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KOMITE NASIONAL KESELAMATAN TRANSPORTASI

Aircraft Serious Incident Investigation Report

PT. Merpati Nusantara Airlines
Xi An MA60; PK-MZG
M. Salahuddin Airport, Bima,
Nusa Tenggara Barat
Republic of Indonesia

12 December 2011

KOMITE NASIONAL KESELAMATAN TRANSPORTASI
REPUBLIC OF INDONESIA
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This Final Report was produced by the Komite Nasional Keselamatan Transportasi (KNKT), 3rd Floor Ministry of Transportation, Jalan Medan MerdekaTimur 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 Organization, the Indonesian Aviation Act (UU No. 1/2009) and Government Regulation (PP No. 62/2013).

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ABBREVIATIONSAND DEFINITIONS

AGL	:	Above Ground Level
AMM	:	Aircraft Maintenance Manual
AOC	:	Air Operator Certificate
ATPL	:	Air Transport Pilot License
ATS	:	Air Traffic Service
BMKG	:	*Badan Meterologi Klimatologi dan Geofisika* (Metrological Climatology and Geophysical Agency)
°C	:	Degrees Celsius
CAAC	:	Civil Aviation Authority of China
CAM	:	Cockpit Area Microphone
CPL	:	Commercial Pilot License
CSN	:	Cycles Since New
CVR	:	Cockpit Voice Recorder
DGCA	:	Directorate General of Civil Aviation
DME	:	Distance Measuring Equipment
EEC	:	Electronic Engine Control
EGPWS	:	Enhance Ground Proximity Warning System
FCOM	:	Flight Crew Operation Manual
FDR	:	Flight Data Recorder
F.I	:	Flight Idle
FL	:	Flight Level
ft	:	Feet
GA	:	Go Around
G.I	:	Ground Idle
hPa	:	Hectopascals
Hrs	:	Hours
ICAO	:	International Civil Aviation Organizationn
IFR	:	Instrument Flight Rules
IIC	:	Investigator in Charge
In Hg	:	Inch Hydrargyrum
Kg	:	Kilogram(s)
Km	:	Kilometer(s)
kts	:	Knots (nm/hours)
L/H	:	Left hand
mbs	:	Millibars
mHz	:	Mega Hertz
Min	:	Minute (S)
Mm	:	Millimeter(s)
MEL	:	Minimum Equipment List
MMF	:	Merpati Maintenance Facility

MTOW	:	Maximum Take-off Weight
Nm	:	Nautical mile(s)
NOTAM	:	Notice to Airman
KNKT (NTSC)	:	*Komite Nasional Keselamatan Transportasi* (National Transportation Safety Committee)
P/A	:	Passenger Address
PF	:	Pilot Flying
PIC	:	Pilot in Command
PL	:	Power Lever
PM	:	Pilot Monitoring
QFE	:	Height above airport elevation (or runway threshold elevation) based on local station pressure
QNH	:	Height above mean sea level based on local station pressure
SIC	:	Second in Command
S/N	:	Serial Number
SSCVR	:	Solid State Cockpit Voice Recorder
SSFDR	:	Solid State Flight Data Recorder
T.O	:	Take off
TSN	:	Time since New
TT/TD	:	Ambient Temperature/Dew Point
UTC	:	Universal Time Coordinate
VMC	:	Visual Meteorological Condition
VOR	:	Very High Frequency Omnidirectional Range

INTRODUCTION

SYNOPSIS

On 12 December 2011, a Xi' An MA60 aircraft registered PK-MZG was being operated by PT. Merpati Nusantara Airline as a scheduled passenger flight. The aircraft was scheduled for a series of flight: DPS-BMU-DPS-AMI-DPS. The second sector was from Muhammad Salahuddin Airport, Bima (BMU/WADB), Nusa Tenggara Barat to Ngurah Rai Airport, Denpasar (DPS/WADD), Bali using flight number MZ 623.

The flight took-off from BMU at 02.38 UTC. While climbing passed 6000ft altitude, left engine fire warning activated.

The flight crew performed actions to feather the propeller 1 minute 16 second after the warning and followed by discharging fire extinguisher bottle.

The pilots decided to return to Bima and landed safely at 0350, no one injured in this incident.

The fire was triggered by the fuel leak on the fitting of the fuel flow transmitter which was found loose. The integration of the engine on the aircraft was performed by the aircraft manufacturer and the fuel flow transmitter has not been removed since.

Following this investigation the NTSC issued several safety recommendations to the Indonesia Directorate General of Civil Aviation, and PT. Merpati Nusantara Airline and the Xi' An Aircraft Industry, China.

1. FACTUAL INFORMATION

1.1 History of the Flight

On 12 December 2011, a Xi' An MA60 aircraft registered PK-MZG was being operated by PT. Merpati Nusantara Airline as a scheduled passenger flight. The aircraft and crew were scheduled for a series of flight on that day DPS-BMU-DPS-AMI-DPS. The second sector was from Sultan Muhammad Salahuddin Airport [1] (WADB/BMU), Bima, Nusa Tenggara Barat to Ngurah Rai Airport (WADD/DPS), Denpasar, Bali with flight number MZ 623.

The aircraft departed Bima at 0238 UTC[2]. On board in this flight were two pilots, two flight attendants, one company engineer and 38 passengers. The Pilot in command (PIC) acted as Pilot Flying (PF) and the Second in Command (SIC) as Pilot Monitoring (PM).

While climbed passing 4,000 feet, the Left DC GEN caution light illuminated and was reset and the light went off.

While climbed passing 6,000 feet the CVR recorded engine fire warning bell activated and disappeared. Three seconds later, the fire warning re-activated. There was a confusion of both pilots to analyze the situation. The pilot contacted to the flight attendant to invite the engineer to come to the cockpit.

One minute 58 seconds after the fire warning re-appear, both pilots agreed to shut the engine. The PIC saw cloud on the flight path and decided to avoid the cloud to clear area. The PM then performed actions to feather the propeller and shot the engine fire extinguisher. The fuel was shut-off 59 seconds later.

The flight crew discharged the second fire extinguisher bottle; however the fire warning light remained illuminated.

The pilots decided to return to Bima and informed the Bima Tower controller regarding the problem and the pilot intention.

The Bima Tower controller informed the Airport Rescue and Fire Fighting (ARFF) agency to stand by. The airport fire fighters (2 fire trucks and 1 ambulance) were standing by the runway.

The aircraft landed safely at 0300 UTC, and there was no one injured in this serious incident.

1 Sultan Muhammad Salahuddin Airport will be named as Bima for the purpose of this report.

2 The 24-hour clock in Universal Time Coordinate (UTC) is used in this report to describe the local time as specific events occurred. Indonesia Central Standard Time (*Waktu Indonesia Tengah*/ WITA) is UTC +8 hours

1.2 Injuries to Persons

Injuries	Flight crew	Passengers	Total in Aircraft	Others
Fatal	-	-	-	-
Serious	-	-	-	-
Minor/None	4	38	42	-
TOTAL	4	38	42	-

1.3 Damage to Aircraft

The number-1 engine experienced in-flight fire. Several components of the engine were burnt, such as wire harness and the cowling.

