUEL PUMP (E2-5050EB) / FUEL LP SW (E2-4075KS)]	2	X			
	06-CRUISE	15 Apr 22 - 20:17	7321		[MAINTENANCE STATUS EEC 2B]		X			
					[null]					
	06-CRUISE	15 Apr 22 - 20:17	7321		[MAINTENANCE STATUS EEC 2A]		X			
					[null]					

Attachment 7b

Fault Tracking	Phase	Date Time	ATA	Source	Title	Class	Occurrence History	Priority	Work	Note
OCCURRENCE	06-CRUISE	15 Apr 22 - 20:18	7100		[ENG 2 STALL]		x			
OCCURRENCE	06-CRUISE	15 Apr 22 - 20:18	710000	EEC2A	[PROPULSION SYSTEM] [null]	1	x			
	06-CRUISE	15 Apr 22 - 20:44	284221	FCMC2	[FUEL INR TK COMP1(39QT1)] [null]	1	x			

Attachment 8

GT/92G REV.: NOV/18(3) AMO 1	SOUTH AFRICAN AIRWAYS - TECHNICAL **NON DESTRUCTIVE INSPECTION REPORT ON BACTERIOLOGICAL /MICROBIAL TYPE ANALYSIS**

1. TO SECTION/COMPANY: Maintenance Planning, Engineering.

COMPONENT/AIRCRAFT LOCATION: Fuel tanks

DATE: 20 Apr 2022 COMPANY ORDER NUMBER: N/A

JOB ACCOUNT NUMBER: N/A NDI REFERENCE NUMBER: 1297

INSPECTION TYPE (LABORATORY): Microbiological contamination analysis

AIRCRAFT TYPE: Airbus REGISTRATION: ZS-SXM

RESULT OF TEST: Fuel samples received from ZS-SXM tested IAW A330 AMM

Task 12-32-28-281-812-A

Subtask 12-32-28-281-061-B, Para 4A(1)(a)

The test revealed a Heavy contamination IAW A330 AMM

Subtask 12-32-28-281-062-A, Para 4B(2)(d)(1)

MICROBMONITOR 2 (Lot:240621A14-1)

RECOMMENDATION: Please do the procedure removal of the microbiological particles from the applicable fuel tanks in less than than 10 days from the above date IAW A330 AMM

Task 12-32-28-281-812-B

Subtask 12-32-28-281-086-A, Para 5A(3)(c)(1)(2) Rev 46 ,Apr 01 2022

Note: The samples started showing heavily contamination within 24Hours of incubation.

I hereby certify that in carrying out the work specified above, all conditions prescribed in the Regulatory Authority Regulations which are applicable thereto, have been complied with.

Analysis done by: P. Radebe Ident. Stamp: Cert. Stamp: SAA 6950 AMO-1

Senior Inspector:

2. TO:

ADDRESSEE'S ACTION AND/OR REMARKS:

Attachment 9

GT/92G REV.: NOV/18(3) AMO 1	SOUTH AFRICAN AIRWAYS - TECHNICAL **NON DESTRUCTIVE INSPECTION REPORT ON BACTERIOLOGICAL /MICROBIAL TYPE ANALYSIS**

1. TO SECTION/COMPANY: Maintenance Planning, Engineering, Tech Ops

COMPONENT/AIRCRAFT LOCATION: Fuel tanks

DATE: 25 Apr 2022 COMPANY ORDER NUMBER N/A

JOB ACCOUNT NUMBER N/A NDI REFERENCE NUMBER 1302

INSPECTION TYPE (LABORATORY): Microbiological contamination analysis

AIRCRAFT TYPE: Airbus REGISTRATION: ZS-SXM

RESULT OF TEST: Fuel samples received from ZS-SXM tested IAW A330 AMM

Task 12-32-28-281-812-A, Subtask 12-32-28-281-061-B, Para 4A(1)(a)

Subtask 12-32-28-281-061-B, Para 4A(1)(a)

The second test confirms microbial growth as Heavy contamination IAW A330 AMM

Subtask 12-32-28-281-062-A, Para 4B(2)(d)(1)

MICROBMONITOR 2 (Lot:240621A14-1)

RECOMMENDATION: Please do the procedure removal of the microbiological particles from the applicable fuel tanks in less than than 10 days from the above date IAW A330 AMM

Task 12-32-28-281-812-B

Subtask 12-32-28-281-086-A, Para 5A(3)(c)(1)(2) Rev 46 ,Apr 01 2022

I hereby certify that in carrying out the work specified above, all conditions prescribed in the Regulatory Authority Regulations which are applicable thereto, have been complied with.

Analysis done by: P. Radebe Ident. Stamp: _____ Cert. Stamp: SAA 6950

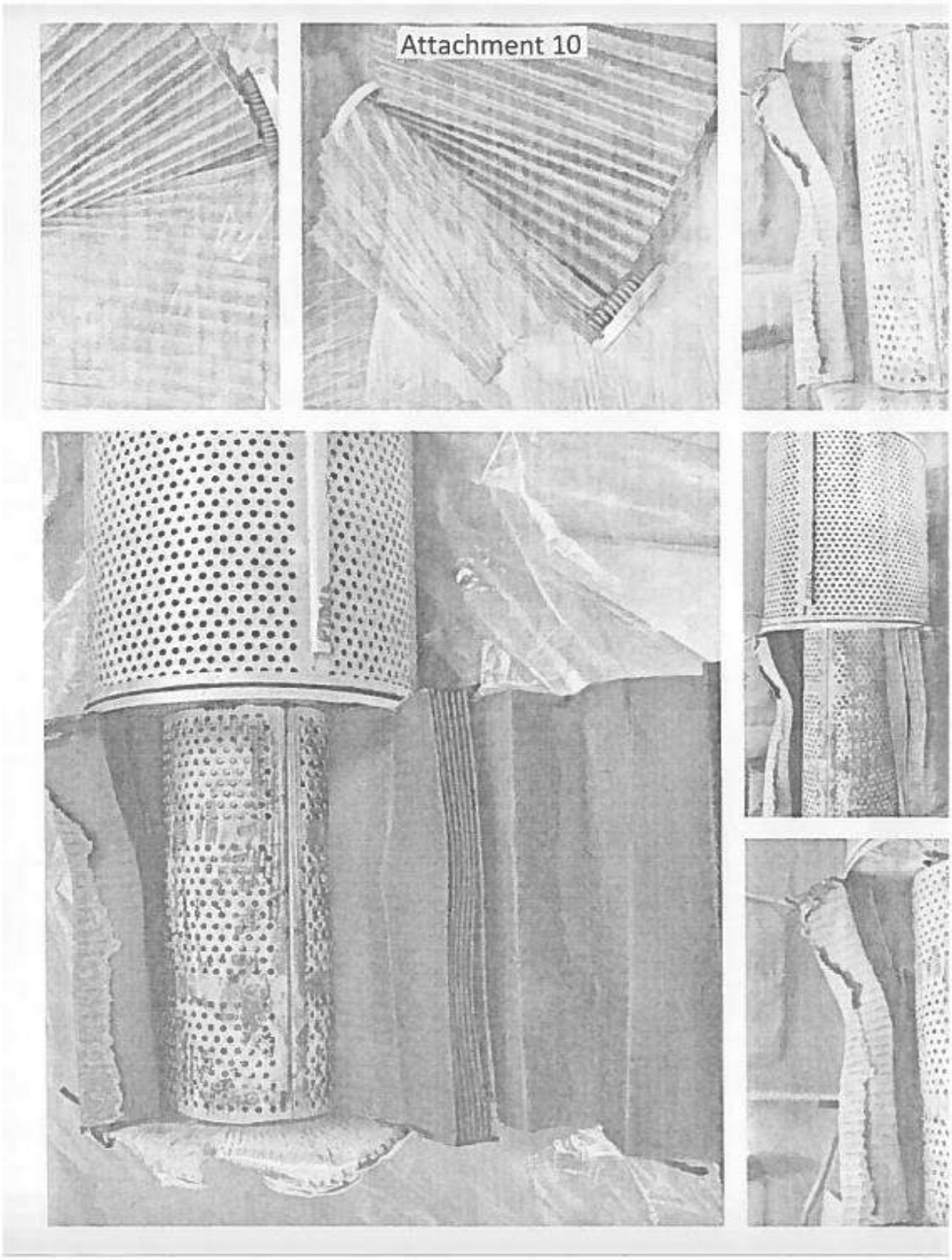
Senior Inspector: _____

2. TO: _____

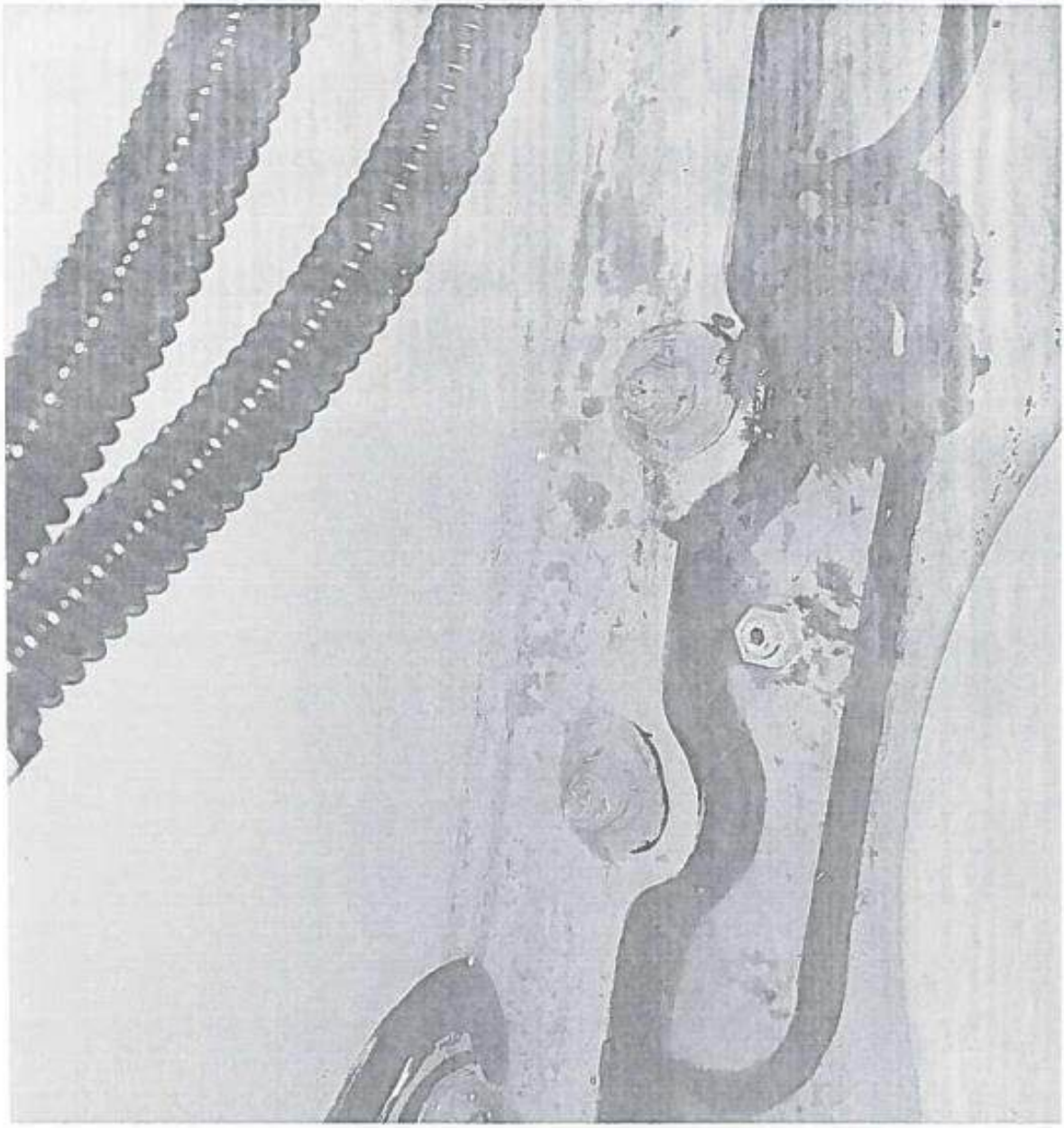
ADDRESSEE'S ACTION AND/OR REMARKS: _____

NOTE: Fuel filter was cut opened and the was brown residue that was found inside.

Please see the attached photos


Attachment 10

Attachment 11



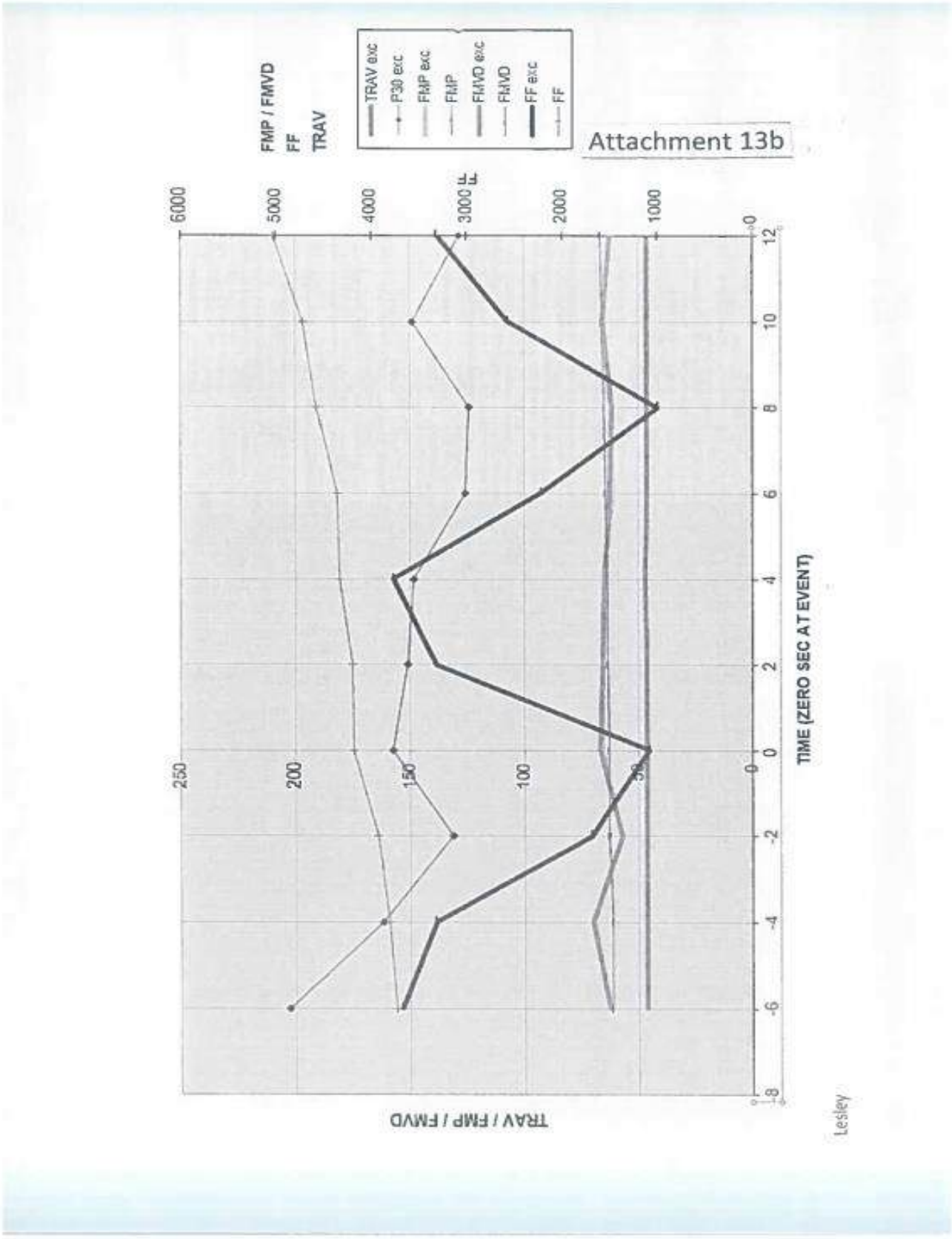
Attachment 12

Attachment 13a

From: Services Control Centre <Services.ControlCentre@Rolls-Royce.com>
Sent: 16 April 2022 10:41
To: Vorster, Henry <Henry.Vorster@Rolls-Royce.com>; Services Control Centre <Services.ControlCentre@Rolls-Royce.com>
Cc: EHM Service Desk <ehmservicedesk@controlsdata.com>
Subject: RE: ENGINE REPORT: ZS-SXM R06 22APR15 202249 SAA9053 4321.RTF

Hi Henry
Thanks for the confirmation that the surge occurred at the time of the tank fuel pump low pressure message. This correlates with the R06 report which shows unstable fuel flow readings at the time of the surge which had a relatively low P30 of ~200psi.

We do not have a requirement to t/s the surge in isolation to the fuel delivery/quality issue.


