KOMITE NASIONAL KESELAMATAN TRANSPORTASI
REPUBLIC OF INDONESIA

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Aircraft Serious Incident Investigation Report

PT. Wings Abadi Airlines

ATR 72-212A; PK-WFG

Polonia Airport, Medan – North Sumatera
Republic of Indonesia

8 August 2011

2023

This Final Report was produced by the *Komite Nasional Keselamatan Transportasi* (KNKT), Transportation Building, 3rd Floor, Jalan Medan Merdeka Timur No. 5 Jakarta 10110, Indonesia.

The report is based upon the investigation carried out by the KNKT in accordance with Annex 13 to the Convention on International Civil Aviation, the Indonesian Aviation Act (UU No. 1/2009) and Government Regulation (PP No. 62/2013).

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Jakarta, 21 November 2023

KOMITE NASIONAL
KESELAMATAN TRANSPORTASI
CHAIRMAN

SOERJANTO TJAHJONO

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ABBREVIATION AND DEFINITION

°C	:	Degree Celsius
AFML	:	Aircraft Flight Maintenance Log
AGL	:	Above Ground Level
AOC	:	Air Operator Certificate
ATPL	:	Airline Transport Pilot License
ATS	:	Air Traffic Services
ATR	:	Avions De Transport Regional
BEA	:	Bureau d'enquêtes et d'Analyses (Accident Investigation Authorities (AIA) of France)
BMKG	:	*Badan Meteorologi, Klimatologi, dan Geofisika,* is the Bureau of Meteorology, Climatology and Geophysics of Indonesia
C of A	:	Certificate of Airworthiness
C of R	:	Certificate of Registration
CASR	:	Civil Aviation Safety Regulation
CAP	:	Crew Alerting Panel
CL	:	Condition Lever. The Condition Lever is the propeller speed control and controlling the fuel shut valve.
Cloud	:	Cloud amount is assessed in octal parts which is the estimated total apparent area of the sky covered with cloud. The international unit for reporting cloud amount for Few (FEW) is when the clouds cover 1/8 area of the sky, Scattered (SCT) is when the clouds cover 3/8 to 4/8 area of the sky and Broken (BKN) is when the clouds cover more than half (5/8 up to 7/8) area of the sky. The CB means that the cumulonimbus cloud was present.
CPL	:	Commercial Pilot License
CSN	:	Cycle Since New
CVR	:	Cockpit Voice Recorder
DC	:	Direct Current
DGCA	:	Directorate General of Civil Aviation
EEC	:	Electronic Engine Control
FA	:	Flight Attendant
FDR	:	Flight Data Recorder
FF	:	An engine parameter to indicate the Fuel Flow
HMU	:	Hydromechanical Unit
IAS	:	Indicated Airspeed
IBV	:	Inter-compressor Bleed Valve

ICAO	:	International Civil Aviation Organization
IFR	:	Instrument Flight Rule
ITT	:	Inter Turbine Temperature, an engine parameter to represent the turbine temperature
km	:	Kilo Meter
KNKT	:	*Komite Nasional Keselamatan Transportasi* is the Indonesia Independent Investigation Authority also known as National Transportation Safety Committee / NTSC)
lbs	:	Lbs is a measuring unit pounds, which originates from the Latin libra
m	:	Meter(s)
MSDS	:	Material Safety Data Sheet
MTOW	:	Maximum Take Off Weight
NP	:	An engine parameter to represent the propeller speed
PF	:	Pilot Flying
PIC	:	Pilot in Command
PLA	:	Power Lever Angle
PM	:	Pilot Monitoring
PWC	:	Pratt & Whitney Canada
QFE	:	An aeronautical code indicating atmospheric pressure at the current ground level.
QNH	:	An aeronautical code indicating the atmospheric pressure adjusted to mean sea level.
QRH	:	Quick Reference Handbook
RFFS	:	Rescue and Fire Fighting Services
SB	:	Service Bulletin
SIC	:	Second in Command
SOP	:	Standard Operation Procedure
SSCVR	:	Solid-State Cockpit Voice Recorder
SSFDR	:	Solid-State Flight Data Recorder
TOC	:	Top of Climb
TOD	:	Top of Decent
TQ	:	An engine parameter to represent the Torque
TSN	:	Time Since New
UTC	:	Universal Time Coordinate
VFR	:	Visual Flight Rule

SYNOPSIS

On 8 August 2011, the aircraft was scheduled for a flight from Polonia Airport (WIMM), Medan, North Sumatera to Cut Nyak Dien Airport (WICT), Meulaboh, Nangroe Aceh Darussalam with flight number IW1252. The flight was the second flight for the crew and the aircraft for that day.

At 0901 LT, after the aircraft took off, when the altitude was approximately 1,600 feet, the right engine fire warning activated and the PIC commanded the SIC to visually check the right engine to identify any sign of fire which was responded by the SIC that the fire was not visible. The SIC handed over the aircraft control to the PIC.

The engine shut down was executed 2 minutes after the first fire warning activation. After the engine shut down execution the fire warning aural warning active 2 times, thereafter SIC pulled the engine fire handle of the right engine. The fire extinguisher was discharged 2 minutes and 30 seconds after the engine shut down. The delay of the engine shut down and discharge fire extinguisher led the engine prolong exposed to the fire and made the engine exhibit severe damage.

On 15 April 2011, the right engine fuel nozzle had been replaced due for scheduled replacement. The engineer did not utilize the proper tooling as recommended by the manufacture resulted in undetected torn off pre formed packing inside of the fuel nozzle assembly position 1. The engine was sent to the Pratt & Whitney Canada for detail examination and confirmed that the pre formed packing inside of the fuel nozzle assembly had broken which resulted in the fuel leakage.

The passengers disembarked from the aircraft normally and no one injured.

The investigation concluded several contributing factors based on the safety issues identified following the accident as follow:

- The utilizing of improper tool during the installation of the fuel nozzle led to the improper position of the right engine fuel nozzle position number 1 which subsequently resulted in undetected torn off to the preformed packing and caused the fuel leak.
- The significant amount of fuel leak was not sufficient to be washed overboard and became self-ignited as the temperature reached the self-ignited value.
- The delaying discharge fire extinguisher led the engine prolong exposed to the fire and made the engine exhibit severe damage.

The *Komite Nasional Keselamatan Transportasi* (KNKT) acknowledged that the safety actions taken by the related parties were relevant to improve safety therefore the KNKT did not issue safety recommendations.

1 FACTUAL INFORMATION

1.1 History of the Flight

An ATR 72-212A aircraft, registered PK-WFG, was being operated as a scheduled passenger flight by PT. Wings Abadi Airline (Wings Air).

On 8 August 2011, the aircraft was scheduled for a flight from Polonia Airport (WIMM), Medan[1], North Sumatera to Cut Nyak Dien Airport (WICT), Meulaboh, Nangroe Aceh Darussalam[2] with flight number IW1252. The flight was the second flight for the crew and the aircraft for that day.

At 0159 UTC[3] (0859 LT), the aircraft took-off on Runway 23. The Second in Command (SIC) acted as Pilot Flying (PF), and the Pilot in Command (PIC) acted as Pilot Monitoring (PM). After takeoff, the Polonia Tower controller transferred the communication to Medan Director controller. The Medan Director controller instructed the pilot to fly on heading 330° and to initially maintain aircraft altitude of 2,000 feet.

At 0901 LT, when the altitude was approximately 1,600 feet, the fire warning of the engine position number 2 (right engine) activated and the PIC commanded the SIC to visually check the right engine to identify any sign of fire, which was responded by the SIC that the fire was not visible. The SIC handed over the aircraft control to the PIC.

At 09:01:38 LT, the Medan Director controller instructed IW 1252 pilot to climb to the altitude of 3,000 feet, the SIC responded by requesting to the Medan Director controller to return to Medan due to engine fire. The Medan Director controller acknowledged the request and instructed the pilot to fly heading 040° which was confirmed by the pilot.

At 09:02:12 LT, the SIC suggested to the PIC for feathering the propeller of the right engine. The PIC confirmed but the feathering to the propeller was not executed yet because both pilots still assessing the engine.

At 09:02:39 LT, the SIC suggested to shut off the fuel valve and the PIC responded to wait.

At 09:02:53 LT, the PIC informed to the Flight Attendant (FA) that the flight would return to Polonia due to right engine problem. The FA acknowledged and informed to the PIC that the passengers were curious to the condition of the right engine. The PIC then asked the FA to check the condition of the right engine.

At 09:03:15 LT, the DC GEN number 2 fault light illuminated. The PIC commanded SIC to shut down the right engine and feather the propeller.

At 09:03:53 LT, the right engine fire warning activated for the second time and at 09:04:00 LT, the right engine fire warning activated again for the third time.

1 The Polonia Airport (WIMM), Medan, North Sumatera, Indonesia will be named as Polonia.

2 The Cut Nyak Dien Airport (WICT), Meulaboh, Nangroe Aceh Darussalam, Indonesia will be named as Cut Nyak Dien.

3 The 24-hours clock in Universal Time Coordinated (UTC) is used in this report to describe the local time as specific events occurred. The Local Time in Medan is UTC + 7 hours.

At 09:04:16 LT, the SIC informed the PIC that he would pull the fire handle of the right engine and confirmed by the PIC.

At 09:04:48 LT, the SIC requesting for priority landing to the Medan Director controller.

At 09:05:18 LT, the pilots discussing the Quick Reference Handbook (QRH).

At 09:05:47 LT, the SIC informed the PIC that he would discharge the fire extinguisher bottle number 1 and confirmed by the PIC.

At 09:05:49 LT, the Medan Director controller instructed the pilot to fly heading on 225° to join final Runway 23.

At 09:05:52 LT, the QRH of single engine operation was initiated.

At 09:06:28 LT, the SIC interrupted in the execution of the QRH informing the PIC that he would discharge the engine fire extinguisher bottle number 2 and confirmed by the PIC.

At 09:06:30 LT, the QRH for the single engine operation was completed.

At 09:06:49 LT, the SIC contacted the company flight operation personnel and informed that they had Electronic Engine Control (EEC) problem or maybe engine fire and they were returning to Polonia.

At 09:07:26 LT, both pilots discussed about the problem and they agreed that maybe it was the computer problem.

At 09:07:54 LT, the pilot was instructed by Medan Director controller to intercept the final Runway 23. After the SIC confirmed that the runway was in sight, then the communication was transferred from Medan Director controller to the Polonia Tower controller for landing clearance. Subsequently the Polonia Tower controller provided the landing clearance.

At 09:08:29 LT, the Polonia Tower controller asked whether they may require ground assistance, the SIC replied by requesting for the fire fighter and push back tractor.

At 09:10:55 LT, the aircraft landed safely.

At 09:11:09 LT, there was a conversation between the SIC and a person related to the occurrence and the problem on the right engine. The SIC was not sure about the problem. The SIC stated that the problem may be related to the EEC, the engine fire warning activated, the torque indicator went blank, the oil pressure decreased, and the engine temperature increasing. The SIC assumed that this might related to the problem of the aircraft two days before. The SIC assumed that the problem was from the computer.

The passengers disembarked from the aircraft normally and no one injured.

1.2 Injuries to Persons

Injuries	Flight crew	Passengers	Total in Aircraft	Others
Fatal	-	-	-	-
Serious	-	-	-	-
Minor	-	-	-	-
None	4	42	46	-
TOTAL	4	42	46	-

The pilots and all passengers are Indonesian.

1.3 Damage to Aircraft

The right engine had substantial damage due to fire.

1.4 Other Damage

There was no other damage.

1.5 Personnel Information

1.5.1 Pilot in Command

Gender	:	Male
Age	:	41 years
Nationality	:	Indonesia
License	:	ATPL
Date of issue	:	14 May 2004
Valid to	:	4 December 2011
Aircraft type rating	:	ATR 72
Medical certificate	:	First class
Date of medical	:	24 June 2011
Valid to	:	24 December 2011
Last proficiency check	:	23 March 2011
Total hours	:	12,051 hours
Total on type	:	-
Last 90 days	:	321 hours 52 minutes
Last 30 days	:	105 hours 02 minutes
Last 24 hours	:	7 hours 52 minutes

This flight	:	11 minutes

1.5.2 Second in Command

Gender	:	Male
Age	:	24 years
Nationality	:	France
License	:	CPL
Date of issue	:	19 April 2010
Valid to	:	21 January 2011
Aircraft type rating	:	ATR 42, ATR 72
Medical certificate	:	First class
Date of medical	:	21 July 2011
Valid to	:	21 January 2012
Last proficiency check	:	14 June 2011
Total hours	:	1,426 hours
Total on type	:	234 hours 25 minutes
Last 90 days	:	306 hours 24 minutes
Last 30 days	:	106 hours 40 minutes
Last 24 hours	:	7 hours 52 minutes
This flight	:	11 minutes

1.6 Aircraft Information

1.6.1 General

Aircraft manufacturer	:	Avions De Transport Regional, France
Aircraft model/type	:	ATR 72-212A (500 Series)
Serial number	:	0882
Year of manufacture	:	2009
Aircraft registration	:	PK-WFG
Certificate of Registration Validity	:	20 December 2011
Certificate of Airworthiness Validity	:	30 November 2011
Time Since New (TSN)	:	3,400 hours 57 hours
Cycle Since New (CSN)	:	4,089 cycles
Maximum Takeoff Weight	:	50,640 lbs

(MTOW)		
Actual Take Off Weight	:	50,265 lbs

1.6.2 Engines

Engine type	:	Turbo-propeller
Manufacturer	:	Pratt & Whitney, Canada (PWC)
Model	:	PW 127 M
Serial Number of the left engine	:	PCE-ED0202
TSN	:	3400 hours 57 minutes
CSN	:	4089 cycles
Serial Number of the right engine	:	PCE-ED0201
TSN	:	3400 hours 57 minutes
CSN	:	4089 cycles

1.6.3 Maintenance Record

The operator issued an instruction for removal and installation of engine fuel nozzles which described in the operator task card number 731361-RAI-10000-1 (Removal and Installation of Fuel Nozzles/Adapters Assembly) as a routine fuel nozzles replacement every 1,000 hours interval.

