KOMITE NASIONAL KESELAMATAN TRANSPORTASI
REPUBLIC OF INDONESIA

FINAL

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Aircraft Accident Investigation Report

Merpati Pilot School

Cessna 172; PK-MSN

Trunojoyo Airport, Sumenep East Java

Republic of Indonesia

19 September2014

2016

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 Organization, the Indonesian Aviation Act (UU No. 1/2009) and Government Regulation (PP No. 62/2013).

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ABBREVIATIONS AND DEFINITIONS

AAIP	:	Approved Aircraft Inspection Program
AFIS	:	Aerodrome Flight Information Service
ARFF	:	Airport Rescue and Fire Fighting
ASTM	:	American Society for Testing Materials
C of A	:	Certificate of Airworthiness
C of R	:	Certificate of Registration
°C	:	Degrees Celsius
DGCA	:	Directorate General of Civil Aviation
FAA	:	Federal Aviation Administration
ICAO	:	International Civil Aviation Organization
km	:	Kilometer
KNKT	:	Komite Nasional Keselamatan Transportasi (National Transportation Safety Committee)
m	:	Meter
MPS	:	Merpati Pilot School
PPPTMGB	:	Pusat Penelitian dan Pengembangan Teknologi Minyak dan Gas Bumi (Development and Research Center of Natural Oil and Gas)
SPL	:	Student Pilot License
STC	:	Supplement Type Certificate
TBO	:	Time Between Overhaul
UTC	:	Universal Time Coordinated
VHF	:	Very High Frequency

INTRODUCTION

SYNOPSIS

On 19 September 2014, a Cessna 172 aircraft registration PK-MSN was being operated by Merpati Pilot School (MPS). The aircraft performed a training solo flight from Trunojoyo Airport, Sumenep to Puteran Training Area and return to Trunojoyo for conducting touch and go flight.

There was no report of aircraft abnormalities during the flight in Puteran training area until the first touch and go. When conducting the second touch and go, just after airborne the Trunojoyo AFIS officer stated that the pilot declared Mayday and acknowledged by the Trunojoyo AFIS officer.

The Trunojoyo AFIS officer stated that while reporting emergency situation, the aircraft was approximately on altitude 400 feet and turned to the right. The right wing tip hit the ground first followed by the nose and fuselage. The aircraft crashed on paddy field at approximately 500 meters from the end of runway 12.

The student pilot was fatally injured and the aircraft was substantially damage.

The safety issues identified on this report were associated to the engine performance inspection and emergency landing training.

The investigation determined the contributing factors was the instantaneous and explosive burning of the fuel/air mixture had led to detonation and caused the engine ran in a degraded performance significantly. Such situation required a proper flying skill and judgment however, the actions deferred when facing to that particular critical condition.

At the time of issuing this report, the Komite Nasional Keselamatan Transportasi had been informed of safety actions resulting from the Merpati Pilot School. While the KNKT acknowledges the safety actions taken by the Merpati Pilot School, there still remain safety issues that need to be considered.

As a result of this investigation, the KNKT issued safety recommendations to address safety issues identified in this report to the Merpati Pilot School and Directorate General of Civil Aviation.

1 FACTUAL INFORMATION

1.1 History of the Flight

On 19 September 2014, a Cessna 172 aircraft, registered PK-MSN was being operated by Merpati Pilot School (MPS) on solo area training exercise from Trunojoyo Airport, Sumenep to Puteran Training Area.

At 1238 LT (0538 UTC[1]), the student pilot made first contact with the Trunojoyo Aerodrome Flight Information Service officer (Trunojoyo AFIS), requested to perform a solo area training exercise to Puteran Training Area with altitude of 2,000 feet.

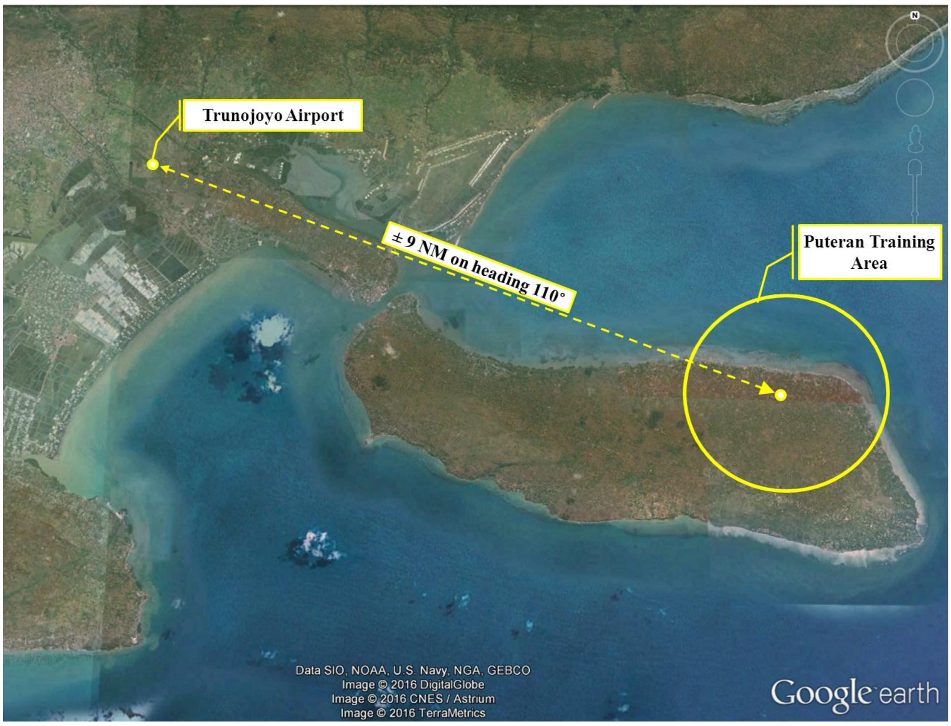

Figure 1: Trunojoyo Airport & Puteran Area

At 0539 UTC, the student pilot started the engine and at 0540 UTC taxied to runway 12.