Attachment 13b
FMP / FMVD
FF
TRAV
TRAV exc
P30 exc
FMP exc
FMP
FMVD exc
FMVD
FF exc
FF
6000
5000
4000
3000
2000
1000
250
200
150
100
50
0
12
10
8
6
4
2
0
-2
-4
-6
-8
TRAV / FMP / FMVD
TIME (ZERO SEC AT EVENT)
Lesley

Attachment 13c

From: Vorster, Henry <Henry.Vorster@Rolls-Royce.com>
Sent: 16 April 2022 09:11
To: Services Control Centre <Services.ControlCentre@Rolls-Royce.com>
Cc: EHM Service Desk <ehmservicedesk@controlsdata.com>
Subject: RE: ENGINE REPORT: ZS-SXM R06 22APR15 202249 SAA9053 4321.RTF

Hi Donna,

Please find attached PFR and pilot report. (apologies for the quality, but you can sort of make out what the pilot experienced) Important to note that the "surge" occurred when they had a tank fuel pump low pressure, which also triggered the LP fuel pressure switch on the main engine fuel pump. Definite proof now that it was F/F interruption rather than an inherent surge. They then reduced the thrust on No.2 and descended to below 20K ft which is the procedure. Then they manually managed thrust thereafter till landing. Left hand tank water drain completed but the amount of water not yet know. Draining water from the R/H tank now. (No.2 Engine)

Kind regards

Henry Vorster
Senior Services Representative

henry.vorster@rolls-royce.com
T +27 11 978 3709 | M +27 82 825 8283
AST Johannesburg
South Africa
1627

APPENDIX 6: PUMA ENERGY INVESTIGATION REPORT

PUMA ENERGY

"Safety First

AIRPORT REFUELLING INVESTIGATION

Doc No. AR 122
Rev 3

DATE:	COUNTRY:	AIRPORT DEPOT:
14-15 April 2022	Ghana	ACC

Aircraft scheduled arrival time:	21:05
Aircraft actual arrival/on blocks time:	21:08
Aircraft scheduled departure time:	22:35
Aircraft actual departure time/off chocks:	

Airline:	South African Airways
Flight number:	SA052
Aircraft type:	A330

FUELLING ACTIVITY

Fuelling equipment used:	RV01 / HD01	Fuelling start time:	22:11
Requested fuelling time:	21:50	Fuelling finish time:	03:00
Equipment in position time:	22:05	Ticket signed time:	03:03
Equipment connecting time:	22:10	Quantity uplifted:	43,255

Comments:

- South African Airways flight SA052 arrived at ACC at 21:08 on 14 April, 2022. The aircraft taxied to Delta bay 1 and was chocked at 21:14
- Fuel was requested at 21:50 and Refueller RV01 was positioned under the right wing of the aircraft at 22:05 with all connections completed at 22:10. A Refueller was used for this fuelling because the parking of the aircraft did not allow access to the hydrant.
- Fuelling started at 22:11 but after pumping about 600 liters, fuelling stopped abruptly.
- The shift supervisor did some troubleshooting and realized there was no problem with the fuelling truck.
- The fuelling operator did a chemical water detector test on the fuel sample from the refueller and the result was negative.
- The Shift Supervisor then informed the flight engineer of the stoppage of flow and suggested that the flight engineer checks from the aircraft.
- The flight engineer informed the Shift Supervisor that there was a problem with the fuelling panel and that he will reset it from the cockpit for fuelling to resume
- The Engineer completed resetting of the fuelling panel and requested for fuelling to resume.
- Fuelling resumed around 22:25 but fuel flow into the aircraft stopped again after pumping an additional 1,300 litres.
- The flight engineer then did some additional checks on the aircraft and requested fuelling to resume but again flow stopped after pumping an additional 500 litres.
- This process was repeated for about 4 more times until a total volume of about 6400 litres was pumped into the aircraft at about 23:00.
- A new shift of Puma refuellers took over the fuelling activity at 23:00 and the new shift supervisor was asked to conduct another chemical water test on the fuel sample as the flight Engineer had observed a water indication on the information display panel inside the cockpit.
- The supervisor completed the water test and the result was negative.
- The flight engineer then drained some water from the aircraft's water drain points and also did a reset of the fuelling panel at about 00:05 for fuelling to resume.
- Fuelling resumed immediately but stopped again after pumping about 2600 litres.
- The engineer continued to drain some more water from the aircraft's fuel tank drain points and asked fuelling to resume but again after pumping about 2700 litres, flow stopped.
- A KLM ground technician who was invited to assist with troubleshooting also conducted a chemical water detector test on the sample from the refueller but the result was still negative.
- The KLM engineer then suggested the issue could be due to low pressure from the Refueller and suggested a different truck is used instead for the fuelling. The aircraft was repositioned at the bay to allow access to the hydrant and hydrant dispenser HD01 was connected to the aircraft.

- Fuel from the hydrant dispenser was tested for water and the result was negative.
- Fuelling resumed at 01:58. After pumping about 2000 litres the aircrafts APU went off and the fuelling panel was shut off causing fuelling to stop.
- The flight engineer drained some more water from the aircraft's drain points and a ground power unit was connected to the aircraft.
- The fuelling panel was resetted again and fuelling resumed at about 02:25
- Fuelling continued successfully and was completed at 03:00 with an additional volume of 31,587 litres pumped.

ADDITIONAL FUELING REQUEST STAND-BY TOP UP

Fuelling equipment used:	NA	Fuelling start time:	
Stand-by request time:	NA	Fuelling finish time:	
Equipment in position time:		Ticket signed time:	
Equipment connecting time:		Top up quantity:	
Comments:			

BRIEF NARRATIVE OF REASON FOR INVESTIGATION

As part of the investigations, the following have been carried out on Refueller RV01

- Quality checks have been carried out on the following points and found clear and bright.
  - ✓ Filter inlet
  - ✓ Filter outlet
- Loop test carried out on EWS functioned correctly.
- Daily quality control checks up to date

SIGN OFF:	OPERATOR:	SUPERVISOR:	DEPOT MANAGER:
Name:	David Zecoh / Isaac Amoah	Prince Yusif / Richard Kwao	Divine Dey
Date:	15/04/2022	15/04/2022	15/04/2022
Signature			

APPENDIX 7: JIG CERTIFICATE OF APPROVAL - PUMA ENERGY

JIG Standards Issue 13

INSPECTION OF AIRPORT DEPOT / HYDRANT / INTO-PLANE FACILITIES IN ACCORDANCE WITH THE JIG INSPECTION PROGRAMME

Location	Kotoka ACC-PUMA:ADHIP
Facility (Airport Depot, Hydrant or Into-Plane Service)	ADHIP
Managing/Operating Company	PUMA
Name of inspector and company	Willem Goosen - PUMA Energy
Date of visit	31-05-2022
Recommendations reviewed with	Divine Dey,
Date of issue of this report	06-06-2022
Overall Assessment (see page 2 for definitions) Note if the assessment is Less than Satisfactory, the report shall be issued within 3 weeks of the inspection and a follow-up inspection shall be scheduled within the next 6 months or preferably sooner.	Satisfactory
Last JIG inspection (name of company and date visited)	N/A -
Has a Tier 3 non-disclosure agreement been signed by all inspecting parties (where applicable)?	N/A
Have any items of a serious nature been communicated to all participants and the local manager without delay?	N/A
Last external HSSE Management System Audit (by participant or consultant) (name of company and date visited)	4 May 2022 (Level 4)
Date of last revision to local/site operating procedures	04-12-2016
Accompanied/Reviewed Inspection?	No

This document shall be used for locations registered to JIG's Inspection Tracking System, known as "JITS". This document shall be deemed a sampling review to determine the overall rating of the operation and identify areas for improvement. It is not a compliance audit.

Joint Inspection Group

Inspected to JIG Standards

This is to certify that

Puma – Kotoka ADHIP

has conducted an
Inspection to JIG Standards

On 28th June 2021 a JIG Inspector deemed this location to have met the JIG Inspection criteria

Mark Newstead
JIG General Manager

Thomas De Boer
JIG Council Chair

Disclaimer Notice: This certificate is not intended to amount to advice on which you should rely. Joint Inspection Group Limited (JIG) did not carry out the inspection. The inspection was conducted by a third-party inspector. JIG excludes all implied conditions, warranties, representations or other terms that may apply to this certificate, including but not limited to the quality of the assessment carried out by the inspector into the location which has been inspected or the accuracy, completeness or up-to-date status of this certificate. This certificate is provided "as is" and "as available" without warranty of any kind. With the exception of any liability which cannot be excluded by law, JIG excludes all liability arising from any use of this certificate. Any use of this certificate and any claims arising out of or in connection with this certificate shall be governed by the laws of England and Wales and subject to the exclusive jurisdiction of the courts of England and Wales.

APPENDIX 8: USE OF SYRINGE AND CAPSULE WATER DETECTOR MANUAL

Use of syringe and capsule water detector

PURPOSE
To test for the presence of suspended water in a sample of Jet fuel

FREQUENCY
As required.

PERSONAL PROTECTIVE EQUIPMENT (The trainer should describe the PPE required for this task, why it is needed and its correct use and maintenance)
PVC gloves, safety glasses, protective uniform.

STAGES	HSE TIPS
Go through the task or subject. Select suitable portions for the learner to master. **KEY POINTS** Anything in a stage which might: Affect the results of the task or test Cause personal injury or affect safety Result in a product spillage Make performance of the task easier or more efficient	These tips are provided for the help of trainers and trainees. This should not preclude the trainer from using his own key tips commensurate with his experience at the specific work-site.
1. CHECK EQUIPMENT 1.1. 5 ml nylon syringe 1.2. Detector capsules 1.3. Glass jar or closed sampler 1.4. Check that syringe operates freely and that the nozzle is not damaged. 1.5. Check that capsules are within the expiry date marked on the bottom of the tube. 1.6. Ensure jar or sampler is clean and free from water.	
2. FIT CAPSULE 1.1. Remove one capsule from tube (handle carefully). Do not touch or allow any moisture to come into contact with the yellow paper of the capsule. Close the tube immediately.	

1.2. With the piston of the syringe fully home, fit the capsule firmly on the nozzle. 1.3. Examine the capsule to ensure it is a uniform yellow colour. If it is not, discard it and fit another.	
3. DRAW SAMPLE 1.4. Draw a fuel sample into a jar or a sampler as per Task Procedure 9. 1.5. Immerse the capsule in the fuel sample and withdraw piston slowly until fuel reaches the 5ml mark.	Aviation Fuels are solvents and when they come into contact with exposed skin may cause it to dry out, this may eventually lead to dermatitis, always wear approved protective gloves when handling fuels. Similarly fuel splashes into the eyes may cause burning and could lead to long term eye damage, safety glasses should always be worn whenever there is a possibility of fuel splashing into the eyes. Ensure eye wash bottles are available. In any instance where open sampling is being carried out a drip tray should be used to ensure product that accidently escapes is captured. If performing this task in high winds position equipment accordingly and try to use your body as a windbreak. For HSE implications and advice regarding aviation fuel products refer to the appropriate Material Safety Data Sheet (MSDS).
4. READ RESULT 5. Examine the capsule for any change of colour between the centre wetted area and the outer annulus. 6. If there is no colour change the result is acceptable and would be recorded as "nil" suspended water. 7. The centre area of the capsule begins to turn green at suspended water concentrations of approximately 10 parts per million (ppm) and will be distinctly green at a concentration of 30 ppm. 8. A few green speckles or a slight change of colour would be recorded as a "trace". A distinct colour change would be recorded as "suspended water".	
9. AFTER SAMPLING 1.6. Dispose of the capsule safely, it can only be used once. 1.7. Empty the syringe into the sample and return the sample to a recovery tank. 1.8. Complete documentation.	When emptying the syringe ensure that the end is submerged below the level of fuel to avoid splashes onto skin or face.

Table of minimum test requirements

The following table summarises the minimum test requirements for all airport operations.

Operation	Control Check [1]	Visual Check (chemical water detector required)	Appearance Check[1]
Receipts by pipeline (dedicated or multi-product) barge/coastal vessels before and during discharge	X		
Receipts by rail or road tank car	X		
Receipt tank sample for recertification			X
Airport storage tank sump drain before release for service	X	X	
In service airport storage tanks sump drain – daily		X	
Airport storage tanks sump drain not in service (settling or awaiting release)			X
Airport fixed filter vessel sumps (receipt) and strainers			X
Airport hydrant filter, loading filter and vehicle filter sumps – daily		X	
Fueller drain points – routine off-ramp (fueller tank draining after filling)		X	
Sampling during fuelling and defuelling		X[2]	
Hydrant low point servicing vehicle tank sump flushing before use and after use – daily		X	

1 A chemical water detector test may also be performed to provide verification of free water status.
2 Requirement for hydrant servicer fuelling samples is detailed in JIG 1 5.3.2. A chemical water detector test shall be performed on at least one of the samples taken during fuelling.

APPENDIX 9: AIRCRAFT FUELING USING A FUELLER MANUAL

Aircraft fuelling using a Fueller or a Fueller / Trailer combination (pressure fuelling)

PURPOSE
To undertake fuelling operation safely to deliver aviation fuels in the correct quantities and to the correct quality standards.

FREQUENCY
As required.

PERSONAL PROTECTIVE EQUIPMENT (The trainer should describe the PPE required for this task, why it is needed and its correct use and maintenance)
Gloves, safety boots, safety glasses, hearing protection, high visibility clothing and protective uniform.

STAGES Go through the task or subject. Select suitable portions for the learner to master. KEY POINTS Anything in a stage which might: affect the results of the task or test cause personal injury or affect safety result in a product spillage make performance of the task easier or more efficient	HSSE TIPS AND OTHER INFORMATION These tips are provided for the help of trainers and trainees. This should not preclude the trainer from using his own key tips commensurate with his experience at the specific work-site.
1. INSPECTION AND CHECKS PRIOR TO DRIVING 1.1. Walk completely around the vehicle to check that the fueller is operational and ready for use. 1.2. Check that fire extinguishers are correctly stowed. 1.3. Check all of the sampling equipment carried on the vehicle. 1.4. Check the unit for leaks, defects, obstructions and that hoses are correctly stowed away. Any defects or leaks should be immediately reported to line management. 1.5. Check that the vehicle has the correct grade of fuel and quantity carried for the expected fuelling. 1.6. Check the correct vehicle is being used for underwing fuelling. 1.7. Check that you have the following: 1.8. Delivery Certificate	Whenever possible the quantity of fuel should be checked by using vehicle stock records and not by manual dipping from the vehicle top. Hearing protection should always be worn in noisy environments. Ear damage is a progressive problem which manifests itself over many years of neglect. If you have to raise your voice to be heard over the surrounding noise in the work environment, you should be wearing hearing protection

1.9. Posted Airfield Price List 1.10. card delivery equipment 1.11. calculator is available 1.12. Credit Stop List 1.13. Incident Report forms	
2. VEHICLE START UP 2.1. Check that the brake interlock and deadman seals are locked in the normal operating condition. 2.2. Move Master Battery Isolation Switch to the 'on' position. 2.3. Start the engine. 2.4. Ensure there is sufficient air pressure prior to moving. 2.5. Release the handbrake.	Do not drive vehicle with the interlock override unsealed. Report to the Supervisor if seals are not in place. Ensure seat belts are fitted and worn at all times vehicle is in motion - **mandatory requirement**.
3. DRIVE AWAY 3.1. Test the brakes as soon as possible and **before** leaving the depot. 3.2. Observe and obey depot and airport speed limits.	If the first time you use the brakes is when you are approaching the aircraft, it may be too late to avoid an accident. Even at low speeds, seat belts are compulsory and can save lives. Vehicles shall not be driven faster than 25km/h (15mph) on the apron. Where airports or local authorities specify a lower limit, this shall be obeyed. Driving at 10/15mph in a head-on collision can result in a higher combined speed. Beware of vehicle and road characteristics and risk of rollover during **all** cornering manoeuvres.
4. APPROACH AIRCRAFT AND PARK 4.1. A second brake check shall be made prior to reaching the aircraft. This must be done in a low congestion area and at least 15 metres (50 feet) before reaching the aircraft. 4.2. Check that aircraft engines have stopped and that the aircraft has been chocked before approaching. Ensure that aircraft anti-collision lights are not flashing. 4.3. Approach aircraft and park, either in the underwing or the stand off position. (Check notice in cab as to which type of approach is to be made, depending on type of aircraft to be fuelled and fueller used).	Perform brake check in such a manner as not to cause danger to other apron traffic. Venting from aircraft tanks can be potentially hazardous if the fuel spray comes into contact with hot surfaces. Always avoid creating the fire triangle (fuel, oxygen, ignition source) by keeping a good clearance from the vents and hot surfaces of the fueller.

