FINAL INVESTIGATION REPORT

SERIOUS INCIDENT (SMOKE IN AFT CARGO) AIRBLUE FLIGHT ABQ-412 (SECTOR LHE – SHJ) AIRBUS A321 NEO, REG. NO. AP-BOE AT ALLAMA IQBAL INTERNATIONAL AIRPORT (AIIAP), LAHORE ON 25TH JULY, 2022

Dated: 14th February, 2024

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SCOPE

Aircraft Accident Investigation Board (AAIB), Pakistan investigations are conducted in accordance with Annex-13 to the International Civil Aviation Organization (ICAO) Convention on International Civil Aviation and Civil Aviation Rules 1994 (CARs 94).

The sole objective of the investigation and the final report of an accident or incident under above stated regulations is the prevention of future accidents and incidents of similar nature. It is not the purpose of such an investigation to apportion blame or liability. Accordingly, it is inappropriate to use AAIB Pakistan investigation reports to assign fault or blame or determine liability, since neither the investigation nor the reporting process has been undertaken for this purpose.

This report contains facts which have been determined up to the time of publication. Such information is published to inform the aviation industry and the public about the general circumstances of civil aviation accidents and incidents.

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ABBREVIATIONS

AAIB	Aircraft Accident Investigation Board
AIIAP	Allama Iqbal International Airport
AOM	Airside Operations Manual
ATPL	Air Transport Pilot Licence
ECS	Environmental Control System
FCOM	Flight Crew Operating Manual
FWC	Flight Warning Computer
h	Hour(s)
hPa	Hectopascal
ICAO	International Civil Aviation Organization
IOU	Incident Occurrence and Unserviceability Report
ISI	In-Service Information
m	Meter(s)
METAR	Meteorological Aerodrome Report
OML	Operational Multi-Pilot Limitation
PCAA	Pakistan Civil Aviation Authority
PFR	Post Flight Report
S/D	Smoke Detector
TFU	Technical Follow Up
TSM	Trouble Shooting Manual
UTC	Universal Time Coordinated

INTRODUCTION

The serious incident was reported to Aircraft Accident Investigation Board (AAIB), Pakistan, by Incident Occurrence and Unserviceability (IOU) Report. The serious incident was notified in accordance with International Civil Aviation Organization (ICAO) Annex-13. Ministry of Aviation, Government of Pakistan issued Memorandum authorizing AAIB, Pakistan to investigate the serious incident. The investigation has been conducted by AAIB, Pakistan. All corresponding timing are mentioned in Universal Time Coordinated (UTC).

SYNOPSIS

On 25th July, 2022 at 1951 hour (h), Airblue flight ABQ-412, Airbus A321 NEO aircraft, Reg. No. AP-BOE took off from Allama Iqbal International Airport (AIIAP), Lahore to perform a scheduled commercial flight to Sharjah International Airport, Sharjah. After take-off, AFT Cargo Compartment smoke warning was triggered. Pilot discharged cargo fire bottles and aircraft safely landed back at AIIAP, Lahore.

Evidence of smoke or fire was not found. Large quantity of inadequately packed animal meat was loaded in the Cargo Compartment, which probably caused the increased humidity level in the AFT Cargo Compartment leading to spurious smoke warning message.

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SECTION – 1 FACTUAL INFORMATION

1.1 History of the flight

1.1.1. On 25th July, 2022 at 1951 h Airblue flight ABQ-412 Airbus A321 NEO aircraft Reg. No. AP-BOE, took-off from AIIAP, Lahore.

1.1.2. At 1951 h, 'SMOKE AFT CARGO SMOKE' warning was triggered.

1.1.3. At 1952 h, Fire Bottle 1 (BTL1) squib was fired indicated by 'CRG FIRE BTL1 AFT SQUIB / DIR 1/2(101RH/102RH)' message and consequently 'CRG FIRE BTL 1 LO PR' message appeared.

1.1.4. At 1952 h, immediately after Fire Bottle 1, Fire Bottle 2 (BTL2) was operated indicated by message 'CRG FIRE BTL2 AFT SQUIB / DIR 1/2 (101RH/102RH).