At 0545 UTC, the aircraft took off and reached Puteran Training Area at 0549 UTC. There was no report of aircraft abnormality during the flight.

At 0612 UTC, the student pilot reported performing a normal operation.

At 0627 UTC, the student pilot reported leaving Puteran Area and advised by Trunojoyo AFIS to join downwind runway 12. The student pilot then informed the intention to perform touch and go exercise.

The first touch and go was performed without abnormality and the pilot informed to conduct the second touch and go.

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

At 0640 UTC, while conducting the second touch and go, the Trunojoyo AFIS officer stated that the student pilot declared Mayday and the Trunojoyo AFIS acknowledged the emergency situation. The Trunojoyo AFIS stated that while reporting emergency situation, the aircraft was approximately at altitude 400 feet, turned to the right then went down and disappeared from the vision. The aircraft crashed on paddy field approximately 500 meters from the end of runway 12.

The eyewitnesses who stayed close to the crash site stated that they heard an engine sound but unsure it was a normal or an abnormal engine sound.

The student pilot was fatally injured and the aircraft was substantially damaged.

Figure 2: The typical Cessna 172 of Merpati Pilot School

1.2 Injuries to Persons

Injuries	Flight crew	Passengers	Total in Aircraft	Others
Fatal	1	-	1	-
Serious	-	-	-	-
Minor/None	-	-	-	N/A
TOTAL	1	-	1	-

1.3 Damage to Aircraft

The aircraft was substantially damaged.

Figure 3: The accident aircraft

1.4 Other Damage

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

1.5 Student Pilot Information

Gender	:	Male
Age	:	21 years
Nationality	:	Indonesia
Marital status	:	Single
License	:	Student Pilot License
Date of issue	:	18 August 2014
Aircraft type rating	:	Cessna 172
Medical certificate	:	Second Class
Last of medical	:	18 August 2014
Validity	:	17 August 2015
Medical limitation	:	Holder shall wear corrective lenses
Flying experience		
Total hours	:	67.28 hours
Total on type	:	67.28 hours
Last 90 Days		32.15 hours
Last 60 Days		22.00 hours
Last 24 Hours		1.01 hours
This flight	:	1.01 hours

The student pilot training record showed that:

The student pilot was trained at another flying school on 2013 with approximate 19 flying hours on Cessna 172 without experience on solo flight.

The first flight on Merpati Pilot School was on 30 April 2014.

The student pilot was released for first solo flight on 21 May 2014 with total flying hour of 10 hours, and performed solo flight for 20 minutes.

On 22 May 2014, the student pilot conducted a flight with instructor and there were several remarks noted by the instructor associated with speed control and landing techniques. On 23 May 2014, the student performed another flight with the instructor and released for the second solo with several remarks similar to the previous flight.

The force landing exercise performed on 5 May and 15 July 2014, there were remarks related to the improper flight technique and incorrect field selection. There was no recorded corrective action performed by the instructor related to the remarks.

The summary of the training records indicated repetitive similar remarks, which were associated with the flight techniques and procedures such as discipline of speed, approach and landing flare out judgment as well as the concentration while doing the tasks.

1.6 Aircraft Information

1.6.1 General

Registration Mark	:	PK-MSN
Manufacturer	:	Cessna Corps
Country of Manufacturer	:	United States of America
Type/ Model	:	Cessna 172P
Serial Number	:	17274909
Year of manufacture	:	1981
Certificate of Airworthiness		
Issued	:	09 December 2013
Validity	:	08 December 2014
Category	:	Normal
Limitations	:	VHF Communication Coverage Only
Certificate of Registration		
Number	:	2659
Issued	:	08 December 2013
Validity	:	08 December 2016
Time Since New	:	4,945 hours 57 minutes
Cycles Since New	:	7,543 cycles
Last Major Check	:	3 July 2014 (200 hours inspection)

Last Minor Check	:	19 September 2014 (Daily / Pre-flight Inspection)

1.6.2 Engines

Manufacturer	:	Textron Lycoming
Type/Model	:	Lycoming 0-320-D2J
Serial Number	:	L-11122-39A
▪ Time Since New	:	4,945 hours 57 minutes
▪ Cycle Since New	:	1,004 cycle (since major overhaul)

1.6.3 Propellers

Manufacturer	:	Mc. Cauley Propeller System
Type / Model	:	1C 160 DTM 7557
Serial Number Propeller #1	:	83241
▪ TSN	:	5,046 hours 07 minutes

1.6.4 Aircraft and Engine Inspection

The MPS Cessna 172 Approved Aircraft Inspection Program (AAIP) that covered the aircraft and Lycoming engine consist of scheduled inspection 50 hour, 100 hour, 200 hour, Annual Inspection and Special Inspection. The Time Between Overhaul (TBO) stated in this AAIP was 2,000 hours.

Every 50 hours, the spark plug was visually inspected and cleaned.

1.7 Meteorological Information

The weather reported by the Trunojoyo Aeronautical Flight Information Service (AFIS) officer was fine with the wind condition of 080° / 15 knots, temperature 35°C and the visibility was more than 10 km.

1.8 Aids to Navigation

Ground-based navigation aids / onboard navigation aids / aerodrome visual ground aids and the serviceability were not factors in this occurrence.

1.9 Communications

All communications between AFIS officer and the crew were recorded by ground based automatic voice recording equipment for the duration of the flight. The quality of the aircraft's recorded transmissions was good.

