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KOMITE NASIONAL KESELAMATAN TRANSPORTASI

Aircraft Accident Investigation Report

PT. Aviasi Solusi Prima (Flybest Flight Academy)
Cessna 152; PK- KFC
8 Miles Radial 153 BTM VOR;
Batam, Riau Island
Republic of Indonesia
12 September 2013

KOMITE NASIONAL KESELAMATAN TRANSPORTASI
REPUBLIC OF INDONESIA
2014

This final report was produced by the Komite Nasional Keselamatan Transportasi (KNKT) 3rd Floor Ministry of Transportation, 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).

The draft final report consists of factual information collected until the final report published. This report includes analysis and conclusion.

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ABBREVIATIONS AND DEFINITIONS

AOC	:	Air Operator Certificated
AKI	:	Anti Knock Index
ATIS	:	Aerodrome Terminal Information Services
AVGAS	:	Aviation Gasoline
°C	:	Degrees Celsius
CAA UK	:	Civil Aviation Authority United kingdom
CAP	:	Civil Aviation Publication
CASR	:	Civil Aviation Safety Regulation
CEO	:	Chief Executive Officer
CPL	:	Commercial Pilot License
DGCA	:	Directorate General Civil Aviation
F/A	:	Fuel /Air
ICAO	:	International Civil Aviation Organization
IIC	:	Investigator in Charge
Km	:	Kilometer(s)
KNKT / NTSC	:	*Komite Nasional Keselamatan Transportasi* / National Transportation Safety Committee
Kts	:	Knot (s)
LT	:	Local Time
MOGAS	:	Motor Gasoline
NM	:	Nautical mile(s)
PF	:	Pilot Flying
PNF	:	Pilot Non Flying
POH	:	Pilot Operating Handbook
RPM	:	Revolutions per Minutes
UTC	:	Universal Time Coordinate
VFR	:	Visual Flight Rule
VOR	:	Very high frequency Omnidirectional Range
WIB	:	*Waktu Indonesia Barat* / Western Indonesian Standard Time

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INTRODUCTION

SYNOPSIS

On 12 September 2013 a Cessna 152 aircraft registered PK-KFC operated by PT Aviasi Solusi Prima (FlyBest Flight Academy) conducted a local flight training from Hang Nadim Airport, Batam. On board the aircraft were a student pilot who acted as Pilot Flying and a flight instructor who acted as Pilot Non Flying.

There was no abnormality in the aircraft system since the taxied out and took off at 23:50 UTC. During climbed to 1500 feet the student pilot increased the power and noted that the engine RPM was only 2,200 RPM, instead of 2500 RPM. Few moments later, while the aircraft altitude at 1,500 feet the engine power started to decrease to 2,000 RPM. The pilot requested to return to Hang Nadim Airport. Finally the oil pressure dropped to zero, and the engine was still running for about 15 second before stopped. The pilot performed emergency procedure and tried to restart the engine but unsuccessful then decided to make an emergency landing over the sea. The aircraft ditched on radial 158° and 8 Nm from BTM VOR.

The instructor and the student pilot on board were minor injured and the aircraft up-side down and floated on the sea.

The flying school was initiated on January 2013 and lean air mixture procedure was introduced. Since June 2013, the flying school changed the fuel type from AVGAS to MOGAS and the lean takeoff procedure was still applied.

The maintenance record showed that the aircraft was grounded on 7 and 11 Sep'13 due to loss of power during the engine power check.

The investigation concluded that the contributing factors of the accident were as follow:

1. The engine were overheating for some period of time (few days) as result of the combination of lean mixture in high engine power and the use of lower octane fuel which in the area of heavy detonation zone.
2. The process of the change of AVGAS to MOGAS which was classified as alteration was not accordance with the CASR sub part 43.13.
3. The discrepancies appeared after the use of MOGAS was unresolved within the management.

Prior to issuing this final report, the Komite Nasional Keselamatan Tarsnportasi (KNKT) has been informed several safety actions taken by PT. Aviasi Solusi Prima (FlyBest Flight Academy) concerning to the leaning mixture procedure, inspections to the engines, fuel MOGAS test and hire an auditor specialist to ensure that the maintenance and alteration could be performed and recorded properly.

As result of this investigation the KNKT issued several safety recommendations to PT. Aviasi Solusi Prima (FlyBest Flight Academy) and the Directorate General of Civil Aviation.

1 FACTUAL INFORMATION

1.1 History of the Flight

On 12 September 2013 a Cessna 152 aircraft registered PK-KFC operated by PT Aviasi Solusi Prima (FlyBest Flight Academy) was being operated on local flight training from WIDD to Bridge 5 training area. On board in this flight was a student pilot who acted as Pilot Flying (PF) and a flight instructor who acted as Pilot Non Flying (PNF).

Both pilots came to the operation room to prepare the flight plan, collected the weather information and performed the walk around inspection. This flight was their second flight of the day.

Referred to the weather information collected, it showed that the weather was suitable for VFR flight.

There was no abnormality reported and/or recorded prior to departure concerning to the aircraft system and condition, the pilots also checked to the engine oil, it which was 5 quarts and the fuel onboard was 23 gallons and there was no indication of water contamination.

Prior to start the engine, the pilot listened to the Aerodrome Terminal Information Services (ATIS) to get the weather information then requested to start the engine. The engine start was normal and the oil pressure and temperature were on green bands. The pilots then performed the engine run up procedure and the engine considered normal for operation.