1.1.5. At 2001 h, aircraft landed back safely on R/W 36L at AIIAP, Lahore.

1.1.6. On arrival, signs of actual fire, smoke, or heat inside the AFT Cargo Compartment were not observed.

1.2 Injuries to persons

1.2.1. There were no injuries to any person during this serious incident.

Injuries	Crew	Passengers	Total in the Aircraft	Others
Fatal	-	-	-	-
Serious	-	-	-	-
Minor	-	-	-	-
None	8	225	233	-
TOTAL	8	225	233	-

Table 1 Injuries to Persons

1.3 Damage to aircraft

1.3.1. There was no damage to the aircraft during this serious incident.

1.4 Other damage

1.4.1. Not applicable.

1.5 **Personnel information**

1.5.1. Salient details of experience and qualification of Pilot Flying and Pilot Monitoring are as under: -

Pilot Flying	
License type	Air Transport Pilot License (ATPL-1648)
Medical date with status	09th May, 2022, Class – 1 Operational Multi-Pilot Limitation (OML)
Flying experience	10896:18 h
On type	2268:00 h
Pilot Monitoring	
License type	Air Transport Pilot License (ATPL-1132)
Medical date with status	17 May, 2022, Class – 1
Flying experience	16510:13 h
On type	9816:13 h

Table 2 Personnel Details

1.6 **Aircraft information**

1.6.1 Details of aircraft are as under: -

Aircraft Details	
Call Sign	ABQ-412
Aircraft Make & Model	A321 NEO
Registration Marking	AP-BOE
Year of Manufacture	2020
Manufacture Serial No.	10162
Owner / Lessor	GE Capital Aviation Services
Operator	Airblue
Engines	CFM LEAP-1A32
Sector	Lahore to Sharjah

Table 3 Aircraft Details

1.6.2 Smoke Detectors P/N PPC1100-00 quantity 06 installed in the AFT Cargo Compartment were removed and tested at shop. All detectors had cleared the functional test. However, all the detectors were dirty and required internal inspection and cleaning.

1.7 **Meteorological information**

1.7.1. No significant weather was reported for AIIAP, Lahore at the time of serious incident. Meteorological Aerodrome Report (METAR) data for AIIAP, Lahore around the time of serious incident indicated high level of humidity (79% - 87%).

1.7.2. METAR: OPLA 251925Z 08008KT 4000 FU SCT100 29/25 Q1006 NOSIG RMK.

METAR AIIAP, Lahore	
OPLA	**Station ID -** AIIAP, Lahore
251925Z	**Date and Time -** Day 25 & Time 1925 UTC
08008KT	**Wind Direction & Speed -** 080° & 08 knots
4000	**Visibility -** 4,000 m
FU	**Weather Phenomena -** Smoke
SCT100	**Scattered Clouds -** 10,000 ft AGL
29/25	**Temperature -** 29°C / **Dewpoint -** 25°C
Q1006	**Altimeter setting -** Air pressure 1006 hPa
NOSIG	**No significant change** is expected to the reported conditions within the next 2 hours
RMK	**Remarks -** Nil

Table 4 METAR Description AIIAP, Lahore at 1925 h

1.7.3. METAR: OPLA 251955Z 07010KT 4000 FU SCT100 29/26 Q1006 NOSIG RMK.

METAR AIIAP, Lahore	
OPLA	**Station ID -** AIIAP, Lahore
251955Z	**Date and Time -** Day 25 &Time 1955 UTC
07010KT	**Wind Direction & Speed -** 070° & 10 knots
4000	**Visibility -** 4,000 m
FU	**Weather Phenomena -** Smoke
SCT100	**Scattered Clouds -** 10,000 ft AGL
29/26	**Temperature -** 29°C / **Dewpoint -** 26°C
Q1006	**Altimeter setting -** Air pressure 1006 hPa
NOSIG	**No significant change** is expected to the reported conditions within the next 2 hours
RMK	**Remarks -** Nil

Table 5 METAR Description AIIAP, Lahore at 1955 h

1.8 Aids to navigation

1.8.1 Not applicable.

1.9 Communications

1.9.1 Not applicable.

1.10 Aerodrome information

1.10.1 Not applicable.

1.11 Flight recorders

1.11.1 Not applicable.

1.12 Wreckage and impact information

1.12.1 Not applicable.

1.13 Medical and pathological information

1.13.1 Not applicable.

1.14 Fire

1.14.1 Not applicable.

1.15 Survival aspects

1.15.1 Not applicable.

1.16 Test and research

1.16.1 Not applicable.

1.17 Organizational and management information

1.17.1 **Airline Operator.** The Airline Operator's Airside Operations Manual (AOM) provide the guidelines for all aspects of the cargo handling. However, in the domain of "Loading Procedure" and "Packing" for perishable goods (fresh / frozen animal meat or fish) the Manual contained inadequate instructions at the time of serious incident.

1.17.2 **Aircraft Manufacturer.** Smoke Detector (S/D) P/N PPC1100-00 series were installed on the AP-BOE aircraft. Airbus Technical Follow Up (TFU) 26.16.00.006 issued on 18th July 2018, has indicated spurious cargo smoke detection events with root cause isolated as design of these Smoke Detectors.