1.10 Aerodrome Information

Airport Name	:	Trunujoyo Airport, Sumenep
Airport Identification	:	WART
Airport Operator	:	Directorate General of Civil Aviation
Airport Certificate	:	004/SBU-DBU/IX/2014

Coordinate	:	107°01’24.93’’S; 113°53’27.13’’E
Elevation	:	10 feet
Runway Direction	:	12 – 30
Runway Length	:	905 meters
Runway Width	:	23 meters
Surface	:	Asphalt

1.11 Flight Recorders

The aircraft was not fitted with a flight data recorder or cockpit voice recorder. Neither recorder was required by current Indonesian aviation regulations.

1.12 Wreckage and Impact Information

The aircraft crashed on paddy field at approximately 500 meters from the end of runway 12 on coordinate 07°1’51’’S; 113°53’45’’E.

The area along the extension of runway 12 was mostly flat up to 1,000 meters in a corridor of 45° to the left and right of the runway extension.

Based on the observation, the right wing tip hit the ground first and followed by the nose and fuselage, and there was a ground mark towards the main wreckage (figure 4).

The right wing, right main wheel and nose wheel detached and found in different location with the main wreckage. The debris spread along 60 meters on approximate direction of 170°. One of the propeller blades bent backward. The detail of the wreckage distribution can be seen on figure 8.

Figure 4: The ground mark towards main wreckage

Figure 5: The wreckage distribution

Figure 6: The main wreckage

Figure 7: The propeller blade bent backward

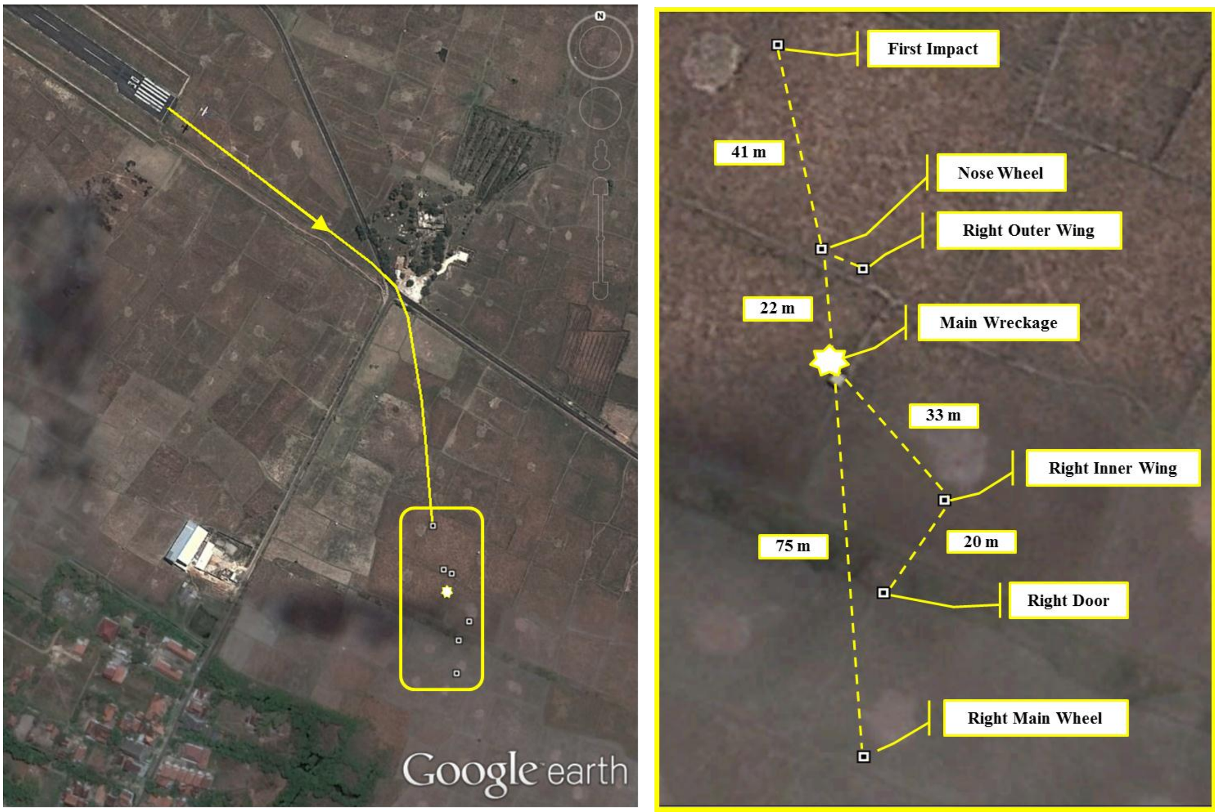

Figure 8: The predicted flight path and aerial view of wreckage distribution

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

There was no evidence of pre or post impact fire.

1.15 Survival Aspects

A few minute after the aircraft crashed, the Airport Rescue and Fire Fighting (ARFF) and local people evacuated the pilot to the Trunojoyo Hospital. The student pilot was not survived in this accident.

1.16 Tests and Research

1.16.1 Fuel Test

On 11 October 2014, the Merpati Pilot School conducted fuel test of samples of fuel taken from the fuel storage of the Merpati Pilot School. The test conducted at Pusat Penelitian dan Pengembangan Teknologi Minyak dan Gas Bumi/PPPTMGB (Development and Research Center of Natural Oil and Gas) laboratory.

The fuel types being tested were Avgas 100%, Shell VPower, premixed fuel of 25% Avgas + 75% Shell VPower and premixed fuel of 40% Avgas + 60% Shell VPower. The tests were based on American Society for Testing Materials (ASTM) D 2699 and ASTM D 2700 to determine the value of Octane Research and Octane Motor.