4.4. Stand off fuellings must be made with no part of the fueller under aircraft tank vents. The vehicle engine and exhausts shall be at least 3 metres (10 feet) away from the aircraft vents. 4.5. Reversing to or from aircraft shall be avoided unless no other alternative is available. If reversing has to be undertaken, a guide person shall be present during vehicle manoeuvring. Truck and trailer combinations shall not be reversed into position. **Note: Reversing onto or from the aircraft is not permissible for a fueller/trailer combination.** 4.6. Underwing approaches should preferably be made from the rear of aircraft, taking great care to stay well clear of aircraft control surfaces and engines. 4.7. Park the fueller ensuring that there are no obstructions in front of the vehicle, which may prevent it being driven away in the event of an emergency. It is important to ensure that the vehicle's exit is not obstructed at any time during the fuelling operation. 4.8. Apply the handbrake	
5. BOND VEHICLE 5.1. Always bond to a designated point on the aircraft (usually located on the undercarriage). The clip shall not be attached to propellers, radio antennae, pitot tubes, or the exhaust nozzle of a piston engine or turbine engine. 5.2. Ensure that the bonding point is located on an unpainted surface. 5.3. If sparking occurs while trying to bond, do not connect fuelling hose until the defect is rectified. 5.4. If fuelling steps are being used (rig steps) these should also be bonded before fuelling begins. (Bond the vehicle to the steps and then the steps to the aircraft).	Bonding to painted surfaces does not provide electrical continuity. Poor electrical continuity will lead to static electricity build up which could provide an ignition source and result in a fire.
6. POSITION AUXILIARY EQUIPMENT AND PREPARE TO FUEL 6.1. Position ladders/steps/platform such that hoses will fall vertically. 6.2. Unwind the hose(s). Position the hose(s) behind the steps / ladder so that they do not present a trip hazard when using or alighting from them. 6.3. Open fuelling panel on the aircraft. (Airline representative personnel should carry out the task of operating aircraft fuel panels unless special arrangements have been made with the airline concerned.) 6.4. Prior to connection of the delivery nozzle(s), the aircraft adaptor(s) shall be checked to ensure that there are no missing or broken lugs, loose or missing securing screws, cracks, excessive	Manual handling can be a problem when working with portable ladders. Bending the back, or twisting movements when lifting, can put pressure on the discs in the back. The condition is progressive and may lead to long-term back pain. To avoid this type of problem, always keep your back straight and bend the knees to lift. Avoid twisting when positioning the ladders. Moving the feet will help to avoid twisting the back. Always ensure that you are properly balanced when working from ladders. Many accidents are caused when

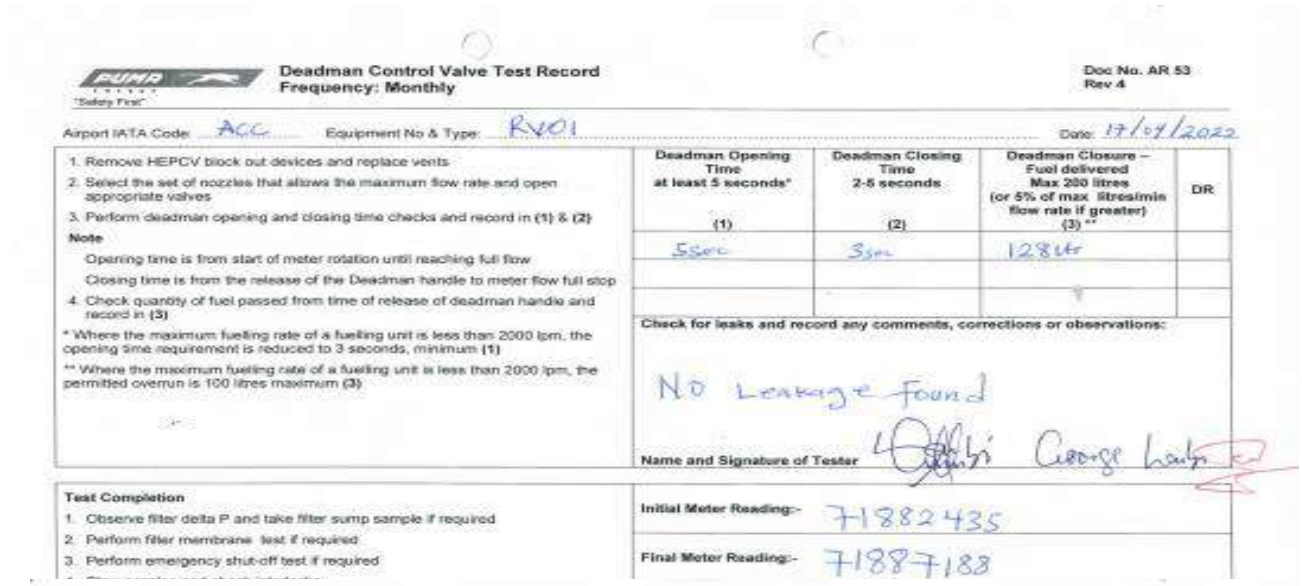
wear or other obvious damage or contamination. Suspect adaptors should be brought to the attention of airline staff for correction before the fuelling can commence. Fuelling staff shall not attempt to tighten loose adaptors themselves. If the condition of the adaptor is considered unsafe, fuelling shall not commence. 6.5. Couple hose(s) to the aircraft. 6.6. After connection, and before commencing fuel flow, rotate nozzle handles to the locked position and open poppet actuation lever. Attempt to remove nozzle – if nozzle can be removed, then its interlock mechanism is defective and it must be removed from service.	people do not remember the three points of contact rule when going up or down ladders. Place the hose on the ladder instead of carrying it up and being off balance. The space on the ladder is limited. Be aware of knocking your head on the fuel panel. Wear a bump cap. Try to avoid excessive bending of the neck when coupling as this, combined with lifting the coupling above the head, puts pressure on the discs in the upper back. Where fitted, keep head away from fuel panel doors when opening. Release catches and slowly open door. Door must be secured in the open position.
7. FUEL AIRCRAFT 7.1. Engage vehicle power take-off (PTO). 7.2. Open the vehicle foot valve. 7.3. Ensure that the vehicle meters are zeroed and also ensure that the totaliser meter figure matches the figure on the flight delivery ticket. 7.4. Note the aircraft registration number, fuel, grade, payment card (if applicable) etc. on the flight receipt. 7.5. Obtain required fuel quantities from airline (or representative). 7.6. On a trailer/fueller combination, open the trailer foot valve. The trailer must be emptied first. 7.7. Operate the vehicle deadman valve and vehicle meter valves. 7.8. Adjust pump speed to obtain maximum flow rate required for the aircraft, ensuring that the maximum rated flow for the hoses in use is not exceeded. 7.9. Examine the nozzle to aircraft adaptor to ensure that there is no leakage. 7.10. When fuelling via an elevated platform, the platform should not be raised or lowered while fuelling is taking place. Fuel flow shall be stopped whenever it is necessary to raise or lower the platform. 7.11. Wherever possible, fuelling should be performed with the operator on the ground, not on the fuelling platform. 7.12. Check the pressure gauge readings on the fuelling panel for any abnormalities. In particular, the differential pressure gauge, to confirm that the vehicle filter is functioning correctly. The results of this check shall be recorded.	To avoid any fuel splashes in the eyes, wear safety glasses. A risk of a static discharge may rise from removing garments (irrespective of anti-static properties) in potentially flammable atmospheres. If an individual is exposed to either Jet or Avgas and clothing is heavily contaminated, the recommended practice is for the individual to shower with water while still fully clothed and then slowly remove clothing to wash underlying skin with soap and water. During the fuelling operation, where possible, keep clear of aircraft vents, remain vigilant and cease pumping if you see the aircraft venting. Beware of other service provider activities around aircraft during refuelling operations and check that fuelling zones are kept clear of unauthorised personnel and equipment. Staff should position themselves at ground level and in front of the vehicle fuelling controls throughout the fuelling operation. If there is any need to move a fuelling platform during fuelling, the flow of fuel must be ceased as a precaution until the platform movement is completed. The movement of the platform may cause stresses on the fuelling hoses and the couplings, with consequent risk of damage or even spillage.

Note: Maximum differential pressure reading for FWS and Filter Monitors is 15psi, (subject to no sudden change in readings). 7.13. With a fueller / trailer combination, where the volume delivered from the trailer is sufficient for the fuelling, then close the foot valve on the trailer on completion of fuelling. In the case where the volume to be delivered is more than the volume available from the trailer, release the deadman valve to stop the flow when the determined quantity available in the trailer is delivered and close the foot valve of the trailer. Note the volume of fuel delivered from the trailer in the remarks column of the Flight Delivery Certificate (DC). 7.14. To continue fuelling, open the foot valve of the fueller and operate the deadman valve. If the volume in the fueller is sufficient to complete the aircraft fuelling requirements, close the foot valve on the fueller after delivering the required fuel. Note the volume delivered from the fueller in the remarks column of the DC. If the volume in the fueller is insufficient, then continue the aircraft fuelling until the available volume in the fueller is dispensed. Operate the deadman valve to stop fuel flow, close the foot valve and note the volume dispensed in the remarks column of the DC.	
8. SAMPLE FUELLER DURING FUELLING OPERATIONS 8.1. For fuellers and fuelling trucks fitted with a filter monitor. 8.2. In addition to the pre-use checks, where appropriate sampling equipment is available on the fueller or fuelling truck, a minimum 1 litre sample shall be drawn at each fuelling and subject to a visual check and, for jet fuel, a syringe and capsule water detector test. 8.3. After the product in the sampling piping has been flushed out, the sample may be taken either: 8.4. At the start of a fuelling operation, immediately after the fuel contained in the main piping and filter vessel has been displaced and full flow has been established, from the outlet side (downstream) of the filter monitor. **Or** 8.5. Immediately after fuelling has been completed from the inlet side (upstream) of the filter monitor. 8.6. Where appropriate sampling equipment is not available on the fueller or fuelling truck, and if not already covered by the pre-use checks required in the a sample shall be drawn and checked each time before the fueller leaves the depot to undertake a fuelling or a consecutive series of fuellings (with no delays between each fuelling). 8.7. After the product in the sampling piping has been flushed out, the procedure shall be for a minimum of a 1 litre sample to be drawn from the fueller tank sump and subjected to a visual check and, for jet fuel, a syringe and capsule water detector test. Any water found shall be	The additional sampling procedures have been introduced in response to the current performance concerns relating to filter monitors. Aviation fuels are solvents and can cause dermatitis by removing natural oils from the skin, always wear the approved protective gloves when sampling and handling the fuel. Similarly, fuel splashes into the eyes may cause burning and could lead to long term eye damage. Safety glasses should always be worn whenever there is a possibility of fuel splashing into the eyes. Ensure eye wash bottles are available. For HSSE implications and advice regarding aviation fuel products refer to the appropriate Material Safety Data Sheet (MSDS).

drained. Sampling and draining shall be repeated until the fuel passes the water detector test. 8.8. Additionally, if required by the airline, take a minimum 2 litre sample from a sample point downstream of the filter water separator or monitor and show it to the Airline Representative. Perform a syringe and capsule water detector test if required. 8.9. For any sample taken from fueller fuellings downstream of the filter monitor, if more than a trace of free or suspended water is found with the syringe and capsule or a distinctive colour change is obtained, the Airline Representative shall be informed immediately and no further fuelling/top up shall be made until the reason for the presence of water has been determined and remedial action taken, including the change-out of the elements. This shall be done even if a second sample taken from the outlet side (downstream) of the filter monitor is water-free. 8.10. For any sample taken from upstream of filter monitor, if more than a trace of free or suspended water is found with the syringe and capsule or a distinctive colour change is obtained, a sample downstream shall be taken. If no water is observed, the fuelling will be viewed as complete. If, however, more than a trace of free or suspended water is found with the syringe and capsule or a distinctive colour change is obtained, the Airline Representative shall be informed immediately and no further fuelling/top up shall be made until the reason for the presence of water has been determined and remedial action taken, including the change-out of the elements. This shall be done even if a second sample taken from the outlet side (downstream) of the filter monitor is water-free.	
9. CLOSE VALVES 9.1. Close all the delivery meter valves in order to complete the fuelling at the required figure. 9.2. Release the vehicle deadman valve. 9.3. Confirm that the engine speed has returned to idle. 9.4. Note: 9.5. If the vehicle is on standby for more than 10 minutes, disengage PTO. 9.6. Close foot valve to tank. 9.7. Enter final meter totaliser readings on the Flight Delivery Certificate. Sign the certificate and obtain the Airline Representative signature for quantities and quality of product delivered. Hand over the airline copy to the representative. **Note: Any density measurements required by airlines shall not be recorded on delivery certificates.** 9.8. Zero the vehicle meters.	To prevent possible injury to the operator the hose shall be re-wound in a safe and controlled manner. If the hose is re-wound without full control of the coupling the operator may get injuries to legs and arms due to the whiplash effect of the hose as it is being returned to its stowage point.

9.9. Disconnect hose coupling(s) from aircraft. 9.10. The aircraft adaptor(s) shall be checked to ensure that there are no missing or broken lugs, loose or missing securing screws, cracks, excessive wear or other obvious damage or contamination. Suspect adaptors should be brought to the attention of airline staff for correction. Fuelling Staff shall not attempt to tighten loose adaptors themselves.	
10. REWIND HOSE(S) 10.1. In the case of a platform operation, place couplings in their stowage points and lower platform. 10.2. In the case of reel hoses pull one coupling at a time to fueller first. (When pulling place hose over shoulder to reduce risk of back strain). Never drag couplings on ground. 10.3. Place the reel hose couplings on ground near fuel compartment of vehicle. 10.4. To prevent possible injury, slowly activate rewind system of fueller to pull in hoses. Stand clear of hoses during rewind. **Note: Fuelling hoses may be laid on the ground next to the vehicle during rewind until the hose is nearly fully rewound (at which time it must be lifted and held).** 10.5. At the point when the hose is fully rewound, stop the rewind system and place the hose end coupling in its stowage	When pulling, place the hose over the shoulder to reduce the risk of back strain. This method is preferred because it keeps the back aligned. Other methods may cause twisting and put pressures on the discs in the back, which may result in back damage over a period of time. Never drag couplings on the ground. Dragging couplings will cause wear and tear and can lead to the coupling malfunctioning on its next use. Damaged couplings may lead to fuel leaks and sprays onto hot aircraft engines with a resultant risk of fires. To prevent possible injury to the operator the hose shall be re-wound in a safe and controlled manner. If the hose is re-wound without full control of the coupling the operator may get injuries to legs and arms due to the whiplash effect of the hose as it is being returned to its stowage point.
11. CLEAR EQUIPMENT AND COMPLETE DELIVERY CERTIFICATE 11.1. Remove and stow auxiliary equipment such as sample bottles, portable ladders, platforms etc. 11.2. Remove the bonding cable from the aircraft and stow. 11.3. Complete the Delivery Certificate, including payment card number (if applicable), aircraft registration, quantities and grade of fuel, and obtain the Pilot/Engineer or Airline Representative's signature. 11.4. Walk completely around the vehicle to check for obstructions and to ensure that all auxiliary equipment has been properly stowed away. Look up. 11.5. Disengage power take-off, release the handbrake and drive the vehicle away.	It is always important to walk round the vehicle after completion of the fuelling operation. It is a busy operation and if your pattern of work has been interrupted for any reason and your sequence broken you may inadvertently have missed a stage, this situation occasionally leads to drive away incidents. The walk around must be a conscious, deliberate step at the completion of every refuelling. A complete circuit must be made around the vehicle to ensure all hoses are stowed and no obstacles impede egress. This must also include looking up to ensure that deck hoses are no longer connected. Ensure seat belts are worn at all times when the vehicle is in motion – **mandatory requirement**.