Referred to the pilot report, the aircraft taxi out and took off at 23:50 UTC with lean mixture, as stated in the company policy, and the takeoff power of 2500 RPM was achieved.

Based on the interview, the flight instructor stated that all the FlyBest procedure during taxi and take off were done included the lean mixture selection. During the takeoff roll the power was slightly less than the normal. The instructor experience, it never found this particular procedure in Europe.

The Pilot Flying flew the aircraft to 1000 feet and followed the Nadim Tower controller instruction to preced point KASAM. At point KASAM the aircraft was controlled by Tanjung Pinang Approach controller and was instructed to fly to Bridge 5 and to climb to 1500 feet. The Pilot Flying increased the power and the pilots noticed that the engine RPM was only 2,200 RPM, instead of 2500 RPM while the engine oil pressure and temperature were on green bands.

After having discussion with the Instructor, the student pilot increased the power, pilots noticed that the engine oil pressure and temperature were on green bands, but the engine indication remained at 2,200 RPM and the aircraft could reach 1,500 feet.

Few moments later, while the aircraft altitude at 1,500 feet the engine power started to decrease to 2,000 RPM, realizing this, the pilot requested to return to Hang Nadim Airport, meanwhile the engine RPM and oil pressure continued decreasing. Finally the oil pressure dropped to zero, and the engine was still running for about 15 seconds prior to stop.

The pilot performed an emergency procedure and tried to re-start the engine but unsuccessful and decided to make an emergency landing over the sea. The aircraft ditched on the shallow sea on radial 153° and 8 Nm from BTM VOR.

The pilots were minor injured and the aircraft was up-side down floated on the sea.

Figure 1: Location of the accident site (Map Courtesy of Google Earth)

Figure 2: The aircraft up-side down floated on the sea

1.2 Personnel Information

1.2.1 Instructor Pilot

Gender	:	Female
Age	:	39 years
Nationality	:	Spain
Marital status	:	Single
Date of joining company	:	1 July 2013
License	:	CPL
Date of issue	:	April 1996
Aircraft type rating	:	G-200/ EA-500
Instrument rating	:	28 February 2014
Medical certificate	:	28 February 2014
Last of medical	:	23 July 2013
Validity	:	23 January 2014
Medical limitation	:	NIL
Last line check	:	06 May 2013

Last proficiency check	:	28 February 2013
Flying experience		
Total hours	:	2,100 hours
Total on type	:	1,000 hours
Last 90 days	:	20 hours
Last 60 days	:	10 hours
Last 24 hours	:	05 hours
This flight	:	10 Minutes

1.2.2 Student Pilot

Gender	:	Male
Age	:	19 years
Nationality	:	Indonesia
Marital status	:	Single
Date of joining company	:	20 July 2013
License	:	Student
Date of issue	:	NIL
Aircraft type rating	:	NIL
Instrument rating	:	NIL
Medical certificate	:	Second Class
Last of medical	:	01 May 2013
Validity	:	01 May 2014
Medical limitation	:	NIL
Last line check	:	NIL
Last proficiency check	:	NIL
Flying experience		
Total hours	:	9 hours
Total on type	:	9 hours
Last 90 days	:	9 hours
Last 60 days	:	9 hours
Last 24 hours	:	-
This flight	:	10 Minutes

1.3 Wreckage and Impact Information

The post-accident engine examination was performed by KNKT investigators and found that the pistons burn and melt, and the exhaust valve damage.

Figure 3: One of the melted and scratched pistons

Figure 4: The damage found on the exhaust valve

1.4 Aircraft Information

1.4.1 Engine Information

The engine installed on the aircraft was Avro Lycoming O-235-L2C and was certified to use gasoline fuel with the Grade Fuel 91-96 Octane Anti Knock Index (AKI) Number as recorded on the engine plate.

The PK-KFC maintenance records few days before the accident were as follow;

- On 11 September the aircraft was squawked for loss of 200 RPM during the run up. Maintenance replaced 2 sparkplugs and cleaned the others due to deposits on the sparkplugs.
- On 12 September PK-KFC flew and ended on the sea due to engine failure when climbing and reached 1500 feet.

1.4.2 Pilot Operating Handbook (POH)

Several significant information taken from the Pilot Operating Handbook (POH) are as follows:

1. **Checklists related to the lean procedures:**

STARTING ENGINE (Temperature above Freezing) point 1 stated Mixture…RICH.

BEFORE TAKEOFF point 6 stated Mixture….RICH (below 3000 feet).

SHORT FIELD TAKEOFF point 5 stated Mixture….RICH (above 3000 feet to obtain maximum RPM).

ENROUTE CLIMB point 3 stated Mixture….RICH below 3000 feet, lean for Maximum RPM above.

DESCENT point 1 stated Mixture… ADJUST for smooth operation (full rich for idle power).

BEFORE LANDING point 1 stated Mixture………..RICH

2. ***TAKEOFF*** (POH page 4.14)

It is important to check full-throttle engine operation early in the takeoff run. Any sign of rough engine operation or sluggish engine acceleration is good cause for discontinuing the takeoff. If this occurs, you are justified in making a thorough full throttle static run up before another takeoff is attempted. The engine should run smoothly and turn approximately 2280 to 2380 RPM with carburetor heat off and mixture leaned to maximum RPM.

Prior to takeoff from fields above 3000 feet elevation, the mixture should be leaned to give maximum RPM in a full-throttle, static run up.

After full throttle is applied, adjust the throttle friction lock clockwise to prevent the throttle from creeping back from a maximum power position.