The test result were as follows:

No	Test Type	Unit	Test Result		Test Method
			Avgas 100%	Shell VPower	
1.	Value of Oktana Riset	-	102.0	97.3	ASTM D 2699
2.	Value of Oktana Motor	-	88.1	86.2	ASTM D 2700

No	Test Type	Unit	Test Result		Test Method
			Premixed fuel of 25% Avgas + 75% Shell VPower	Premixed fuel of 40% Avgas + 60% Shell VPower	
1.	Value of Oktana Riset	-	100.3	100.4	ASTM D 2699
2.	Value of Oktana Motor	-	88.5	88.7	ASTM D 2700

Refer to Supplement Type Certificate (STC) number 3O8/832-22OO, the engine Lycoming 0-320-D2J required the minimum octane number of 91.

According to Bhasin (2010) on IOWA research online[2] regarding the posted octane number is calculated by (R+M)/2.

The test result shows that the octane number for premixed avgas: VPower (3:1) was (100.3+88.5)/2 = 94.4 and for premixed 4:6 was (100.4 + 88.7)/2 = 94.55.

2 Bhasin, A. (2010). *Method for determination of octane rating by flame quenching experiments*. University of Iowa, 2010. The document can be found at http://ir.uiowa.edu/etd/782

1.16.2 Piston Inspection

An engine tear down inspection was performed at the Merpati Maintenance Facilities by the KNKT investigators. The engine tear down revealed that there were signatures of overheating on the piston crown.

The further inspection was conducted at the Laboratory of Metallurgy, Institute of Technology Bandung. The inspection revealed that the pistons of number 1 and 3 cylinders were found locally melted at its cylinder head (figure 9 and 10).

Figure 9: Piston number 1

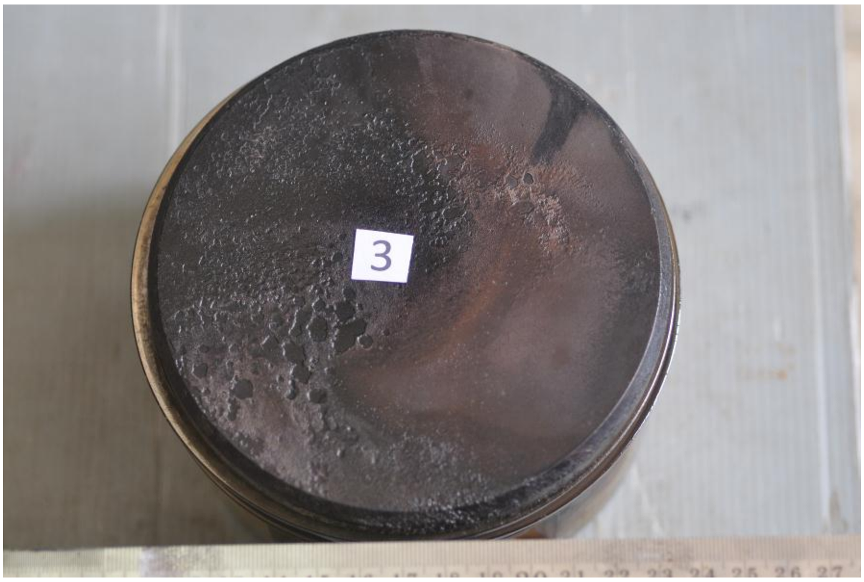

Figure 10: Piston number 3

Metallographycal examinations were performed on two locations near and far from the melted zone. Several micrographs are shown as follows:

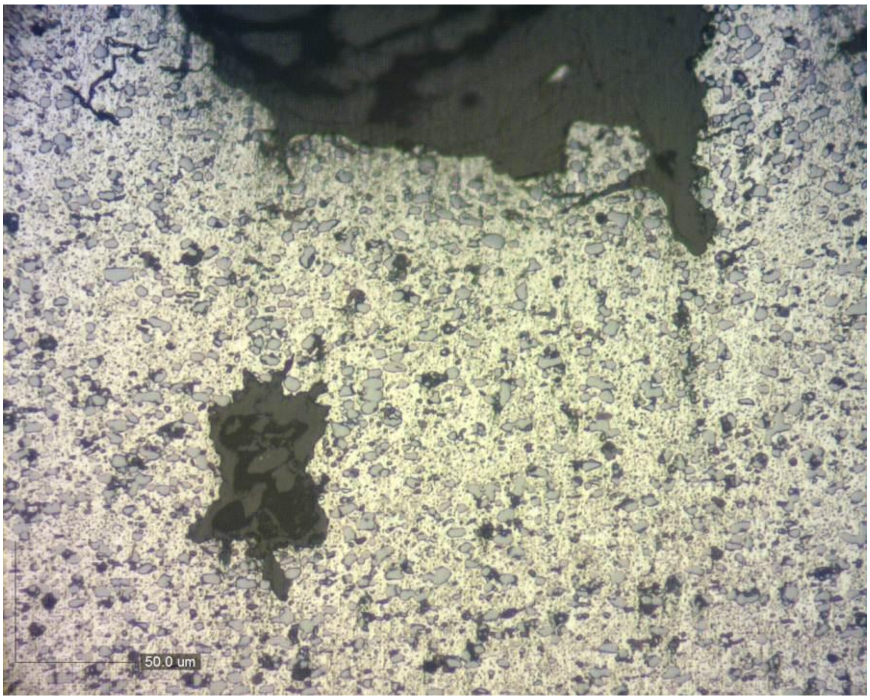

Figure 11: Microstructure nears the melted zone; the depth of structure change is approximately 50 µm