APPENDIX 10: MAINTENANCE RECORDS OF VEHICLES (RV01 AND HD01)



PUMA ENERGY
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Deadman Control Valve Test Record
Frequency: Monthly

Doc No. AR 53
Rev 4

Airport IATA Code: ACC Equipment No & Type: RV01 Date: 17/04/2022

1. Remove HEPCV block out devices and replace vents
2. Select the set of nozzles that allows the maximum flow rate and open appropriate valves
3. Perform deadman opening and closing time checks and record in (1) & (2)

Note

Opening time is from start of meter rotation until reaching full flow

Closing time is from the release of the Deadman handle to meter flow full stop

4. Check quantity of fuel passed from time of release of deadman handle and record in (3)

* Where the maximum fuelling rate of a fuelling unit is less than 2000 lpm, the opening time requirement is reduced to 3 seconds, minimum (1)

** Where the maximum fuelling rate of a fuelling unit is less than 2000 lpm, the permitted overrun is 100 litres maximum (3)

Deadman Opening Time at least 5 seconds* (1)	Deadman Closing Time 2-5 seconds (2)	Deadman Closure – Fuel delivered Max 200 litres (or 5% of max litres/min flow rate if greater) (3) **	DR
5sec	3sec	128Lts	

Check for leaks and record any comments, corrections or observations:

No Leakage Found

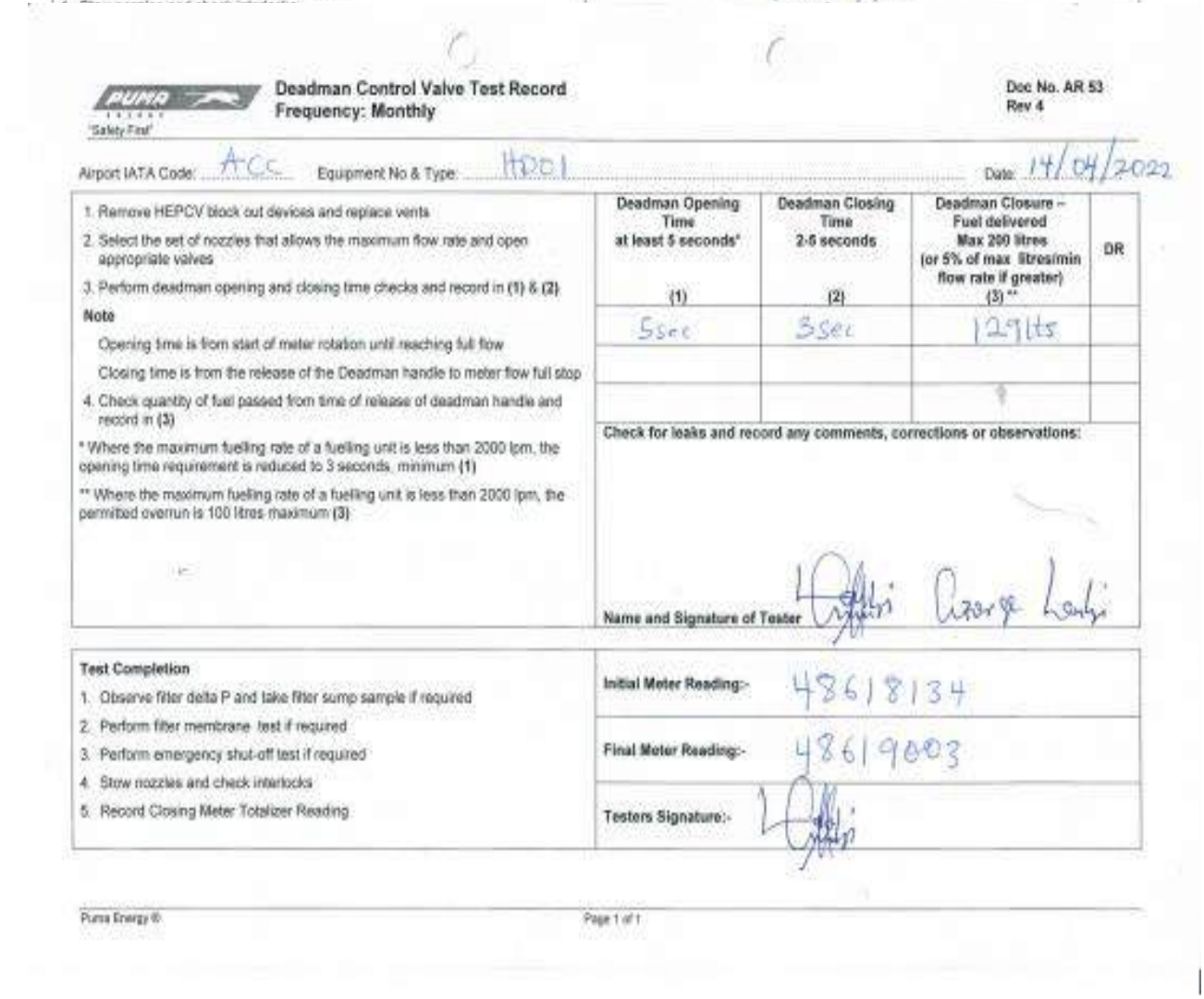
Name and Signature of Tester George Lartey

Test Completion

1. Observe filter delta P and take filter sump sample if required
2. Perform filter membrane test if required
3. Perform emergency shut-off test if required

Initial Meter Reading:- 71882435

Final Meter Reading:- 71887188



PUMA ENERGY
"Safety First"

Deadman Control Valve Test Record
Frequency: Monthly

Doc No. AR 53
Rev 4

Airport IATA Code: ACC Equipment No & Type: HD01 Date: 17/04/2022

1. Remove HEPCV block out devices and replace vents
2. Select the set of nozzles that allows the maximum flow rate and open appropriate valves
3. Perform deadman opening and closing time checks and record in (1) & (2)

Note

Opening time is from start of meter rotation until reaching full flow

Closing time is from the release of the Deadman handle to meter flow full stop

4. Check quantity of fuel passed from time of release of deadman handle and record in (3)

* Where the maximum fuelling rate of a fuelling unit is less than 2000 lpm, the opening time requirement is reduced to 3 seconds, minimum (1)

** Where the maximum fuelling rate of a fuelling unit is less than 2000 lpm, the permitted overrun is 100 litres maximum (3)

Deadman Opening Time at least 5 seconds* (1)	Deadman Closing Time 2-5 seconds (2)	Deadman Closure – Fuel delivered Max 200 litres (or 5% of max litres/min flow rate if greater) (3) **	DR
5sec	3sec	129Lts	

Check for leaks and record any comments, corrections or observations:

Name and Signature of Tester George Lartey

Test Completion

1. Observe filter delta P and take filter sump sample if required
2. Perform filter membrane test if required
3. Perform emergency shut-off test if required
4. Stow nozzles and check interlocks
5. Record Closing Meter Totalizer Reading

Initial Meter Reading:- 48618134

Final Meter Reading:- 48619003

Testers Signature:-

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Fire Extinguisher Inspection Record
Frequency: Monthly

Doc No. AR 20
Rev 0

Airport IATA Code: ACC Equipment No & Type: RVEL Year: 2022

Date	No.	Look at the pressure gauge ensure the indicator is reading green. Check the condition of the extinguisher housing Unit	Name & Signature
4/04/22	FE01	In good Condition	
	FE02	In good Condition	
	CA1	In good Condition	
	DE1	In good Condition	
16/05/22	FE01	In good Condition	
	FE02	In good Condition	
	CA1	In good Condition	
	DE1	In good Condition	
16/06/22	FE01	In good Condition	
	FE02	In good Condition	
	DE1	In good Condition	
	CA1	In good Condition	

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PUMA ENERGY
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Fire Extinguisher Inspection Record
Frequency: Monthly

Doc No. AR 20
Rev 0

Airport IATA Code: AXS Equipment No & Type: HD01 Year: 2022

Date	No.	Look at the pressure gauge ensure the indicator is reading green. Check the condition of the extinguisher housing Unit	Name & Signature
12/04/22	FE01	In good Condition	
	FE02	In good Condition	
	GM	In good Condition	
	DE1	In good Condition	
16/05/22	FE01	In good Condition	
	FE02	In good Condition	
	GM	In good Condition	
	DE1	In good Condition	
16/06/22	FE01	In good Condition	
	FE02	In good Condition	
	GM	In good Condition	
	DE1	In good Condition	

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PUMA ENERGY
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Fueller Monthly Inspection Record
Frequency: Monthly

Doc No. AR 38
Rev 4

Airport IATA Code: ACC Equipment No & Type: ACC RVD1 Year: 2022

Criteria	Record	Result	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
General Inspection for Damage, Cleanliness & Leaks		Pass / Fail	Pass	Pass	Pass	Pass	Pass	Pass						
Fuel, Engine Oil & Radiator Water reservoir - Visual Check		Pass / Fail	Pass	Pass	Pass	Pass	Pass	Pass						
Interlock override seals		Pass / Fail	Pass	Pass	Pass	Pass	Pass	Pass						
Interlock function, override switch and warning lights		Pass / Fail	Pass	Pass	Pass	Pass	Pass	Pass						
Deadman override seals		Pass / Fail	Pass	Pass	Pass	Pass	Pass	Pass						
All Tyres, correct pressure, wheel nuts and damages		Pass / Fail	Pass	Pass	Pass	Pass	Pass	Pass						
Fueller tank top visual inspection (Note 1)		Pass / Fail	Pass	Pass	Pass	Pass	Pass	Pass						
Flushing of Underwing fuelling hoses not used within one month		Used / Flushed	Used	Used	Used	Used	Used	Used						
All Emergency Stop Devices		Pass / Fail	Pass	Pass	Pass	Pass	Pass	Pass						
Report Written: Unsafe Practice Condition (UPC) Defect Report (DR)														
Date:			8/1/22	8/02/22	11/03/22	11/04/22	17/05/22	16/06/22						
Signature														

Note 1: It is only necessary to climb up the ladder and look over the top to visually inspect the roof. Should debris be found only then is it necessary to climb onto the roof with the appropriate protection in place to clean and remove debris.

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Hydrant Dispenser Monthly Inspection Record
Frequency: Monthly

Doc No. AF
Rev 3

Airport IATA Code: ACC Equipment No & Type: HD01 Year: 2022

Criteria	Record	Result	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov
General Inspection for Damage, Cleanliness & Leaks		Pass / Fail	Pass	Pass	Pass	Pass	Pass	Pass					
Fuel, Engine Oil & Radiator Water reservoir - Visual Check		Pass / Fail	Pass	Pass	Pass	Pass	Pass	Pass					
Interlock override seals		Pass / Fail	Pass	Pass	Pass	Pass	Pass	Pass					
Interlock function, override switch and warning lights		Pass / Fail	Pass	Pass	Pass	Pass	Pass	Pass					
Deadman override seals		Pass / Fail	Pass	Pass	Pass	Pass	Pass	Pass					
All Tyres, correct pressure, wheel nuts and damages		Pass / Fail	Pass	Pass	Pass	Pass	Pass	Pass					
Flushing of fuelling hoses not used within one month		Used / Flushed	Used	Used	Used	Used	Used	Used					
All Emergency Stop Devices		Pass / Fail	Pass	Pass	Pass	Pass	Pass	Pass					
Report Written: Unsafe Practice Condition (UPC) Defect Report (DR)													
Date:			1/1/22	1/02/22	15/03/22	13/04/22	11/05/22	10/06/22					
Name of Operator													
Signature													

Note 1: It is only necessary to climb up the ladder and look over the top to visually inspect the roof. Should debris be found only then is it necessary to climb onto with the appropriate protection in place to clean and remove debris.

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PUMA ENERGY
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Over wing Reel Hose Coupler, Nozzle & Strainer Inspection & Maintenance Record.
Frequency: Monthly

Doc No. AR 02
Rev 2

Airport IATA Code: ACC Equipment No. & Type: RV0 1 Grade of Fuel: JET A-1

Coupling, Nozzle Type & Size: EATON

Date	Hose No.	Details of Inspection: i.e. Within tolerance & put back in service / Strainer broken & replaced / etc	Name & Signature
13/01/22	01	No Sediment found, Strainer OK	George
11/02/22	01	No Sediment found, Strainer OK	Lalji
11/03/22	01	No Sediment found, Strainer OK	Lalji
14/04/22	01	No Sediment found, Strainer OK	George
16/05/22	01	No Sediment found, Strainer OK	Lalji
16/06/22	01	No Sediment found, Strainer OK	George
14/07/22	01	No sediment found, Strainer OK	

Note: **Circulate 1000 litres of product through hose prior to putting unit back into service.**

- Use Carter Quick Disconnect Couplings Wear Gauge Model No. IF220351 & Poppet Adjustment Gauge Model No. 64000 when required & Carter type 61657-2 aircraft adaptor wear gauge
- Prior to disassembling Quick Disconnect, Slide the Sleeve to the locked position (away from the threaded end of the Housing and lock it in place with one Screw. Attempt to insert gauge IF220351 into the open end (opposite to the threaded end). If the gauge slides into the part, the Sleeve is worn out and has to be replaced.

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Hose End Coupler, Nozzle & Strainer Inspection & Maintenance Record.
Frequency: Monthly

Doc No. AR 02
Rev 2

Airport IATA Code: ACC Equipment No. & Type: HD01 Grade of Fuel: JET A-1

Coupling, Nozzle Type & Size: ELAFLEX PN 47013 2½

Date	Hose No.	Details of Inspection: i.e. Within tolerance & put back in service / Strainer broken & replaced / etc	Signature
15/02/22	38	No Sediments, No leakage, Strainer ok	
	39	No Sediments, No leakage, Strainer ok	
10/03/22	38	No Sediments, No leakage and Strainer is ok	
	39	Strainer ok. No Sediments, no leakage	
13/04/22	38	Strainer ok. No Sediments, no leakage	
13/04/22	39	Strainer ok. No Sediments, No leakage	
16/05/22	38	Strainer ok, No Sediments, No leakage	
16/05/22	39	Strainer ok, No Sediments, No leakage	
16/06/22	38	Strainer ok, No Sediments, No Leakage	
16/06/22	39	Strainer ok, No Sediments, No Leakage	

Note: Circulate 1000 litres of product through hose prior to putting unit back into service.

- Use Carter Quick Disconnect Couplings Wear Gauge Model No. IF220351 & Poppet Adjustment Gauge Model No. 64000 when required & Carter type 61657-2 aircraft adaptor wear gauge
- Prior to disassembling Quick Disconnect, Slide the Sleeve to the locked position (away from the threaded end of the Housing and lock it in place with one Screw. Attempt to insert gauge IF220351 into the open end (opposite to the threaded end). If the gauge slides into the part, the Sleeve is worn out and has to be replaced.
- If the gauge does not enter the part, the unit is acceptable for use and disassembly can continue.

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Under Wing Reel Hose QD & Strainer Inspection & Maintenance Record.
Frequency: Monthly

Doc No. AR 02
Rev 2

Airport IATA Code: ACC Equipment No. & Type: GH REEL Grade of Fuel: JET A-1

Coupling, Nozzle Type & Size: EATON 50mm

Date	Hose No.	Details of Inspection: i.e. Within tolerance & put back in service / Strainer broken & replaced / etc	Signature
14/12/21	06	No sediment found, strainer ok	
18/01/22	06	No sediment found, Strainer ok	
11/02/22	06	No Sediment found, Strainer ok	
11/03/22	06	No Sediment found, Strainer OK	
13/04/22	06	No Sediment found, Strainer ok	
16/04/22	06	No Sediment found, Strainer ok	
16/06/22	06	No Sediment found, Strainer ok	

Note: **Circulate 1000 litres of product through hose prior to putting unit back into service.**

- Use Carter Quick Disconnect Couplings Wear Gauge Model No. IF220351 & Poppet Adjustment Gauge Model No. 64000 when required & Carter type 61657-2 aircraft adaptor wear gauge
- Prior to disassembling Quick Disconnect, Slide the Sleeve to the locked position (away from the threaded end of the Housing and lock it in place with one Screw. Attempt to insert gauge IF220351 into the open end (opposite to the threaded end). If the gauge slides into the part, the Sleeve is worn out and has to be replaced.
- If the gauge does not enter the part, the unit is acceptable for use and disassembly can continue.

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Under Wing Reel Hose QD & Strainer Inspection & Maintenance Record.
Frequency: Monthly

Doc No. AR 02
Rev 2

Airport IATA Code: ACC Equipment No. & Type: HD01 (UNDERWING REEL HOSE) Grade of Fuel: JET-A1

Coupling, Nozzle Type & Size: EATON 2" (PN-47013)

Date	Hose No.	Details of Inspection: i.e. Within tolerance & put back in service / Strainer broken & replaced / etc	Signature
14/01/22	37	Hose end coupler ok, strainer checked and ok	
14/02/22	37	Hose end Coupler ok, Strainer checked and ok	
16/03/22	37	Hose end Coupler ok, Strainer checked and it ok	
12/04/22	37	Hose end Coupler ok, Strainer checked and it ok	
16/05/22	37	Hose end Coupler ok, Strainer checked and it ok	
16/6/22	37	Hose end Coupler ok, Strainer Checked and it ok	

Note: **Circulate 1000 litres of product through hose prior to putting unit back into service.**

- Use Carter Quick Disconnect Couplings Wear Gauge Model No. IF220351 & Poppet Adjustment Gauge Model No. 64000 when required & Carter type 61657-2 aircraft adaptor wear gauge
- Prior to disassembling Quick Disconnect, Slide the Sleeve to the locked position (away from the threaded end of the Housing and lock it in place with one Screw. Attempt to insert gauge IF220351 into the open end (opposite to the threaded end). If the gauge slides into the part, the Sleeve is worn out and has to be replaced.
- If the gauge does not enter the part, the unit is acceptable for use and disassembly can continue.