On 15 April 2011, the removal and installation of fuel nozzles/adapters assembly (based on the task card number 731361-RAI-10000-1) was performed to the right engine at the engine TSN of 2,775.15 hours and CSN 3,317 cycles. The task card number 731361-RAI-10000-1 report showed that all of 14 fuel nozzles were replaced. Following the replacement of the fuel nozzles of the right engine, the engine performance run up was conducted with the satisfactory result.

The task card number 731361-RAI-10000-1 referred to the fuel nozzle part number were 3059760-01 (item 10 or 10A refer to the figure 1 below), 3059757-01 (item 20 or 20H refer to the figure 1 below) and 3059754-01 (item 40 or 40H refer to the figure 1 below). Each of the fuel nozzles were connected with the fuel distribution flexible hoses.

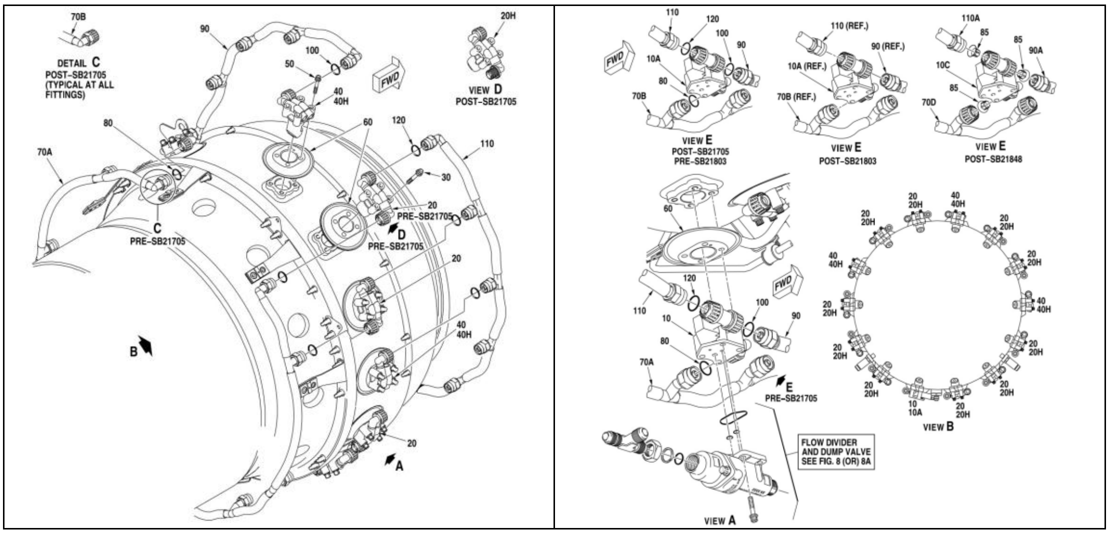
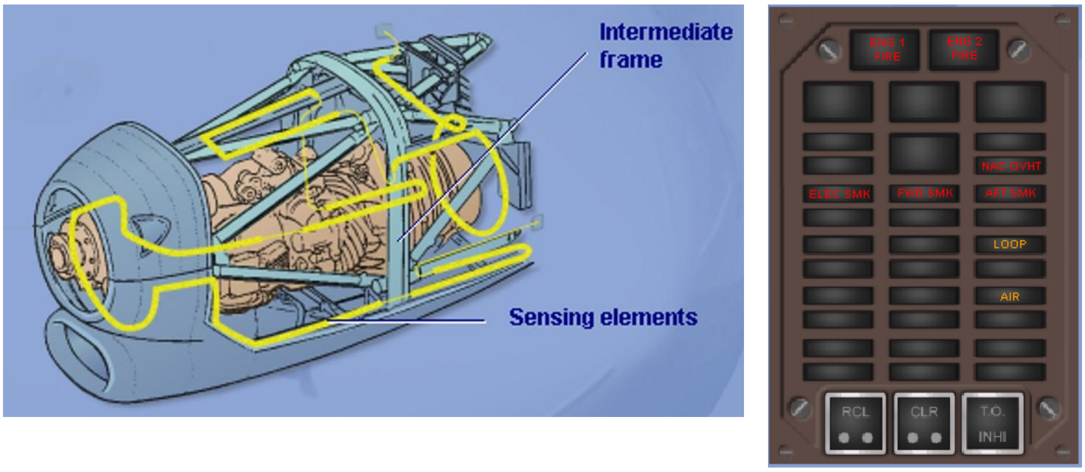


Figure 1: The illustrated fuel manifold installation

The Aircraft Flight & Maintenance Log (AFML) recorded that on 6 August 2011, the right engine fuel filter clogging caution light illuminated and the problem has been rectified two days before occurrence.

1.6.4 Engine Fire Detection System

Each engine is equipped with fire detection system which consists of two identical detection loops (A and B) mounted in parallel and a fire detection control unit. The fire detection loop is mounted on the surrounding engine within the engine cowling. The fire detection loop is shown in the figure below.



Engine fire detection loop indicated by the sensing elements

Crew Alerting Panel (CAP)

Figure 2: Fire detection loop and Crew Alerting Panel on the center instrument panel

The detection principle is based on the variation of resistance and capacitance of the detection loop. If fire is detected, the master warning light will illuminate accompany by aural warning.

The associated engine fire handle on the crew overhead panel will illuminate and the warning light in the Crew Alerting Panel (CAP) on center instrument panel will also illuminate.

If the fire is detected and the fire handle on the overhead panel is illuminate, pulling the fire handle will arm the squib buttons which ready to discharge. Pressing the squib button will discharge the fire extinguisher from the squib bottle to the respective engine where the fire handle is pulled.

The illustrated fire extinguisher system is shown in the figure below.

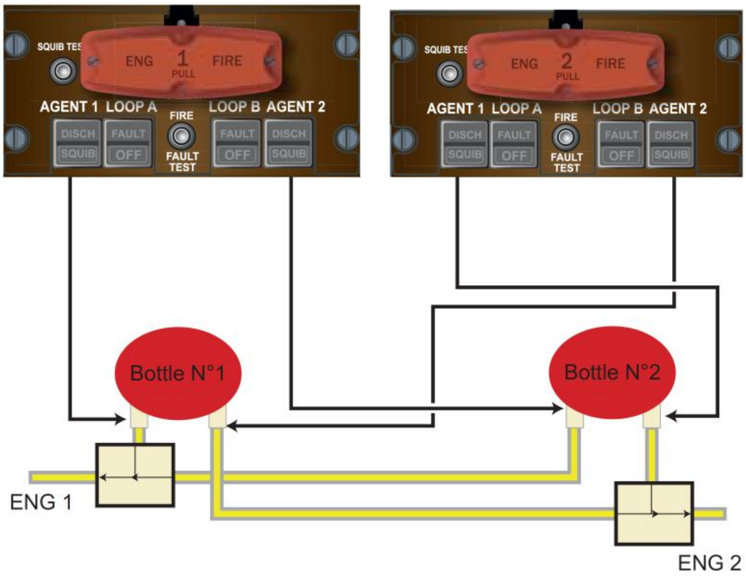


Figure 3: Fire handle on the overhead panel in associated with the fire bottle (squib)

1.6.5 Direct Current (DC) Generation System

The Direct Current (DC) system is supplied by the 2 generators (from the left and right engines). The generators acting as a starter generator during engine start and become a DC generator electrical supply when the engine high pressure compressor (NH) above 61.5% rotation.

The DC GEN push button in the cockpit comprises OFF and FAULT lights. If the engine is not running and the battery switch is put to the ON position, the FAULT light of the DC GEN push button will illuminate. When the engine is running and the NH rotation is more than 61.5%, the FAULT light of the DC GEN push button will extinguish allowing the DC electrical supply to the DC Bus system.

In the normal engine running, the illumination of the FAULT light of the DC GEN push button indicates that the DC generator has problem or the NH falls below 61.5% rotation. During this condition, depressing the DC GEN push button will illuminate the OFF light and the FAULT light remains.

1.6.6 Fuel Nozzle Assembly

The engine PW127M fuel system consists but not limited to Engine Electronic Control (EEC), Hydromechanical Unit (HMU) and other system to provide the engine performance.

The engine equipped with 14 fuel nozzle assembly which delivered the fuel from the fuel tank into the engine after had been metered by the EEC and controlled by the HMU.

The procedure of fuel nozzle removal and installation is described in the Engine Maintenance Manual chapter 72-01-40.

The fuel nozzles of the accident engine were Post-SB 21705, whereas the fuel nozzle arrangement is as follow:

- The fuel nozzle position 1, 4 and 12 installed with the part number 3059754-01.
- The fuel nozzle position 2, 3, 5-9, 13, and 14 installed with the part number 3059757-01.
- The fuel nozzle position 10 was installed with part number 3059760-01.

The installation of the fuel nozzle is shown in the figure below.

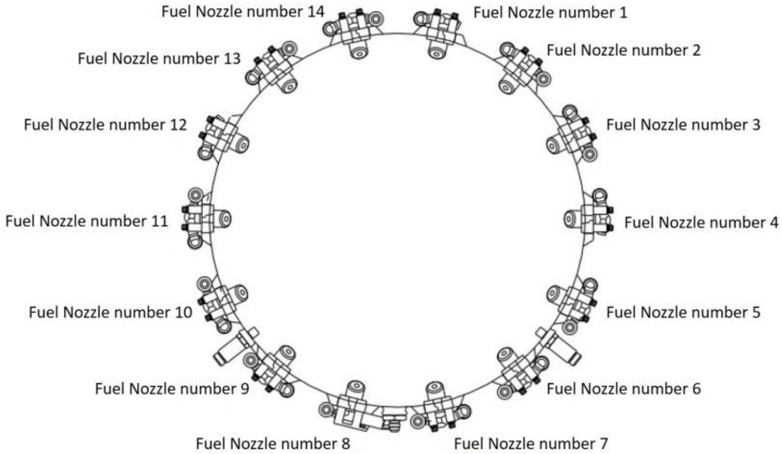


Figure 4: Fuel nozzle arrangement

The illustrated fuel nozzle and manifold is shown in the figure below.

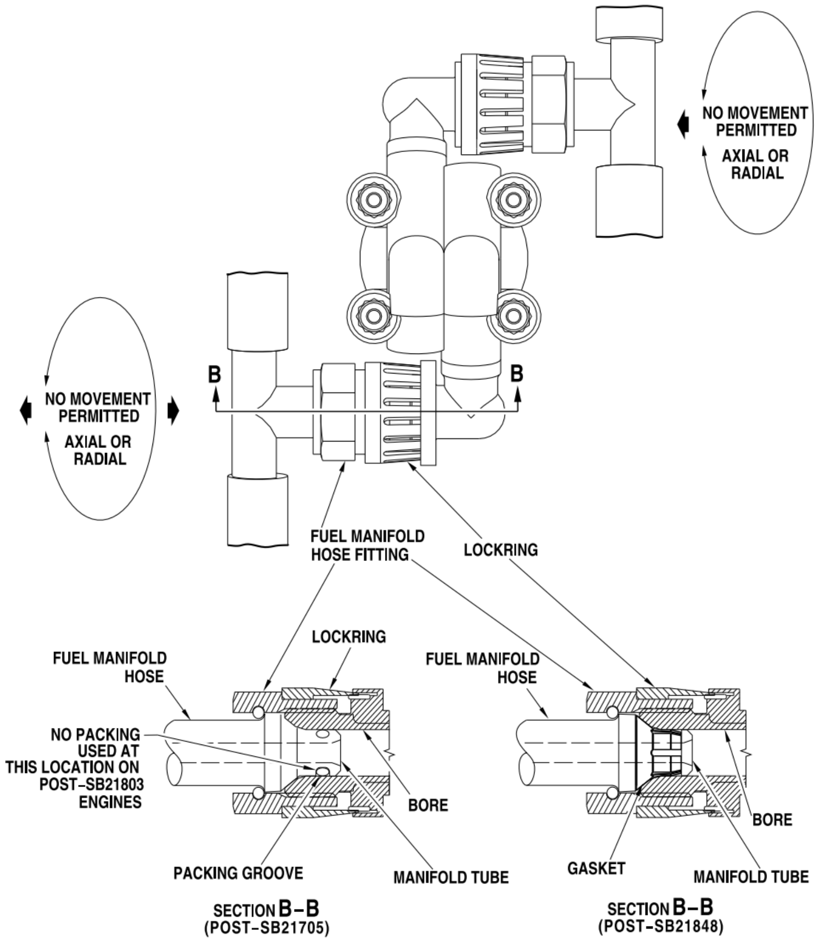


Figure 5: Fuel Nozzle Assembly

The typical view of the Post-SB 21705 fuel nozzles is shown in the figures below.

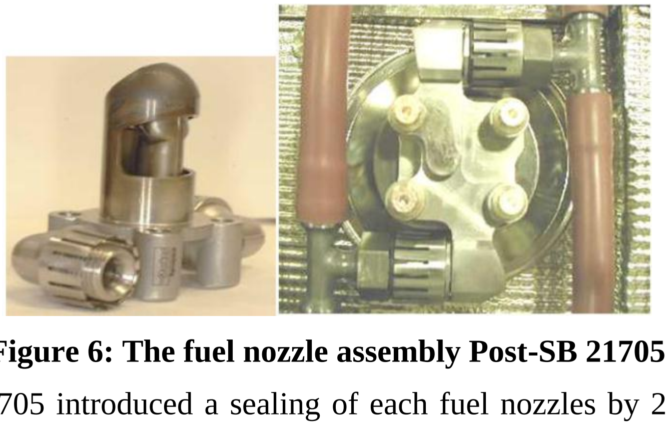


Figure 6: The fuel nozzle assembly Post-SB 21705

The Post-SB 21705 introduced a sealing of each fuel nozzles by 2 distinct features which are primary and secondary sealing.

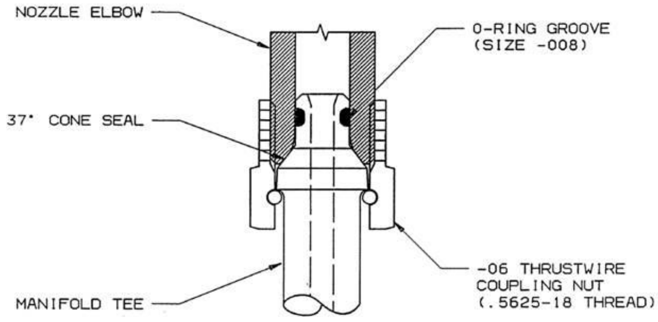


Figure 7: The sealing feature of SB 21705

The primary sealing is metal to metal surface sealing between manifold fitting (see the MANIFOLD TEE refer to the figure 7 above) and the fuel adapter (see the NOZZLE ELBOW refer to the figure 7 above).