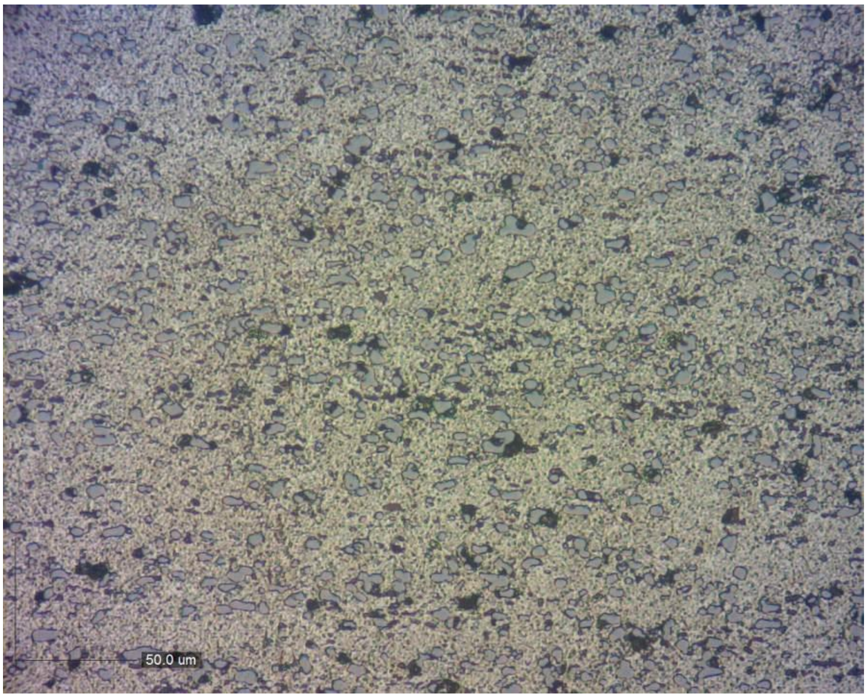

Figure 12: Microstructure at about 3 cm from the melted zone

The microstructure change is 50 µm from the melted zone. It indicates that the process of overheating was in a relatively short time, probably in the order of minutes.

The origin of overheating is most probably due to detonation.

The piston showed a significant carbon deposit and scrubbing action. Theoretically referred to FAA Powerplant handbook volume 1, carbon deposit can build up on the cylinder due to the incomplete combustion within the engine cylinder. The carbon deposit may lead to misfiring. This condition similar to early timing of spark plug or pre-ignition where the charge in the cylinder is ignite before required time for normal engine firing. This combination of pre-ignition with the incorrect fuel mixture and/or fuel octane quality will ignite spontaneously and burn with explosive violence that leads to detonation.

Detonation is the spontaneous combustion of the unburned charge ahead of the flame fronts after ignition of the charge. The explosive burning during detonation results in an extremely rapid pressure rise. This rapid pressure rise and the high instantaneous temperature, combined with the high turbulence generated, cause a scrubbing action on the cylinder and the piston. This can burn a hole completely through the piston.

The results of engine tear down and metallurgical examination revealed in the following points:

- The engine failure was due to detonation;
- The duration of overheating is in the order of minutes.

1.17 Organizational and Management Information

Aircraft Owner	:	PT. Merpati Nusantara Airlines
Address	:	Jl. Angkasa Blok B.15 Kav 2-3 Jakarta 10720
Aircraft Operator	:	Merpati Pilot School
Address	:	Jl. Juanda International Airport Surabaya 61253
Certificate Number	:	OC 141/006

1.17.1 The MPS Pilot School Procedure Manual

3.12.5. EMERGENCY (Forced landing)

Below 1000 ft

1. *Fly A/C or push flight control fwd for gliding attitude*
2. *Clean configuration: gears up & flaps up*
3. *Check gliding speed: 70 KIAS*
4. *Trim the A/C*
5. *Select the field 45° left & right*
6. *Call MAYDAY 3X*
7. *Check for cause:*

   Ignition .... Both

   Master switch .... On

   Carburetor heater .... Off

   Mixture .... Full rich

   Fuel valve .... On/both

8. *Secure the engine:*
   Ignition .... Off
   Master switch .... Stand by (for flaps & radio)
   Mixture .... Idle cut off
   Fuel valve .... Off

3.12.8 EMERGENCY PROCEDURE
DURING TAKE-OFF
(Just After Airborne)

A. *Engine fails*
   1. *Decide to land again*
   2. *Close throttle smoothly*
   3. *Maintain heading or keep straight*
   4. *Apply brake if necessary, till the A/C stops*
   5. *Complete the "final check list"*
   6. *Call tower and explain the trouble*
   7. *Cancel the flight*

The other procedure related to the engine failure was stated in cockpit briefing exercise as follows:

3.12.12 COCKPIT/BRIEFING EXERCISES
TAKE-OFF BRIEF

1. *Take-off from left hand seat, for static or normal T/O*
2. *Check unstick speed (Vr)*
3. *If anything malfunction before Vr, I will abort take-off:*
   - *close throttle*
   - *max brake*
   - *out of R/W*
   - *call ATC for cancellation of departure*
4. *Engine malfunction after airborne*
5. *If enough R/W continue landing*
6. *If out of R/W, continue for T/O*
7. *Malfunction at 500 ft*
8. *I will fly A/C check 45° L/R select the field execute force landing*
9. *Malfunction at 1000 ft RTB to join down wind Execute emergency landing*
   TAKE-OFF BRIEF COMPLETED, ANY QUESTION?

1.17.2 Cessna 172S Information Manual

PERFORMANCE – SPECIFICATIONS

RATE-OF-CLIMB AT SEA LEVEL ....730 FPM

TAKEOFF PERFORMANCE:

Ground Roll .... 575 FEET

Total Distance Over 50 Foot Obstacle.................................. 1630 FEET

The above performance figures are based on airplane weights at 2550 pounds, standard atmospheric conditions, level, hard-surfaced dry runways and no wind. They are calculated values derived from flight tests conducted by Cessna Aircraft Company under carefully documented conditions and will vary with individual airplanes and numerous factors affecting flight performance.