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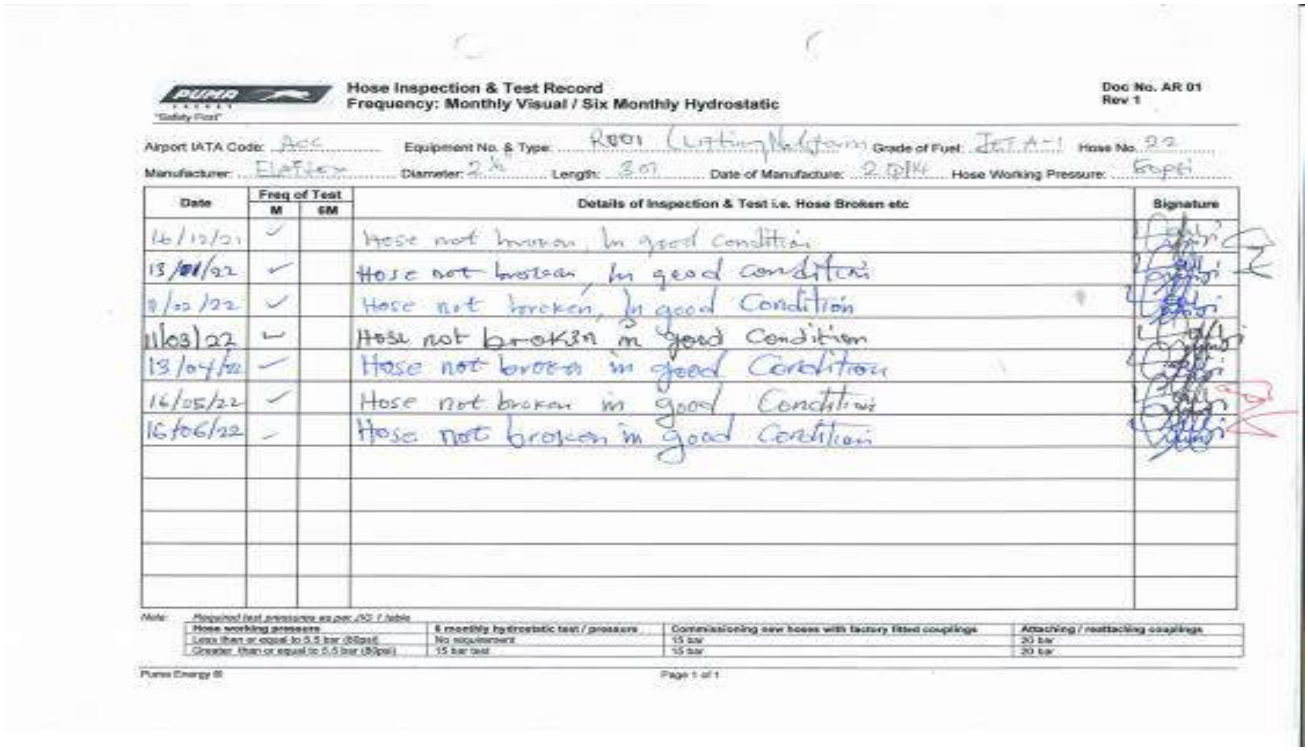
Page 1 of 1



Hose Inspection & Test Record
Frequency: Monthly Visual / Six Monthly Hydrostatic

Doc No. AR 01
Rev 1

Airport IATA Code: ACC Equipment No. & Type: R001 (Cutting Platform) Grade of Fuel: JET A-1 Hose No. 22
Manufacturer: Elaflex Diameter: 2" Length: 30' Date of Manufacture: 2018 Hose Working Pressure: 60psi

Date	Freq of Test M	Freq of Test 6M	Details of Inspection & Test i.e. Hose Broken etc	Signature
16/12/21	✓		Hose not broken, in good condition	
13/01/22	✓		Hose not broken, in good condition	
9/02/22	✓		Hose not broken, in good Condition	
11/03/22	✓		Hose not broken in good Condition	
13/04/22	✓		Hose not broken in good Condition	
16/05/22	✓		Hose not broken in good Condition	
16/06/22	✓		Hose not broken in good Condition	

Note: *Required test pressures as per JIG 1 table*

Hose working pressure	6 monthly hydrostatic test / pressure	Commissioning new hoses with factory fitted couplings	Attaching / reattaching couplings
Less than or equal to 5.5 bar (80psi)	No requirement	15 bar	20 bar
Greater than or equal to 5.5 bar (80psi)	15 bar test	15 bar	20 bar

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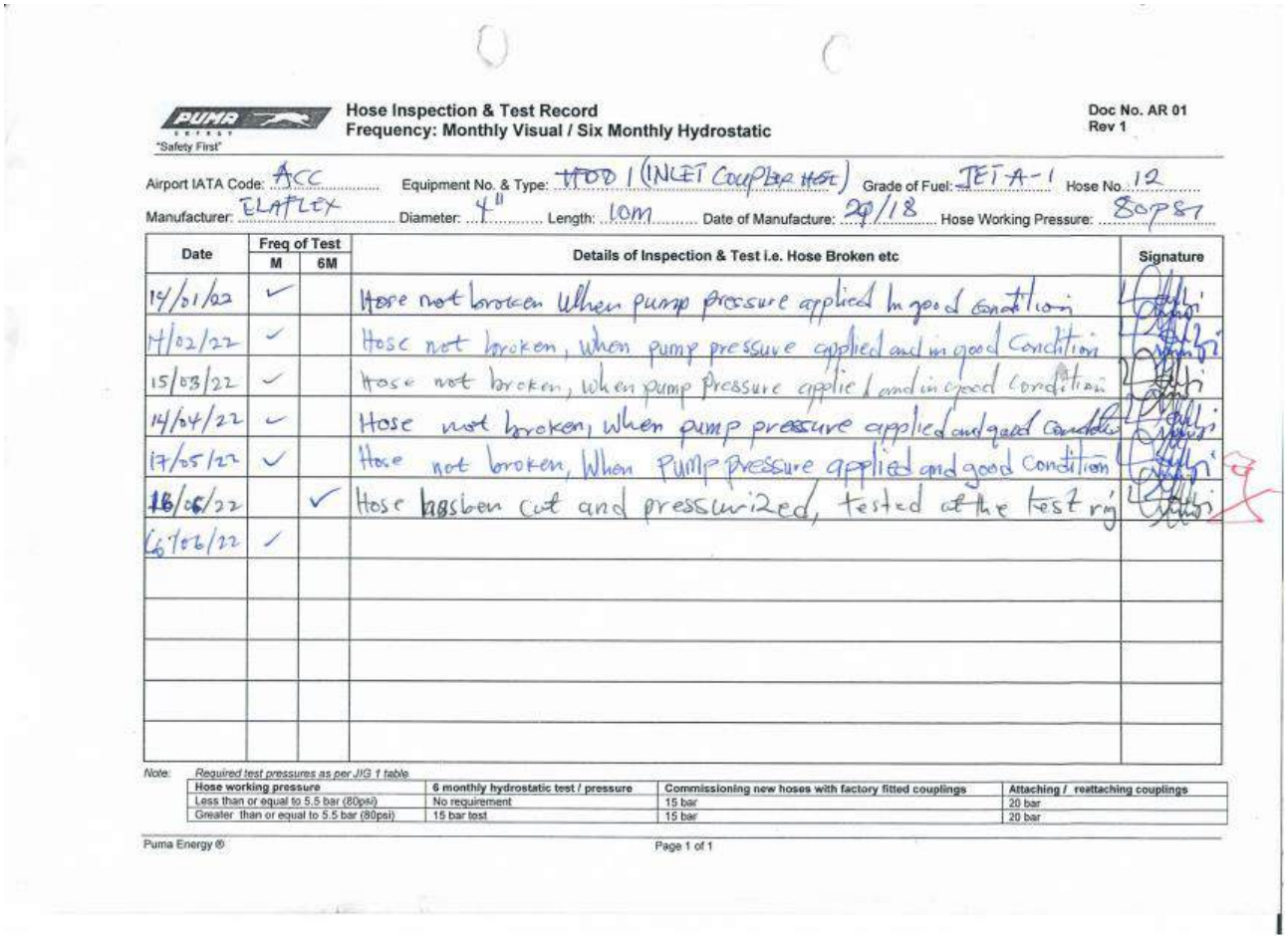

Hose Inspection & Test Record
Frequency: Monthly Visual / Six Monthly Hydrostatic

Doc No. AR 01
Rev 1

Airport IATA Code: ACC Equipment No. & Type: HOSE 1 (INLET COUPLER HOSE) Grade of Fuel: JET A-1 Hose No. 12
Manufacturer: ELAFLEX Diameter: 4" Length: 10m Date of Manufacture: 2018 Hose Working Pressure: 80psi

Date	Freq of Test M	Freq of Test 6M	Details of Inspection & Test i.e. Hose Broken etc	Signature
14/01/22	✓		Hose not broken when pump pressure applied in good condition	
14/02/22	✓		Hose not broken, when pump pressure applied and in good Condition	
15/03/22	✓		Hose not broken, when pump Pressure applied and in good Condition	
14/04/22	✓		Hose not broken, when pump pressure applied and good Condition	
17/05/22	✓		Hose not broken, When Pump Pressure applied and good Condition	
16/06/22		✓	Hose has been cut and pressurized, tested at the testing	
6/06/22	✓			

Note: *Required test pressures as per JIG 1 table*

Hose working pressure	6 monthly hydrostatic test / pressure	Commissioning new hoses with factory fitted couplings	Attaching / reattaching couplings
Less than or equal to 5.5 bar (80psi)	No requirement	15 bar	20 bar
Greater than or equal to 5.5 bar (80psi)	15 bar test	15 bar	20 bar

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PUMA ENERGY
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Hose Inspection & Test Record
Frequency: Monthly Visual / Six Monthly Hydrostatic

Doc No. AR 01
Rev 1

Airport IATA Code: ACC Equipment No. & Type: HD 01 LINES 1 AND 2 Grade of Fuel: JET A-1 Hose No. Hose 37

Manufacturer: Star Master Diameter: 8mm Length: 13 meters Date of Manufacture: Q1 2021 Hose Working Pressure: 400 PSI

Date	Freq of Test M	Freq of Test 6M	Details of Inspection & Test i.e. Hose Broken etc	Name &Signature
14/01/22	✓		Inlet Coupler Sense line hose checked	
14/02/22	✓		Inlet Coupler Sense line hose checked	
15/03/22	✓		Inlet Coupler Sense line hose checked	
14/04/22	✓		Inlet coupler Sense line hose checked	
16/05/22	✓		Inlet Coupler Sense line hose Checked	
16/06/22			Inlet Coupler Sense line hose checked	

Note: *Required test pressures as per JIG 1 table*

Hose working pressure	6 monthly hydrostatic test / pressure	Commissioning new hoses with factory fitted couplings	Attaching / reattaching cour
Less than or equal to 5.5 bar (80psi)	No requirement	15 bar	20 bar
Greater than or equal to 5.5 bar (80psi)	15 bar test	15 bar	20 bar

PUMA ENERGY
"Safety First"

Hose Inspection & Test Record
Frequency: Monthly Visual / Six Monthly Hydrostatic

Doc No. AR 01
Rev 1

Airport IATA Code: ACC Equipment No. & Type: HD01 Grade of Fuel: JET A-1 Hose No. 37

Manufacturer: ELAFLEX Diameter: 2½" Length: 4m Date of Manufacture: 10-14 Hose Working Pressure: 80 PSI

Date	Freq of Test M	Freq of Test 6M	Details of Inspection & Test i.e. Hose Broken etc	Signature
14/01/22	✓		Hose not broken, Pump pressure applied ~~OK~~	
14/02/22	✓		Hose not broken, pump pressure applied and is OK	
16/03/22	✓		Hose not broken, Pump pressure applied and it OK	
14/04/22	✓		Hose not broken, Pump pressure applied and it is in good condition	
17/05/22	✓		Hose not broken, Pump pressure applied and is in good Condition	
16/06/22			Hose not broken, pump pressure applied and in good Condition	

Note: *Required test pressures as per JIG 1 table*

Hose working pressure	6 monthly hydrostatic test / pressure	Commissioning new hoses with factory fitted couplings	Attaching / reattaching couplings
Less than or equal to 5.5 bar (80psi)	No requirement	15 bar	20 bar
Greater than or equal to 5.5 bar (80psi)	15 bar test	15 bar	20 bar

PUMA ENERGY "Safety First"

Under Wing Deck Hoses QD & Strainer Inspection & Maintenance Record.
Frequency: Monthly

Doc No. AR 02
Rev 2

Airport IATA Code: ACC Equipment No. & Type: RVO 1 Grade of Fuel: JET A-1

Coupling, Nozzle Type & Size: EATON 62 cm

Date	Hose No.	Details of Inspection: i.e. Within tolerance & put back in service / Strainer broken & replaced / etc	Name & Signature
13/01/22	04	No Sediment found, Strainer and 'O'Ring OK	Lalji
11/02/22	04	No Sediment found, Strainer and 'O' Ring OK	George
8/03/22	04	No Sediment Found, Strainer and O'Ringe OK	George
13/09/22	04	No Sediment found, Strainer and 'O'Ring OK	Lalji
16/05/22	04	No Sediment found, Strainer and 'O'Ring OK	Lalji
16/06/22	04	No Sediment Found, Strainer and 'O'Ring OK	George

Note: **Circulate 1000 litres of product through hose prior to putting unit back into service.**

- Use Carter Quick Disconnect Couplings Wear Gauge Model No. IF220351 & Poppet Adjustment Gauge Model No. 64000 when required & Carter type 61857-2 aircraft adaptor wear gauge
- Prior to disassembling Quick Disconnect, Slide the Sleeve to the locked position (away from the threaded end of the Housing and lock it in place with one Screw. Attempt to insert gauge IF220351 into the open end (opposite to the threaded end). If the gauge slides into the port, the Sleeve is worn out and has to be replaced.

PUMA ENERGY "Safety First"

Fixed & Mobile Ladder Inspection
Frequency: Monthly

Doc No. AR 54
Rev 2

Airport IATA Code: ACC Equipment No & Type: RVO 1 Year: 2022

ITEM TO BE CHECKED/SERVICED		Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Equipment Checks (If Applicable)													
Structural Checks													
Weld joints, steps & side railings ok	Yes /No	Yes	Yes	Yes	Yes	Yes	Yes						
Steps - Non slippery	Yes /No	Yes	Yes	Yes	Yes	Yes	Yes						
Bends or damage to ladder	Yes /No	No	No	No	No	No	No						
Bolt joints tight	Yes /No	Yes	Yes	Yes	Yes	Yes	Yes						
Plastic end cap fittings on leg base ok	Yes /No	N/A	N/A	N/A	N/A	N/A	N/A						
Condition of Hinges ok	Yes /No	N/A	N/A	N/A	N/A	N/A	N/A						
Railing / kick plate secure	Yes /No	Yes	Yes	Yes	Yes	Yes	Yes						
Ladder Serially numbered	Yes /No	Yes	Yes	Yes	Yes	Yes	Yes						
Tyres (If Applicable)													
Tyre Air Pressure & Wear & Condition	Yes /No	N/A	N/A	N/A	N/A	N/A	N/A						
Wheel Axle (If Applicable)													
Bearing Lubrication ok	Yes /No	Yes	Yes	Yes	Yes	Yes	Yes						
Excessive Wheel Play	Yes /No	No	No	No	No	No	No						
Locking Secured e.g. Split Pin	Yes /No	Yes	Yes	Yes	Yes	Yes	Yes						
Swivel Bed & A Frame (If Applicable)													
Check Integrity & Lubrication ok	Yes /No	Yes	Yes	Yes	Yes	Yes	Yes						
Tow eye / Safety chains ok	Yes /No	Yes	Yes	Yes	Yes	Yes	Yes						
Report Written: Unsafe Practice Condition (UPC) Defect Report (DR)													
Date:		13/01											
Signature:													

PUMA ENERGY

"Safety First"

Fixed & Mobile Ladder Inspection
Frequency: Monthly

Doc No. AR 54
Rev 2

Airport IATA Code: ACC Equipment No & Type: HD01 Year: 2022

ITEM TO BE CHECKED/SERVICED		Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Equipment Checks (If Applicable)													
Structural Checks													
Weld joints, steps & side railings ok	Yes /No	Yes	Yes	Yes	Yes	Yes	Yes						
Steps - Non slippery	Yes /No	Yes	Yes	Yes	Yes	Yes	Yes						
Bends or damage to ladder	Yes /No	No	No	No	No	No	No						
Bolt joints tight	Yes /No	Yes	Yes	Yes	Yes	Yes	Yes						
Plastic end cap fittings on leg base ok	Yes /No	Yes	Yes	Yes	Yes	Yes	Yes						
Condition of Hinges ok	Yes /No	Yes	Yes	Yes	Yes	Yes	Yes						
Railing / kick plate secure	Yes /No	Yes	Yes	Yes	Yes	Yes	Yes						
Ladder Serially numbered	Yes /No	Yes	Yes	Yes	Yes	Yes	Yes						
Tyres (If Applicable)													
Tyre Air Pressure & Wear & Condition	Yes /No	N/A	N/A	N/A	N/A	N/A	N/A						
Wheel Axle (If Applicable)													
Bearing Lubrication ok	Yes /No	Yes	Yes	Yes	Yes	Yes	Yes						
Excessive Wheel Play	Yes /No	N/A	N/A	N/A	N/A	N/A	N/A						
Locking Secured e.g. Split Pin	Yes /No	Yes	Yes	Yes	Yes	Yes	Yes						
Swivel Bed & A Frame (If Applicable)													
Check Integrity & Lubrication ok	Yes /No	Yes	Yes	Yes	Yes	Yes	Yes						
Tow eye / Safety chains ok	Yes /No	N/A	N/A	N/A	N/A	N/A	N/A						
Report Written: Unsafe Practice Condition (UPC) Defect Report (DR)													
Date:		14/01/22	14/02/22	14/03/22	14/04/22	14/05/22	14/06/22						
Signature:													

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PUMA ENERGY

"Safety First"

Sampling Visual Check Record
Frequency: Daily

Doc No. ARSS 10
Rev 2

Airport IATA Code: ACC

Equipment No & Type: RY01

Grade of Fuel: Jet A1

KEY TO RESULTS	WW = Water White	C & B = Clear & Bright	FW = Free Water	MG = Microbial Growth
	SC = Straw Colour	SW = Suspended Water	SD = Sediment / Dirt	PS = Pipe Scale

Date	Time	Sample Point Origin	Result of First Sample	Quantity Flushed if not C & B	Result of Final Sample	Authorised Signature	Defect Report
07/04/22	09:15	Tank LP	S/C	—	C+B		
		B. filter	S/C	—	C+B		
		A. filter	S/C	—	C+B		
08/04/22	8:45	Tank LP	S/C	—	C+B		
		B-filter	S/C	—	C+B		
		A-filter	S/C	—	C+B		
09/04/22	07:15	Tank LP	S/C	—	C+B		
		B-filter	S/C	—	C+B		
		A. filter	S/C	—	C+B		
10-4-22	07:00	Tank LP	SC	—	C+B		
		B. filter	SC	—	C+B		
		A. filter	SC	—	C+B		
11-4-22	07:00	Tank LP	SC	—	C+B		
		B. filter	SC	—	C+B		
		A-filter	SC	—	C+B		
12/04/22	6:42	Tank LP	S/C	—	C+B		
		B. filter	S/C	—	C+B		
		A. filter	S/C	—	C+B		
17/04/22	7:00	Tank LP	S/C	—	C+B		
		B. filter	S/C	—	C+B		
		A-filter	S/C	—	C+B		