Figure 1: The left engine cowling was damaged

1.4 Other Damage

There was no other damage to property and/or the environment.

1.5 Personnel Information

1.5.1 Pilot in Command

Gender	:	Male
Age	:	39 years
Nationality	:	Indonesia
License	:	ATPL
Date of issue	:	*Information not available*
Validity	:	31 March 2012
Aircraft type rating	:	MA-60
Medical certificate	:	First Class
Last of medical	:	25 October 2011
Validity	:	26 April 2012
Last proficiency check	:	27 September 2012
Flying experience		
Total hours	:	4,813 hours 53 minutes
Total on type	:	1,531 hours 45 minutes
Last 90 days	:	*Information not available*
Last 30 days	:	*Information not available*
Last 24 hours	:	5 hours 24 minutes
This flight	:	23 minutes

1.5.2 Second in Command

Gender	:	Male
Age	:	40 years
Nationality	:	Indonesia
License	:	ATPL
Date of issue	:	14 May 2004
Validity	:	30 November 2012
Aircraft type rating	:	MA-60
Medical certificate	:	First Class
Last of medical	:	09 November 2011
Validity	:	09 May 2012
Last proficiency check	:	28 November 2012

Flying experience

Total hours	:	*Information not available*
Total on type	:	1088 hours 09 minutes
Last 90 days	:	*Information not available*
Last 30 days	:	*Information not available*
Last 24 hours	:	05 hours 24 minutes
This flight	:	23 minutes

1.6 Aircraft Information

1.6.1 General

Aircraft manufacturer	:	Xi' An Aircraft Industry, China
Aircraft model/type	:	MA 60
Serial number	:	0505
Year of manufacture	:	2007
Aircraft registration	:	**PK-MZG**
Certificate of Registration	:	2806
Valid to		03 March 2014
Certificate of Airworthiness	:	2806
Valid to	:	03 March 2012
Total time since new (TSN)	:	1,679 hours
Cycles Since New (CSN)	:	1,873 cycles
MTOW		21,800 kg
Actual Take Off Weight	:	18,344 kg
Estimated Landing Weight	:	17,645 kg

1.6.2 Engines

Manufacturer	:	Pratt & Whitney, Canada
Type/Model	:	Turbo-propeller
Model	:	PW 127J
Serial Number-1 engine	:	PCE-EA0065
Time Since New	:	1,679 hours
Cycles Since New	:	1,873 cycles
Serial Number-2 engine	:	PCE-EA0068
Time Since New	:	1,679 hours
Cycles Since New	:	1,873 cycles

The integration of the engine on the aircraft was performed by the aircraft manufacturer.

1.7 Meteorological Information

The current weather reported at 02; 00 UTC on day of the serious incident by the local airport authority was

Surface wind	:	Calm
Visibility	:	10 km
Present weather	:	Clear
Cloud	:	2 CU / 450 m
Temperature	:	31° C
Dew Point	:	25° C
QNH	:	1008 mbs
QFE	:	1008 mbs

1.8 Aids to Navigation

Not relevant to this investigation.

1.9 Communications

All communications between 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.

1.10 Aerodrome Information

Aerodrome Code	:	WADB/BMU
Airport Name	:	Sultan Muhammad Salahuddin
Certificate Number	:	046/SBU-DBU-XI/2011
Runway Direction	:	13 - 31
Runway Length	:	1,650 meters
Runway Width	:	30 meters
Surface	:	Asphalt
Fire Fighting Category	:	Category VI

1.11 Flight Recorders

The aircraft was equipped with a Digital Flight Data Recorder (DFDR) and Cockpit Voice Recorder (CVR).

1.11.1 Digital Flight Data Recorder

Manufacturer : Shaanxi Qianshan Avionics Co. Ltd., China

Type/Model : Solid State

Part Number : FB-30C

Serial Number : 0608012

The FDR was downloaded at the Merpati Maintenance Facility (MMF) at Surabaya under the KNKT supervision.

The DFDR contains 25 hours and 82 parameters of good quality recording.

The related parameters recorded in the DFDR in the incident flight were represented in the following plot.

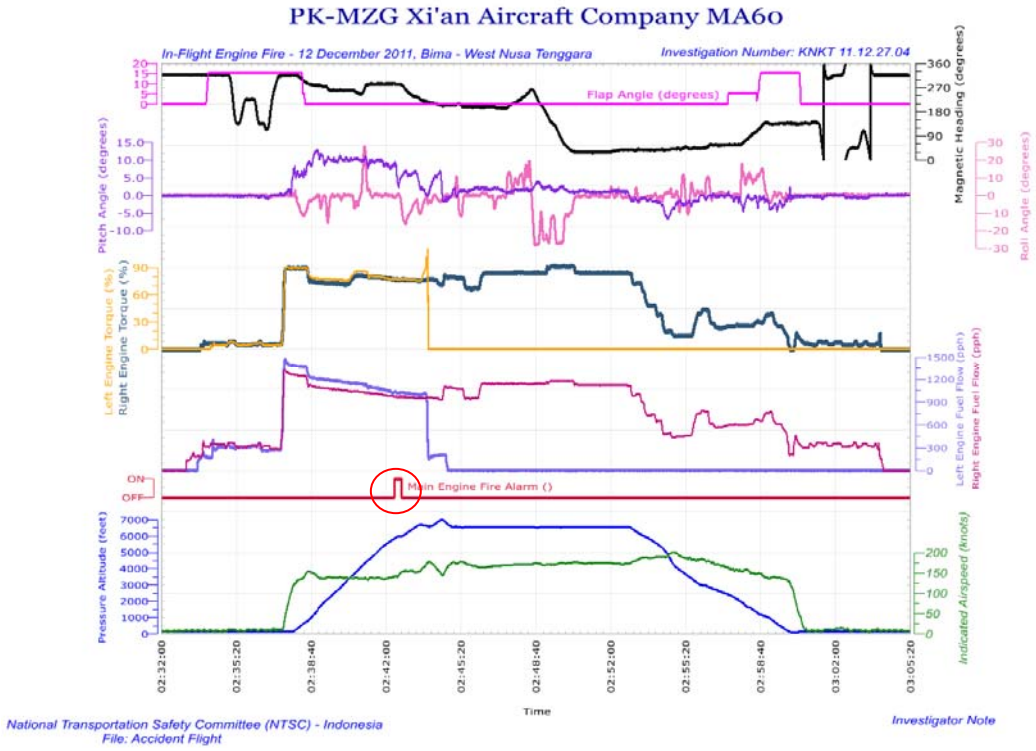

Figure 2: FDR data plot from the incident flight

The difference of fuel flow can be observed in the plot of fuel flow for engine number 1 and number 2. The difference of fuel flow indicated that there was fuel leak in the fuel line of engine number 1.