The secondary sealing is done by the installation of preformed packing (see the O-RING GROOVE (SIZE –008) refer to the figure 7 above) on the fuel nozzle manifold fitting. The preformed packing is designed as secondary backup sealing for added protection.

The primary and secondary sealing are parts of the locking feature which consisted in the lock ring (Moeller Fingers) and crowned ring (Moeller Ring). The typical arrangement of Moeller Finger and Moeller Ring are shown in the figure below.

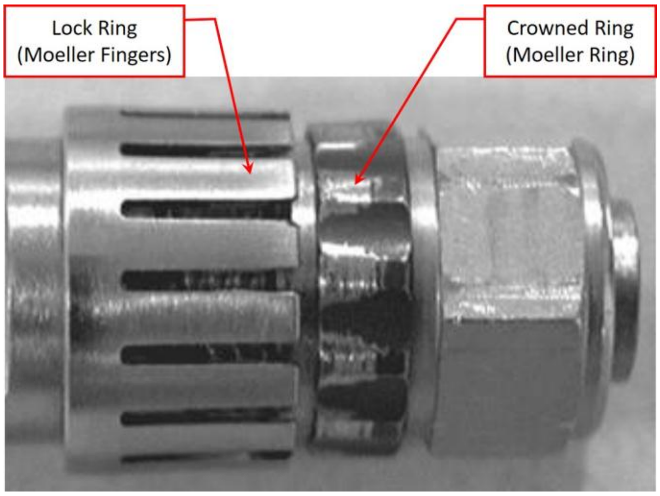


Figure 8: Moeller Fingers and Moeller Ring

While locking features seals can ensure efficient sealing, but improper installation of Moller Fingers on the Moeller Ring will result in premature wear of the preformed packing secondary sealing.

The PWC recommends the removal and installation of the fuel nozzle assembly should use the proper tooling of PWC tool kit part number PWC56616. The investigation revealed that on 15 April 2011, during the installation of the fuel nozzle, the engineer did not utilize the proper tool kit. Without utilizing the proper tool while the engine was still installed on the nacelle, the engineer could have difficulties in aligning and correct applying torque to the fuel nozzle position number 1 and 14. The other positions of the fuel nozzle may be able to be installed easier.

The engine PW127M series installed on the ATR72-212A also equipped with confined engine cowling with the sufficient circulation air. Any leakage of liquid including the fuel in small amount will be washed overboard by the air flow during the flight. In addition, several drains were equipped on the bottom of the engine cowl which allows any leakage of fluid including any fluid on external of hot section area was discharged overboard. The engine ventilation is shown in the figure below.

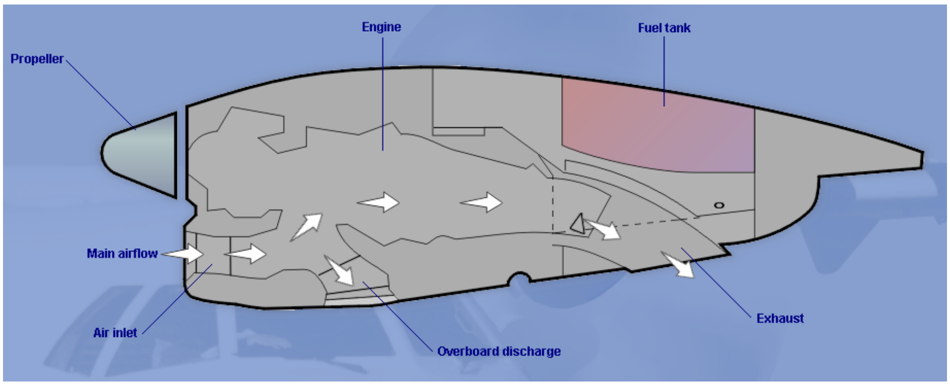


Figure 9: The engine ventilation

1.7 Meteorological Information

The weather report for Polonia as reported by the Agency of Meteorology, Climatology and Geophysics (*Badan Meterologi, Klimatologi, dan Geofisika*) of Indonesia, issued on 8 August 2011 at 0900 LT is as follow.

Surface wind	: 160/4 knots
Visibility	: 7 km
Cloud[4]	: Few/1800 feet.
Temperature	: 28°C
Dew Point	: 24°C
QNH[5]	: 1011 mb
QFE[6]	: 1007 mb

Day light condition prevailed at the time of the accident.

1.8 Aids to Navigation

Both ground base navigation and aircraft navigation systems were operating normally during the flight and considered not relevant to this occurrence.

4 Cloud amount is assessed in octal parts which is the estimated total apparent area of the sky covered with cloud. The international unit for reporting cloud amount for Few (FEW) is when the clouds cover 1/8 area of the sky.

5 QNH is an aeronautical code indicating the atmospheric pressure adjusted to mean sea level.

6 QFE is an aeronautical code indicating atmospheric pressure at the current ground level.

1.9 Communications

All communications between Air Traffic Services (ATS) and the crew were recorded by ground based automatic voice recording equipment and the Cockpit Voice Recorder (CVR) for the duration of the flight. The quality of the recorded transmissions was good. The communication equipment and their serviceability were not a factor in this occurrence.

1.10 Aerodrome Information

Aerodrome Code	:	WIMM (MES)
Airport Name	:	Polonia, Airport
Airport Address	:	Polonia International Airport Jl. Imam Bonjol Medan 20157
Airport Class	:	Category 1
Airport Authority	:	PT Angkasa Pura II (Persero)
Type of Traffic Permitted	:	IFR and VFR
Coordinates	:	03° 33’ 33” N / 098° 40’ 16” E
Elevation	:	90 feet
Runway Length	:	2900 m
Runway Width	:	45 m
Runway	:	05 - 23

1.11 Flight Recorders

The aircraft equipped with a Flight Data Recorder (FDR) and a Cockpit Voice Recorder (CVR).

Flight Data Recorder (FDR)

Manufacturer	:	Fairchild
Type	:	SSFDR (Model FA2100)
Part number	:	2100-4043-00
Serial number	:	00060068

Cockpit Voice Recorder (CVR)

Manufacturer	:	Fairchild
Type	:	SSCVR (Model FA2100)
Part number	:	2100-1020-02
Serial number	:	000601801

The data of both recorders were successfully downloaded in the KNKT recorder facility in Jakarta.

1.11.1 FDR Data

The significant events recorded on the FDR of the serious incident flight from takeoff until landing is shown in the following figure.

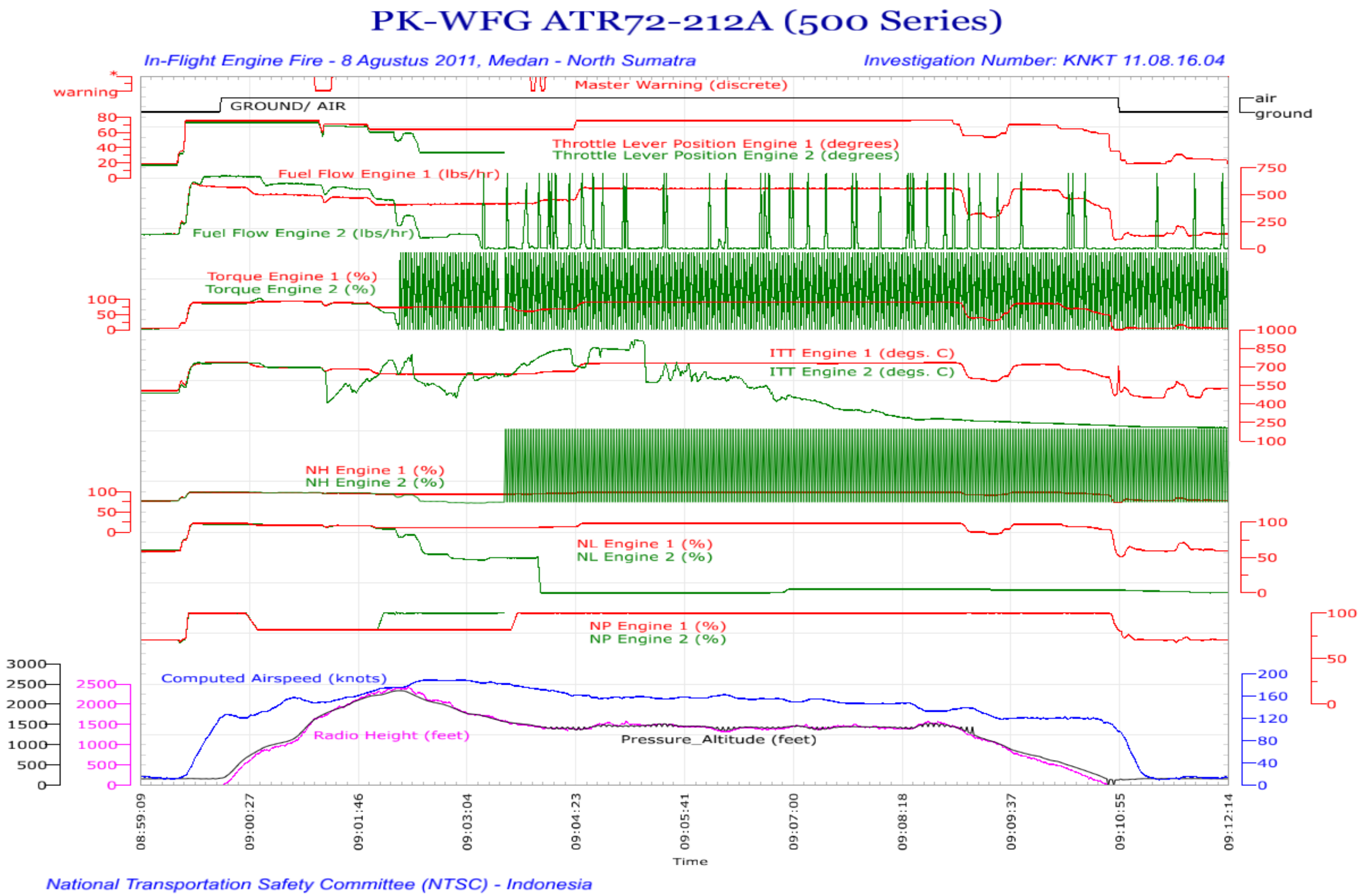


Figure 10: Significant FDR parameters recorded of the serious incident flight

The FDR data showed significant parameters as follows:

1. At 08:59:46 LT, the take-off power set with the left power lever angle was 76° and the right engine power lever angle was 73°. The left and right propeller speed (NP)[7] was at the same 100%, and the left engine fuel flow was higher by 16 lbs/hour than the right engine fuel flow.
2. At 08:59:48 LT, the right engine fuel flow was start increasing while the power levers were still the same as take-off setting.
3. At 09:00:09 LT, the aircraft took-off and the right engine fuel flow was higher 102 lbs/hour (the left engine fuel flow was 574 lbs/hour and the right engine fuel flow was 676 lbs/hour) while the power levers angle remained.
4. At 09:01:17 LT, the master warning active when the aircraft was at an altitude of 1,640 feet. The power levers position remained, the left engine fuel flow was 494 lbs/hour and the right engine fuel flow was 592 lbs/hour. At this time the Inter Turbine Temperature (ITT) of the left and right engine indicated 693°C and 695°C respectively. Three seconds later the FDR recorded a reducing right power lever position from 73° until 55°.
5. At 09:01:21 LT, the right engine ITT start decreasing from 690°C but the other parameter like torque (TQ) and propeller speed (NP) were relatively maintain.
6. At 09:01:25 LT, the right power lever position was put back from 55° to 68-69° and maintain in this value. The right engine ITT reached 403°C then rising and reached 755°C at 09:02:10 LT.
7. At 09:02:17 LT, the FDR stop recording the right engine TQ parameter. The right engine ITT was drop momentarily and the rising again until 09:02:25 LT the right engine ITT reached 805°C and then gradually decreasing.
8. At 09:02:32 LT, the FDR recorded the right engine power lever was gradually decreasing until reached 33°.
9. At 09:03:17 LT, the right engine fuel flow was indicated zero and the right engine ITT was recorded 612°C and increasing.
10. At 09:03:34 LT, the right engine NP parameter stop recording, at the same time the right engine ITT continued increasing.
11. At 09:03:53 LT, the second master warning activation was recorded for 3 seconds and the right engine ITT was recorded 738°C and keep increasing.
12. At 09:04:00 LT, the third time master warning activation for 3 seconds and the right engine ITT was recorded 792°C and increasing.
13. At 09:04:18 LT, the ITT reached 845° for 2 seconds and then decreasing.
14. At 09:07:54 LT, the aircraft was at altitude of 1,440 feet (Radio Altitude) and the heading was 212°.
15. At 09:10:55 LT, the air ground parameter recorded ground, indicated that the aircraft landed.
16. At 09:12:14 LT, end of recording.

7 NP: Propeller rotation speed. In the case of engine PW127M, the maximum propeller rotation speed is 1212 rotation per minutes (RPM) which equal with 101% NP.

1.11.2 CVR Data

The significant excerpts of the CVR data from the beginning of takeoff roll until the aircraft landed is as follow:

TIME (LT)	DESCRIPTION
08:59:32	The aircraft started the rolling take off.
09:00:20	After the aircraft was airborne, the Polonia Tower controller transferred the communication to the Medan Director controller and confirmed by the pilot.
09:01:17	The engine fire aural warning was heard.
09:01:18	The PIC asked to the SIC to check the visual condition of the engine, and there was no sign of fire.
09:01:24	The SIC handed over the aircraft control to the PIC.
09:01:30	The PIC disengage the autopilot
09:01:32	The SIC suggested the PIC to call the Flight Attendant (FA). The SIC then called the FA. At 09:01:34 LT, the SIC also advised the PIC to reduce something (unintelligible) and confirmed by the PIC.
09:01:38	The Medan Director controller instructed the flight to climb to 3,000 feet, the SIC then informed to the Medan Director controller that they have engine fire and requested for return to Polonia. The pilot then was instructed to fly to heading 040 degrees.
09:02:12	The SIC asking the PIC to feather the propeller of the right engine. The PIC confirmed but the feathering to the propeller was not executed yet because both pilots still assessing the engine.
09:02:31	The PIC asked about the Engine Electronic Computer (EEC), which responded by the SIC that the EEC had failed.
09:02:39	The SIC asked whether the right engine fuel to be shut off. The PIC responded to wait.
09:02:53	The PIC informed to the FA that the flight would return to Polonia due to right engine problem. The FA informed the PIC that the passengers were curious to the condition of the right engine. The PIC then asked the FA to check the condition of the right engine.
09:03:15	The SIC said that the DC Gen number 2 fault.
09:03:17	The PIC commanded to shut down the right engine and to feather the propeller.