3. ***FUEL SAVING PROCEDURE FOR FLIGHT TRAINING OPERATIONS*** (POH page 4-15)

For best fuel economy during flight training operations, the following procedures are recommended.

1. *Use 55% to 60% power while transitioning to and from the practice area (approximately 2200 – 2250 RPM).*
2. *Lean the mixture for maximum RPM during climbs above 3000 feet. The mixture maybe left leaned for practicing such maneuvers as stalls.*

3. *Lean the mixture for maximum RPM during all operations at any altitude, including those below 3000 feet, when using 75% or less power.*

Using the above recommended procedures can provide fuel saving of up to 13% when compared to typical training operations at a full rich mixture.

1.5 Organizational and Management Information

Aircraft Owner	:	PT. Aviasi Solusi Prima (FlyBest Flight Academy)
Address	:	Ruko Tol Boulevard No. B27, Bumi Serpong Damai, Tangerang Selatan
Aircraft Operator	:	PT. Aviasi Solusi Prima (FlyBest Flight Academy)
Address	:	Ruko Tol Boulevard No. B27, Bumi Serpong Damai, Tangerang Selatan
Operator Certificate Number	:	AOC/141-015

The PT Aviasi Solusi Prima (FlyBest Flight Academy) is a Flying School under CASR Part 141 with Certificate number AOC/141-015.

The Head Office located at Ruko Tol Boulevard Block B27 Serpong, Tangerang and the training facilities was located at Hang Nadim International Airport, CIQ building A, Batu Besar, Batam.

The organization key personal consist of CEO, Chief Flight Instructor, Chief Aircraft Maintenance and Chief Inspector.

The fleets operated were 5 Cessna 152 aircrafts and started the operation on January 2013. During the initial conducting the flight training the operator had used AVGAS fuel and lean air mixture on takeoff policy was introduced since the beginning of the operation. Since June 2013, the operator changed the fuel type from AVGAS to MOGAS and maintained the existing policy of lean air mixture on takeoff.

The investigation could not found the performances data and the DGCA approval to the changes of the fuel type by the FlyBest Flight Academy.

1.5.1 Change of the Takeoff Power Rating

The Chief Instructor has issued a policy to use lean air mixture on takeoff by referred to the statement on the POH for Fuel Saving Procedure for Flight Training Operations (POH page 4-15), 3; which stated: "*Lean the mixture for maximum RPM during all operations at any altitude, including those below 3000 feet, when using 75% or less power.*"

The investigation could not find detail procedure to conduct such policy.

1.5.2 Maintenance Record

Prior to the use of the MOGAS there was no indication of abnormal engine operations. After the use of MOGAS, there were several other instances of rough running engine and deposit on sparkplugs.

The maintenance recorded that almost after every flight the maintenance personnel had to clear the magnetos due to a rough running engine to remove deposits from the sparkplugs.

According to the correspondences within the FlyBest Flight Academy, it seemed that there were some discrepancies of opinion to the fuel policies of the used of AVGAS changed to MOGAS. The area of such discrepancies was about the fuel MOGAS stored time period and some advices not to continue to use the MOGAS for the operation.

1.5.3 The Engines Maintenance Record

The operator list of maintenance discrepancies report showing the engine issues were as follows:

PK-KFA

On 9, 10, 11 and 12 June the aircraft was squawked for loss of power. The cause of the loss of power was the sparkplugs had deposits and required to be cleaned. On 12 June the aircraft also had high oil temperatures.

On August 1 the aircraft was grounded for high oil temperatures. The oil cooler was removed and replaced. PK-KFA continued to have high oil temperatures after the new oil cooler was installed, but not in the red.

PK-KFB

On 30 August the aircraft was squawked for a rough running engine and the plugs were cleaned.

On 11 September the aircraft was squawked for rough engine and the spark plugs were removed and cleaned. The message received was as follows “a problem with Charlie…climbing no more than 200 fpm and with full throttle in straight and level no more than 2200 RPM…can we use alfa even if it is not dispatched?”

The constant removing and cleaning of the plugs caused the #1 cylinder plug hole to become unserviceable and the aircraft was grounded until the heli-coil kit arrived to fix the aircraft. It was down for 3 weeks.

PF-KFC

On 7 September the aircraft was grounded for loss of power and the sparkplugs were cleaned.

On 11 September the aircraft was squawked for loss of 200 RPM during the run up. Maintenance replaced 2 sparkplugs and cleaned the others due to deposits on the sparkplugs.

On 12 September PK-KFC went down due to engine failure which was caused by detonation.

PK-KFF

On 28 July PK-KFF was grounded for right magneto dropping to many RPM during the run up prior to take off. The mechanics replaced 4 spark plugs due to residue on them.

1.5.4 Chief Instructor Information

The Instructor pilot had over 1000 hours in type at the time of the accident and over 2100 hours of total time. The instructor was fully aware of the results from improper leaning procedures. The instructor has flown for more than two years on small aircraft with piston engine using MOGAS fuel.

All instructors were aware of such results and if any of the instructors had felt this procedure was outside a safe operation then they would have expressed their disagreement with such procedures.

Based on the interview with the Chief Instructor, it stated that the lean mixture takeoff procedures had become the company policy the reason were the air density, vapor pressure etc. This policy has been instructed since January 2013 to the flight instructors.