1.17.3 The MPS Approved Aircraft Inspection Program (AAIP)

Refer page 12 of AAIP:

3) Mixing Fuel Mogas and Avgas (3:1)

i. *Prepare non contaminated empty drum.*
ii. *Perform checks on the fuel before it is mixed with the color code gel in anticipation of water contamination.*
iii. *Fill 75% (150 liters) Mobile unleaded gasoline (Mogas)*
iv. *Add with 75% (50 liters) 100 LL (Avgas).*
v. *Blend smooth (at least 50 times) using pump Fuel.*

Close the filling hole and hole measurements.

1.18 Additional Information

1.18.1 General information on Detonation

Referred to Glencoe Aviation Technology Series, Aircraft Powerplants; seventh edition by Michael J. Kroes and Thomas W-Wild page 56.

Detonation is caused when the temperature and pressure of the compressed mixture in the combustion chamber reach levels sufficient to cause instantaneous burning (explosion) of the fuel-air mixture. Excessive temperatures and/or pressures can be caused by several different engine parameters, such as high inlet-air temperature, insufficient ignition timing, excessively lean fuel-air mixture, and excessive compression ratio. Their relationship to detonation is shown with regard to cylinder pressure and temperature.

A principal cause of detonation is operation of an engine with either a fuel whose octane rating is not sufficiently high for the engine or a high-combustion-rate fuel. A high-octane fuel can withstand greater temperature and pressure before igniting than can a low-octane fuel. When detonation occurs, the fuel-air mixture may burn properly for a portion of its combustion and then explode as the pressure and temperature in the cylinder increase beyond their normal limits.

Detonation will further increase the temperature of the cylinders and pistons and may cause the head of a piston to melt. Detonation will generally cause a serious power loss. Instead of the piston received a smooth push, it gets a very short high-pressure push, much like the head of the piston being hit with a hammer. This high-pressure push occurs too quickly to be absorbed by the piston, with the result being a loss of power.

Detonation will result whenever the temperature and pressure in the cylinder become excessive. A very lean mixture will tend to burn at slower rate than will a rich mixture, allowing the cylinder to be subjected to high temperatures for a longer time than usual. If this condition is not corrected, the cylinder temperature will continue to climb until detonation occurs. Detonation can also be caused by excessive intake air temperature. This condition can be caused by the carburetor heat during high-power settings of the engine or excessive supercharging Detonation cannot generally be detected in an aircraft engine as easily as pre-ignition.

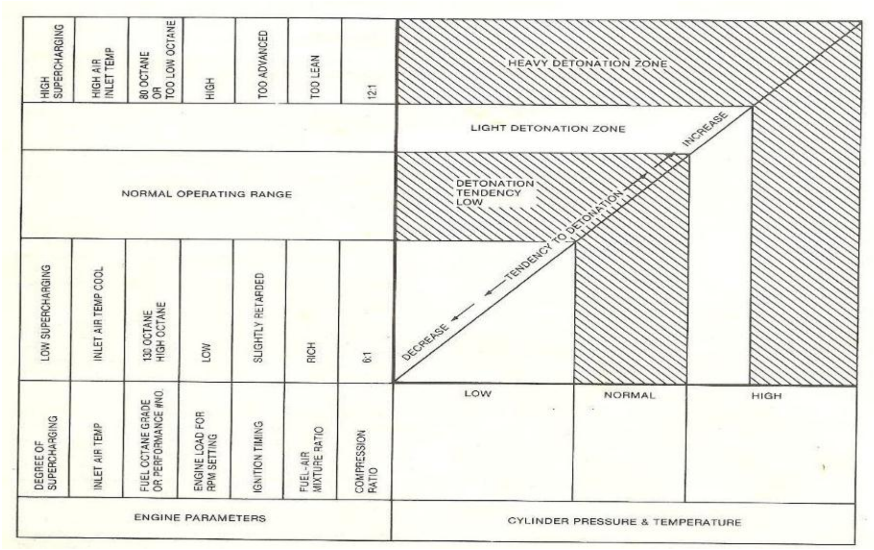

Figure 13: Factor that effect of detonation

1.18.2 Other Cases of Detonation

There were other cases of detonation reports compiled by KNKT mentioning several occurrences caused by detonation:

1. Between 2010 and 2011, six aircraft involved 30 pistons damaged using mogas, and one accident involved aircraft that used mogas.
2. In 2012, an engine was reported to have two pistons melted.
3. In 2013, there were six aircraft reported of having damage on the pistons and one was involved in an accident. The accident was investigated by KNKT and found that the engine pistons head burn, melted and scratched indicated of the hot operation resulting by a high temperature, detonation that resulted by the in-sufficient fuel air mixture.

Following the occurrences there was a policy change in the fuel use premixed fuel mogas and avgas with ratio 1:1, there was no detonation reported.

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

Based on the factual data gathered during the investigation, such as the signatures of overheating on the piston head and the spread out of aircraft debris over the paddy field, the analysis will therefore focus on two safety issues as follow;

- The engine quit after the aircraft airborne;
- The aircraft rolled to right.

2.1 Engine Quit After the Aircraft Airborne

At the crash site found that one of the propeller blades was bend half side backward. This indicated that the propeller was on slow rotation or stop when impacted to the ground.

The detail observation of the engine in the workshop and laboratory examination showed there were carbon deposits, scrubbed and melted locally on the pistons surface. The condition piston surface most likely was a result of the detonation.