TIME (LT)	DESCRIPTION
09:03:53	The engine fire aural warning heard for the second time.
09:04:00	The engine fire aural warning heard for the third time.
09:04:16	The SIC informed the PIC that he would pull the fire handle of the right engine and confirmed by the PIC.
09:04:48	The SIC request for priority landing to the Medan Director controller.
09:05:18	The pilots discussing the QRH for single operation.
09:05:47	The SIC informed the PIC that he would discharge the fire extinguisher bottle number 1 and confirmed by the PIC.
09:05:49	The Medan Director controller instructed the pilot to fly on heading 225° to join final Runway 23.
09:05:52	The pilots executing the QRH for single engine operation.
09:06:28	The SIC interrupted in executing of the QRH and informing the PIC that he would discharge the engine fire extinguisher bottle number 2 and confirmed by the PIC.
09:06:49	The SIC informed to the PIC that he would contact the company ground which agreed by the PIC. The SIC then contacted the company informed that they intend to return due to EEC problem and possibly engine fire.
09:07:26	Both pilots discussed about the problem and they agreed that maybe it was the computer problem.
09:07:54	The pilot was instructed by Medan Director controller to intercept the final Runway 23. After the SIC confirmed that the runway was in sight, then the communication was transferred from Medan Director controller to the Polonia Tower controller for landing clearance. Subsequently the Polonia Tower controller provided the landing clearance.
09:08:29	The Polonia Tower controller asked whether they may require ground assistance. The SIC asked for fire fighter, push back tractor.
09:10:55	The aircraft touch down.
09:11:15	There was a conversation between the SIC and a person related to the occurrence and the problem on the right engine. The SIC was not sure about the problem. The SIC stated that the problem may be related to the EEC, the engine fire warning activated, the torque indicator went

TIME (LT)	DESCRIPTION
	blank, the oil pressure decreased, and the engine temperature increasing. This might relate to the problem of the aircraft two days before. The SIC assumed that the problem was from the computer.

1.12 Wreckage and Impact Information

The investigation found that most of the engine components on the engine hot section had fire damaged. The damages observed on the engine cowling and in several engine components, such as ruptured Inter-compressor Bleed Valve (IBV), deteriorated flexible fuel manifold, burnt wire harnesses, and melted drain plumbing.

Figure 11: The damaged on the hot section

Figure 12: The evidence of fire on the external of hot section area

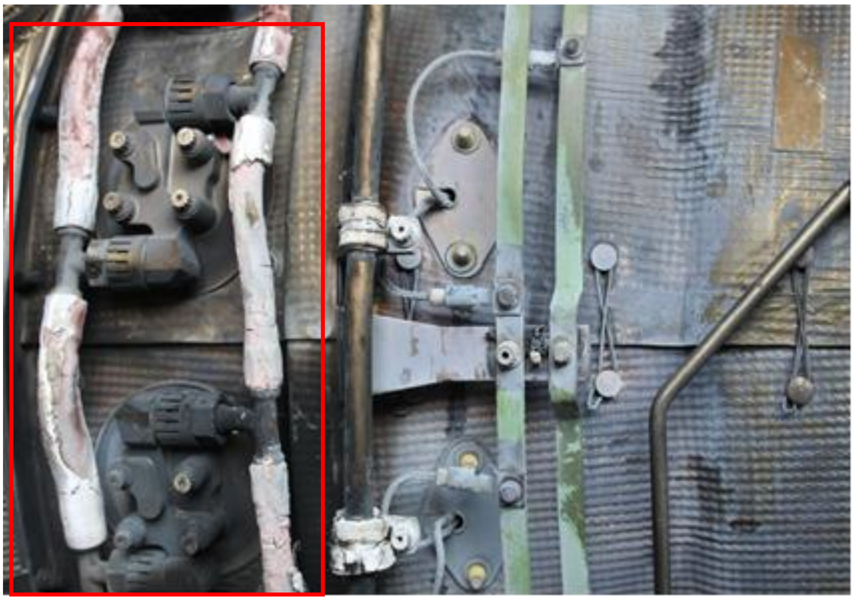


Figure 13: The burn of flexible fuel hose with whitish coloured

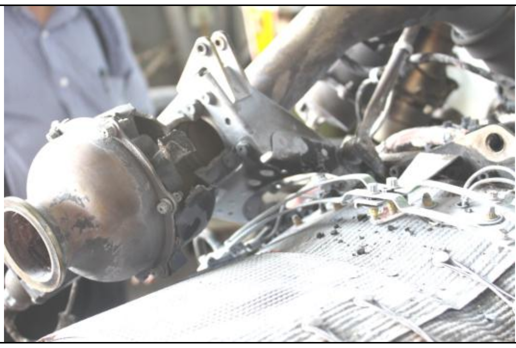
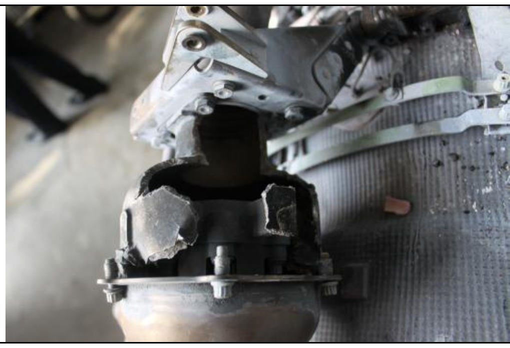
	
Ruptured IBV	Disintegration of the IBV, viewed from above

Figure 14: The ruptured Inter-compressor Bleed Valve (IBV)

1.13 Medical and Pathological Information

No medical or pathological investigations were conducted as result of this occurrence, nor were they required.

1.14 Fire

At 09:01:17 LT, the FDR recorded the master warning activation and supported by the CVR which recorded the fire aural warning activation. At 09:03:17 LT, the FDR recorded that the right engine fuel flow was zero indicated that the engine shutdown was executed by closing the Condition Lever (CL) of the right engine.

At 09:03:53 LT, the FDR recorded another master warning activation and supported by the CVR which recorded the second aural fire warning. The third master warning activation was recorded in the FDR at 09:04:00 LT which supported by the CVR which recorded the third aural warning activation.

At 09:04:16 LT, the fire handle of right engine was pulled by the SIC.

At 09:05:47 LT, the fire extinguisher bottle number 1 was discharged and at 09:06:28 LT the fire extinguisher bottle number 2 was discharged.

After the aircraft parked at the gate, it was confirmed that the right engine was exposed by the fire.

During the investigation, the Material Safety Data Sheet (MSDS) of the fuel was also reviewed. The uplift fuel was Avtur Jet A-1 and the MSDS from the fuel provider stated that the auto-ignition (self-ignition) of the fuel was 220°C.

1.15 Survival Aspects

After the aircraft landing, two Rescue and Fire Fighting Services (RFFS) command car and fire truck approached and stand by for further support. The aircraft stopped and parked on the parking gate. All passengers and crew disembark normally.

1.16 Tests and Research

1.16.1 Engine Examination at Pratt & Whitney Canada Facility

After the right engine experienced inflight fire, the engine was removed on 13 August 2011. The engine was prepared to send to the Pratt & Whitney Canada (PWC) facility for detail examination.

The engine was received in PWC facility in Service Centre St-Hubert, Quebec Canada on November 2011 and the detail investigation was performed on 14 to 16 November 2011. The PWC provided the result of engine examination as described in the document PWC Engine Shop Report number 11GI06054A.

The result of the examination is as follow.

1. Based on all the evidences, the examination confirmed that the source of the right engine nacelle fire event originated from fuel leakage at the inlet fitting of the secondary fuel flow manifold hose and adapter of the fuel nozzle number 1 (see Figure 4: Fuel nozzle arrangement).

   The fuel leakage from the fuel nozzle number 1 was primarily due to a stretch pinch-fracturing of the preformed packing of the inlet fitting.

2. The torn-off preformed packing fragment being trapped at the conical face of the hose/adapter inlet fittings would interfere with the interface seating of the fittings and the coupling nut torque process. In addition, the missing section of the preformed fractured packing would cause the relaxation of the packing stretch pinch on the hose inlet fitting and manifold inlet fitting bore. In fact, the combination of the above conditions would generate an improper centering and seating of the hose inlet fitting within the manifold inlet fitting bore. The evidence of torn-off preformed packing is shown in the figure below.

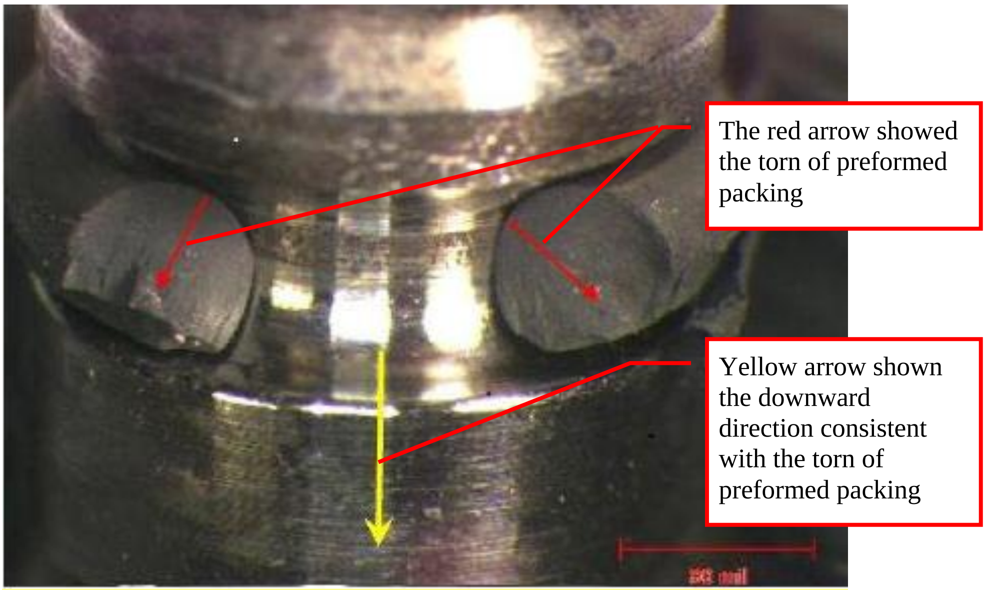


Figure 15: The torn-off preformed packing

The torn-off preformed packing (O-ring) fragment being trapped at the conical face of the hose of the adapter inlet fittings would interfere with the interface seating of the fittings and the coupling nut torque process.

In addition, the missing section of the fractured packing would cause the relaxation of the packing stretch pinch on the hose inlet fitting and manifold inlet fitting bore. The combination of the above conditions would generate an improper centering and seating of the hose inlet fitting within the manifold inlet fitting bore. The fuel can escape from improper centering of the fuel nozzle which resulted in the fuel leak.

The evidence shows that the preformed packing fracture occurred during the handling installation of the hose elbow inlet fitting to the adapter inlet fitting bore. This likely occurred during replacement of the fuel flow manifold adapters at engine TSN of 2775.3 hours.

3. The damage to the engine externals including the inter-compressor bleed valve (IBV), except for the elbow inlet-fitting packing fracture at the secondary fuel nozzle number 1, was considered secondary due to being exposed to elevated temperature generated from the engine nacelle fire.

The conclusion of the engine examination confirmed that the source of the right engine fire originated from a fuel leakage at nozzle position number 1.

1.16.2 The Evaluation of Previous 10 Flights Prior to the Occurrence

The FDR model FA2100 data normally contained more than 25 flight hours which can be utilized for the evaluation. Based on this capability, the investigation evaluates the last 10 flights before the occurrence to profile the fuel flow and the Power Level Angle (PLA).

The fuel flow and PLA were profiled based on the flight phase while in the same time, the propeller speed (NP) and engine torque (TQ) were utilized as the reference to the evaluation. The flight phase was considered as follow:

1. The taxi out, where the aircraft taxi from the apron to the runway. The taxi out is considered after the aircraft ground speed is more than 10 knots but less than take off speed.
2. The take-off phase. The take-off phase is considered after the Power Lever Angle was set in the take-off power and the Indicated Air Speed (IAS) is more than V1[8]. The take-off phase is considered ended when the Radio Altimeter indicated about 1,000 feet or the aircraft altitude is about 1,000 feet Above Ground Level (AGL).
3. The climb phase. The climb phase is considered after the Radio Altitude indicated more than 1,000 feet until the aircraft altitude reached the Top of Climb (TOC) altitude.
4. The cruise phase. The cruise phase is considered after the aircraft reached the intended cruising altitude. The cruising altitude ended when the aircraft reached at the Top of Descent (TOD) indicated by aircraft altitude before it was gradually decreasing of the pressure altitude parameter.

8 The V1 is critical engine failure speed or takeoff decision speed. It is the speed at which the pilot is to continue the takeoff in the event of an engine failure or other serious emergency. At speeds less than V1, it is considered safer to stop the aircraft within the accelerate-stop distance.

5. The descent and landing phase. The descent and landing phase is considered after the aircraft reached the Top of Descent (TOD) until the aircraft touch down on the runway.
6. The landing roll phase. The landing roll phase is considered after the aircraft touch down on the runway until the aircraft reached the lowest ground speed before it was increase again with the intention to taxi in to the apron.
7. The taxi in phase where the aircraft taxied in to the apron or parking gate. The taxi in phase is considered when the aircraft ground speed increased after the landing ground roll ended. The end of the taxi in phase is considered when the aircraft reach the parking gate and one of the engine fuel flows was stop.