1.6 Other Information

1.6.1 Indonesia Regulations

CASR Part 1, Definition –

Major alteration *means an alteration not listed in the aircraft, aircraft engine, or propeller specifications –*

> *(1) That might appreciably affect weight, balance, structural strength, performance, powerplant operation, flight characteristics, or other qualities affecting airworthiness; or*
>
> *(2) That is not done according to accepted practices or cannot be done by elementary operations.*

CASR sub part 43.13 Performance Rules (general).

Each person performing maintenance, alteration, or preventive maintenance on an aircraft, air-frame, engine, propeller, or appliance shall use the methods, techniques, and practices prescribed in the current manufacturer's maintenance manual or Instructions for Continued Airworthiness prepared by its manufacturer, or other methods, techniques, and practices acceptable to the DGCA, except as noted in section 43.16. Tools, equipment, and test apparatus necessary to assure completion of the work in accordance with accepted industry practices shall be used. Where special equipment or test apparatus is recommended by the manufacturer involved, that equipment or apparatus, or its equivalent if acceptable to the DGCA, must be used.

1.6.2 Fuel Air Ratio Chart

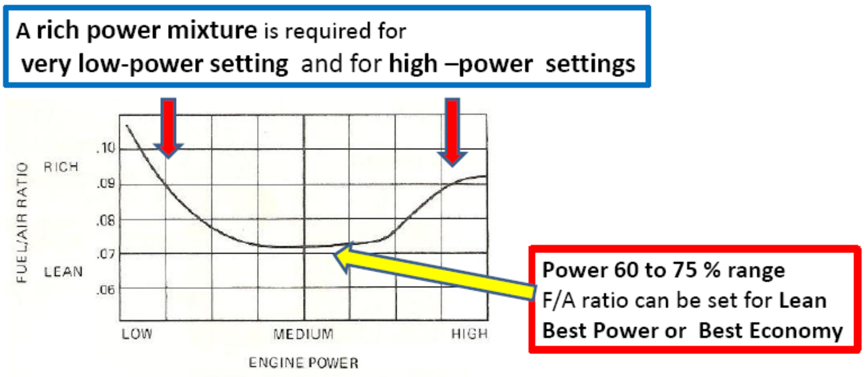

Figure 5: Fuel air ratio required for different power setting taken from Aircraft Power Plant by Kroes. Wild, page 121

1.6.3 Detonation

Definitions

Detonation:

1. Occurs when temperature and pressure of the compressed fuel air mixture in the combustion chamber reach to explosion of the fuel air mixture and make excessive temperature.
2. This caused by high inlet-air temperature, insufficient fuel octane rating, excessive engine load, over advanced ignition timing, excessively lean fuel-air mixture and excessive compression ratio.
3. Relationship between cylinder pressure and temperature.

Compression Ratio (CR):

1. Is a factor that controls the maximum horse power (HP) which can be developed by the engine, maximum HP increases as the compression ratio increases.
2. Compression ratio greater than 10:1 pre-ignition or detonation may occur, cause overheating, loss of power, and damage of the engine.
3. If the engine has a compression ratio as high as 10:1 the fuel used must have a high antiknock characteristic (high octane rating/performance number)
4. Common for gasoline engine to have compression ratio of about 7:1, however, certain high-performance engines have higher ratios.
5. The compression ratio is too high for the fuel being used, detonation of the fuel will occur thus causing overheating, loss of power, and probable damage to the pistons and cylinders.

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.

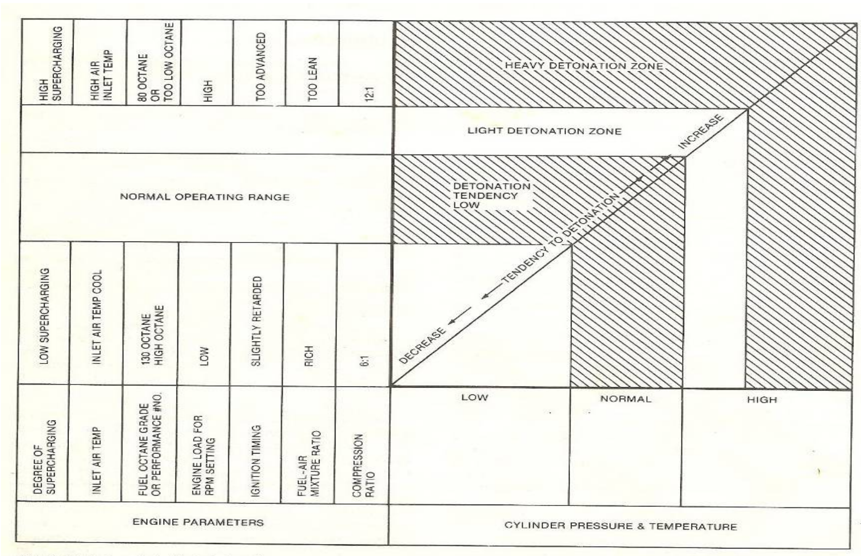

Figure 6: Factor that effect of detonation

Refer to the table above: the combination of MOGAS with octane of 91, lean air mixture on takeoff (high engine load for RPM setting) condition will go into the envelope of heavy detonation zone.

1.6.4 Use of Motor Gasoline (MOGAS) in Certain Light Aircraft

Refer to The CAP 747 issued by Civil Aviation Authority (CAA) of United Kingdoms.

General

It should be noted that although CAA is satisfied that the listed aircraft/engines may be operated with adequate safety on MOGAS, provided the limitations are observed, CAA takes no responsibility for infringement of manufacturer's warranty, accelerated deterioration of the engine or airframe components, or any other long term deleterious effects.