1.17.2.1 Design of S/D P/N PPC1100-00 series is based on single optical measurement. This technology cannot distinguish in all cases of real smoke particles with other particles in the air like spray, dust, humidity, or condensation. In dusty or humid environments, the single optical detector can trigger spurious smoke alarms.

1.17.3 The circumstances where spurious warning can occur have been identified by Airbus In-Service Information (ISI) 26.10.00007 and can in the most part be avoided by taking various precautionary measures contained in the referred ISI.

1.17.4 The circumstances where spurious warning can occur have been identified by Airbus ISI 26.10.00.007 and can, in the most part, be avoided by taking various precautionary measures contained in the referred ISI. In particular, the ISI identifies extreme condensation / humidity related to the carriage of humidity generating cargoes such as tropical fruits and vegetables etc.

1.17.5 New Smoke Detectors, embodying state-of-the-art technology, will introduce the capability to discriminate between real smoke and spray/vapour/condensation. Such technology is currently under final development. This new generation of Smoke Detectors will be available for line fit and retrofit market.

1.18 **Additional information**

1.18.1 Not applicable.

1.19 **Useful or effective investigation techniques**

1.19.1 Not applicable.

SECTION 2 - ANALYSIS

2.1 **General**

2.1.1 In AFT Cargo Compartment of the aircraft, total number of 6 Smoke Detectors P/N PPC1100-00 are installed, 2 in each position A, B and C as depicted in picture below: -

Figure 1 Location of Smoke Detectors in AFT Cargo Section

2.1.2 Two detectors are installed in each position to provide redundancy to the detection system. In case, one Smoke Detector at a position is faulty, the smoke detection function remains operational to generate warning message to Flight Warning Computer (FWC).

2.1.3 These Smoke Detectors could trigger spurious cargo smoke detection due to their design limitations and have caused spurious warning as per Airbus ISI 26.10.00007.

2.2 **Aircraft**

2.2.1 On 24th July, 2022 aircraft maintenance Post Flight Report (PFR) indicated failure message associated with Smoke Detector at position 5WH, “SMK DET AFT LDCC (5WH)” a day prior to this serious incident occurred.

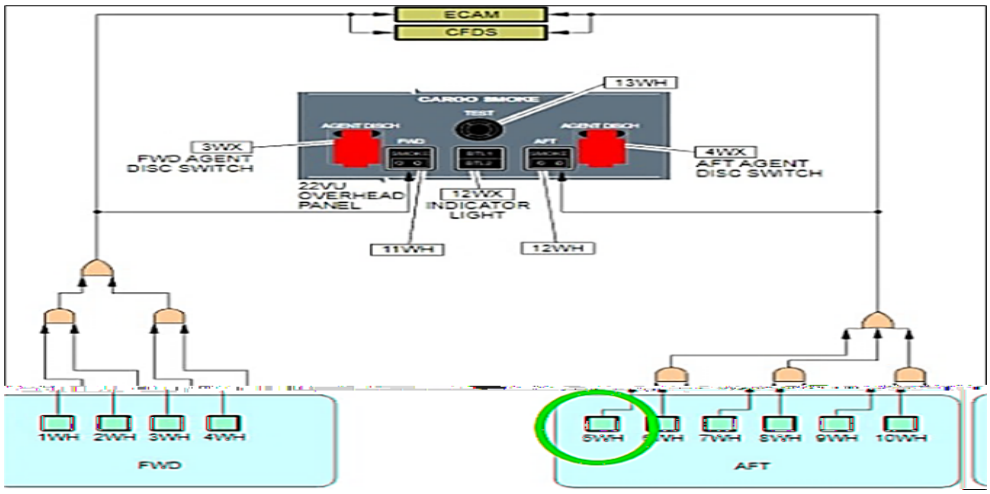

Figure 2 Fire / Smoke Warning System

2.2.2 This failure message had no previous history. The defect was cleared by reset of the involved system as per Airbus Trouble Shooting Manual (TSM) Philosophy. The Smoke Detector at position 5WH cleared the functional test at shop. So, its contribution to this serious incident is unlikely.

2.2.3 After this serious incident, inspection of the AFT Cargo Compartment did not reveal sign of actual smoke or fire. In-flight warning message of 'SMOKE AFT CARGO SMOKE' was a spurious warning message.

2.2.4 It was found during the inspection that 3,200 kg of frozen animal meat was loaded in the AFT Cargo Compartment.

2.2.5 Animal meat was packed in fabric bags and traces of fluid / blood were found on these bags. It indicated inadequate packing / sealing of the bags containing the animal meat.