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PUMA ENERGY
"Safety First"

Sampling Visual Check Record
Frequency: Daily

Doc No. ARSS 10
Rev 2

Airport IATA Code: ACC

Grade of Fuel: Jet A1

Equipment No & Type: AV - 01

KEY TO RESULTS	WW = Water White	C & B = Clear & Bright	FW = Free Water	MG = Microbial Growth
	SC = Straw Colour	SW = Suspended Water	SD = Sediment / Dirt	PS = Pipe Scale

Date	Time	Sample Point Origin	Result of First Sample	Quantity Flushed if not C & B	Result of Final Sample	Authorised Signature	Defect Report
14/04/22	7:42	Tank LP	S/C	—	C&B		
		B filter	S/C	—	C&B		
		A filter	S/C	—	C&B		
15-4-22	07:15	Tank LP	S/C	—	C&B		
		B filter	S/C	—	C&B		
		A filter	S/C	—	C&B		
16-4-22	05:20	Tank LP	S/C	—	C&B		
		B filter	S/C	—	C&B		
		A filter	S/C	—	C&B		
17-4-22	07:20	Tank LP	S/C	—	C&B		
		B filter	S/C	—	C&B		
		A filter	S/C	—	C&B		
18-4-22	07:10	Tank LP	S/C	—	C&B		
		B filter	S/C	—	C&B		
		A filter	S/C	—	C&B		
19-4-22	06:45	Tank LP	S/C	—	C&B		
		B filter	S/C	—	C&B		
		A filter	S/C	—	C&B		
20-4-22	06:30	Tank LP	S/C	—	C&B		
		B filter	S/C	—	C&B		
		A filter	S/C	—	C&B		

APPENDIX 11: FUEL DELIVERY TICKET

PUMA ENERGY

10549622
14/04/202

Kotoka International Airport (ACC)
PLOT 20, Kotoka International Airport
Accra, Ghana

DELIVERY TICKET

Customer	: South African Airways		
Supplier	: Puma Energy		
Service	: Fuelling		
Flight Number	: SA52	Flight Type	: I
Next Dest	: JNB	Final Dest	: JNB
Aircraft Type	: 330	Aircraft Reg	:
Operator	: Zecoh		
Vessel	:	Product	: JETA1
Stand	: DELTA 1	Pit	:

Times	Task Start	Meter Start	Meter End	Task End
	21:24	21:24	01:40	03:00
Meter				
Observed Temp		30.0 °C		30.0 °C
Meter End		73501916		157128
Meter Start		73490248		157128
Meter Total		11668		0
Quantity Delivered				11668 LT

Batch Number ACC-J-2022-T1-07

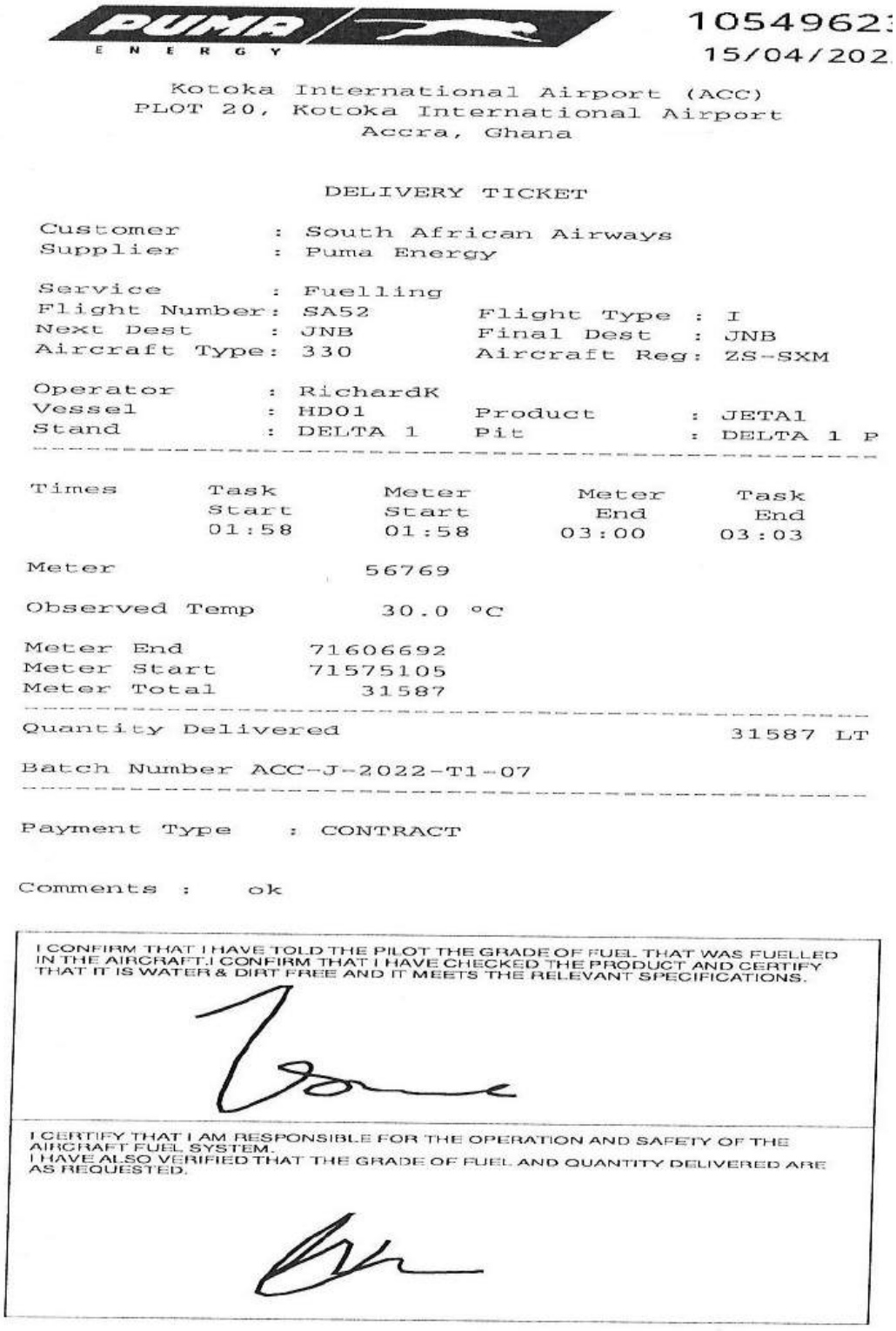
Payment Type : CONTRACT

Comments : ok

I CONFIRM THAT I HAVE TOLD THE PILOT THE GRADE OF FUEL THAT WAS FUELLED IN THE AIRCRAFT.I CONFIRM THAT I HAVE CHECKED THE PRODUCT AND CERTIFY THAT IT IS WATER & DIRT FREE AND IT MEETS THE RELEVANT SPECIFICATIONS.

I CERTIFY THAT I AM RESPONSIBLE FOR THE OPERATION AND SAFETY OF THE AIRCRAFT FUEL SYSTEM.
I HAVE ALSO VERIFIED THAT THE GRADE OF FUEL AND QUANTITY DELIVERED ARE AS REQUESTED.

Fuel ticket issued on the day of incidence (RV01)



PUMA ENERGY

1054962:
15/04/202

Kotoka International Airport (ACC)
PLOT 20, Kotoka International Airport
Accra, Ghana

DELIVERY TICKET

Customer : South African Airways
Supplier : Puma Energy

Service : Fuelling
Flight Number: SA52 Flight Type : I
Next Dest : JNB Final Dest : JNB
Aircraft Type: 330 Aircraft Reg: ZS-SXM

Operator : RichardK
Vessel : HD01 Product : JETA1
Stand : DELTA 1 Pit : DELTA 1 P

Times	Task Start	Meter Start	Meter End	Task End
	01:58	01:58	03:00	03:03

Meter 56769

Observed Temp 30.0 °C

Meter End 71606692
Meter Start 71575105
Meter Total 31587

Quantity Delivered 31587 LT

Batch Number ACC-J-2022-T1-07

Payment Type : CONTRACT

Comments : ok

I CONFIRM THAT I HAVE TOLD THE PILOT THE GRADE OF FUEL THAT WAS FUELLED IN THE AIRCRAFT.I CONFIRM THAT I HAVE CHECKED THE PRODUCT AND CERTIFY THAT IT IS WATER & DIRT FREE AND IT MEETS THE RELEVANT SPECIFICATIONS.

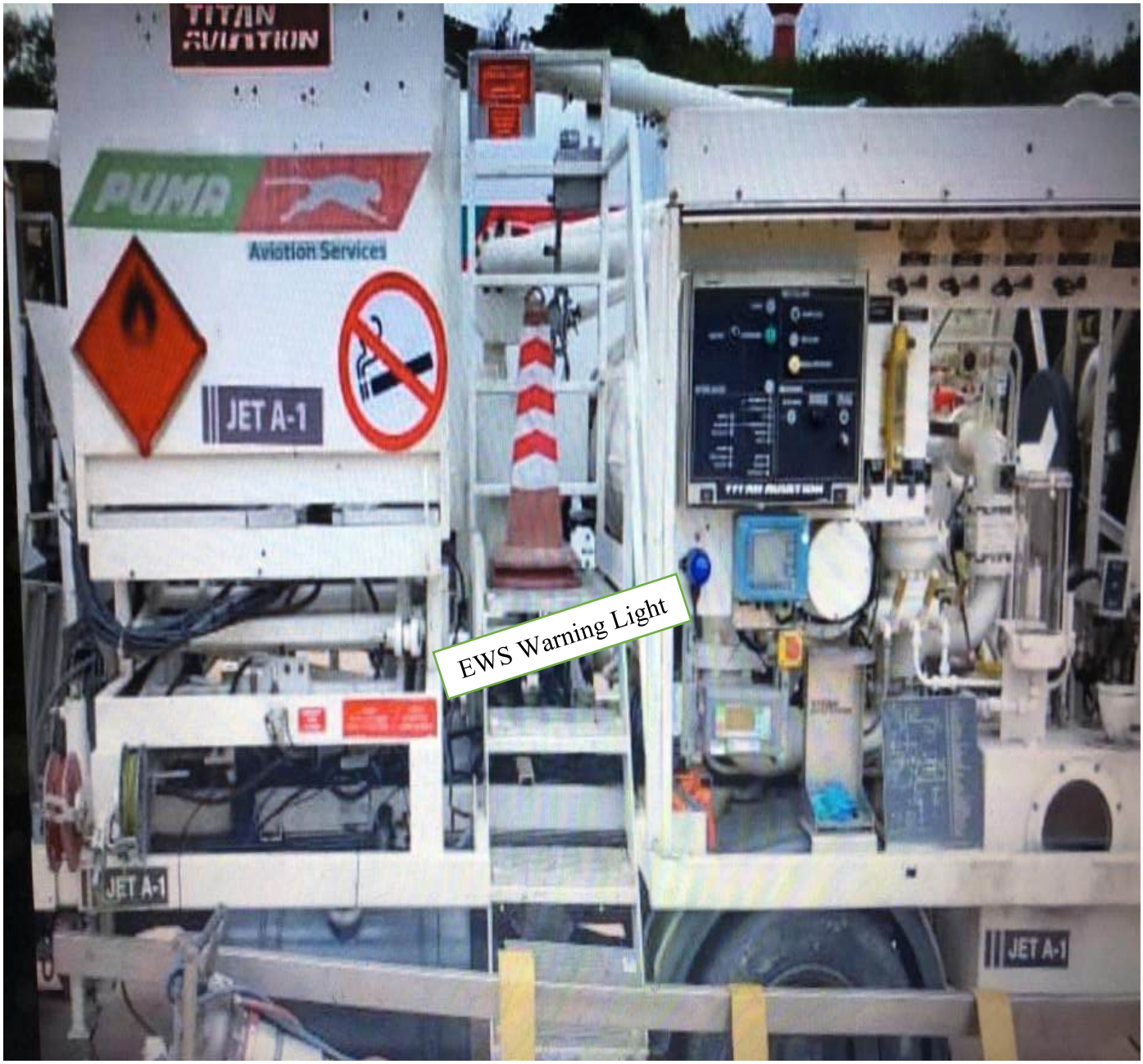
I CERTIFY THAT I AM RESPONSIBLE FOR THE OPERATION AND SAFETY OF THE AIRCRAFT FUEL SYSTEM.
I HAVE ALSO VERIFIED THAT THE GRADE OF FUEL AND QUANTITY DELIVERED ARE AS REQUESTED.

Fuel ticket issued on the day of incidence (HD01)

APPENDIX 12: REFUELLER VEHICLE (RV01)

EWS Warning Light

APPENDIX 13: HYDRANT DISPENSER (HD01)