The evaluation revealed the average of difference of the fuel flow of both engines on the previous 10 flights prior the occurrence as follow:

Note:

PLA : Power Lever Angle

NP : Propeller Speed

TQ : Torque

FF : Fuel Flow

The Flight Phase	PLA1 (°)	PLA2 (°)	NP1 (%)	NP2 (%)	TQ1 (%)	TQ2 (%)	FF1 (lbs/hr)	FF2 (lbs/hr)
Taxi out	20.94	18.91	70.79	70.78	4.69	5.28	138.32	138.54
Takeoff	75.99	73.00	95.61	95.99	88.80	88.65	550.44	557.59
Climb	76.00	73.00	82.00	82.00	80.71	80.71	412.72	418.96
Cruise	76.00	73.00	82.00	82.00	71.93	71.93	354.54	359.47
Descent until touch down	52.15	49.60	82.27	82.27	34.25	33.58	237.52	238.39
Landing roll	19.26	17.47	72.70	72.88	7.04	6.44	146.63	142.78
Taxi in	20.40	18.45	70.12	69.50	4.16	4.60	130.85	131.86

The table above showed that during the taxi out, descent (until touch down), landing roll and taxi in, the average fuel flow of the right engine was higher than the left engine between 0.8 and 1 lbs/hour. During the takeoff, cruise and climb, the right engine fuel flow was higher than left engine between 5 and 7 lbs/hour. The table above also showed that the right engine PLA was lower than the left engine PLA averagely between 2° and 3°.

During the accident, the difference of the fuel flow of the taxi out was relatively similar to the previous flight but the takeoff and climb was increase averagely between 92 lbs/hour and 102 lbs/hour as shown in the table below.

The Flight Phase	PLA1 (°)	PLA2 (°)	NP1 (°)	NP2 (°)	TQ1 (°)	TQ2 (°)	FF1 (lbs/hr)	FF2 (lbs/hr)
Taxi out	19.00	17.00	70.79	70.78	4.00	4.00	133.11	132.56
Takeoff	76.00	73.00	93.37	93.38	90.34	89.40	546.88	639.03
Climb	76.00	73.00	82.00	82.00	93.43	93.43	497.19	599.43

In this evaluation, the investigation revealed that to achieve the same NP and TQ, the right engine PLA was lower (between 2° and 3°) than the left engines PLA in any flight phase while at the same time the fuel flow of the right engine was higher than the left engine. In these differences, the TQ and the NP parameters were relatively in the same value.

1.17 Organizational and management information

Aircraft Owner	:	PT. Wings Abadi Airlines
Address	:	Jl. Gajah Mada No. 7
		Jakarta 10130
Aircraft Operator	:	PT. Wings Abadi Airlines
Address	:	Jl. Gajah Mada No. 7
		Jakarta 10130
AOC Number	:	AOC 121/002

1.17.1 Aircraft Operator Manuals

1.17.1.1 Company Operation Manual (COM)

Chapter 1

1.3.16 PILOT IN COMMAND (PIC)

The PIC is responsible to the Chief Pilot for the operation and safety of the aircraft and for the safety of the all persons onboard during flight time. For this purpose, he/she will have final authority for the disposition of the aircraft during the time in which he/she is solely in command. He/she shall ensure that all operations are conducted in accordance with procedures laid down in this manual. He/she should also ensure him/her self and all his/her crewmember that the Flight Execution implies:

- *Safety*
- *Schedule regularity*

- *Passenger comfort …*

The PIC shall ensure that during flight:

- *The checklist devised for use in the various phases of flight is carried out.*
- *The relevant instructions and limitations laid down in the manuals such as the AFM or AOM/FCOM, MEL, and the C of A for the operation of the aircraft are observed.*
- *Communication with controlling agencies and OCS is maintained as required.*
- *Wherever possible, the FO is granted a sufficient number of takeoffs and landings to assist him/her in maintaining competency…*

Chapter 6 Emergency Procedure

6.1 General

… When faced with an emergency, ATC expects the pilot to take whatever action is considered necessary. ATC will assist pilots in any way possible when an emergency is declared. Pilots are requested to advice ATC as soon as possible of any deviations from altitude or route necessitated by any emergency in order that every effort can be made to minimize conflict with other traffic…

Sub chapter 6.2.5 Engine Fire

6.2.5.2 Aircraft Fire Warning

When a fire warning is experienced in flight, even though it may be suspected to be due to a fault in the fire detection system, the following procedures shall apply:

Emergency fire procedures as outlined in the AOM/FCOM/AFM.

The aircraft shall be landed at the nearest suitable airport and may not be returned for service until the system has been rectified.

1.17.1.2 Standard Operating Procedure (SOP)

The Standard Operating Procedure (SOP) Chapter 2 NOR 02-10-01 page 3.

Communication in the cockpit

Talks, requests and calls out must be limited to the minimum during the critical phases of the flight (take-off, approach, landing or missed approach).

Technical communications between both pilots have to comply with the standard announcements and call outs explained in this manual.

1) *Emergency situation*

   ICAO definition:

   "A condition of being threat by serious and/or imminent danger and of requiring *immediate assistance"*

Such as a situation is encountered when the aircraft safety is directly concerned. It includes emergency maneuvers, fires, smokes and needs immediate assistance.

Example: Engine fire, smoke

2) *Abnormal situation*

ICAO definition:

"A condition concerning the safety of an aircraft or other vehicle, or of some person on board or within sight, but which does not require immediate assistance".

Such as a situation is encountered when the aircraft safety is directly concerned. It includes system failures or unusual events.

It's generally triggered by master caution+ single chime+ amber light on CAP, and refer to following failure C/L (amber). PF may delay crew action or C/L, if necessary.

Example: engine flame out.

1.17.1.3 Engine Fire Procedure

The followings are the copy of Quick Reference Handbook (QRH) for in flight engine fire procedure.

The boxed items correspond to action performed by memory by the crew within a minimum period of time.

■ *: highlights a precondition to apply an action*

● *: highlights the moment when an action is to be applied*

IN FLIGHT ENG FIRE
OR SEVERE MECHANICAL DAMAGE

PL affected side .... FI
CL affected side .... FTR THEN FUEL SO
FIRE HANDLE affected side.................................PULL
● **After 10 seconds**
FIRST AGENT affected side................................ DISCH
■ **If fire after further 30 seconds**
SECOND AGENT affected side .... DISCH

LAND ASAP
SINGLE ENG OPERATION procedure (2.04)...................APPLY

Figure 16: The QRH of Inflight Engine Fire of Severe Mechanical Damage

72	FOLLOWING FAILURES POWER PLANT	2.04	
		OCT 08	001

SINGLE ENG OPERATION

LAND ASAP

CL operating side .... MAX RPM
PWR MGT 1 + 2 .... TO if necessary then MCT
R SYNPHR .... OFF
FUEL PUMP affected side .... OFF
DC GEN affected side .... OFF
ACW GEN affected side .... OFF
PACK affected side .... OFF
BLEED affected side .... OFF
TCAS (if installed) .... TA ONLY
OIL PRESSURE ON FAILED ENGINE .... MONITOR

Note: In icing conditions, FLAPS 15 will be selected to improve drift down performances and single engine ceiling.

Note: Refer to pages (4.61) and (4.62) to determine single engine gross ceiling.

Note: If during the flight, a positive oil pressure has been noted on the failed engine for a noticeable period of time, maintenance must be informed.

Note: monitor fuel balance. Recommended operational maximum fuel unbalance is 200 kg (440 lb).

- **When FUEL CROSS FEED is required**

  FUEL PUMP affected side .... ON
  FUEL X FEED .... ON
  FUEL PUMP on operating ENG .... OFF

- **For approach**

  MAX APPROACH SLOPE for Steep Slope Approach .... 5.5°
  BLEED NOT AFFECTED .... OFF
  APPROACH SPEED .... NOT LESS THAN 1.1VMCA
  Note: Refer to page (4.64) to determine 1.1VMCA.

Note: At touch down, do not reduce below FI before nose wheel is on the ground.

Figure 17: The QRH of Single Engine Operation

1.17.2 Directorate General of Civil Aviation (DGCA)

CASR SUBPART 830.B. OCCURRENCE REPORT 830.5 Mandatory Occurrence Report

a. *The operators, any Indonesian operators or any foreign operators, shall immediately, with the minimum delay and by the most suitable and quickest means available, shall report the National Transportation Safety Committee (KNKT) and the Directorate General of Civil Aviation (DGCA) when an aircraft accident or serious incident occurs.*

b. *The written occurrence report as state in point (a) above shall filled to KNKT* *and DGCA within 24 hours after the accident or serious incident occurred.*

c. *When an aircraft is believed to have been involved in an accident and serious incident, it shall be reported to both KNKT and DGCA in according to point (a) and (b) above*

1.17.3 Pratt & Whitney Canada (PWC)

1.17.3.1 The Pratt & Whitney Canada (PWC) Service Experience

On 31 March 2010, the Pratt & Whitney Canada (PWC) published a Service Experience with the title of Flexible Fuel Manifold which described the evolution of the fuel nozzle of PW100 engine and the recommendation for removal and installation of the fuel nozzle.

The original fuel nozzle of PW100 engines configuration included a large quantity of sub-assembly of the fuel nozzles consist of 42 transfer tubes, 144 preformed packings and 14 locking plates. The total pieces of the fuel nozzles arrangement for 1 engine is involving 210 detail parts (including the transfer tubes, preformed packing and locking parts). This arrangement required 16 man-hours to install in 1 engine.

Figure 18: The original arrangement of fuel nozzles assembly

In 1999, the PWC introduced the SB 21607 involving a new fuel manifold configuration featuring a flexible three pieces fuel manifold. The SB 21607 significantly reduced quantity of the preformed packings from 144 to 26 pieces. In addition, the man-hours requirement was significantly reduced from 16 to 8 man-hours.

Even if the improved design still featured installation fail-safe devices, the symmetrical interface between the fuel nozzle adapters and the fuel manifold hoses resulted in the possibility to install the nozzles in reverse position.

In 2004, the PWC updated the SB 21607 to SB 21705 to avoid the possibility of reverse installation to the fuel nozzles.

Figure 19: The SB 21705

The Service Experience recommend the operator to utilize the tool kit part number PWC56616 for fuel nozzle flexible manifold removal and installation.

Figure 20: The PWC tool kit part number PWC56616

This tool kit is to ensure that the removal and installation to the fuel nozzles and manifold in the difficult location (such as fuel nozzle and manifold position 1 and 14 in the PW100 engine) can be managed properly.

1.17.3.2 The Pratt & Whitney Canada (PWC) Service Bulletin 21803R4

On 21 July 2011, the PWC issued a SB which then was updated on 08 February 2012 refer as SB number 21803R4 with the subject of TURBOPROP ENGINE FUEL NOZZLE MANIFOLD SYSTEM – MODIFICATION.

The SB related to a fuel nozzle retaining nut that is improperly torqued can result in improper seating of the metal-to-metal seal at the fuel nozzle to manifold interface, and can lead to movement and wear of the preformed packing seal during engine operation. This can result in fuel leakage. The preformed packing is removed to permit verification of the metal-to-metal seal integrity.

The instruction summary to the updated SB is as follow:

1. Clarify installation and leak check procedure, a CAUTION and steps 10 and 11 in the SB 21803R4 was added in the Accomplishment Instructions,

2. Add fuel leak check procedure in lieu of manifold adapter leak check,
3. Add Note 2 in Accomplishment Instructions (the purpose of the nitrogen leak check is to detect a nozzle that would have been left un-torqued (hand tight)).

The PWC determined that the compliance of the SB is CATEGORY 5 which is the PWC recommended to do the SB when the engine is disassembled and access is available to the necessary subassembly (i.e. module, accessories, components, or build groups).

1.18 Additional information

1.18.1 Occurrence report

The *Komite Nasional Keselamatan Transportasi* (KNKT) did not aware of this serious incident until received an email from Pratt and Whitney Canada asked the progress of the investigation.

The operator assumed that this occurrence was not a mandatory reporting occurrence and did not send notification to the KNKT.

The investigation commenced on 16 August 2011.

1.18.2 Similar events reported by Bureau d'Enquêtes et d’Analyses (BEA)

The Bureau d'Enquêtes et d’Analyses (BEA - French investigation authority) reported that between January 2003 and August 2010, PWC identified 25 cases of fuel leaks on the PW 120 engine series involving the injectors of which 10 led to engine fire occurrences.

Sealing between the injector and the manifold is ensured by tightening, metal against metal, to a torque level defined by the manufacturer. The two O-rings create an additional safety when this tightening is not correct. Any damage to them can lead to a leak.

The maintenance manual specifies changing the fuel nozzle every 1,000 flying hours. After the installation, sealing of the fuel nozzle can be checked by leakage check (wet ventilation), then by a ground run at 80% of TQ for 10 minutes. The incorrect tightening left a leak at the level of the metal to metal contact and led to a fuel leak at the level of the number 14 fuel nozzle when the preformed packing (O-ring) was damaged.

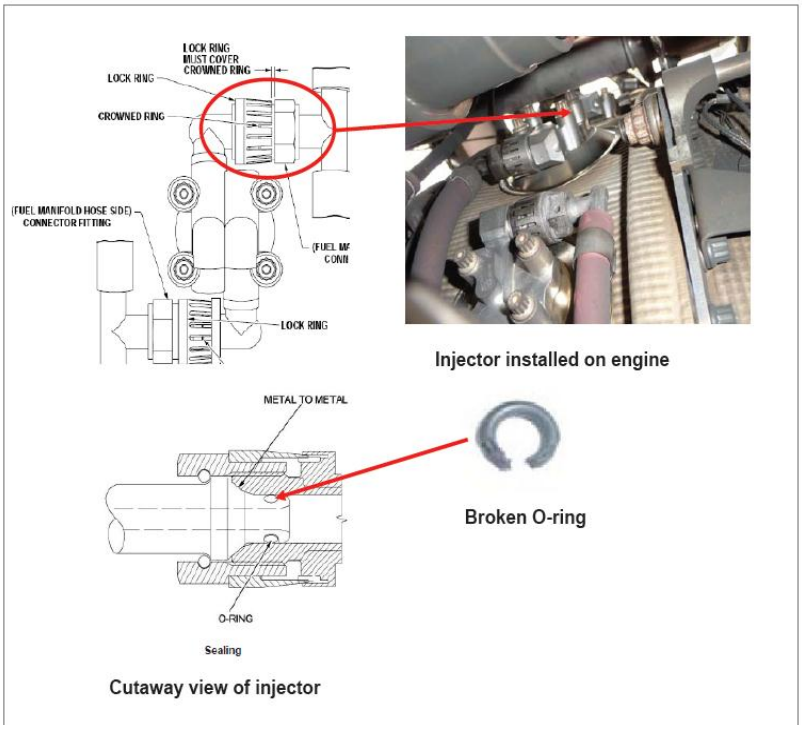


Figure 21: The Sample of Broken Pre-formed packing (O-Ring)

The BEA found that the leaks mainly occurred on the fuel nozzle located at the top (fuel nozzles number 1 and 14) and the bottom (fuel nozzle number 7) of the engine. These fuel nozzles were more difficult to access when the engine was still installed in the nacelle and the engineer may have difficulties in applying the correct tightening torque.