Note*: With regard to the limitation on fuel temperature, it may be assumed that the temperature of the fuel in the tank prior to the commencement of the flight is less than 20°C unless the ambient temperature has been in excess of this temperature for some hours, or the aircraft has been standing in continuous direct sunshine*

Refer to Safety Sense Leaflet 4: Use of MOGAS issued by Civil Aviation Authority (CAA) UK

3 Operating Limitations

Motor gasolines have a higher vapour pressure than AVGAS and are also subject to seasonal variation. To reduce the likelihood of interruption of fuel flow to the engine due to vapour lock, the following operating limitations are imposed for all flights using MOGAS:

- *a Prior to take-off, the temperature of the fuel in the aircraft tank(s) must be less than 20°C.*
- *b The aircraft must not be flown at altitudes greater than 6000 ft, unless the CAA has agreed, in writing, to different limitations for that particular aircraft.*

1.6.5 Aviation Gasoline (AVGAS)

History of AVGAS Grades

Avgas is gasoline fuel for reciprocating piston engine aircraft. As with all gasoline, avgas is very volatile and is extremely flammable at normal operating temperatures. Procedures and equipment for safe handling of this product must therefore be of the highest order.

Avgas grades are defined primarily by their octane rating. Two ratings are applied to aviation gasoline (the lean mixture rating and the rich mixture rating) which results in a multiple numbering system e.g. Avgas 100/130 (in this case the lean mixture performance rating is 100 and the rich mixture rating is 130).

In the past, there were many different grades of aviation gasoline in general use e.g. 80/87, 91/96, 100/130,108/135 and 115/145. However, with decreasing demand these have been rationalised down to one principle grade, Avgas 100/130. (To avoid *confusion and to minimise errors in handling aviation gasoline, it is common practice to designate the grade by just the lean mixture performance, i.e. Avgas 100/130 becomes Avgas 100).*

Some years ago, an additional grade was introduced to allow one fuel to be used in engines originally designed for grades with lower lead contents: this grade is called Avgas 100LL, the LL standing for 'low lead'.

All equipment and facilities handling avgas are colour coded and display prominently the API markings denoting the actual grade carried. Currently the two major grades in use internationally are Avgas 100LL and Avgas 100. To ease identification the fuels are dyed i.e. Avgas 100LL is coloured blue, while Avgas 100 is coloured green.

Very recently a new Avgas grade 82 UL (UL standing for unleaded) has been introduced. This is a low octane grade suitable for low compression engines. It has a higher vapour pressure and can be manufactured from motor gasoline components. It is particularly applicable to those aircraft which have STCs to use automotive gasoline.

AVGAS Grades

Avgas 100

The standard high octane fuel for aviation piston engines, It has a high lead content and is dyed green. There are two major specifications for Avgas 100. The ASTM D 910 and UK DEF STAN 91-90. These two specifications are essentially the same but differ over antioxidant content, oxidation stability requirements and max lead content.

Avgas 100LL

This grade is the low lead version of Avgas 100. Low lead is a relative term. There is still up to 0.56 g/litre of lead in Avgas 100LL. This grade is listed in the same specifications as Avgas 100, namely ASTM D 910 and UK DEF STAN 91-90. The Avgas 100LL is dyed blue.

Avgas 82 UL

This is a relatively new grade aimed at the low compression ratio engines which don't need the high octane of Avgas 100 and could be designed to run on unleaded fuel. Avgas 82UL is dyed purple and specified in ASTM D 6227.

Source from the Shell Global

The Avgas is used in small piston engine powered aircraft within the General Aviation community. Predominately activities such as private pilots, flight training, flying clubs and crop spraying. Piston engines operate using the same basic principles as spark ignition engines of cars, but they have a much higher performance requirement.

In today's General Aviation community there are only two main Avgas grades (100 and 100LL low lead) - a rationalisation that has enabled fuel companies to continue supplying a market that would otherwise have become uneconomic. Worldwide, total

Avgas volumes are low, since Avgas-fuelled aircraft, although they outnumber jet-fuelled aircraft, are generally much smaller.

1.6.6 Motor Gasoline (MOGAS)

Transport Canada has approved the use of automotive gasoline (mogas) in specific categories of aircraft, subject to certain limitations. Every pilot who contemplates the use of mogas should read Transport Canada's Use of Automotive Gasoline (MOGAS) in Aviation.

There are three considerations regarding mogas: the use of mogas is not generally supported by engine manufacturers; mogas is not engineered for aviation purposes; and, in using mogas, the pilot assumes sole responsibility for quality (and therefore liability) associated with its use.

Transport Canada basically followed the process of formal approval established by the US FAA which issued Supplementary Type Certificates (STCs) for specific engines and aircraft; while these were recognized by Transport Canada, it imposed altitude and temperature restrictions in view of the unique characteristics of Canadian mogas—i.e., Canadian Aircraft were restricted to flight below 6000', and at temperatures below 24°C. This restriction, however, has since been removed for certain category aircraft. As well, for aircraft categories, Transport Canada now provides blanket approval, meaning that STCs are not required for these aircraft.