The plots also show the engine fire warning activation, the torque decreasing and fuel shut off.

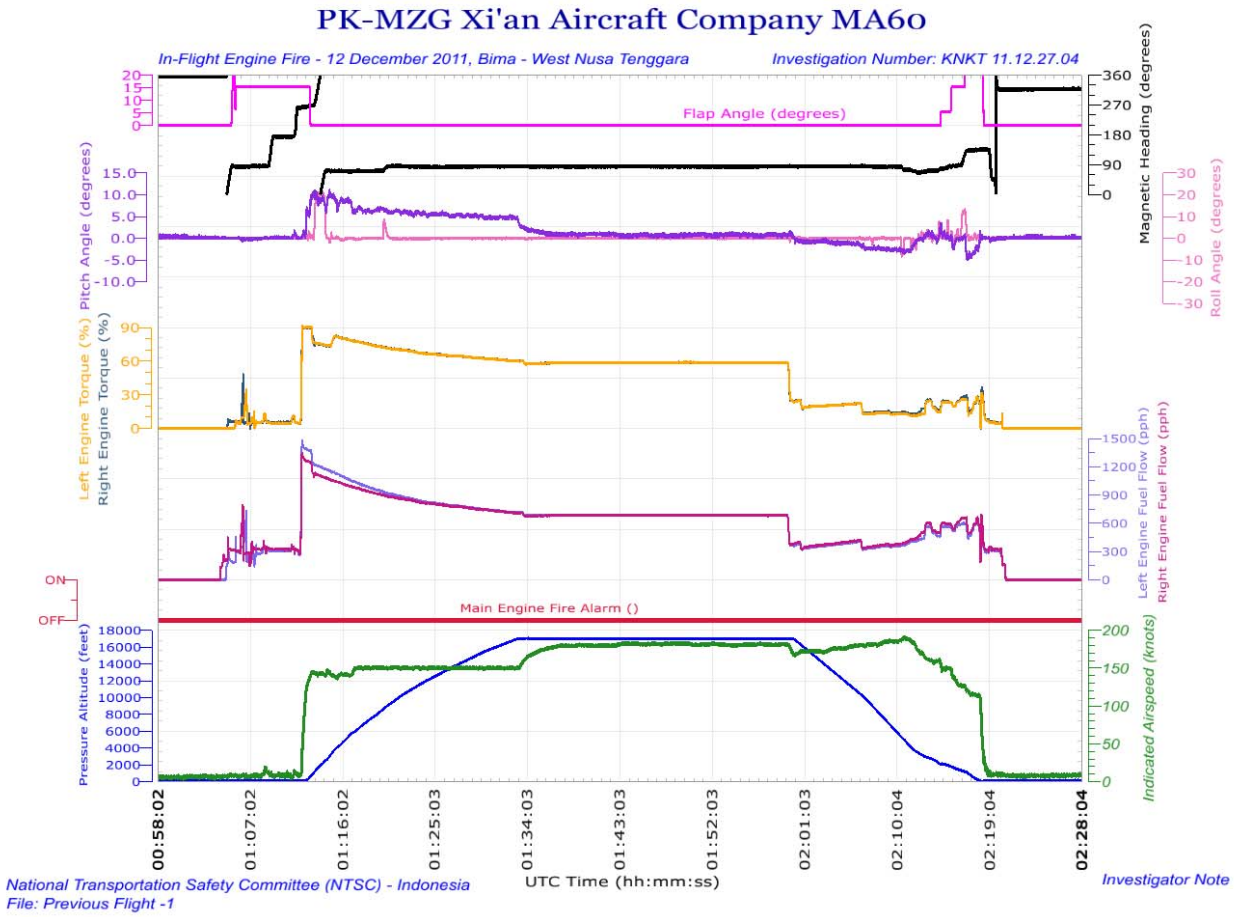

Figure 3: FDR data plot from previous flight

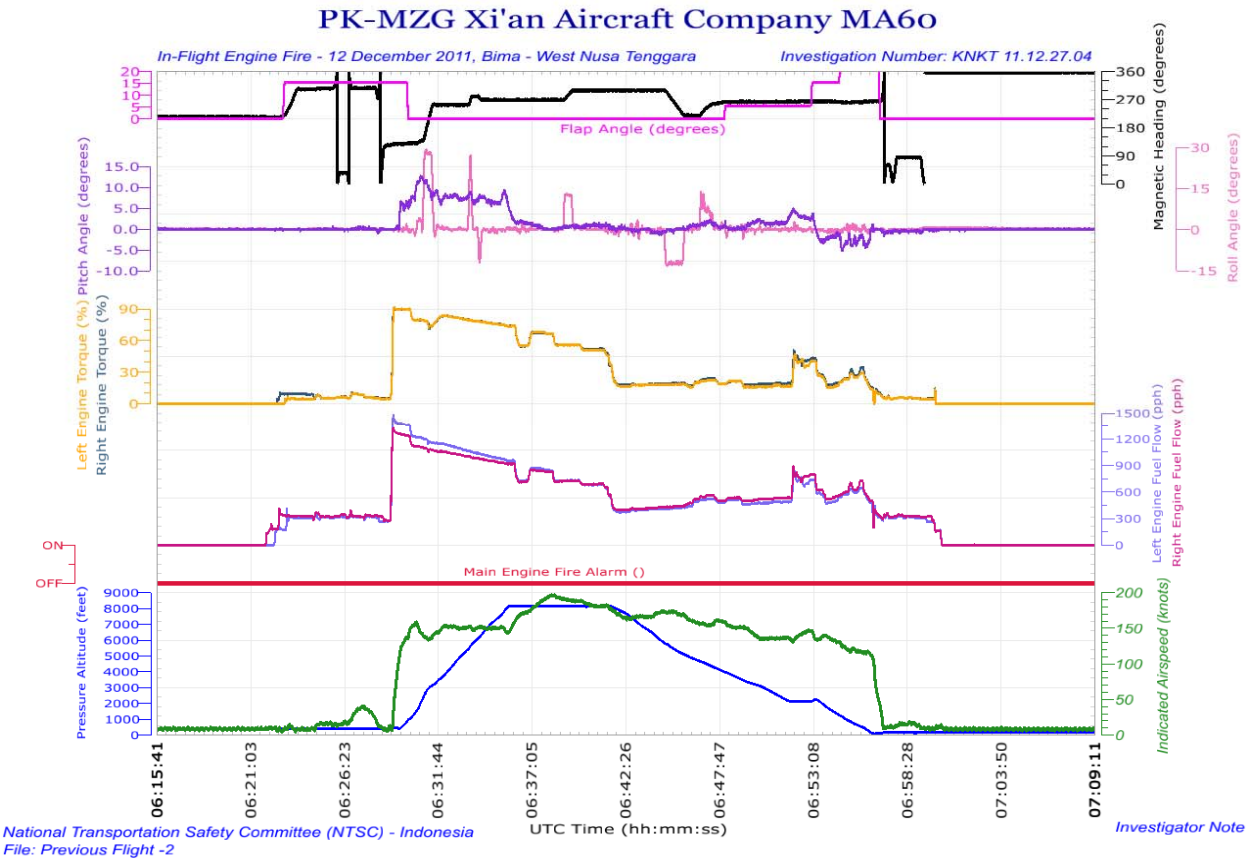

Figure 4: FDR data plot from the previous flight: 2nd flight before the incident

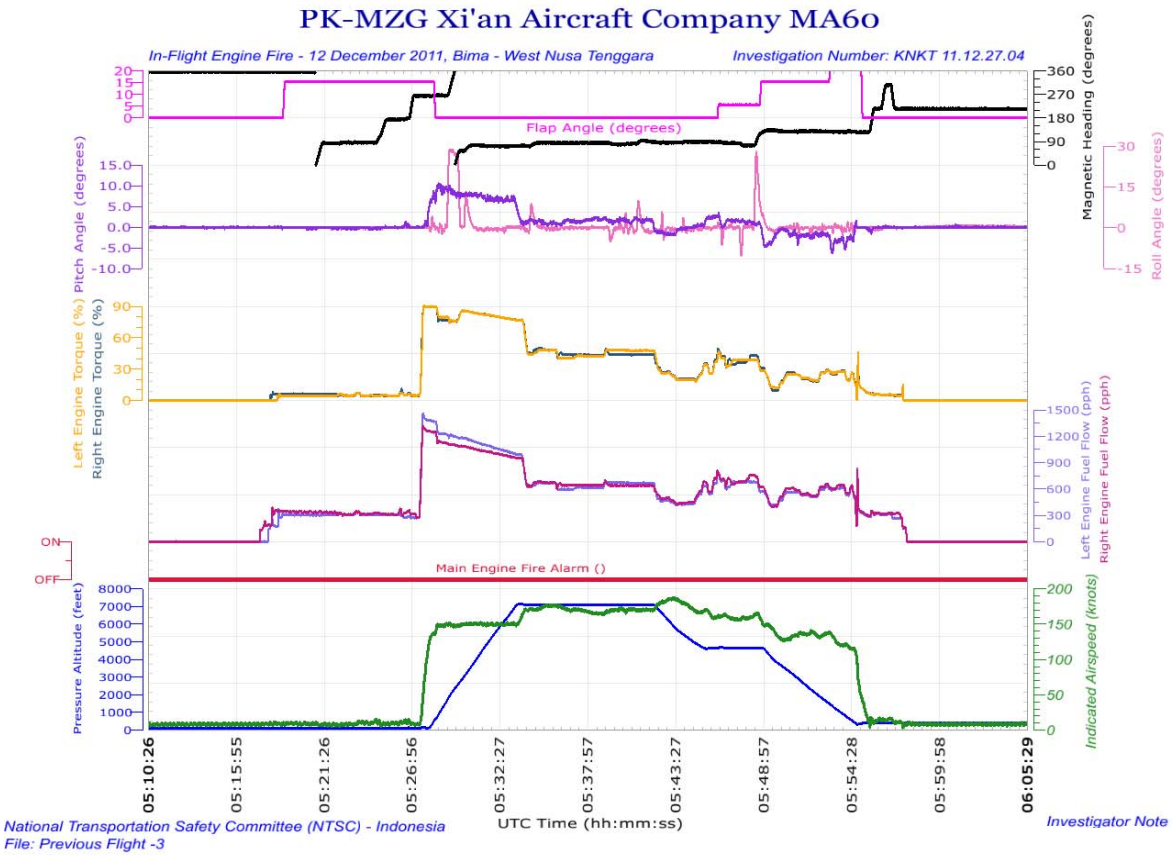

Figure 5: FDR data plot from the previous flight: 3rd flight before the incident