Figure 3 Traces of fluid / blood on bags

2.2.6 Loading of the animal meat on the aircraft was supervised by the Airside Executive of the Airline Operator.

2.2.7 According to Airbus ISI 26.16.00007: -

> *"Cases of cargo smoke detection system activation have been observed when cargo bay condensation levels are at an extreme level. These warnings are almost always related to the carriage of humidity generating cargoes such as tropical fruits and vegetables etc. These cargoes cause humidity levels to increase in unventilated compartments with the result that large quantities of condensation can form, the droplets of which appear to the smoke detector to be similar to smoke particles. This condensation can be avoided by transporting humidity generating cargo in ventilated compartments or where appropriate by using sealed containers."*

2.2.8 Airside Operations Manual did not contain the elaborate instructions for the packing of perishable goods, animal meat etc on the aircraft. Consequently, adequate packing of animal meat could not be ensured while loading the meat on the aircraft. This anomaly probably remained unnoticed or effective intervention was not exercised by the Supervisor.

2.2.9 Animal meat contained in inadequate packing could have generated the humidity, thus increasing the humidity level in the sealed Cargo Compartment. This situation combined with the high relative humidity level at the Aerodrome could have led to

condensation, the droplets of which appeared to Smoke Detector as smoke particles, leading to spurious smoke warning after take-off.

2.2.10 After this serious incident, Airline Operator has reviewed the procedure for packing and loading of the perishable goods including animal meat on-board the aircraft to address the inadequacies.

2.3 **Flight Operations**

2.3.1 Flight crew handled the emergency as per the Flight Crew Operating Manual (FCOM) instructions.

2.4 **Human Factors**

2.4.1. Not applicable.

SECTION 3 – CONCLUSIONS

3.1. Findings

3.1.1. Inspection of the AFT Cargo Compartment did not reveal sign of actual smoke or fire. In-flight warning message of 'SMOKE AFT CARGO SMOKE' was a spurious warning message.

3.1.2. 3,200 kg of frozen animal meat was loaded in the AFT Cargo Compartment.

3.1.3. Animal meat was packed in fabric bags and traces of fluid / blood were found on these bags.

3.1.4. Animal meat was not adequately packed and sealed to avoid humidity generation in the sealed AFT Cargo Compartment.

3.1.5. Loading of the animal meat on the aircraft was supervised by the Airside Executive of the Airline Operator.

3.1.6. METAR data for AIIAP, Lahore around the time of serious incident indicated high level of humidity.

3.1.7. According to Airbus ISI 26.16.00007 "cases of cargo smoke detection system activation have been observed when cargo bay condensation levels are at an extreme level. These warnings are almost always related to the carriage of humidity generating cargoes such as tropical fruits and vegetables etc."

3.1.8. Airbus recommends transport of humidity generating cargo in ventilated compartments or where appropriate by using sealed containers.

3.1.9. Airside Operations Manual did not contain the elaborate instructions for the packing and loading of perishable goods, animal meat etc on the aircraft.

3.1.10. Adequate packing of animal meat was not ensured and while loading the meat on the aircraft. This anomaly probably remained unnoticed or effective intervention was not exercised by the supervisor.

3.1.11. Animal meat caused increase in the humidity level of Cargo Compartment. This situation combined with the high relative humidity level at the Aerodrome could have led to condensation, the droplets of which appeared to Smoke Detector as smoke particles, leading to spurious smoke warning after take-off.

3.1.12. After this serious incident, Airline Operator has reviewed the procedure for packing and loading of the perishable goods including animal meat on-board the aircraft to address the inadequacies.

3.2. Causes / Contributing Factors

3.2.1. Cause

3.2.1.1. Animal meat loaded on aircraft was not adequately packed. It generated humidity which augmented the prevailing high humidity level in the sealed AFT Cargo Compartment leading to in-flight spurious smoke warning.

*WARNING ERROR (SCF−NP−AVION−WRNERR) **

3.2.2. Contributing Factor

3.2.2.1. Lack of elaborated instructions for the packing and loading of perishable goods, animal meat etc. on the aircraft.

3.2.2.2. Spurious smoke warning occurred due to design limitation of Smoke Detector P/N PPC1100-00.

**Note: Aviation Occurrence Category (ADREP Taxonomy)*
SYSTEM / COMPONENT FAILURE OR MALFUNCTION (NON-POWERPLANT): *WARNING ERROR (SCF−NP−AVION−WRNERR)*

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SECTION 4 – SAFETY RECOMMENDATIONS

4.1. Safety Recommendations

4.1.1. PCAA may ensure that Airline Operators and Ground Handling Agencies have elaborated instructions for the packing and loading of perishable goods, animal meat etc on the aircraft.