Operational Considerations

1. *Material Compatibility. Transport Canada warns that mogas may be associated with the deterioration of rubbers and plastics in aircraft fuel systems.*

2. *Alcohol. Fuels containing alcohol (methanol or ethanol) other than de-icing fluids are not permitted for aircraft use, owing to the manner in which alcohol attacks rubber and plastic components in the fuel systems. Importantly, fuel manufacturers need not indicate when alcohol is present in automobile fuel. Manual alcohol testing procedures undertaken by the pilot must therefore be used. As a means of monitoring elastomers (natural or synthetic rubbers or plastics), Transport Canada additionally recommends frequent inspection of the o-rings found in fuel sump drains—the pilot should look for o-ring blockage when the drains are open, and o-ring leakage when the drains are closed. As well, the fuel filter should be checked frequently for particulate originating from deteriorated elastomers.*

3. *Carburettor Icing. Because mogas has higher volatility than aviation fuels, mogas absorbs more heat during air/fuel mixture process and is therefore subject to greater cooling during vaporization—the result being that ice accumulates at higher ambient temperatures, making the likelihood of carburettor icing higher while flying with mogas.*

4. *Vapour Lock. Again, because of the increased volatility of mogas, there is increased probability of experiencing vapour lock whereby mogas vaporises in fuel lines. This is especially common in instances of shutting down aircraft immediately after running at full operating temperatures; the fuel in the lines adjacent to the engine become "heat soaked" and vaporization occurred. Full fuel flow should be verified prior to takeoff and effort to reduce engine temperature by reducing throttle should be used if vapour lock is encountered in*

flight. Automotive fuel varies in volatility owing to the four seasonal grades that are produced (Aviation fuel has only one volatility grade), and special consideration should be given to avoiding winter grade fuels which have increased volatility, and therefore increased risk of vapour lock, as well as carburettor icing.

5. *Filtering. Transport Canada recommends that all mogas be filtered using a 5-micron filter/separator, or finer; the filter should also have a "go/no-go" system, which responds to the presence of water contamination by shutting off. Makeshift filters, such as a chamois or felt material, should only be used in emergencies, owing to the possibility of fibres clogging the fuel system.*
6. *Cross-contamination. Unlike aviation fuel, mogas is not transferred using dedicated fuel lines; there is therefore increased risk of fuel cross-contamination whereby two fuels are mixed. Transport Canada recommends that mogas vendors perform fuel-testing procedures referred to as the "Clear and Bright", "Free Water," and "Density" tests.*
7. *Electrostatic Discharge. Transport Canada recommends that the fuel storage container should be bonded by wire to the tank being fuelled. It notes that the hazard of fire increases substantially with the use of plastic containers, which cannot be bonded to the aircraft. Transport Canada writes: "Many accident reports have revealed that an arc was created when the [plastic jerry] can was pulled away at the end of the pour following sufficient charge accumulation. By this time the tanks are likely full and the results can be lethal."*

1.6.7 The Fuel Specification Test

The MOGAS which was stored at FlyBest facility was examined in the Laboratorium Minyak dan Gas Bumi (Lemigas – Laboratory of fuel and natural gas) and the test result was the fuel has met the octane required for the operation as stated in the report dated 04 November 2013 File No:260/PPP/8.15/X/2013.

No	Sample	Ratio mix	RON ASTM D 2699	MON ASTM D 2700	AKI NUMBER (R+M):2
1.	MOGAS	100%	96.7	90.9	187.6 : 2 = 93.8

1.6.8 Metallurgy Observation on Damage Piston

The damaged piston was analyzed at Institute Technology Bandung (ITB) and the summarized of the report is described as follows:

Observation

Observation was performed by metallographic method. A sample was sectioned from the damaged piston. The cut was taken from the burned / punctured location, as well as the intact location. The idea was to compare the microstructures between the locations near the punctured hole and about two centimetres away.

Figure 8: Burned and punctured area

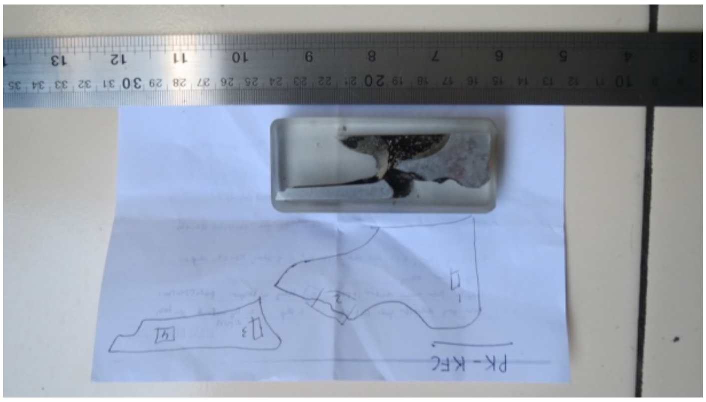

Figure 7: Sectioned sample for metallographic examination

The metallographic results are shown in the following figures. The scale bar is shown at the lower left of each picture.