The fuel octane quality have critical limit of temperature and compression. The combination of piston condition with the ambient temperature will lead ignition spontaneously and burn with explosive violence. This instantaneous and explosive burning of the fuel/air mixture will lead to detonation. The explosion causes the cylinder temperatures and pressures to spike very quickly. If this condition exists for very long, the engine can be damaged or destroyed.

The data of several pistons with similar condition showed that the engines degraded in performance and led to engine coughing.

The inspection to the damaged piston found a melted zone indicated the process of prolong overheat and damaged in order of minute.

The data of the damaged pistons of several operators involved several aircraft used mogas or premixed mogas and avgas that met the octane number requirement showed significant carbon deposit.

Mogas is categorized as leaded fuels. Using leaded fuels will always burn with more carbon deposits than unleaded fuels (avgas).

The carbon deposit may be detected during the spark plug inspection since the deposit may rest to the spark plug head. The borescope inspection method is sufficient to detect the carbon deposit on the piston surface during the spark plug inspection.

Following the occurrences, there was a policy change in the fuel use premixed fuel mogas and avgas with ratio 1:1, there was no detonation reported.

The instantaneous and explosive burning of the premixed fuel led to cumulated carbon deposit and caused the piston detonation made the engine running in degraded performance indicated by the propeller was on slow rotation or stop when impacted to the ground.

2.2 The Aircraft Rolled to the Right

As of the statement of Trunojoyo AFIS officer when on the second touch and go, the student pilot called "Mayday" when the aircraft altitude was approximately 400 feet, the aircraft turned to the right then went down and disappeared from the vision. The aircraft debris was found spread out over the flat and wide paddy field approximately 500 meters southeast from end of runway 12.

Examination to the spread out debris along 60 meters from the first impact mark at approximate direction of 170° and this trajectory was align with white surface land along the takeoff path (ref to the Google earth). Observation found that the part of right wing tip hit the ground first then followed by the nose wheel and the fuselage.

The Pilot School Procedure Manual stated that on the simulation of engine failure after take-off, the student pilot should maintain the aircraft heading or keep straight. The Emergency Procedure stated in the crew briefing, if the engine failure after the rotation speed (Vr) and out of runway, the student pilot should continue to fly the aircraft then select a clear and safest area within the 45° left or right of the take-off path to land the aircraft.

Refer to the training record concerning to emergency exercises, it showed that the student pilot experienced with the improper flight technique and wrong of field selection. However, there was no corrective action recorded by the instructor.

The aircraft was on touch and go and normally would be airborne at rolling distance less than normal take off compare to the normal take off distance to reach 50 feet above runway that requires approximately 500 meters according to the operation manual.

The total of runway length was 905 meters, and the distance from end of runway 12 to the white surface land was about 276 meters. Assuming the aircraft airborne at 500 meters from the beginning runway 12 therefore the distance since 50 feet to the white surface land was 681 meters. The white surface land was the predicted point when the aircraft started to turn.

Assuming the aircraft takeoff speed was 70 knots and rate of climb was 730 feet/minute, the aircraft would be over the white surface land at approximate altitude of 245 feet.

Assuming the aircraft engine failed at such altitude and the pilot flew the aircraft with the recommended gliding speed of 70 knots and rate of descend 500 feet/minute. Then the aircraft would impact the ground at approximately 29 seconds and at distance approximately 1,020 meters. The suitable area for emergency landing was available at this distance.

The illustration below was based on the known trajectory and the direction of the aircraft debris of 170°.

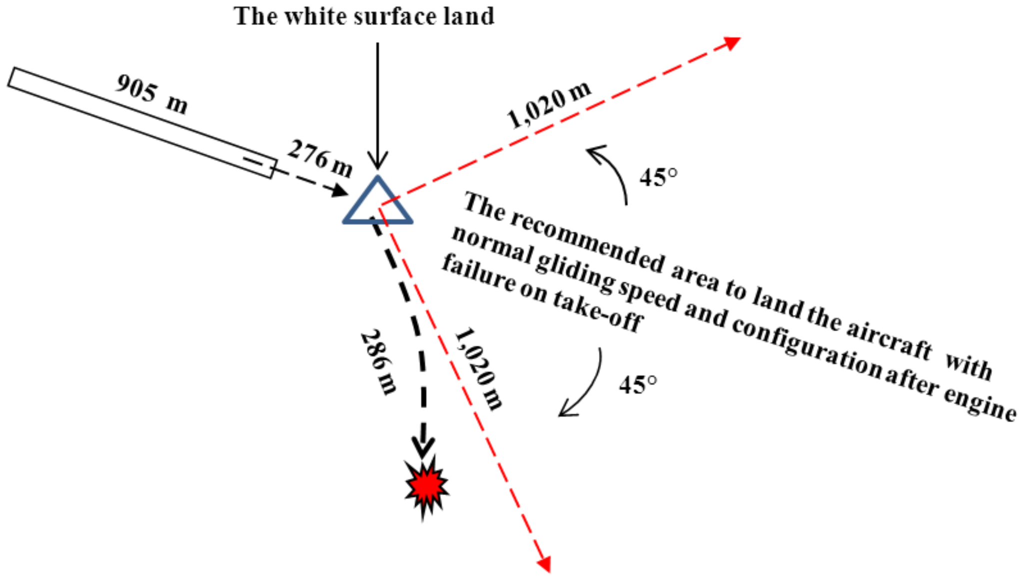

Figure 14: The expected trajectory and crash site

The investigation could not determine the actual altitude and position when the engine failed. However, based on the assumption of the normal takeoff distance and comparing with the eyewitness, the engine fail occurred between 245 feet to 400 feet.