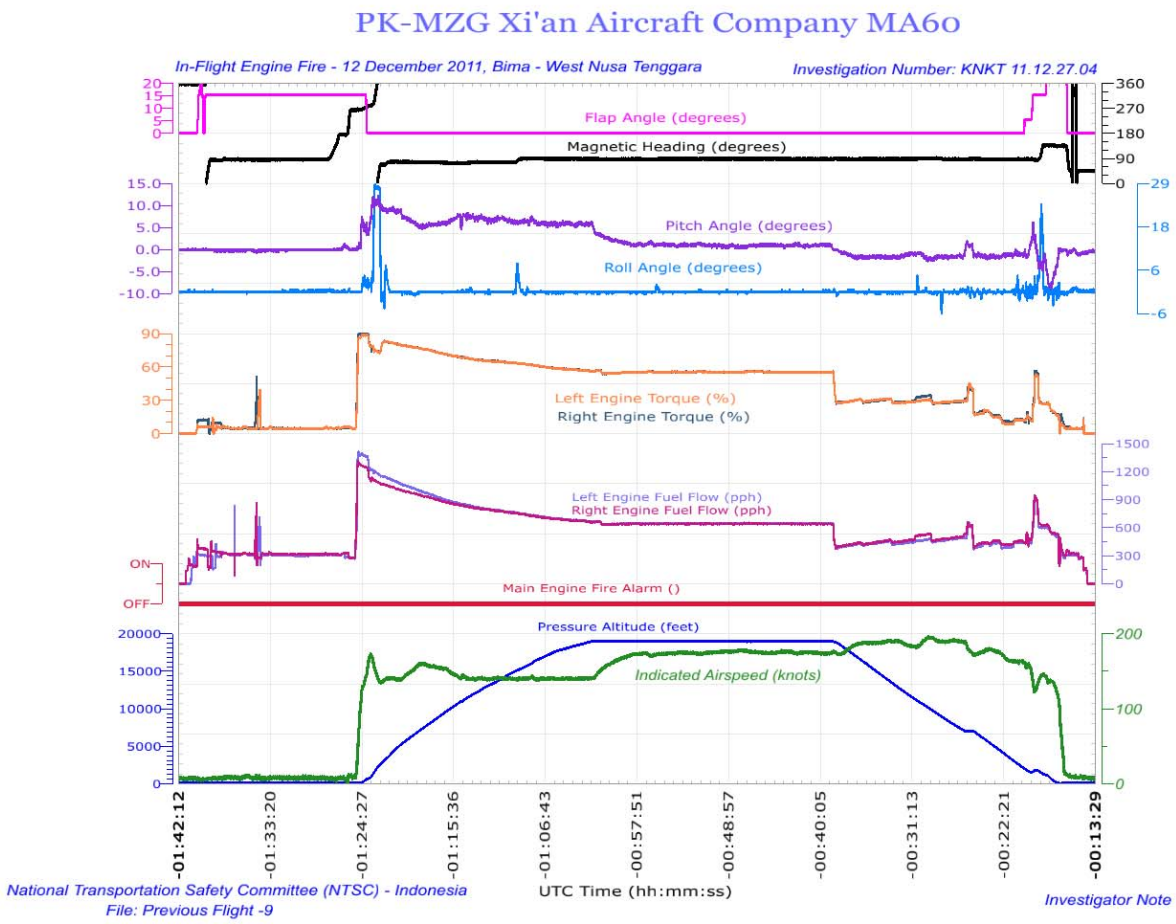

Figure 6: FDR data plot from the previous flight: 9th flight before the incident

FDR data plot from several flights before the incident showed also a similar pattern of fuel flow. These patterns were observed in the 9 flights before the incident. It indicated that the fuel leak occurred in several flights before the incident.