TITAN
PUMA
Aviation Services
JET A-1
EWS Warning Light
JET A-1
JET A-1

APPENDIX 14: OPERATIONAL DATA PLATES FOR RV01 AND HD01

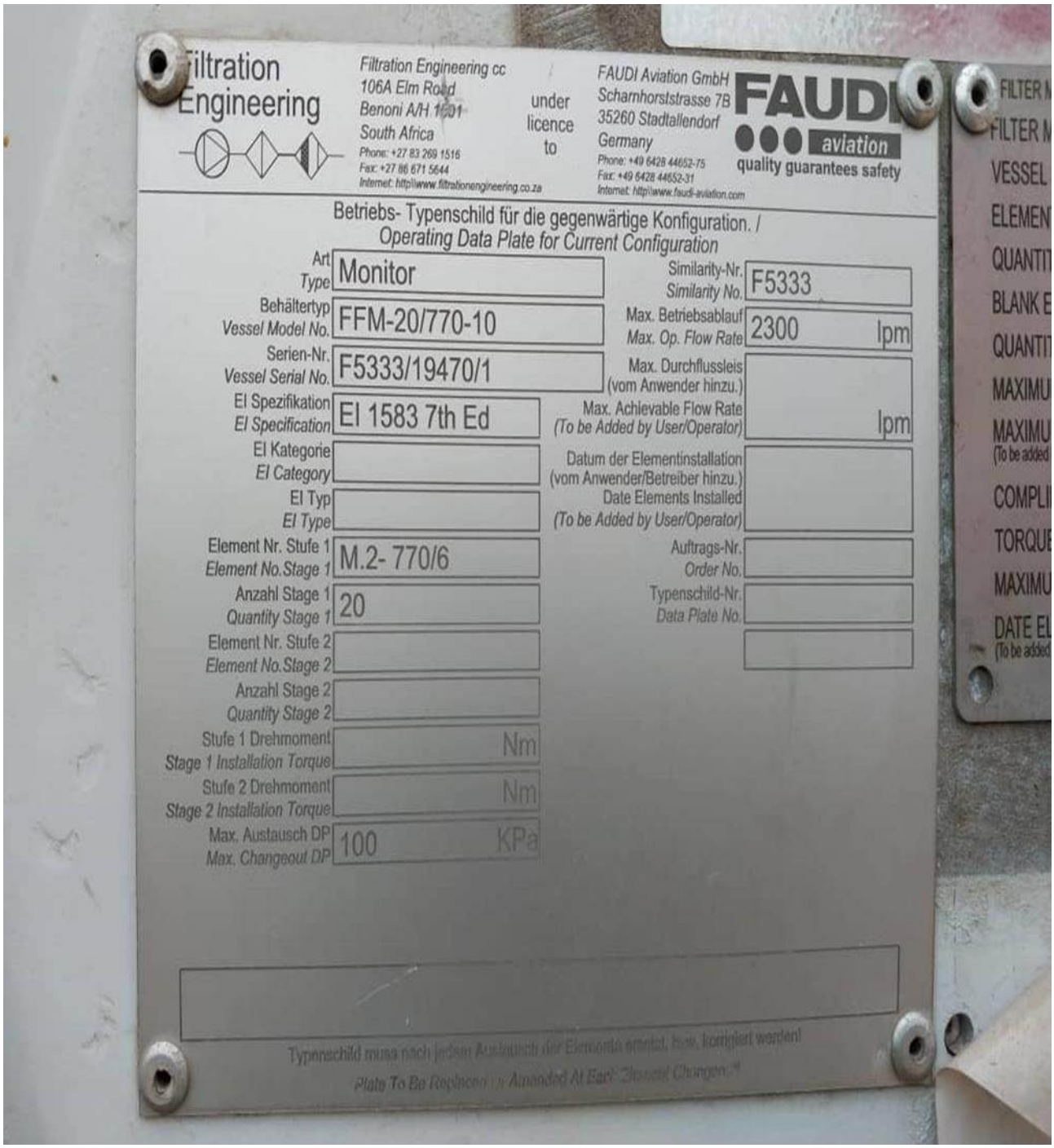


Figure 1: RV01 Data Plate

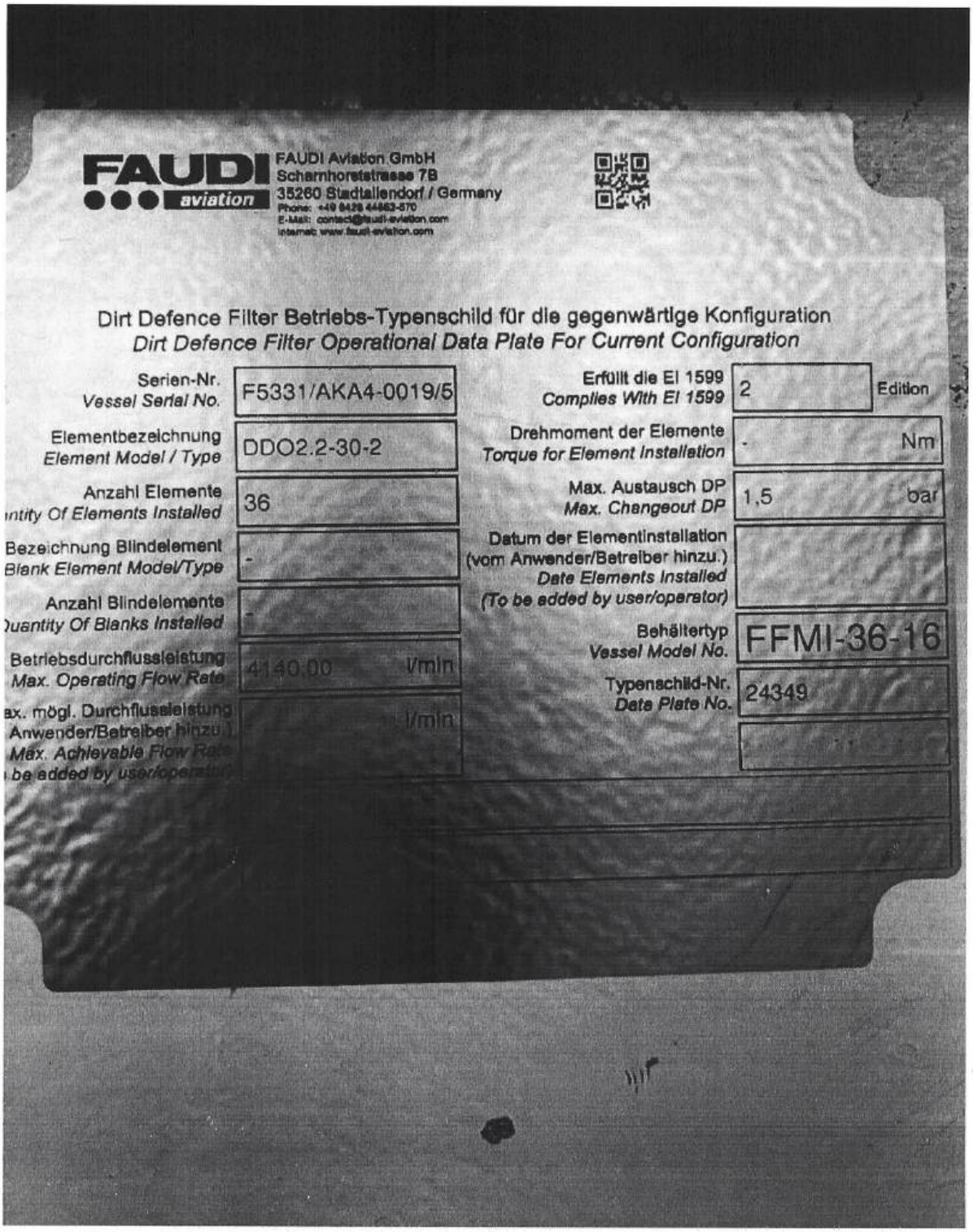


Figure 1: HD01 Data Plate

APPENDIX 15: PUMA ENERGY CUSTOMER AIRLINES AT KIA

- Emirates Airlines
- British Airways
- Ethiopian Airlines
- KLM Royal Dutch Airlines
- Air France
- Tap Portugal
- Delta Airlines
- Network Airline Management
- United Airlines
- Air Ghana
- Royal Air Maroc
- Kenya Airways
- South African Airways
- Titan Airways

APPENDIX 16: AD HOC INSPECTION OF PUMA ENERGY FACILITIES: UNITED AIRLINES

From: Divine Dey
Sent: 07 June 2022 15:52
To: Goco, Pete
Subject: RE: Fuel Investigation

Thank you very much Pete. It was a pleasure having you at the depot.

We will be available to provide any additional information you may need concerning this investigation.

Thanks again and enjoy the rest of your stay.

Regards,
Divine.

From: Goco, Pete <peter.goco@united.com>
Sent: 07 June 2022 15:03
To: Divine Dey <Divine.Dey@blueocean.com.gh>
Subject: [EXTERNAL] Fuel Investigation

Divine,

United Airlines Fuel Technical Services would like to extend our utmost gratitude in accommodating us to conduct our fuel investigation on a very short notice.

Our fuel investigation have generated sufficient data to conclude that we don't have any concerns with the fuel quality in ACC. Although we would like to request the continued support if there is a need for further documentation or data in the future.

It was a pleasure working with the ACC Puma team. You and your staff have performed very well to assist us in every way and having the facility and records well organized.

Regards,

Pete Goco
Sr Stf Rep - Fuel Technical Services
United Airlines| WHQQA |
233 S. Wacker Dr. Chicago, IL 60606
Mobile: 847-754-5269 | peter.goco@united.com

APPENDIX 17: EMAIL FROM SOUTH AFRICAN AIRWAYS

From: Prince Mereotlhe <PrinceMereotlhe@flysaa.com>
Date: Monday, 18 July 2022 at 10:12 AM
To: Hawkins, Stuart <StuartHawkins@aaib.gov.uk>, Frank Masoga <MasogaF@caa.co.za>
Cc: Paul Forjoe <paul.forjoe@aibghana.gov.gh>, Nthabiseng Malumedzha <MalumedzhaN@caa.co.za>, Clinton Montague <ClintonMontague@flysaa.com>, Kiran I Sikosana <SiyabongaSikosana@flysaa.com>
Subject: RE: South African Airways A330-300 reg: ZS-SXM engine surge 15/4/22

Good afternoon Stuart and Frank,

In Johannesburg the tanks were sumped a few times and no water was found.

The ±400 litres were drained in Accra prior to the return leg to JNB, and this was a mixture of fuel and water (but mainly water).

Kind Regards,

Prince Mereotlhe | Manager • Flight Technical and Maintenance Standards | Operations

Mobile: +27 60 583 4737 | Phone: +2711-978-3031 | Fax: +2711-978-5560 | E-Mail: PrinceMereotlhe@flysaa.com
Room 404,4th Floor,Block G,Airways Park,OR Tambo International Airport- Johannesburg- South Africa

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From: Hawkins, Stuart [mailto:StuartHawkins@aaib.gov.uk]
Sent: Monday, July 18, 2022 11:29 AM
To: Frank Masoga <MasogaF@caa.co.za>; Prince Mereotlhe <PrinceMereotlhe@flysaa.com>
Cc: Paul Forjoe <paul.forjoe@aibghana.gov.gh>; Nthabiseng Malumedzha <MalumedzhaN@caa.co.za>
Subject: RE: South African Airways A330-300 reg: ZS-SXM engine surge 15/4/22

Dear Frank and Prince,

Could you also please confirm whether any water was drained from the tanks after the aircraft landed in Johannesburg on 15/4/22 or during the following few days.

Thank you.

Kind regards,

Stuart

Stuart Hawkins
Senior Inspector of Air Accidents
Air Accidents Investigation Branch
Phone +44 (0)1252 510300 Fax +44 (0)1252 376999

From: Frank Masoga <MasogaF@caa.co.za>
Sent: 15 July 2022 17:31
To: Prince Mereotlhe <PrinceMereotlhe@flysaa.com>
Cc: Hawkins, Stuart <StuartHawkins@aaib.gov.uk>; Paul Forjoe <paul.forjoe@aibghana.gov.gh>; Nthabiseng Malumedzha <MalumedzhaN@caa.co.za>
Subject: Fwd: South African Airways A330-300 reg: ZS-SXM engine surge 15/4/22

Dear Prince,

Please see below follow up questions for clarification and once again thank you for your cooperation and assistance thus far.

Regards

Frank

Get Outlook for Android

APPENDIX 18: AIRBUS IN-SERVICE INFORMATION

WISE — In-Service Information — AIRBUS

A340/A330 FAMILY - WATER MANAGEMENT - WATER DRAINAGE INTERVAL EXTENSION FOR WING TANKS - NEW WATER SCAVENGE SYSTEM

EDIT | SAVE

ATA: 28-11
A/C Type: A330 A340
Part Number:
Supplier: PANASONIC AVIONICS CORPORATION
Linked Articles: TEU 28.17.00.002
FIN:
A/C Serie:
Linked Documentation: AOT 28A3114
Topic:
Ref: 28.11.00001
First Issue Date: 27-JUL-2009
Last Publication Date: 24-SEP-2018
Last Internal Publication Date: 07-JUN-2017

This article cancels and supersedes SIL ref 28-090.

Engineering Support

Engineering Support — Go to Engineering Support survey!

Model:
Manufacturer:
First Issue Date: 27-JUL-2009
Last Publication Date: 15-JUL-2014
Last Internal Publication Date: 28-OCT-2015

SUBJECT: **A340/A330 FAMILY – Water Management – Water Drainage Interval Extension for wing tanks – New Water Scavenge System**

APPLICABILITY: All A330/A340 Family Aircraft

REFERENCES:

MPD task 28-11-00-10-1; MPD 28-11-00-08-1; MPD 28-11-00-01-1
Operate the water drain valves to drain accumulated water from the centre, inner and outer wing vent surge tanks
AMM Task 12-32-28 P.Block 680 - Drain Water Content
AMM Task 12-32-28 P.Block 281 - Sample Fuel for Microbiological Contamination Analysis
AMM Task 12-31-28 P.Block 281 - Cold Weather Maintenance – Fuel
SIL 28-079 - Microbiological Contamination In Fuel Tanks
AMM 28-17-56 Water Scavenge
TFU 28.00.00.008 Fuel Tank Water Scavenge Improvements
TFU 28.17.00.002 Potential fuel restriction linked to water scavenge operation
AOT A330-28A3114 Deactivate water scavenge system

0. REASON FOR REVISION

This article has been revised to contemplate the failure of a jet flow pump on the Rib3 Water Scavenge System due to blockage and to allow a resumption of the drain interval escalation process once the jet flow pump is replaced.
The opportunity is taken to improve the article wording while the technical content remains the same.

1. PURPOSE

Fuel wing tank water drain difficulties have been raised by operators of A330/A340 family. This article is to advertise the operators the existence of the water management modification (drainage & scavenge): the objective is to reduce the amount of water that is drained from fuel tanks and reduce the opportunity for microbiological contamination development and Fuel Quantity Indication issues. This document will be used to support the A330/A340 family operators that have embodied the new wing tank water scavenge system to explain an interval extension evaluation procedure to their local airworthiness authorities (LAA), then the wing tank water drainage interval could be extended from the current interval of 7 days to an appropriate interval agreed with their LAA.

2. BACKGROUND

The current A330/A340 family MPD task recommends that the water drainage should be completed on a weekly basis but may be adjusted on approval of local airworthiness authorities: "DEPENDING ON OPERATING ENVIRONMENT & OPERATOR'S EXPERIENCE, A HIGHER INITIAL INTERVAL MAY BE USED".

Operators have been struggling to comply with MPD requirements due to operational constraints or maintenance burdens, as it is out of synchronization with other scheduled maintenance checks as well as climatic conditions. Particularly when undertaking cold weather operations, it means that water drainage performed has limited effectiveness, since fuel tank temperature needs to be above freezing for a certain time to ensure an efficient drainage.

The new wing tank water scavenge system was developed with the purpose of enabling an extension of the water drainage interval from 7 days to an appropriate interval agreed with their LAA.

The feedback of the In-service evaluations of the pre/post mod A330 and A340 aircraft has demonstrated that water is being drained in much reduced quantities; as a consequence of the new water scavenge system. It is therefore concluded that with the introduction of the above modifications an extension of the water drainage interval could be achievable.

3. PROCEDURE

This document presents the requirements of the evaluation, the process for conducting the evaluation and the pass/fail criteria. The article also includes an appendix which provides a data collection sheet, which shall be used for the interval extension evaluation process for submission to their LAA.

The escalation process is applicable to both ETOPS and non-ETOPS a/c, provided the Operators seek agreement from their LAA.

The following modifications have been introduced, for further details on the MOD, please refer to the relevant SBs:

A330-200/300
SB 28-3105 Rib 3 Water Scavenge jet pump
SB 28-3106 Rib 1 Water Scavenge pipe
SB 28-3107 Rib 2 Water Drain & scavenge pipe

Note: for A330-200/300 fitted with RRT700 engines, please refer to AOT A330-28A3114 and TFU 28.17.00.002 for further details.

A340-200/300
SB 28-4023 Fuel – Water Scavenge – Install a Water Scavenge system
SB 28-4121 Rib 1 AFT Inner tank scavenge pipe and water drain pipe

A. Method of Data Collection for Evaluation of Task Interval Extension

Before any embodiment of A330/A340 water scavenge system, the operator is responsible for the implementation of a data collection survey to establish the baseline performance of the pre-mod aircraft with respect to water management. The measurement of performance would be based on the volume of water drained via the water drain valves.
This document does not by itself approve the extension of the water drainage interval from the recommended MPD interval of 7 days.

An extension is to be agreed by the individual Operator with their LAA.
It is recommended that prior to undertaking this procedure, the Operator should consult their LAA to agree the implementation of the evaluation in terms of interval, (i.e. one step or several steps to reach the targeted water drain interval), evaluation duration, aircraft effectivity (ETOPS or non-ETOPS) etc

B. Fuel Tanks Covered

Data collection process is to record data from all aircraft fuel tanks, including:

- Inner Wing tanks
- Outer Wing tanks
- Centre Tank (both water drain valves)
- Surge tanks

Note: Trim tanks and ACTs are excluded from these guidelines. However, operators may decide to extend the water drain interval also to these tanks if approved by their LAA.

C. Water Drain Valve Evaluation Period and Intervals

The current interval defined in the MPD is to operate the water drain valves every 7 day calendar time. This includes the centre tank whether or not it is being used.

To support the extension of the water drainage interval, supporting data is to be collected for a minimum evaluation period. The minimum period of operation at the extended interval is specified in Table 1.

Drainage Interval	Minimum Evaluation Period
Weekly – current period	2 months(*)
Two-weekly – suggested next step	3 months
400FH	6 months
Extended interval up to a maximum of 800FH or A-Check interval	Minimum of 12 months

Table 1 – Minimum Evaluation period for Drainage Intervals

(*) The evaluation period of 2 Months for weekly drainage is to be taken as a baseline.

The above proposed draining intervals and evaluation periods are based on the aircraft utilization assumptions as defined in A330/A340 MPD. Operators whose aircraft utilisation differs significantly from these assumptions may need to make adjustments to this water drainage interval escalation task with their Regulatory Authority.

At the end of the evaluation periods proposed in Table (1), the operator is to review the data against the advisory pass/fail criteria defined in paragraph 3 G. below. This data can then be used to support the water drainage interval extension.

D. Seasonal Fluctuations

The drainage interval and evaluation period defined in paragraph 3.C does not account for any seasonal variation in the accumulation and drainage of water. Accordingly it is suggested that once the new extended water drainage interval is implemented, data should continue to be collected at this new interval, until a total of 12 months of data has been collected and analysed over all seasons: this is to ensure there is no seasonal increase in drained water quantities.

When operating in cold weather the fuel remaining in the tank may be below 0°C, in this case any accumulated water and/or Water Drain Valves (WDV) may be frozen. In such conditions the operator should ensure that when water drainage is performed, it is performed in accordance with the approved cold weather procedure (refer to AMM task 12-32-28).

E. Maintenance actions

During the minimum evaluation period, as specified in tables 1 , the operator should record the drainage data, as specified in paragraph 4. In addition, the operator should carry out regular fuel sampling checks for microbial and water contamination.

Any in-service issues that arise and may be attributed to water contamination should be reviewed fully before proceeding with the extension of the water drainage task interval. If abnormally high volumes of water are found during the period of the evaluation, then this may indicate the need to revert to a more frequent water drainage interval.

F. Aircraft Selection & Route Structure

The water accumulation rate in an aircraft fuel system is determined by the water held within the fuel and the water held within the air that is introduced from the vent system. Therefore, it is preferable that aircraft used to support the water drainage interval extension have high utilization.

The accumulation and drainage of water is also dependant on the operating environment of the routes of the A/C. Therefore any aircraft involved in the survey should be representative of the route network, so that the variation in environmental conditions may be factored into the results.

In addition, the survey data should be from the same aircraft rather than haphazard data received from the fleet. To ensure that continuous drainage data is obtained, it is important that all the drainage records of all
the aircraft in the survey are collected. If the task of monitoring the complete fleet is impracticable, it is better to limit the evaluation to specific aircraft in the fleet that represent the fleet route structure.

G. Pass/Fail Criteria

The operator should consider terminating the evaluation period for a given drainage interval as per Table 1, and eventually the water drainage interval escalation task, if any of the following criteria occur:-

- Any adverse operating effects on engines and fuel system equipment that may be attributed to water e.g. FQI erratic or lost, fuel pump failures, engine filters clogged, etc..
- Engine /APU maintenance issues that may be attributed to water, e.g APU starvation,

If during the evaluation period, the water quantity drained from each of the water drain valve locations for the A330/A340 aircraft post-water scavenge modifications tables A1 to A2 are above the Pass/Fail Criteria volumes this should be investigated to establish whether the result is spurious or can be justified prior to take any decision in terminating the evaluation period.