The aircraft impact point was at 286 meters from the aircraft started to turn (white surface land) and out of the recommended area for emergency landing after takeoff. The aircraft initial impact point and the trajectory indicated that the aircraft rolled to the right and dive.

Referred to the training record, there were significant remarks related to the improper flight technique and wrong of field selection. There was no recorded corrective action performed by the instructor related to the remarks.

The impact point and trajectory indicated that the aircraft was uncontrolled that might be caused of the lack of flying skill and judgment when facing a critical situation.

3 CONCLUSIONS

3.1 Findings[3]

1. The student pilot held valid license and medical certificate.
2. The aircraft had valid C of A and C of R, there was no report or record of aircraft abnormalities prior to the accident.
3. The student was trained in other flying school in 2013 prior joined the Merpati Pilot School in 2014 with approximate 19 flying hours on Cessna 172 with no experience on solo flight. The student pilot was released for first solo flight on 21 May 2014.
4. The force landing training exercise performed on 5 May and 15 July 2014, there were remarks related to the improper flight technique and wrong of field selection. There was no recorded corrective action performed by the instructor related to the remarks.
5. When conducting the second touch and go, just after airborne the Trunojoyo AFIS officer stated that the pilot declared Mayday and acknowledged by the Trunojoyo AFIS officer. The aircraft was approximately on altitude 400 feet and turned to the right.
6. The aircraft crashed on paddy field at approximately 500 meters from the end of runway 12. The wreckage spread out to different location with approximate direction of 170° along 60 meters. One of the propeller blades was bend half side backward.
7. The student pilot was fatally injured and the aircraft was substantially damage.
8. The impact point and trajectory indicated that the aircraft was uncontrolled that might be caused of the lack of flying skill and judgment when facing a critical situation.
9. The detail observation of the engine in the workshop and laboratory examination showed there were carbon deposits, scrubbed and melted locally on the pistons surface. The condition piston surface most likely is a result of the detonation.
10. The instantaneous and explosive burning of the premixed fuel led to cumulated carbon deposit and caused the piston detonation made the engine running in degraded performance indicated by the propeller was on slow rotation or stop when impacted to the ground.
11. The data of the damaged pistons of several operators involved several aircraft used mogas or premixed mogas and avgas that met the octane number requirement showed significant carbon deposit.
12. Following the occurrences, some operators changed the fuel policy to use mixed fuel mogas and avgas with ratio 1:1, afterward there was no detonation reported.

3 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.

3.2 Contributing Factors[4]

- The instantaneous and explosive burning of the premixed fuel led to cumulated carbon deposit and caused the piston detonation made the engine running in degraded performance.
- The pilot emergency training was inadequate to provide sufficient skill and judgment to control the critical condition.

4 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 SAFETY ACTION

At the time of issuing this report, the Komite Nasional Keselamatan Transportasi had been informed of safety actions taken by the Merpati Pilot School.

The safety actions were as follows:

1. Performed one time inspection refers to task card of 200 hours Approve Aircraft Inspection Program (AAIP) for all aircraft.
2. Performed visual inspection on the cylinder kit (cylinder bore, piston ring, and piston head) to detect any possibilities of inappropriate function.
3. Documented the result of all inspection as the evidence.
4. Fueling all aircraft using avgas until the KNKT recommendation has been issued.

5 SAFETY RECOMMENDATIONS

As a result of this investigation, the KNKT issued safety recommendations to address safety issues identified in this report associated to engine performance inspection and emergency landing training.

The Directorate General of Civil Aviation is responsible to oversight the appropriate implementation of the recommendations addressed to the relevant parties.

KNKT acknowledged the safety actions taken by the Merpati Pilot School, there still remain safety issues that need to be considered. The KNKT issues the following safety recommendations:

5.1 Merpati Pilot School

- **04.O-2016-36.1**

  To review the engine maintenance inspection to include with related action required, whenever early identification of detonation is detected.

- **04.O-2016-37.1**

  To review the current method of assessing the student pilot to include corrective action in the case of the unsatisfied emergency exercise training.

5.2 Directorate General of Civil Aviation

- **04.R-2016-38.1**

  Based on the record of the detonation cases since 2010 on several operators indicate more than 30 pistons damaged and two accidents, therefore the KNKT recommends evaluation of premixed fuel include the engine maintenance performance inspection procedures.

- **04.R-2016-39.1**

  The recommendations addressed to Merpati Pilot School in this final report might affect to other operators (flying school), therefore KNKT recommends extending the recommendation to the other operators.

6 APPENDICES

6.1 Special Instruction of Merpati Pilot School

Merpati

MERPATI PILOT SCHOOL

SPECIAL INSTRUCTION
INSPEKSI DAN PEMAKAIAN FUEL
AFTER ACCIDENT PK-MSN

I. PRAKATA

Sehubungan dengan terjadinya Accident PK-MSN tgl. 19 September 2014 di Sumenep, maka dianggap perlu untuk melakukan beberapa korektif dan preventif prosedur.

II. INSTRUKSI PEKERJAAN

1. Lakukan one time inspection dengan task card 200 hours inspection program AAIP MPS pada semua pesawat MPS yang On Line.
2. Lakukan pengecekan secara visual pada cylinder kit, yaitu Cylinder bore, Piston Ring, dan Piston Head tentang kemungkinan terjadinya ketidaksesuaian.
   Dokumentasikan hasil pemeriksaan yang dilakukan sebagai evidence pekerjaan telah dilaksanakan.
3. Refueling pesawat MPS yang On line supaya menggunakan AVGAS murni (100%), sebelum ada rekomendasi resmi pemakaian fuel dari KNKT.
4. INSTRUKSI INI SUPAYA DILAKUKAN SECARA DISIPLIN DAN PENUH TANGGUNG JAWAB. TERIMA KASIH.

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