1.19 Useful or effective investigation techniques

The investigation was conducted in accordance with NTSC-approved policies and procedures, and in accordance with the standards and recommended practices of Annex 13 to the Chicago Convention.

2 ANALYSIS

Based on the factual data collected, the analysis will discuss on the topics related to the origin of engine fire and the flight operation procedure responding to the engine fire. Therefore, the analysis will discuss the following:

- The origin of engine fire
- The inflight engine fire procedures

2.1 The Origin of Fire

After the engine position number 2 (right engine) experienced inflight fire, the right engine was sent to the PWC facility in Canada for detail examination on November 2011.

The detail examination of the right engine in the PWC facility revealed that the preformed packing of the inlet fitting of the fuel nozzle number 1 was torn-off. The torn-off preformed packing was trapped at conical face of the adapter inlet fittings led to relaxation of the hose inlet fitting. The relaxation of the inlet fitting would generate improper centering and seating of the hose inlet fitting within the manifold inlet fitting bore. The improper centering and seating of the hose inlet fitting within the manifold inlet fitting bore led to the loosening of the fuel nozzle lock ring (Moeller Fingers) and crowned ring (Moeller Ring). This loosening of the lock ring and crowned ring resulted in the fuel leakage.

The last maintenance performance related to the fuel nozzle before the occurrence was the replacement of the fuel nozzle which was conducted on April 2011 as the right engine was due for the fuel nozzle replacement which was scheduled every 1,000 hours. The engineer utilized task card number 731361-RAI-10000-1 for the removal and installation of the 14 fuel nozzles. Following the replacement of the fuel nozzles of the right engine, the engine performance run up was conducted with the satisfactory result.

The torn-off on the preformed packing most likely occurred during the fuel nozzle replacement especially the fuel nozzle at position number 1. According to the maintenance personnel, the fuel nozzle at position number 1 and 14 were the most difficult positions for removal and installation.

At the time of replacement of the fuel nozzle assembly, the engineer did not utilize the proper tool as recommended by the engine manufacturer. Without the proper tool, the installation of the fuel nozzle might not get any difficulty. The utilization of improper tool might have resulted to the relaxation of the inlet fitting which then generated improper centering and seating of the hose inlet fitting within the manifold inlet fitting bore. This led to the loosening of the fuel nozzle lock ring and crowned ring which resulted in the fuel leakage.

The investigation did not have the information of the fuel flow performance since the removal and installation of the right engine fuel nozzle until the occurrence date to represent any fuel leakage. However, reviewing the 10 previous flights revealed that the fuel flow of the right engine was higher than the left engine.

The fuel flow of the right engine during the takeoff and climb were significantly increased during the occurrence flight which were between 92 lbs/hour and 102 lbs/hour. The increasing of fuel flow without any changes in the right engine parameters indicated that some fuel might have been leaked.

The little amount of fuel leak before the occurrence date may be difficult to be identified during the line maintenance activities. In addition, the little amount of fuel leak which collected in the engine cowling can be washed overboard through the ventilation system during the flight.

The FDR data showed that on the takeoff and climb during the occurrence flight, there was significant amount of the fuel leak which might had been collected on the bottom of the engine cowling and the ventilation system was not sufficient to wash the leakage fuel overboard.

The fuel which collected on the bottom of the engine cowling might had been heated by the engine. The temperature inside of the engine cowling especially on the hot section area might have reached the fuel self-ignition temperature which made the remaining fuel in the engine cowling became self-ignited.

The data the FDR showed that other than fuel flow differences, the engine parameters were normal before the fire warning activation. This indicated that the origin of the fire was not ignited from the internal engine problem. The significant damage on the hot section of the engine supported the evidence that the fuel might have been self-ignited on the hot section area of the engine.

In summary, the utilization of improper tool might have resulted to the relaxation of the inlet fitting which then generated improper centering and seating of the hose inlet fitting within the manifold inlet fitting bore. This led to the loosening of the fuel nozzle lock ring and crowned ring which resulted in the fuel leakage. The fuel leak collected on the bottom of the engine cowling which then self-ignited due to the high temperature as the temperature was higher than the self-ignition temperature.

2.2 The In-flight Fire Handling

The FDR data showed that the fire warning active at 09:01:17 LT (about 1 minute 30 second after the power lever was placed to the take-off setting), which was confirmed by the CVR when the aural fire warning was triggered.

A second later, the PIC commanded the SIC to check visually to the engine condition while at the same time the PIC took over the control and disengaging the autopilot. The SIC could not confirm the fire as it was not visible from the cockpit window. About the same time the SIC advised the PIC to reduce something (that was not clearly heard on the CVR) but the FDR data showed that the right power lever angle was momentarily reduced from 73° to 55° and back to 69°.

At 09:01:21 LT, the right engine ITT start decreasing until 09:01:25 LT the right engine ITT reached 403°C then rising. At this time the FDR recorded the right engine power lever was gradually decreasing from 69°until reached 33°.

At 09:01:38 LT, the Medan Director controller instructed the pilot to climb to 3,000 feet but the PIC commanded the SIC to request for returning to Polonia which was confirmed by the Medan Director controller.

At this time the right engine was still operating as the pilots were still accessing to the right engine condition.

At 09:02:17 LT, the parameter of right engine torque on the FDR stopped recording and at 09:02:31 LT, and the CVR recoded pilot conversation that the Engine Electronic Computer (EEC) had failed.

At 09:02:53 LT, the PIC informed to the Flight Attendant (FA) that the flight would to return to Polonia due to right engine problem and asked the FA to check the condition of the right engine.

At 09:03:15 LT, the DC GEN number 2 fail light illuminated. The PIC commanded SIC to shut down the right engine and feather the propeller. The illumination of the DC GEN fault light indicated that the engine rotation had fall below 61.5% rotation leading to stop. Two seconds later the FDR recorded that the fuel flow decreased to zero, mean that the right engine had been shut down. It was consistent with the CVR when the PIC commanded the SIC to shut down the engine and feather the propeller. At 09:03:34 LT, the right engine NP was stop, mean that the right engine propeller stopped.

However, 19 seconds later or at 09:03:53 LT, the CVR recorded the aural fire warning for 3 seconds. The fire warning repeated at 09:04:00 LT for another 3 seconds. At the same time the ITT was rising and the FDR recorded the top of ITT was 845°C at 02:04:18 LT and then gradually decreasing. The activation of the engine fire warning might have been triggered by the increasing of the engine temperature.

At 09:04:48 LT, the SIC requested priority landing to the Medan Director controller which was approved. Afterward, the pilots discussed and executed the QRH, and at 09:05:47 LT, SIC discharged the fire extinguisher bottle number 1. The second fire extinguisher bottle was discharged at 09:06:28 LT.

The aircraft operator Company Operation Manual (COM) stated that when a fire warning is experienced in flight, even though it may be suspected to be due to a fault in the fire detection system, the procedures as described in the aircraft manual shall be applied.

The FDR recorded that the engine fire warning active at 02:01:17 LT. Following this activation, the PIC took over control of the aircraft and asked the SIC and the FA to visually confirm the fire sign. At 02:03:15 LT, the DC GEN number 2 fail light illuminated and afterward the PIC commanded to shut down the right engine. At 02:05:47 LT, SIC discharged the fire extinguisher bottle number 1 followed by discharging the fire extinguisher bottle number 2 at 02:06:28 LT.

The QRH of engine fire warning stated the memory items procedure to perform the Power lever to FI (Flight Idle), followed by Condition Lever to FTR (Feather) then fuel SO (Shut off) and subsequently Fire Handle to be pulled. These actions would stop the fuel supply to the engine hence the engine would shut down. The procedure stated that after 10 seconds, the first agent (first fire extinguisher bottle) should be discharged and 30 seconds later when the fire still exist second agent should be discharged.

The pilot execution of shut down the engine 2 minutes after the warning active and discharged the fire agent about 2.5 minutes after engine shut down were not accordance to the procedure. The delay of the discharge fire extinguisher to extinguish the fire led the engine prolong exposed to the fire and made the engine exhibit severe damage.

The CVR also recorded that most of the actions such as informing the FA, shut down the engine and feathering the propeller, and contacting the company round personnel were suggested by the SIC. This indicated that the duties and responsibilities of the PIC as described in the COM were not properly performed.

3 CONCLUSION

3.1 FINDINGS

The findings are statements of all significant conditions, events or circumstances in the accident sequence. The findings are significant steps in the accident sequence, but they are not always causal, or indicate deficiencies. Some findings point out the conditions that pre-existed the accident sequence, but they are usually essential to the understanding of the occurrence, usually in chronological order.

1. The aircraft was airworthy and there was no evidence that the aircraft has any system malfunction prior to the serious incident.
2. Both pilots have valid license and medical certificates.
3. The Pilot in Command (PIC) acted as the Pilot Monitoring (PM) and the Second in Command (SIC) acted as Pilot Flying (PF).
4. At 0901 LT, when the altitude was approximately 1,600 feet, the right engine fire warning activated and the PIC commanded the SIC to visually check the right engine to identify any sign of fire which was responded by the SIC that the fire was not visible. The SIC handed over the aircraft control to the PIC.
5. At 09:01:17 LT, the master warning light illuminated at the aircraft altitude of 1,640 feet. The power levers position remained, the left engine fuel flow was 494 lbs/hour and the right engine fuel flow was 592 lbs/hour. At this time the left and right engine Inter Turbine Temperature (ITT) was 693°C and 695°C respectively. Three seconds later the FDR recorded a reducing right engine power lever from 73° until 55°, then at 09:01:25 LT the power lever position was put back at 68-69° and maintain in this value.
6. At 09:01:21 LT, the right engine ITT start decreasing from 690°C but the other parameter like torque (TQ) and propeller speed (NP) were relatively maintain. At 09:01:25 LT, the right engine ITT reached 403°C then rising. The FDR recorded the right engine power lever was maintain at 69° and then gradually decreasing until reached 33°.
7. At 09:01:21 LT, the FDR recorded that the right engine power lever decreased from 62° to 55° and then back to 68° while at the same time ITT decreasing from 690°C while the other engine parameter was relatively maintained.
8. At 09:01:38 LT, when the Medan Director controller instructed to climb to the altitude of 3,000 feet, the SIC requested to the Medan Director controller to return to Medan due to engine fire which was acknowledge by the Medan Director controller and instructed the pilot to fly heading 040° which was confirmed by the pilot.
9. At 02:02:12 LT, The SIC confirm to the PIC for feathering the propeller of the right engine and confirmed by the PIC but the feathering to the propeller was not executed yet because both pilots still assessing the engine.
10. At 09:02:39 LT, the SIC suggested shutting off the fuel valve and the PIC commanded to stand by.

11. At 09:03:15 LT, the DC GEN number 2 fail light illuminated. The PIC commanded SIC to shut down the right engine and feather the propeller of the right engine.
12. At 09:03:53 LT, the right engine fire warning activated for the second time and at 09:04:00 LT, the right engine fire warning activated again for the third time.
13. At 09:04:16 LT, the PIC commanded the SIC to pull the fire handle of right engine. Afterward the SIC requesting the Medan Director controller for priority landing, which was confirmed by the Medan Director controller.
14. At 09:05:18 LT, the pilots discussing the Quick Reference Handbook (QRH).
15. At 09:05:47 LT, the fire extinguisher bottle number 1 was discharged.
16. At 09:05:49 LT, the pilot was vectored by the Medan Director controller to fly heading 225 to join final runway 23.
17. At 09:05:52 LT, the QRH was executed for single engine operation.
18. At 09:06:28 LT, while executing the QRH, the fire extinguisher bottle number 2 was discharged and at 09:06:30 LT, the QRH for the single engine operation was completed.
19. After the aircraft landed safely and parking at the gate, it was revealed that the right engine was exhibit severe damage exposed by fire.
20. The engine was removed and sends to the Pratt and Whitney Canada (PWC) for detail examination and investigation. The conclusion of the engine investigation confirmed that the source of the right engine fire originated from a fuel leakage at nozzle position number 1. The accumulated fuel evaporated and became self-ignited.
21. The utilizing of improper tool during the installation of the fuel nozzle led to the improper position of the right engine fuel nozzle position number 1 which subsequently resulted in undetected torn off to the preformed packing and caused the fuel leak.
22. The significant amount of fuel leak was not sufficient to be washed overboard and became self-ignited as the temperature reached the self-ignited value.
23. The pilot execution of shut down the engine was performed 2 minutes after the warning active and discharged the fire agent about 2.5 minutes after engine shut down were not accordance to the procedure. The delay of the discharge fire extinguisher to extinguish the fire led the engine prolong exposed to the fire and made the engine exhibit severe damage.
24. The aircraft operator Company Operation Manual (COM) stated that when a fire warning is experienced in flight, even though it may be suspected to be due to a fault in the fire detection system, the procedures as described in the aircraft manual shall be applied.
25. Until the aircraft landed, the pilots were assumed that the fire warning might be due to a false warning that might associate with the rectification two days before or due to the computer problem.

26. The Komite Nasional Keselamatan Transportasi (KNKT) did not aware of this serious incident until received an email from Pratt and Whitney Canada, asked the progress of the investigation. The operator assumed that this occurrence was not a mandatory reporting occurrence and did not send notification to the KNKT. The investigation initiated on 16 August 2011 or 8 days after the occurrence.

3.2 Contributing Factor

Contributing factors is defined as actions, omissions, events, conditions, or a combination thereof, which, if eliminated, avoided or absent, would have reduced the probability of the accident or incident occurring, or mitigated the severity of the consequences of the accident or incident.