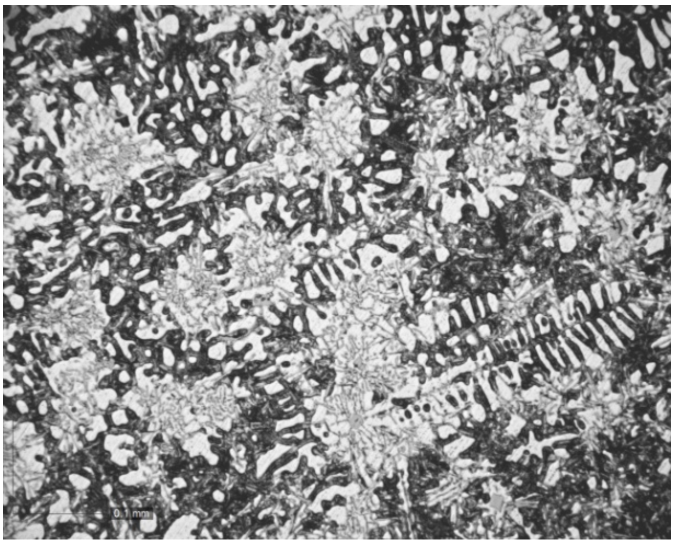

Figure 8: Microstructure at the piston wall, approximately 3 cm from the hole: original microstructure (i.e. the dendrites)

The area adjacent to the burned / hole area is typical a melted structure. The structure shows melted and solidified structure showing also free silicon grains. The original structure still existed, that is dendrites as a result of casting process, even at a distance of 2 cm from the burned hole.

Analysis

The fact that at a close distance from the hole showed the original structure indicates that the extreme overheating occurred at relatively short period of time (few days).

Conclusion

It can be concluded that the overheating occurred at relatively short period of time (few days).

1.6.9 Shared Situation Awareness (SA)

(adapted from Endsley & Jones, 1997; 2001)

Shared situation awareness (SA) can be defined as "the degree to which team members possess the same SA on shared SA requirements"

Thus, shared SA refers to the overlap between the SA requirements of the team members, as presented in Figure 9. As depicted by the clear areas of the figure, not all information needs to be shared. Clearly, each team member is aware of much that is not pertinent to the others on the team. Sharing every detail of each person's job would only create a great deal of "noise" to sort through to get needed information. It is only that information which is relevant to the SA requirements of each team member that is needed.

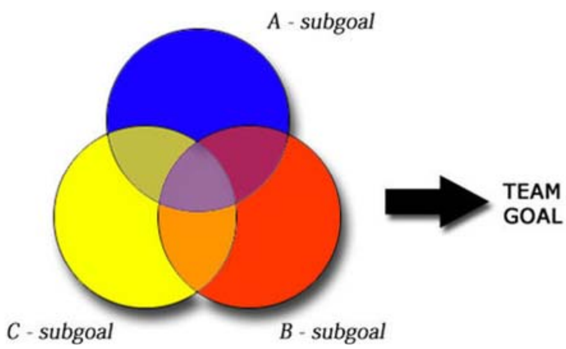

Figure 9: Shared SA Requirements

2 ANALYSIS

The analysis part of this Final Report will discuss the relevant issues related to the engine quitted on 22 November 2013.

The investigation determined that there were three relevant issues which the analysis will focus on. The relevant issues are:

- The cause of engine failure;
- The changed of operational procedure;
- Management Situational Awareness.

2.1 The cause of engine Failure

The metallurgy observation on the damage piston concluded that the failure of the piston was due to the overheating which occurred at relatively short period of time (few days).

During the interview, pilots did not mention about the engine temperature. Pilots noticed that the engine oil pressure and oil temperature were on green bands while the RPM could not reached 2500 RPM.

The overheated engine could expand the piston resulted to the loss of power and even damaging the power section, piston heads and exhaust valves burn or melt, and exhaust valves seat damage. Engine overheat or excessive temperature caused by detonation.

Detonation caused by improper fuel air mix ratio that contributes by high inlet-air temperature, insufficient fuel octane rating, excessive engine load, over advanced ignition timing, excessively lean fuel-air mixture and excessive compression ratio.

The lean air mixture, means reduce the amount of fuel to be mixed with the certain amount of air, or in other words, lean air mixture means less fuel. Lean fuel air mixture on high engine power such as take-off power might cause to detonation and increase the temperature of the engine.

Another factor that may contribute to detonation is lower octane fuel. On the lower octane fuel, the fuel air ratio become improper just like lower amount of fuel (too much air).

Refer to the factors that effect of detonation table, the condition of MOGAS fuel (with octane of 91) with RICH fuel air mixture in the high engine load would be in the envelope of LIGHT DETONATION ZONE.

The condition of AVGAS fuel (lean mixture performance rating is 100 and the rich mixture rating is 130) was used and lean air mixture in high engine load would be in the envelope of LIGHT DETONATION ZONE. The POH recommended for takeoff below 3000 feet with lean air mixture, the power limited to 75% power. The limited power would reduce the engine load and would be in the NORMAL OPERATING CONDITION, according to the factors that effect of detonation table.

Refer to the factors that effect of detonation table: The condition in the accident flight, of lean fuel air mixture, combined with lower octane fuel of MOGAS with octane of 91 (compare to AVGAS of lean mixture performance rating is 100 and the rich mixture rating is 130), has made improper fuel air ratio. The combination of these two conditions on high engine load (takeoff power of 2500 RPM) was in the envelope of HEAVY DETONATION ZONE.

2.2 The Changes of Operational Procedure

The implementation of lean the mixture for maximum RPM with AVGAS during all operations at any altitude, including those below 3000 feet was allowed when using 75% or less power as stated in the POH.

The operator has introduced the policy of takeoff with lean mixture in order for cost saving. The investigation could not find special procedure for the implementation of the policy. During the interview, the pilots stated that the takeoff was performed with 2500 RPM which was the maximum engine power instead of 75% (± 2200 RPM) as recommended by the POH.

During the operation with AVGAS fuel and lean takeoff power policy was applied, there was no significant maintenance problem recorded. However, the investigation could not find the performance record while the policy was implemented.