The fuel flow depends on the engine power setting. It reached its highest value at the take off stage, and it became smaller during climb. It is shown that the leak was at takeoff, and reduced gradually in the climb stage, and even ceased during cruise.

The trend of fuel leak increment from the previous nine flights until the occurrence of in-flight engine fire is shown on the following table.

Flight	Differences of Fuel Flow [pounds per hour]
Incident flight	129
-1	110
-2	106
-3	92
-9	102

Table 1: The differences of fuel flow on takeoff of several flights

1.11.2 Cockpit Voice Recorder (CVR)

The CVR was downloaded at KNKT facilities and contained 120 minutes of good quality recording. The audio files were examined found to contain the accident flight

Manufacturer : Honeywell, USA

Type/Model : Solid State

Part Number : 980-6022-001

Serial Number : CVR 120-08251

The excerpt of the significant information from the CVR for the flight:

UTC	EVENT DESCRIPTION
02.38.00	Aircraft departure
02.42.23	Left engine fire warning activated and then disappeared. The warning reappeared 3 seconds later.
02.43.01	The pilots called the flight attendant to ask the engineer to come to the cockpit
02.43.23	The engineer entered the cockpit and informed that the fire was visually observed on the left engine.
02.43.39	The pilot feathered the propeller.
02.43.58	The pilot decided RTB
02.44.14	The engine fire extinguisher discharged
02.44.38	Engine shut down actions were performed
02.44.59	Before landing checklist reading
02.45.49	Engine failure shut down checklist reading
02.46.56	Engine fire extinguisher shot two
02.47.44	The engine fire warning light still illuminate
02.47.55	One engine drift down checklist reading
02.50.13	Reading the engine failure or shut down checklist reading for second time.
03.00.00	Aircraft touch down

1.12 Wreckage and Impact Information

An inspection performed on the aircraft to find the location of fire as well as the location of fuel leak. The sign of the most severe fire was at the bottom plate just in front of the partition of hot and cold section. The fuel line under the fuel flow transmitter was found wet.

In order to provide a higher fuel pressure, cold cranking of the left engine was performed several times. The cranking was performed by licensed personnel of PT. Merpati Nusantara, witnessed by Pratt & Whitney representative, Xi'An Aircraft Manufacturer personnel, and supervised by KNKT investigators.

During cold cranking the fuel leak was found at a fitting under the fuel flow transmitter at a rate of 21 droplets per minute.