The identification of contributing factors does not imply the assignment of fault or the determination of administrative, civil or criminal liability. The presentation of the contributing factors is based on chronological order and does not show the degree of contribution.

The KNKT concluded the contributing factors as follows:

- The utilizing of improper tool during the installation of the fuel nozzle led to the improper position of the right engine fuel nozzle position number 1 which subsequently resulted in undetected torn off to the preformed packing and caused the fuel leak.
- The significant amount of fuel leak was not sufficient to be washed overboard and became self-ignited as the temperature reached the self-ignited value.
- The delaying discharge fire extinguisher led the engine prolong exposed to the fire and made the engine exhibit severe damage.

4 SAFETY ACTIONS

At the time of issuing this Report, the National Transportation Safety Committee had been informed on the safety actions that as follows:

4.1 PT Wings Abadi Airlines

PT Wings Abadi Airlines has issued a Recommendation and Safety Action, which are as follow:

1. The Board of Instructor issue a safety action of engine fire execution dated 23 August 2013, to enforce the emergency/abnormality training procedure during the simulator recurrent training and or proficiency check as follows:
   - Indication of engine fire
   - To initiate the engine fire procedure and action (memory items) with the minimum time delay (time management)
   - To enforce the engine fire procedure and action.
   - To enforce the task sharing procedures
   - To execute the emergency/ abnormality according the philosophy
   - To initiate the memory items in minimum time delay for any emergency/ abnormality.
2. Maintenance Directorate to perform one time inspection in Inter-compression Bleed Valve and Fuel Nozzle installation.
3. Operation Directorate had to review the implementation of emergency procedures.
4. The Wings Air Engineering Instruction No. ATR72-EA-73-013R4 mainly to fulfill SB No 21803 R4 and additional marking to ensure that the tightness easy to check.

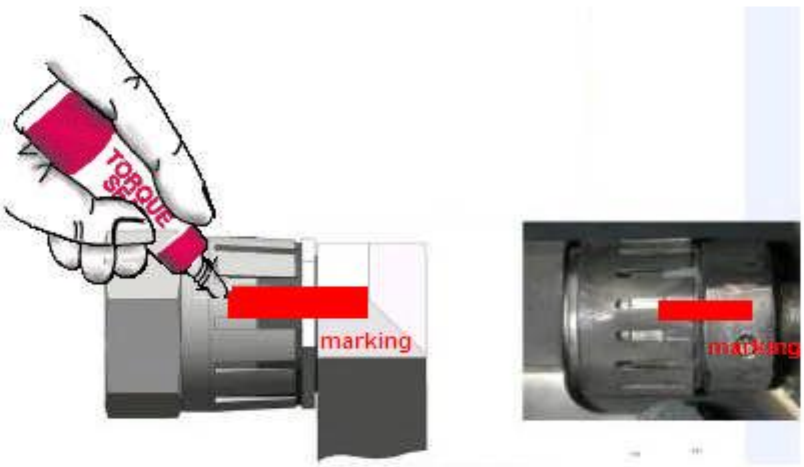


Figure 22: The marking on of the Moeller Finger and Moeller Ring to ensure the tightness

4.2 Pratt & Whitney

The Pratt & Whitney Engine manufacturer published Service Bulletins (SB) number on 21 July 2011 and updated on 8 February 2012.

The summary of the SB was described that a fuel nozzle retaining nut that is improperly torqued can result in improper seating of the metal to metal seal at the fuel nozzle to manifold interface, and can lead to movement and wear of the preformed packing seal during engine operation. This can result in fuel leakage. The preformed packing is removed to permit verification of the metal to metal seal integrity.

4.3 Directorate General of Civil Aviation (DGCA)

The DGCA has published Advisory Circular (AC 19-01) Mandatory Occurrence Report in 2017, which requires aircraft operator to report any incident, serious incident, or accident to the DGCA and or KNKT.

5 SAFETY RECOMMENDATION

The *Komite Nasional Keselamatan Transportasi* (KNKT) acknowledged the safety actions taken by the related parties. The KNKT considered that the safety actions were relevant to improve safety therefore, the KNKT is not issuing safety recommendations in this report.

6 APPENDICES

6.1 The Evaluation of 10 Flight Prior the Occurrence

The Fuel Flow Record of 10 Flights Prior the Accident Based on the Fight Phase

Note : In this evaluation, the investigation revealed that the Power Lever Angle (PLA) of the left and right engine was in the different angle in any flight phase, whereas the left engine PLA was higher than the right engine PLA while the propeller rotation (NP) relatively in the same value.

The investigation did not find the reason why the PLA was different, however the "what if" scenario was applied to evaluate the behavior of the fuel flow when the PLA is in the same angle position refer to the left engine PLA. In this "what if" scenario, the investigation considered that the fuel flow is linear with the movement of the PLA.

1. The Taxi Out Phase

   In this evaluation, the taxi out is considered after the aircraft ground speed is more than 10 knots but less than take off speed.

Flight Phase		Taxi Out									
Date	Flight	PLA1 (°)	PLA2 (°)	FF1 Lbs/hr	FF2 Lbs/hr	ITT1 (°C)	ITT2 (°C)	NP1 (%)	NP2 (%)	TQ1 (%)	TQ2 (%)
8/6/2011	flt-1	22.13	20.22	136.00	141.74	495.15	490.75	70.71	70.69	5.04	6.33
8/6/2011	flt-2	20.45	18.37	133.53	133.88	499.58	477.49	70.77	70.81	4.34	4.62
8/7/2011	flt-1	19.94	17.87	141.98	134.79	513.58	475.68	70.96	70.89	4.26	4.51
8/7/2011	flt-2	19.81	18.41	138.53	137.90	504.19	478.56	70.80	70.82	4.64	4.91
8/7/2011	flt-3	18.23	17.15	135.34	133.13	511.92	488.00	70.80	70.69	4.00	4.00
8/7/2011	flt-4	19.00	17.00	135.43	133.57	512.00	494.00	70.86	70.71	4.43	4.57
8/7/2011	flt-5	22.28	19.96	135.50	137.81	515.80	497.76	70.74	70.74	4.26	4.96
8/7/2011	flt-6	19.97	18.05	137.92	137.43	529.11	507.22	70.69	70.74	4.26	4.96
8/7/2011	flt-7	25.01	22.50	150.66	158.56	524.73	517.03	70.77	70.80	7.21	9.14
8/8/2011	flt-1	22.56	19.59	138.26	136.56	527.09	475.42	70.81	70.86	4.45	4.76
8/8/2011	flt-2 acc.	19.00	17.00	133.11	132.56	507.78	488.00	71.00	70.89	4.00	4.00

Flight Phase		Taxi Out									
Date	Flight	PLA1 (°)	PLA2 (°)	FF1 Lbs/hr	FF2 Lbs/hr	ITT1 (°C)	ITT2 (°C)	NP1 (%)	NP2 (%)	TQ1 (%)	TQ2 (%)
Average		20.94	18.91	138.32	138.54	513.31	490.19	70.79	70.78	4.69	5.28
Differences			2.03		0.22						
The average fuel flow if the PLA in the same angle		20.94	20.94	138.32	153.38						
Differences					15.06						
The accident flight		19.00	17.00	133.11	132.56						
Differences			2		0.6						
The average fuel flow if the PLA in the same angle		19.00	19.00	133.11	148.15						
Differences					15.04						

2. The Take-off Phase

In this evaluation, the take-off phase is considered after the Power Lever Angle was set in the take-off power and the Indicated Air Speed (IAS) is more than V1.

The take-off phase is considered ended when the Radio Altimeter indicated about 1,000 feet or the aircraft altitude is about 1,000 feet Above Ground Level (AGL).

Flight Phase		Take-off									
Date	Flight	PLA1 (°)	PLA2 (°)	FF1 Lbs/hr	FF2 Lbs/hr	ITT1 (°C)	ITT2 (°C)	NP1 (%)	NP2 (%)	TQ1 (%)	TQ2 (%)
8/6/2011	flt-1	75.93	73.00	560.31	567.69	711.55	709.86	99.41	99.48	86.59	86.03
8/6/2011	flt-2	76.00	73.00	547.25	553.96	710.86	709.54	95.95	95.92	90.32	90.32
8/7/2011	flt-1	76.00	73.00	561.26	565.55	729.60	725.99	95.58	95.58	90.28	90.27
8/7/2011	flt-2	75.97	73.00	556.46	563.60	719.90	720.75	96.97	96.96	88.00	87.90
8/7/2011	flt-3	76.00	73.00	564.67	573.42	730.47	733.17	98.32	98.30	89.05	88.77
8/7/2011	flt-4	76.00	73.00	557.76	565.60	730.42	732.28	97.42	97.38	88.38	88.17
8/7/2011	flt-5	76.00	73.00	534.71	541.72	719.96	720.26	92.61	92.62	88.24	88.19
8/7/2011	flt-6	75.99	73.00	533.88	541.80	719.47	719.09	93.27	93.19	87.28	87.07
8/7/2011	flt-7	76.00	73.00	533.10	540.34	716.23	717.19	91.94	91.92	88.94	88.81
8/8/2011	flt-1	76.00	73.00	555.02	562.21	723.59	722.98	94.59	94.57	90.97	90.95
8/8/2011	flt-2 acc.	76.00	73.00	546.88	639.03	718.03	718.71	93.37	93.38	90.34	89.40
Average		75.99	73.00	550.44	557.59	721.20	721.11	95.61	95.59	88.80	88.65
Differences			2.99		7.14						
The average fuel flow if the PLA in the same angle		75.99	75.99	550.44	580.42						
Differences					29.97						
The accident flight		76.00	73.00	546.88	639.03	718.03	718.71	93.37	93.38	90.34	89.40
Differences			3		92.20						
The average fuel flow if the PLA in the same angle		76.00	76.00	546.88	665.29						
Differences					118.41						

3. The Climb Phase

In this evaluation, the climb phase is considered after the Radio Altitude indicated more than 1,000 feet until the aircraft altitude reached the Top of Climb (TOC) altitude.

Flight Phase		Climb									
Date	Flight	PLA1 (°)	PLA2 (°)	FF1 Lbs/hr	FF2 Lbs/hr	ITT1 (°C)	ITT2 (°C)	NP1 (%)	NP2 (%)	TQ1 (%)	TQ2 (%)
8/6/2011	flt-1	76.00	73.00	406.33	412.89	682.64	686.31	82.00	82.00	79.15	79.16
8/6/2011	flt-2	76.00	73.00	417.97	424.36	682.70	684.94	82.00	82.00	81.60	81.62
8/7/2011	flt-1	76.00	73.00	412.17	417.71	686.65	687.22	82.00	82.00	80.60	80.59
8/7/2011	flt-2	76.00	73.00	420.05	426.46	683.37	685.07	82.00	82.00	82.43	82.43
8/7/2011	flt-3	76.00	73.00	409.02	415.65	682.91	686.30	82.00	82.00	80.25	80.23
8/7/2011	flt-4	76.00	73.00	412.97	419.41	683.15	685.94	82.00	82.00	80.65	80.65
8/7/2011	flt-5	76.00	73.00	405.61	411.77	683.40	686.07	82.00	82.00	79.61	79.61
8/7/2011	flt-6	76.00	73.00	409.78	416.19	682.80	684.91	82.00	82.00	80.31	80.31
8/7/2011	flt-7	76.00	73.00	410.85	416.97	681.79	684.71	82.00	82.00	80.32	80.32
8/8/2011	flt-1	76.00	73.00	422.48	428.18	686.96	688.18	82.00	82.00	82.21	82.20
8/8/2011	flt-2 acc.	76.00	73.00	497.19	599.43	694.38	695.67	82.00	82.00	93.43	93.43
Average		76.00	73.00	412.72	418.96	683.64	685.96	82.00	82.00	80.71	80.71
Differences			3		6.24						
The average fuel flow if the PLA in the same angle		76.00	76.00	412.72	436.18						
Differences					23.45						
The accident flight		76.00	73.00	497.19	599.43	694.38	695.67	82.00	82.00	93.43	93.43
Differences			3		102.2						

Flight Phase		Climb									
Date	Flight	PLA1 (°)	PLA2 (°)	FF1 Lbs/hr	FF2 Lbs/hr	ITT1 (°C)	ITT2 (°C)	NP1 (%)	NP2 (%)	TQ1 (%)	TQ2 (%)
The average fuel flow if the PLA in the same angle		76.00	76.00	497.19	624.06						
Differences					126.87						

4. The Cruise Phase

In this evaluation, the cruise phase is considered after the aircraft reached the intended cruising altitude. The cruising altitude ended when the aircraft reached at the Top of Descent (TOD) indicated by aircraft altitude before it was gradually decreasing of the pressure altitude parameter.

In this cruise flight phase, the accident flight was not taken into account because the accident flight was return to base and the right engine was shut down.

Flight Phase		Cruise										
Date	Flight	Altitude	PLA1 (°)	PLA2 (°)	FF1 Lbs/hr	FF2 Lbs/hr	ITT1 (°C)	ITT2 (°C)	NP1 (%)	NP2 (%)	TQ1 (%)	TQ2 (%)
8/6/2011	flt-1	14000	76.00	73.00	350.05	355.27	672.55	676.40	82.00	82.00	70.59	70.60
8/6/2011	flt-2	13000	76.00	73.00	370.06	375.67	681.27	683.57	82.00	82.00	75.30	75.29
8/7/2011	flt-1	14000	76.00	73.00	353.27	357.57	678.63	680.12	82.00	82.00	71.32	71.33
8/7/2011	flt-2	13000	76.00	73.00	359.77	364.52	672.56	673.79	82.00	82.00	72.49	72.50
8/7/2011	flt-3	15000	76.00	73.00	345.78	351.14	678.08	682.97	82.00	82.00	70.68	70.68
8/7/2011	flt-4	14000	76.00	73.00	350.41	355.68	674.49	677.75	82.00	82.00	71.02	71.02
8/7/2011	flt-5	15000	76.00	73.00	344.00	348.75	677.05	681.00	82.00	82.00	70.34	70.33
8/7/2011	flt-6	14000	76.00	73.00	353.51	358.41	674.70	676.53	82.00	82.00	71.78	71.77
8/7/2011	flt-7	14000	76.00	73.00	353.40	358.15	673.54	676.73	82.00	82.00	72.06	72.06
8/8/2011	flt-1	13000	76.00	73.00	365.14	369.50	675.97	677.50	82.00	82.00	73.77	73.76

Flight Phase		Cruise										
Date	Flight	Altitude	PLA1 (°)	PLA2 (°)	FF1 Lbs/hr	FF2 Lbs/hr	ITT1 (°C)	ITT2 (°C)	NP1 (%)	NP2 (%)	TQ1 (%)	TQ2 (%)
8/8/2011	flt-2 acc.	14000	76.00	73.00	350.05	355.27	672.55	676.40	82.00	82.00	70.59	70.60
Average			76.00	73.00	354.54	359.47	675.88	678.64	82.00	82.00	71.93	71.93
Differences				3		4.93						
The average fuel flow if the PLA in the same angle		76.00	76.00	354.54	374.24							
Differences					19.70							
The accident flight												
Differences												
The average fuel flow if the PLA in the same angle												
Differences												

5. The Descent and Landing Phase

In this evaluation, the descent and landing phase is considered after the aircraft reached the Top of Descent (TOD) until the aircraft touch down on the runway.