The following questions should be considered when determining if the result is spurious or part of a trend:

- Was the volume of water drained measured correctly and/or accurately? (Ref Procedure in Paragraph 4.B)
- When was the tank drained previously? Was the previous drainage missed?
- When was the drained sample taken (e.g. before/after refuel)?
- Has there been a change in the operation of the aircraft, such as new route structure?
- Does the result conform to the water drained data trend records for the evaluation
- Is the result consistent with other aircraft involved in the evaluation operating in similar routes?

Different scenarios may occur depending on the aircraft type:

G1. A340 aircraft type

G1.1. If it is found that the result is a spurious result, then the evaluation may be continued.

G1.2. If the result is considered to be valid and is part of a trend, and relates to various WDV or a single WDV then, there should be no further extension to the drainage interval.

G2. A330 aircraft type

G2.1. If it is found that the result is a spurious result, then the evaluation may be continued.

G2.2. If the result is considered to be valid and is part of a trend, and relates to various WDV or a single WDV different from WDV FIN 5104QS1/5104QS4 then, there should be no further extension to the drainage interval

G2.3. If the result is considered to be valid and is part of a trend and relates to WDV FIN 5104QS1/5104QS4 only, then the cause of the event has to be investigated as per TSM TASK 28-17-00-810-802-A *Fuel- Too Much Water Found During the Water Drain Procedures*. There are three possibilities:

G2.3.1. Jet flow pump blockage:
a. If jet flow pump blockage is confirmed replace the jet flow pump .
b. If the jet flow pump can only be replaced at the next convenient maintenance opportunity then, revert back to the water drain interval quoted in the MPD for the period the aircraft will be operating with the jet-flow pump blocked

G2.3.2. Stand-by pump malfunction.
a. Do the applicable maintenance action to restore the pump functioning .
Note: Following the rectification of a jet flow pump blockage or Stand-by pump malfunction issue, the evaluation period as per Table 1 can be resumed.

G2.3.3. If the cause of the event is neither a jet flow pump blockage nor a Stand-by pump malfunction, then there should be no further extension to the drainage interval

NOTES:

Larger volumes of water may be permitted to accumulate in transfer (i.e. non-feed) tanks. The limits in Table A1 - A2 are rounded to the nearest 0.5 litre and should be regarded as the maximum values for the permissible criteria.

The records of water drained from each aircraft should be recorded so that the data trend can be reviewed against the limits in Tables A1 – A2 before a decision is taken to move to the next drainage interval.

The records of water drained from each aircraft should be entered onto a graph so that the data trend line can be reviewed against the specified Pass/Fail criteria.

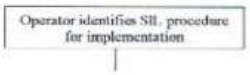
In the case of A330 aircraft type, once the evaluation process has been completed and an appropriate drainage interval has been agreed with the corresponding LAA, the water quantities drained from each aircraft should still be recorded to monitor for a possible jet flow pump blockage as per G2.3.1

4. METHOD

The following paragraph outlines the method by which the data can be taken and recorded in order to support the water drainage interval extension.

A. Process Method

The below figure (1) presents the process for the water drainage evaluation.



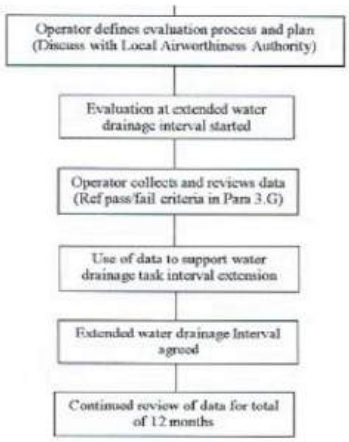


Figure 1: Process Model for In-Service Water Drainage Extension

B. Guidance for Water Drain Method

Operate all water drain valves (WDVs) to remove all traces of water in accordance with AMM procedure 12-32-28 P.Block 301. When draining water, the drained sample should be clear and bright, if milky this indicates the presence of emulsified water. Also check for signs of the presence of microbiological contamination. Measure and record the volume of fluid removed and volume of water content. Confirm all traces of water have been removed by operating the water drain valve several times, if necessary, allowing a few minutes delay between drain operations.

Any drainage samples that are emulsified (colour of drained fuel is not clear and bright) should be allowed to settle for up to five minutes to allow the separate layers of fuel and water to form. If no further water has settled in this time the volume of emulsified water may be regarded as being negligible. Record the volumes of the separate layers of fuel and water.

It is important that during the process of extending the water drainage interval, each drainage operation is carried out thoroughly and correctly to avoid the risk of microbiological contamination, and water build-up in the tanks.

C. Cold Weather Precautions

Prior to performing a water drainage task, ensure that water is not in its frozen state by checking that the fuel tank temperatures are above + 5 °C and the WDVs are not frozen. If it is suspected that the WDVs are frozen:

- either carry out the water drainage cold weather maintenance procedure in AMM procedure 12-31-28 P.B 201 "Cold Weather Maintenance – Fuel"
- or drain the fuel/water at least 1 hour after refuel.

Note: Drainage samples taken in a tank being less than +5°C often have no water content, this is due to the water present in the tank being frozen.

D. Data Collection

The proforma to use for data collection is provided in Appendix 9.

Print and also record/retain the MCDU probe capacitances post flight to establish if there is any trend in increased capacitance, which is indicative of build-up of water.

At the end of the evaluation period for the extended drainage interval, the operator should review the list of any unscheduled removals, faults or operating issues associated with ATA 28 equipment during the review period. In particular, the airline should monitor the FQI system for failure effects.

E. Pre and Post Interval Extension Evaluation checks

Prior to undertaking the drainage interval extension the operator should carry out a fuel sampling check for microbial and water contamination in accordance with AMM task 12-32-28 P.B 281 - Sample Fuel for Microbiological Contamination Analysis and SIL 28-079. At the end of each evaluation period the operator should carry out a further fuel sampling check for microbial and water contamination.

If excessive quantities of water are permitted to build up in the fuel system, this can lead to an increased risk of fuel quantity indication disruption and fuel tank microbiological contamination.

5. DATA PRESENTATION

Data collected by following the process described in this article should be used to determine whether the quantity of water drained from each tank is less than that specified by the pass/fail criteria. If the quantity of water drained is greater than the specified quantity in the Pass/Fail criteria then the previous water drainage interval should be used.

6. MODIFICATION INFORMATION

Not Applicable

7. MATERIAL

Not Applicable

8. PROCUREMENT

Not Applicable

9. APPENDIX

A330 Water Drain Valve Drainage Limits Post Water Management Mods			
WDV Location	**Fin No.**	**Water Drain Limit (litres)***	**Justification**
Inner Wing Tank (Rib 1 – 2)	5102QS1/5102QS2	1.5	Main wing tank sump – feed tank
Collector Cell (Rib 2-3)	5104QS2/5104QS3	0.5	Feed tank
Standby Pump area (Rib 3- 4)	5104QS1/5104QS4	1.5	Feed tank (sump)[1] ([1]when Stdby pump ON)
Inner Wing Tank (Rib 4 – 5)	5107QS1/5107QS2	0.5	Feed tank[1] ([1]when Stdby pump ON)
Outer Wing Tank	5101QS1/5101QS2	0.5	Non-feed tank, limit reflects smaller tank volume
Vent Surge Tank	5100QS1/5100QS2	0.5	Non-feed tank, limit reflects smaller tank volume
Centre Tank LHS & RHS	5103QS1/5103QS2	1.0	Non-feed tank, limit reflects large tank volume

Table A1

*Notes: water drain limit applies for one water drain valve

A340 Water Drain Valve Drainage Limits Post Water Management Mods			
WDV Location	**Fin No.**	**Water Drain Limit (litres)***	**Justification**
Inner Wing Tank Fwd (Rib 1-2)	5115QS1/5115QS2	1.5	Main wing tank sump – non-feed tank
Inner Wing Tank (Rib 1-2)	5102QS1/5102QS2	1.5	Main wing tank sump – transfer tank
Inboard Collector Cell (Rib 2-3)	5104QS2/5104QS3	0.5	Feed tank
Outboard Collector Cell (Rib 3- 4)	5104QS1/5104QS4	0.5	Feed tank
Inner Wing Tank (Rib 4 – 5)	5107QS1/5107QS2	0.5	Non-feed tank
Outer Wing Tank	5101QS1/5101QS2	0.5	Non-feed tank, limit reflects smaller tank volume
Vent Surge Tank	5100QS1/5100QS2	0.5	Non-feed tank, limit reflects smaller tank volume
Centre Tank LHS & RHS	5103QS1/5103QS2	1.0	Non-feed tank, limit reflects large tank volume

Table A2

*Notes: water drain limit applies for one water drain valve

Objective

To collect accurate water drainage data to provide the basis to extend the water drainage interval and reduce scheduled maintenance cost.

Data Collection

Complete this proforma accurately in accordance with the guidance below. Print and record/retain the MCDU probe capacitances post flight to establish if there is any trend in increased capacitance (Ref. step 2 below).

The survey data must be from the same aircraft rather than haphazard data received from the fleet. To ensure that continuous drainage data is obtained, it is important that all the drainage records of all the aircraft involved in the ISE are provided. The ISE should involve aircraft and routes representative of the fleet.

Guidance on Water Drainage Method

Operate all water drain valves (WDVs) to remove all traces of water in accordance with AMM procedure 12-32-28. Measure and record the volume of fluid removed and volume of water contets. Confirm all traces of water have been removed by operating the water drain valve several times. if necessary, allow a few moments delay between drain operations to allow water to collect at the valve/pick-up.

Any drainage samples that are emulsified should be allowed to settle for up to a minute to allow the separate layers of fuel and water to form. If no further water has settled in this time the volume of emulsified water may be regarded as being negligible. Record the volumes of the separate layers of fuel and water.

Note: Prior to carrying out water drainage task, ensure that water is not in its frozen state by checking that the fuel tank temperatures are above +5 °C and the WDVs are not frozen. If it is suspected that the WDVs are frozen either carry out the water drainage cold weather maintenance procedure in AMM procedure 12-32-28/3 or drain the fuel/water at least 1 H after refuel procedure.

Step 1: Enter aircraft details below

Aircraft Registration	Airport	Date/time	Air temperature

Step 2: Pre-Water Drain Print MCDU Input Parameters (probe capacitances), Refuel parameters and perform ground scan and attach results

Step 3 : Enter individual fuel tank quantities and temperatures below

Individual Fuel Tank Quantities (Litre)

L OUTER	L INNER	R INNER	R OUTER	CTR	FOB

ECAM Fuel Temperatures (Degree °C)

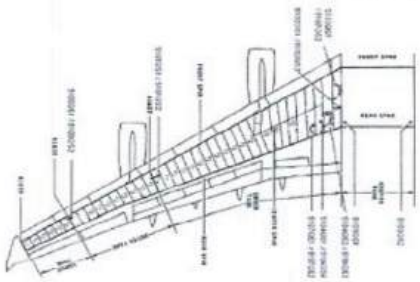
L OUTER	L INNER	R INNER	R OUTER

Step 4: Please answer the following questions immediately prior to water drain checks

1. OAT (provide as much detail as possible of the OAT since aircraft elanded.....
2. Elapsed time since aircraft landed .....
3. Elapsed time since any fuel uplift following landing.....
4. No. of flights since last drain procedure & destinations .....

Comments: .....

A330/A340 Water Drainage Datasheet



Step 5: Enter quantity of water only drained below. Drainage samples that are emulsified should be allowed to settle briefly (up to 5min) to allow the separate layers of fuel and water to form. Emulsified water may be regarded as being negligible.

Quantity of Water Drained (Litre)

L SUPPLY	L OUTER	L INNER	L INNER	L INNER	L INNER	L FWD INNER DR LT

L SURGE	L OUTER	RIB 4-5	RIB 3-4	RIB 2-3	RIB 1-2	(A340 Only)
5100QS1	5101QS1	5107QS1	5104QS1	5104QS2	5102QS1	5115QS1
Quantity of Water Drained (Litre)						
R SURGE	R OUTER	R INNER RIB 4-5	R INNER RIB 3-4	R INNER RIB 2-3	R INNER RIB 1-2	R FWD INNER RIB 1-2 (A340 Only)
5100QS2	5101QS2	5107QS2	5104QS4	5104QS3	5102QS2	5115QS2
Quantity of Water Drained (Litre)						
L CENTRE	R CENTRE					
5103QS1	5103QS2					

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APPENDIX 19: BEA COMMENTS

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BEA
Bureau d'Enquêtes et d'Analyses
pour la sécurité de l'aviation civile

BEA Comments

Subject: BEA comments on the draft Final Report on the serious incident that occurred on 15th April 2022 to the Fixed Wing AIRBUS - A330 - 300 registered ZS-SXM and operated by South African Airways (SAA).

The BEA has been consulted with respect to the draft final report on the abovementioned serious incident. In order to promote safety learnings within the aeronautical community, the BEA considers that it would be beneficial to add information to the Final report on :

- the ground phase in order to improve the operators and personnel in charge of refueling awareness.
- the in-flight phase to improve crews awareness.

In accordance with paragraph 6.3 of ICAO Annex 13, this document is to be appended to the final report.

Significant comment 1 : On ground phase

1.1 Refuelling

BEA suggest adding in the factual part of the Final Report a description of the fuel system based on the information provided to Ghana AIB by Airbus.

In the draft final report, it is mentioned that :

- *The aircraft landed at Accra with about 9 tons of fuel. During the refuelling, the fuelling stopped after about 600 litres uplifted to the aircraft, with fuel quantity indications set to XX. The fuel system was not capable of measuring the fuel quantity in the tanks due to probe capacitance out of range (often indicative of excess water).*
- *Then, the aircraft experienced several other fuelling interruptions with fuel quantity indications set to XX.*
- *During the troubleshooting phase, no equipment malfunction was identified.*
- *It was reported that "200 litres of water were drained from each of the aircraft's wing tanks". The CCTV helped at reducing the amount of liquid drained between 140 litres and 280 litres (the quantity of water could not be determined)*

Morevoer, the operator indicated that:

- *The aircraft did not experience any anomaly during the previous flight neither during refuelling at Accra, nor during the event flight. The post-event troubleshooting performed on arrival at Johannesburg did not reveal any system nor engine issue.*

Airbus indicates in the fuel system description that *FQI XX is the result of at least 4 probes failure that may be the results of an equipment malfunction, or fuel contamination.*

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ENCASIA

Based on the above mentioned information, it is possible to provide substantial explanation on how fuel contamination can cause the automated fuelling system to stop and would provide safety lessons to operators and personnel in charge of refueling.

1.2 Airbus safety action

BEA suggests adding a chapter related to SAFETY MEASURES TAKEN SINCE OCCURRENCE

Airbus troubleshooting manuals (TSM)

BEA suggests adding that Airbus has launched a review of the following TSM tasks in order to identify some ways of improvement to address the possible fuel contamination and the multiple reset :

- TSM task 28-42-00-810-951-A Fuel - Tank Quantity and FOB Quantity Shown Amber XX
- TSM task 28-25-00-810-821-A 'Refuel Will Not Start or Cannot Be Completed'

Airbus Information to operators

- BEA suggests adding information on the Airbus Operators Information Transmission (OIT 999.0044/22 REV 00 released in June 2022) related to fuel shortage and associated fuel quality risks.

Significant comment 2 : In-flight phase

BEA suggests adding information provided by the FDR and PFR analysis performed by Airbus and Rolls-Royce and supported by the BEA.

- After about 5h of flight, the aircraft experienced a low pressure of the right main pump 2 then, within the same minute, a low pressure of the 3 right pumps.
- 15m later, the aircraft reached FL200 to enable the fuel gravity feeding, in accordance with published manufacturer procedure (FCOM)
- Few minutes later, the aircraft experienced 3 engine #2 stall ECAM warnings.
- The descent was performed with engine #2 at reduced thrust. However, during final approach, both thrust levers were pushed several times and engine #2 followed the command

Rolls-Royce determined that the engine #2 suffered engine fuel starvation. The fuel filters were not clogged as the bypass valve did not activate and no related ECAM warning triggered.

Therefore and taking into account that:

- During the previous flight, the aircraft did not experience any FQI XX
- The first FQI XX and fuelling stop occurred when about 600 litres were uplifted into the aircraft
- Presence of water in the fuel was confirmed after the event flight
- Inspections confirmed that pumps inlet & scavenge were not blocked
- Fuel filters were not clogged and bypass valve did not activate

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BEA fully supports the Airbus and Rolls-Royce analysis that considers that It is unlikely that the engine fuel starvation was due to the presence of MBC and is more likely due to presence of a high concentration of water in the fuel, which occurred, at least, during the first fuelling phase (initial 600 litres).

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Unless otherwise indicated, recommendations in this report are addressed to the appropriate regulatory authorities having responsibility for the matters with which the recommendation is concerned. It is for those authorities to decide what action is taken. In Ghana the responsible authority is the Ghana Civil Aviation Authority or the Aircraft Accident and Incident Investigation and Prevention Bureau, GL-025-7631, info@aibghana.gov.gh.


AIRCRAFT ACCIDENT AND INCIDENT INVESTIGATION AND PREVENTION BUREAU
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