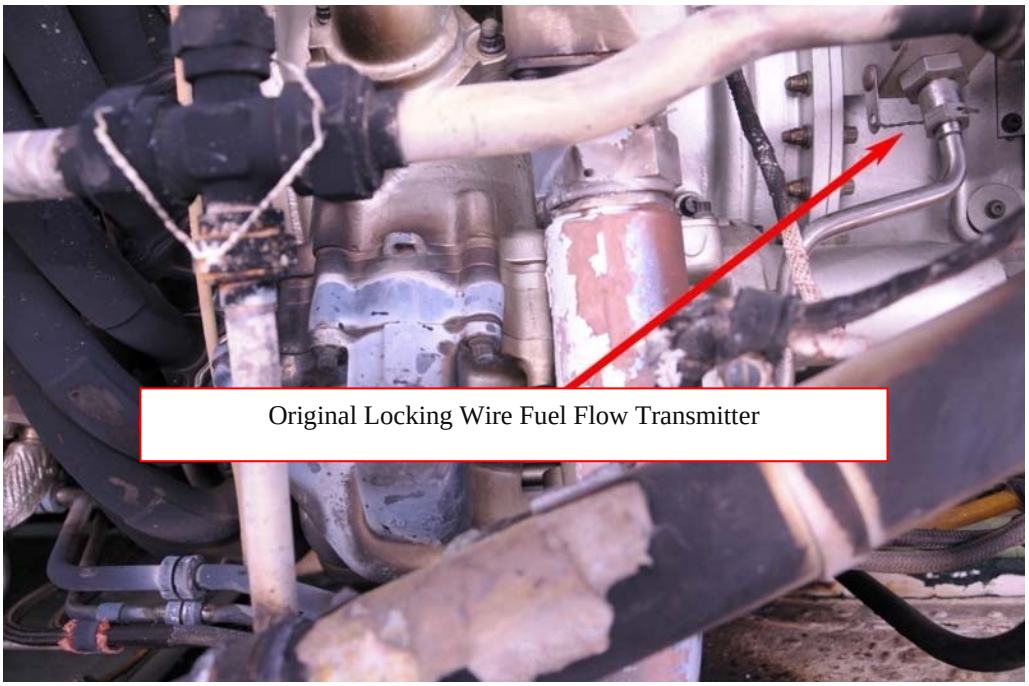

Figure 7: Original locking wire at the fitting

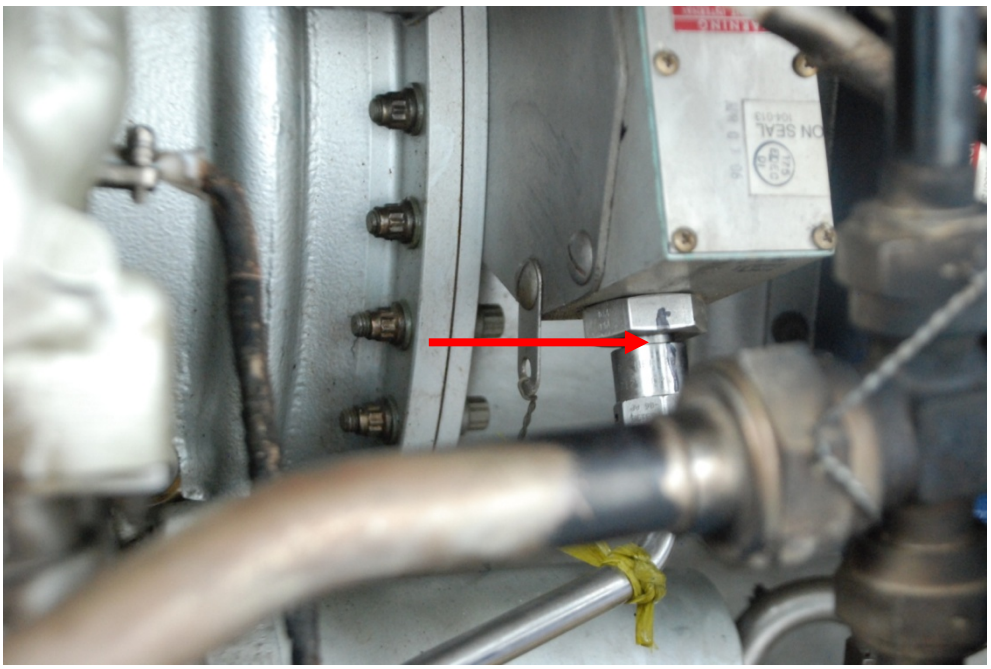

Figure 8: A blue line drawn on the fitting showing the original position

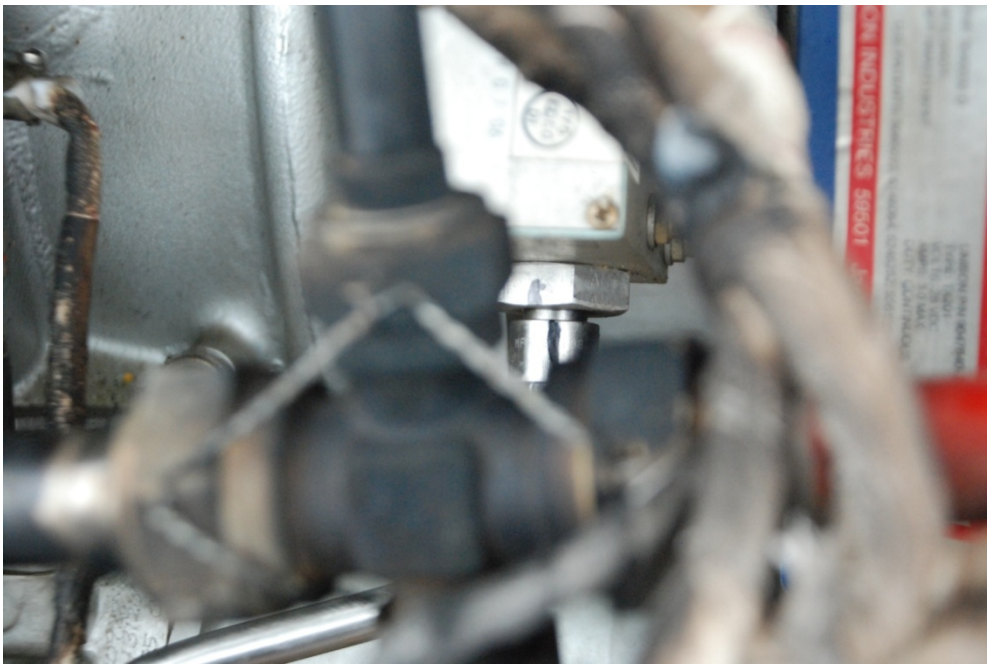

Figure 9: The shifting of blue line after tightening of the fitting

The original locking wire on the fuel fitting at the lower part of the fuel flow transmitter was intact. After opening the locking wire, the fitting was found to be not properly tightened. A further tightening could rotate the nut of about 5mm.

After a retightening the fuel fitting, a cold cranking was performed and there was no fuel leak observed in the corresponding tube.

There was no rework performed by the operator on the fuel flow transmitter. The installation of this particular fitting was performed by the aircraft manufacturer.

1.13 Medical and Pathological Information

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

1.14 Fire

Fire initiated from the lower part of the cowling in front of the partition between hot and cold section of the engine number 1 where the fuel leak accumulated at that location. The fire moved upward crossing the frame bulkhead to the hot section as revealed in figure 2 showing the sign of fire direction.

Figure 10: Signature of fire in front of bulkhead frame

Figure 11: The most intense fire occurred on the floor just in front of the bulkhead frame

1.15 Survival Aspects

Not relevant to this investigation.

1.16 Tests and Research

Not relevant to this investigation.

1.17 Organizational and Management Information

Aircraft Owner	:	PT. (Persero) Merpati Nusantara Airlines
Aircraft Operator	:	PT. (Persero) Merpati Nusantara Airlines
Address	:	JL. Angkasa Blok B.15 KAV. 2&3, Kemayoran, Jakarta
AOC Number	:	AOC / 121-002

1.17.1 Pilot Training

The pilot training syllabus in Merpati for the MA 60 consisted of 146 hours ground training, 8 simulator sessions (4 hours for each session) for transition training or 15 simulator sessions training for first joining pilot (*ab-initio*) and 100 hours line training, while the standard simulator training sessions in Xi An Aircraft industry consist of 22 simulator sessions (2 hours for each session).

The first three batches of pilot training were performed at Xi'An, China and were mentored by manufacturer instructors with interpreter using the aircraft manufacturer syllabus.

The subsequent pilot training was conducted by Merpati instructors using the Merpati syllabus.

PIC was trained in China, and the SIC was in Jakarta with instructors from aircraft manufacturer. The syllabus for both trainings were using Merpati syllabus.

1.18 Additional Information

Relevant information taken from aircraft manuals, are as follows:

1.18.1 Flight Crew operation Manual (FCOM).

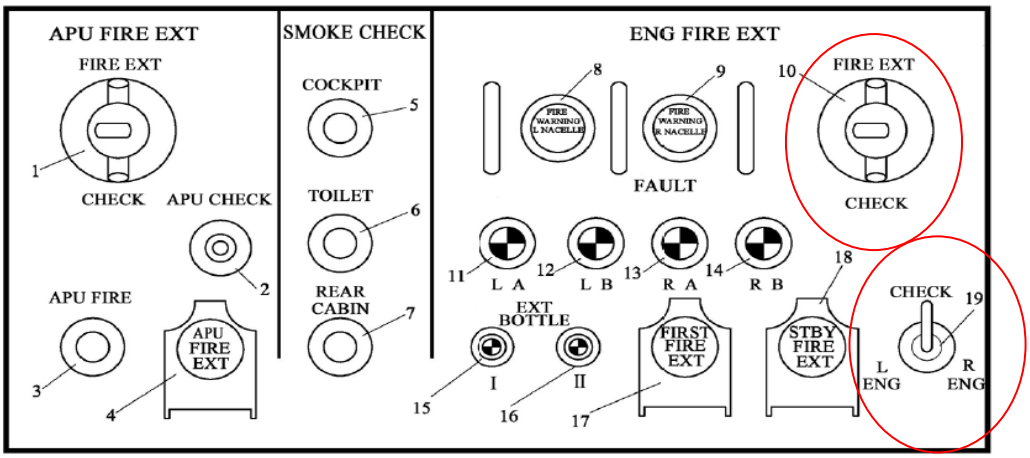

Figure 12: Aircraft Fire Extinguishing System Control Panel (FCOM volume 1 Chapter 9.2.6)

9.3.2 Disposition under Firing (FCOM volume 1 chapter 9.3)

A Engine firing

If pilot judges from various signals that an engine is on fire, the following operation shall be performed:

(1) Pull power lever to "FI";

(2) Pull condition lever to "FEATHER", then to "CUT OFF" to shut down the engine;

(3) The fuel shutoff valve is set at OFF;

(4) Press down "FIRST FIRE EXT" button;

(5) Turn off AC generator;

(6) Turn off DC generator;

(7) Close bleed;

(8) Close hydraulic shutoff valve.