Flight Phase		Descent and Landing									
Date	Flight	PLA1 (°)	PLA2 (°)	FF1 Lbs/hr	FF2 Lbs/hr	ITT1 (°C)	ITT2 (°C)	NP1 (%)	NP2 (%)	TQ1 (%)	TQ2 (%)
8/6/2011	flt-1	51.39	48.91	234.45	230.34	537.96	526.34	84.71	84.69	32.78	31.53
8/6/2011	flt-2	53.19	50.86	254.11	249.83	553.82	538.48	82.00	82.00	37.73	36.78

Flight Phase		Descent and Landing									
Date	Flight	PLA1 (°)	PLA2 (°)	FF1 Lbs/hr	FF2 Lbs/hr	ITT1 (°C)	ITT2 (°C)	NP1 (%)	NP2 (%)	TQ1 (%)	TQ2 (%)
8/7/2011	flt-1	51.32	49.06	221.93	218.55	287.01	521.84	82.00	82.00	30.78	30.16
8/7/2011	flt-2	50.67	48.41	234.97	230.88	535.24	520.71	82.00	82.00	31.32	30.99
8/7/2011	flt-3	49.37	46.92	210.05	206.12	523.95	510.73	81.98	81.99	27.83	27.01
8/7/2011	flt-4	54.37	51.92	269.56	307.54	563.40	551.65	82.00	82.00	41.12	40.79
8/7/2011	flt-5	52.78	50.06	233.78	230.76	549.26	536.19	82.00	82.00	35.11	34.62
8/7/2011	flt-6	56.75	54.03	275.06	273.54	574.87	564.92	82.00	82.00	44.16	43.53
8/7/2011	flt-7	50.69	47.71	217.13	214.20	533.33	521.10	82.00	82.00	30.61	30.03
8/8/2011	flt-1	50.95	48.14	224.20	222.14	535.81	527.43	82.00	82.00	31.03	30.37
8/8/2011	flt-2 acc.	51.39	48.91	234.45	230.34	537.96	526.34	84.71	84.69	32.78	31.53
Average		52.15	49.60	237.52	238.39	519.47	531.94	82.27	82.27	34.25	33.58
Differences			2.55		0.86						
The average fuel flow if the PLA in the same angle		52.15	52.15	237.52	250.62						
Differences					13.10						
The accident flight											
Differences											
The average fuel flow if the PLA in the same angle											
Differences											

6. Landing Roll Phase

In this evaluation, the landing roll phase is considered after the aircraft touch down on the runway until the aircraft reached the lowest ground speed before it was increase again with the intention to Taxi In to the apron.

Flight Phase		Landing Roll									
Date	Flight	PLA1 (°)	PLA2 (°)	FF1 Lbs/hr	FF2 Lbs/hr	ITT1 (°C)	ITT2 (°C)	NP1 (%)	NP2 (%)	TQ1 (%)	TQ2 (%)
8/6/2011	flt-1	16.67	15.77	168.40	157.23	500.77	481.37	74.03	74.10	12.97	10.53
8/6/2011	flt-2	21.22	19.06	137.53	136.68	504.04	484.44	71.95	72.00	5.12	5.22
8/7/2011	flt-1	19.00	17.00	148.07	145.43	518.21	490.11	72.86	73.18	5.89	5.86
8/7/2011	flt-2	19.00	17.00	146.24	138.63	517.87	479.24	72.92	73.26	6.08	5.55
8/7/2011	flt-3	20.53	18.62	145.26	144.17	513.86	491.85	71.63	71.78	6.86	6.65
8/7/2011	flt-4	18.57	17.39	141.06	136.95	511.70	490.91	72.39	72.49	6.63	5.85
8/7/2011	flt-5	19.09	17.19	145.12	142.29	515.00	495.56	72.05	72.24	7.14	6.58
8/7/2011	flt-6	19.98	17.90	136.84	136.32	507.76	487.64	71.61	71.72	5.07	5.25
8/7/2011	flt-7	19.13	17.35	155.28	150.38	506.10	499.85	74.55	74.80	9.08	7.63
8/8/2011	flt-1	19.43	17.40	142.55	139.67	510.50	492.98	73.02	73.24	5.52	5.31
8/8/2011	flt-2 acc.	16.67	15.77	168.40	157.23	500.77	481.37	74.03	74.10	12.97	10.53
Average		19.26	17.47	146.63	142.78	510.58	489.39	72.70	72.88	7.04	6.44
Differences			1.79		-3.86						
The average fuel flow if the PLA in the same angle		19.26	19.26	146.63	157.43						
Differences					10.79						
The accident flight											
Differences											

Flight Phase		Landing Roll									
Date	Flight	PLA1 (°)	PLA2 (°)	FF1 Lbs/hr	FF2 Lbs/hr	ITT1 (°C)	ITT2 (°C)	NP1 (%)	NP2 (%)	TQ1 (%)	TQ2 (%)
The average fuel flow if the PLA in the same angle											
Differences											

7. Taxi In Phase

In this evaluation, the taxi in phase is considered when the aircraft ground speed increased after the landing ground roll ended. The end of the taxi in phase is considered when the aircraft reach the parking gate and one of the engine fuel flows was stop.

Flight Phase		Taxi In									
Date	Flight	PLA1 (°)	PLA2 (°)	FF1 Lbs/hr	FF2 Lbs/hr	ITT1 (°C)	ITT2 (°C)	NP1 (%)	NP2 (%)	TQ1 (%)	TQ2 (%)
8/6/2011	flt-1	20.72	18.57	123.97	129.90	503.51	486.32	69.89	69.96	3.89	4.78
8/6/2011	flt-2	18.84	17.59	133.83	133.81	509.57	493.35	70.94	71.00	4.31	4.64
8/7/2011	flt-1	20.63	18.64	132.46	134.66	493.03	474.04	70.08	70.78	4.19	4.53
8/7/2011	flt-2	19.00	17.00	132.65	131.21	506.39	483.26	70.77	70.86	4.00	4.00
8/7/2011	flt-3	22.34	20.51	127.44	139.38	508.01	507.55	69.94	70.75	4.23	5.60
8/7/2011	flt-4	22.00	19.77	133.00	137.23	514.62	525.46	70.38	70.77	4.54	5.23
8/7/2011	flt-5	23.07	20.89	135.49	138.90	513.15	502.40	70.79	70.74	4.45	5.60
8/7/2011	flt-6	19.00	17.00	133.33	132.00	512.83	490.50	70.67	70.83	4.00	4.00
8/7/2011	flt-7	19.38	17.52	123.50	110.05	497.71	504.79	66.90	58.41	3.95	3.62
8/8/2011	flt-1	19.00	17.00	132.81	131.45	603.62	476.19	70.84	70.90	4.00	4.00
8/8/2011	flt-2 acc.	20.72	18.57	123.97	129.90	503.51	486.32	69.89	69.96	3.89	4.78
Average		20.40	18.45	130.85	131.86	516.24	494.39	70.12	69.50	4.16	4.60

Flight Phase		Taxi In									
Date	Flight	PLA1 (°)	PLA2 (°)	FF1 Lbs/hr	FF2 Lbs/hr	ITT1 (°C)	ITT2 (°C)	NP1 (%)	NP2 (%)	TQ1 (%)	TQ2 (%)
Differences			1.95		1.01						
The average fuel flow if the PLA in the same angle		20.40	20.40	130.85	145.79						
Differences					14.94						
The accident flight											
Differences											
The average fuel flow if the PLA in the same angle											
Differences											

6.2 The Company Standard Operating Procedure of the Communication

Wings Air	**NORMAL PROCEDURES** INTRODUCTION OF NORMAL PROCEDURES	NOR 02.10.01	
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Pilot flying transfer

- **PF** function can be transferred, due to external factors, with the following announcement:

«YOUR CONTROL» or «YOU HAVE CONTROL»

- The pilot who receives the **PF** function announces respectively:

«MY CONTROL» or «I HAVE CONTROL»

- After **PF / PNF** function change, crew have to change and check that coupling is set to the new PF side.
- When possible, prior to the transfer, the PF reminds the PNF of the main flight parameters.

b) Safety recommendations

Execution of given orders

- Crewmembers must inform each other of any task done.
- PF orders and PNF executes and announces when complete.

Anti collision monitoring

- crew should avoid paper work (flight log, technical log,...) between the ground and flight level 100 (except for ATC clearance).
- Anti collision monitoring (outside by visual check and inside by ATC frequency listening and TCAS) has to be done by both crew members.

Communication in the cockpit

- Talks, requests and calls out must be limited to the minimum during the critical phases of the flight (take-off, approach, landing or missed approach).
- Technical communications between both pilots have to comply with the standard announcements and call outs explained in this manual.

Headset

- Crew must wear headset:
  - before engine start and up to 10000 feet
  - From 10000 feet to engine shut down.
  - On Captain's decision.

6.3 Similar Occurrence that was investigated by BEA

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REPORT
INCIDENT

Fire on left engine during start-up

[1] Unless otherwise specified, the times in this report are expressed in Universal Time Coordinated (UTC). 10 hours should be subtracted for local time in Tahiti.

Aircraft	ATR 72-212A registered F-OIQO
Date and time	18 November 2011 at 17 h 20[1]
Operator	Air Tahiti
Place	Moorea airport (French Polynesia)
Type of flight	Scheduled public transport of passengers
Flight crew	Captain (PF) Copilot (PNF)
Consequences and damage	Left engine slightly damaged

HISTORY OF FLIGHT

During start-up of the left engine, the crew noticed that the inter-turbine temperature (ITT) was not increasing at a nominal rate and stabilised between 300 and 400°C. Engine RPM stabilised between 30 and 40%. The Captain was then thinking of abandoning the start-up sequence when the engine fire alarm came on. He applied the engine ground fire procedure and fired extinguisher n°1 without success. Firing the second extinguisher put out the fire.

Evacuation of the passengers took place without incident.

Additional Information

Inspection of the engine showed traces of soot and some burns, mainly around the ITT sensor manifold. The lower engine cover had 2 delaminated areas with black marks. The engine was cleaned, the manifold and the cover changed. An engine ground run was performed and the aeroplane was returned to service the following day.

Examination of the engine showed that the cause of the fire was a fuel leak at the level of the manifold at injector n°14. Removal of the manifold showed that one of the two O-rings was cut (see photo and cutaway on following page).

The injection system

The combustion chamber on a Pratt & Whitney PW120 series engine is an annular chamber fed by 14 injectors.

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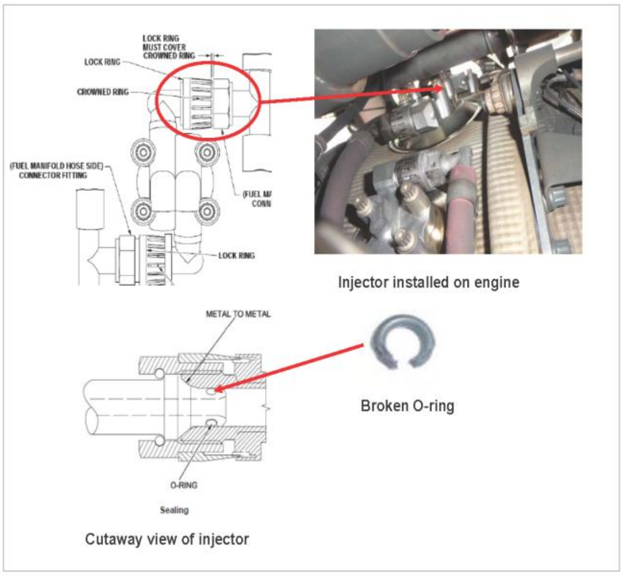

Injector installed on engine

Broken O-ring

Cutaway view of injector

Sealing between the injector and the manifold is ensured by tightening, metal against metal, to a torque level defined by the manufacturer. The two O-rings create an additional safety when this tightening is not correct. Any damage to them can lead to a leak.

The maintenance manual specifies changing the injector nozzle manifold every 1,000 flying hours. Once the operation is finished, sealing of the injectors is checked by a leakage check (wet ventilation), then by a ground run at 80% performed for 10 minutes. The presence of the O-rings can mask incorrect tightening during this leakage check.

Similar Events

Between January 2003 and August 2010, Pratt and Whitney Canada identified 25 cases of fuel leaks involving the injectors, of which 10 led to engine fires.

The leaks mainly appeared on the injectors located at the top and at the bottom (injectors 14 and 7) of the chamber. These are more difficult to access when the engine is installed in the nacelle and the maintenance mechanic can have difficulties in applying the correct tightening torque.

In order to reduce the number of events, the manufacturer took a series of steps:

- publications and revisions of service information letters aimed at operators, in order to improve awareness of the risks run following an error in tightening the injectors,
- introduction of an indicator that makes it possible to check the correct level of tightening: (revision of the engine maintenance manual in June and August 2009).

KOMITE NASIONAL KESELAMATAN TRANSPORTASI REPUBLIK INDONESIA
Jl. Medan Merdeka Timur No.5 Jakarta 10110 INDONESIA
Phone : (021) 351 7606 / 384 7601 Fax : (021) 351 7606 Call Center : 0812 12 655 155
website 1 : http://knkt.dephub.go.id/webknkt/ website 2 : http://knkt.dephub.go.id/knkt/
email : knkt@dephub.go.id