Check the yellow signal lights of group I go out. 30 s later:

CAUTION: "FIRE EXT -CHECK" SWITCH CAN BE SET AT NEUTRAL POSITIONONLY 30s LATER AFTER THE FIRE BOTTLE DISCHARGED.

(9) Set "FIRE EXT-CHECK" switch at neutral position, then at "FIRE EXT" position;

Check the fire signal light, if it is still on:

(10) Press down "STBY FIRE EXT" button;

(11) Descend and land aircraft as soon as possible.

1.18.2 Quick Reference Handbook (QRH)

MA60 **QRH chapter 1.2**

For all control operation, the pilot responsibility stated in the following is suitable. Pilot flying (PF) should perform aircraft controlling in whole operation procedure.

PF will responsible for:

——PL

——Flight path and airspeed control

——Aircraft configuration

——Navigation

PM will responsible for

——Checklist reading

——Perform required action

——CL

——Communication

——Operating top control panel.

Checklist indicating engine shutdown, must be assessed by the captain to determine whether an actual shutdown or operation at reduced power is the safest course of action. In this situation, it must consider probable affection caused by engine rotation at min. required power.

For checklist which contains memory items or memory and reference items combined together, PM should firstly verify each memory item has been completed, during verification, usually PM should read these checklist loudly, but PF does not need to respond except for items that are not in agreement with the checklist. But during verify the abnormal checklist about landing, PF must verify and answer checklist items.

Engine Fire

Condition: Fire is detected in the related engine. Red warning characters ENGFIRE on the integrated warning light box illuminate, and the main warning light on the integrated warning light box flashes. it means there is fire in the related engine.

■ *In-flight operation procedure*

If the engine catches the fire after V1, complete the in-flight operation procedure of engine fire after the aircraft shall be in 400 ft of the flight altitude or above obstacle clearance height and the aircraft STATES is stable.

Power lever (engine fire)·····F.I

Condition lever (engine fire) ·····FEATHER position, then pull to CUT OFF position

Fuel shutoff switch (engine fire) ····· Off

First fire extinguishing button ····· Press down

CAUTION: THE FIRE EXT ─CHECK SWITCH SHALL NOT BE PUT AT NEUTRAL POSITION UNTIL THE FIRE-EXTINGUISHER BOTTLE SPRAYS 30 SECONDS LATER.

Fuel EMER electrical pump (engine fire) ····· Off

Ignition in flight switch (engine fire) ·····OFF

Bleed shutoff switch (engine fire) ·····OFF

Hydraulic shutoff switch (engine fire) ····· Off

Check the group □ yellow signal light has gone out.

30 s later :

FIRE EXT ─CHECK switch ·····

····· In neutral, then put at FIRE EXT position

If fire signal light still illuminate, press second fire extinguishing button.

Check the group □ yellow signal light has gone out.
Transponder mode selector ·····TA mode
Plan to land at the nearest suitable airport.
Do "Engine Failure or Shutdown" checklist when it is in proper time.

1.19 Useful or Effective Investigation Techniques

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

2. ANALYSIS

2.1 The Location / Origin of Fire

Fire initiated from the lower part of the cowling in front of the partition between hot and cold section of the engine number 1 where the fuel leak accumulated at that location. The fire moved upward crossing the frame bulkhead to the hot section.

2.2 The Occurrence of Fuel Leak

During an inspection after the incident, the location of fuel leak was indicated at a tube and fitting which was found wet. The fuel leak was confirmed during cold cranking in which droplets of fuel leak observed at that location. The amount of fuel leak during cold cranking was also measured, i.e. 21 droplets per minute.

During take-off the fuel pressure is much higher than during cold cranking. Therefore the fuel leak might be much larger during take-off and climb stage.

The FDR revealed that the fuel flow difference reached up to 150 pph (pound per hour), or equivalent to 2.5 lbs/minute. During takeoff, the takeoff power was applied for approximately 2 minutes; therefore the fuel leak on the bottom of the engine contained approximately 5 lbs of fuel.

Some part of the leaking fuel evaporated, and in the elevated temperature environment approaching the flash point a self-ignition could occur.

The FDR showed that the fuel flow difference between the engine number 1 and number 2 occurred already since the 9th flight before the incident flight with similar pattern of plots. The quantity of fuel flow difference increasing. The gradually increase of fuel leak indicated that indeed it was a leak that typically caused by mechanical loosening.

2.3 The Identification of Engine Fire and Pilot Executions

Based on CVR the sequent of events with reference time of the engine fire warning activation can be summarized as follows:

After the engine fire warning activated, both pilots have discussion of the event.

44 seconds: the pilot called the flight attendant to ask the engineer to come to cockpit.

1 minute: the engineer entered the cockpit and informed that the fire was observed on the left engine.

1:16 seconds: the propeller feathered.

1:35 seconds: the PIC decided to RTB.

1:51 seconds: the engine fire extinguisher bottle was discharged.

2:15 seconds: Engine shut down actions were performed

2:36 seconds: Before landing checklist reading

2:46 seconds: Engine failure shut down checklist reading

4.33 seconds: Engine fire extinguisher shot two

5:21 seconds: The engine fire warning light still illuminates

5.32 seconds: One engine drift down checklist reading

In this incident there was uncertainty in identifying the occurrence of fire. The fire warning was not immediately considered as the highest degree of warning. There was lengthy discussion between the pilots before a decision was made. This situation might arise from the fire warning that was not immediately perceived as engine fire. The pilot performed fire drill after the engineer informed that the fire on the left engine was visually observed.

1.16 seconds after the engine fire warning activated, the propellers were feathered. The FDR recorded drop in engine torque. 35 seconds after propeller feathered, the extinguisher bottle was discharged and followed by the fuel cut off. The FDR recorded the fuel flow was zero. The sequence of pilot actions were not accordance to the procedures stated in the FCOM and QRH.

Discharging the fire extinguisher before shutting down the fuel supply would certainly un-effective to extinguish the fire.

The incorrect sequence of the pilot actions indicated that the fire drill was not well pattern memorized. Schemata or mental model is a representation of the structure and operation of a system. Mental models are developed largely through experience, regular training and active interaction with the environment. The incorrect sequence could have been a result of insufficient pilot training, most specifically in in-flight engine fire.

2.4 Cockpit Resources Management (CRM) Perspective

After the activation of the engine fire warning, there was lengthy discussion between pilots related to the occurrence. The delay of the pilot action had prolonged exposure the risk of the fire and jeopardize to the safety of the flight.

The CVR revealed that during the execution of the fire drill the PF focused on the flight without cross check to the fire drill. In other hand, while the PF briefed of the intention of the flight, the PM focused on the checklist reading. This indicated there was lack of crew coordination. The commandership of the PIC most likely insufficient to manage the crew coordination, this might due to the SIC was older.

The conversation recorded from the CVR shown that the PM and PF action did not show check and recheck philosophy.

According to the job distribution stated in the QRH chapter 1.2, the PF is responsible to the progress of the flight while the PM responsible to the checklist execution.

Furthermore the QRH stated*: For checklist which contains memory items or memory and reference items combined together, PM should firstly verify each memory item has been completed, during verification, usually PM should read these checklist loudly, but PF does not need to respond except for items that are not in agreement with the checklist. But during verify the abnormal checklist about landing, PF must verify and answer checklist items.*

The QRH stated that the PM should read the checklist, but the PF does not need to respond. This procedure might lead to omission of the PF to monitor the checklist execution as there is no requirement for respond. The procedure does not reflect a check and recheck philosophy.

3. CONCLUSIONS

3.1 Findings

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 aircraft was within the correct weight and balance limitation.
4. The PIC acted as pilot flying since the engine fire warning illuminated.
5. A fuel leak occurred at a fuel line fitting located under the fuel flow transmitter.
6. The fuel line fitting attached to the fuel flow transmitter was originally installed by the aircraft manufacturer was found un-properly tightened although the locking wire was still in place.
7. The sequence of the pilot actions was not accordance with the procedures; the fire extinguisher bottle was discharge before the fuel has been cut off.
8. The incorrect sequence could have been a result of insufficient pilot training, most specifically in in-flight engine fire.
9. The communication was not effective between pilots (CRM).
10. The coordination between pilots during the emergency phase did not show the check recheck philosophy.
11. The unnecessary conversation recorded on the CVR between pilots since the horn activated.

3.2 Contributing Factors[3]

The fire on the left engine was due to fuel leak on the fuel line fitting which was improperly tightened.

The delay of the pilot action had prolonged exposure the risk of the fire and jeopardize to the safety of the flight.

3 "Contributing Factors" is defined as events that might cause the occurrence. In the case that the event did not occur then the accident might not happen or result in a less severe occurrence.

4. SAFETYACTION

At the time of issuing this draft final investigation report, the Komite Nasional Keselamatan Transportasi (KNKT) has been informed of safety actions resulting from this occurrence.

4.1 PT. Merpati Nusantara Airlines

Immediately after investigation the KNKT held a post briefing. One of the recommendations to the operator is to perform or to check the possibility of fuel leak.

PT. Merpati Nusantara had performed one time inspection to observe any fuel leak on MA60 fleet. Engineering Instruction issued no. MA60/S72-00-11068R1 on 13 December 2011: concerning inspection on engine PW127J and Engineering Instruction no. MA60/S73-31-11069 issued on 16 December 2011: concerning inspection on the fuel flow transmitter.

4.2 Xi' An Aircraft Manufacturer

Xi' An aircraft manufacturer published:

1. Service Bulletin MA60-73-SB293, requiring operators to check the installation and connecting of fuel and oil lines in engine nacelle for all aircraft in services, eliminating pipeline loosen risks caused by installation or environment. Check result show the torque of the pipe connectors is satisfied with requirement of torque and no fuel leakage was found.
2. Service Bulletin MA60-73-SB302, requiring operators to perform torque requirement during the replacement of engine fuel flow meter. The measures above can eliminate hidden danger of non-properly installed plumbing.

5. SAFETY RECOMMENDATIONS

As a result of the investigation, the Komite Nasional Keselamatan Transportasi (KNKT) issues the following recommendations:

5.1 PT Merpati Nusantara Airlines

The Komite Nasional Keselamatan Transportasi (KNKT) recommends to the PT. Merpati Nusantara Airlines should:

- Review the pilot training syllabus to ensure the standard qualification.
- Emphasize the Crew Resources Management (CRM) training to improve the communication, role play and commandership.

5.2 Xi'An Aircraft Manufacturer

The Komite Nasional Keselamatan Transportasi (KNKT) recommends to the Xi'An Aircraft Manufacturer to review the operation procedures to include check and recheck philosophy.

5.3 Directorate General of Civil Aviation

The Komite Nasional Keselamatan Transportasi (KNKT) recommends to the Indonesia Directorate General of Civil Aviation should review the policy in approving training syllabus ensure the standard qualification.

6. APPENDICES

6.1 “Emergency Procedure” and “Non Normal Procedure” in QRH

OPERATIONAL PHYLOSOPHY

“Emergency Procedure” are the procedure for emergency situations in which it is required that crew decide and take action immediately to protect the aircraft and its occupants from serious harm by the use of special or conventional system or techniques. They are critical elements for ensuring continuous safe operations of aircraft in emergency situations of flight and serious system failures.

A checklist prescribing engine shutdown must be evaluated by the captain to determine whether an actual shutdown or operation at reduced power is the safest course of action. It must consider probable effects if the engine is operated at the minimum needed power.

For a checklist with memory items or with a combination of memory items and reference items, the pilot monitoring (PM) first verifies that each memory item has been done. The checklist is normally read aloud during this verification. The pilot flying (PF) does not need to respond except for items that are not in agreement with the checklist items and give responses accordingly.

The checklist title and reference items, including the response or action as well as any amplifying information, are read aloud by the pilot monitoring (PM) as much of the condition statement as needed to verify that the correct checklist has been selected. The pilot flying (PF) does not need to repeat this information but must acknowledge that the information was heard and understood. The pilot flying (PF) or the pilot monitoring (PM) takes action based on each crewmembers area of responsibility. With the aircraft stationary on the ground, the captain as pilot flying and the first officer as pilot monitoring take action based on preflight areas of responsibility.

Before moving the critical control surfaces in flight, both crewmembers must agree before action is taken for:

- An inoperative engine power lever;
- A condition lever;
- An engine, APU or cargo fire switch;
- A generator drive disconnect switch;
- A flight control switch;

These do not apply to both engines shutdown checklist.

The pilot flying (PF) may also direct reference checklist to be done by memory if no hazard is created by such action, or if the situation does not allow reference to the checklist.