On June 2013 the MOGAS started to be used to replace the AVGAS. The MOGAS test to the fuel stored on the operator facility and was performed after the accident indicated that the fuel quality was on the condition as it was delivered from the fuel provider. The fuel octane was also met to the engine requirements.

The changes of fuel type was intended for cost saving. The investigation could not find any engine setting adjustment and performance calculation prior to the implementation of the MOGAS.

After the use of MOGAS, the policy of lean takeoff power was still implemented. During this period, there were some problems on the engines of all aircrafts operated, especially on the rough running engine and deposit on sparkplugs.

Furthermore the United Kingdom CAA published Safety Sense Leaflet related to the use of MOGAS, stated that the MOGAS have a higher vapour pressure than AVGAS and are also subject to seasonal variation. To reduce the likelihood of interruption of fuel flow to the engine due to vapour lock, the operation using MOGAS are limited the temperature of the fuel in the aircraft tank(s) must be less than 20°C and the aircraft must not be flown at altitudes greater than 6000 ft.

The investigation could not find data performances and DGCA approval to the changed of fuel type to MOGAS. This indicated that the process of the change of AVGAS to MOGAS which was classified as alteration was not accordance with the CASR sub part 43.13.

2.3 Management Situational Awareness

Shared situation awareness (SA) can be defined as "the degree to which team members possess the same SA on shared SA requirements".

Shared SA refers to the overlap between the SA requirements of the team members. Not all information needs to be shared and only the information which is relevant to the SA requirements of each team member that is needed. Achievement of the goal of the team (team goal), rely on the successful shared SA.

According to the correspondences within the FlyBest Flight Academy, it seemed that there were some discrepancies of opinion to the fuel policies of the used of AVGAS changed to MOGAS. The area of such discrepancies was about the fuel MOGAS stored time period and some advices not to continue to use the MOGAS for the operation.

The discrepancies appeared after the use of MOGAS was unresolved within the management. The advices from the operation not to continue the use of the MOGAS was not significantly responded by the other related departments within the FlyBest Flight Academy. It indicated that the management did not implement shared SA hence the team goal did not achieve.

3 CONCLUSIONS

According to factual information during the investigation, the National Transportation Safety Committee founded any initial findings as follows:

3.1 Findings

These findings should not be read as apportioning blame or liability to any particular organisation or individual.

1. The aircraft was airworthy prior to this occurrence.
2. All crew have valid licenses and medical certificates.
3. The aircraft was operated under a correct weight and balance envelope.
4. On board in this flight was a student pilot who acted as Pilot Flying (PF) and a flight instructor who acted as Pilot Non Flying (PNF).
5. The pilots performed the engine run up procedures prior to takeoff and indicated that the engine considered normal for operation.
6. Referred to the pilot report, the aircraft taxi out and took off with lean mixture and the takeoff power of 2500 RPM was achieved.
7. The pilot noticed that the engine RPM was only 2,200 RPM, instead of 2500 RPM and increased the power, the engine oil pressure and temperature were on green bands, but the propeller rotation remained at 2,200 RPM.
8. Few moments later, the engine power started to decrease to 2,000 RPM, and the engine RPM and oil pressure continued decreasing and finally stop.
9. The pilot performed an emergency procedure and tried to re-start the engine but unsuccessful and decided to make an emergency landing over the sea.
10. The aircraft was grounded on 7 and 11 September 2013 and the maintenance recorded that on 11 September the aircraft was squawked for loss of 200 RPM during the run up. Maintenance replaced 2 sparkplugs and cleaned the others due to deposits on the sparkplugs.
11. The fleets operated were 5 Cessna 152 aircrafts and started the operation on January 2013. Since the initial conducting the flight training the operator had used AVGAS fuel and lean mixture on takeoff. The maintenance did not record significant problem of engine during this period.
12. The Cessna Pilot Operating Handbook (POH) stated lean fuel air mixture used Avgas for maximum RPM during all operations at any altitude, including those below 3000 feet, when using 75% or less power.
13. The investigation could not find special procedure to the modification of the procedure for takeoff with leaned mixture.
14. The Mobil Gasoline (MOGAS) has been used on the aircraft operations since June 2013. After the MOGAS was use there were several instances where the maintenance was alerted to a rough running engine and cleaned the sparkplugs.

15. In respect to this particular fuel changes, the investigation could not find any data performances, and DGCA approval to the changed of fuel type which classified as alteration.
16. The United Kingdom CAA published Safety Sense Leaflet 4 related to the use of MOGAS, stated that the MOGAS have a higher vapour pressure than AVGAS. To reduce the likelihood of interruption of fuel flow to the engine due to vapour lock, the operation using MOGAS are limited the temperature of the fuel in the aircraft tank(s) must be less than 20°C and the aircraft must not be flown at altitudes greater than 6000 ft.
17. Operational Considerations, Material Compatibility. Transport Canada warns that mogas may be associated with the deterioration of rubbers and plastics in aircraft fuel systems.
18. The MOGAS stored at FlyBest facility was examined and the test result was the fuel has met the octane required for the operation.
19. Metallurgy Observation on the damage piston concluded that the overheating occurred at relatively short period of time (few days).

3.2 Contributing Factors[1]

- The engine were overheating for some period of time (few days) as result of the combination of lean mixture in high engine power and the use of lower octane fuel which in the area of heavy detonation zone.
- The process of the change of AVGAS to MOGAS which was classified as alteration was not accordance with the CASR sub part 43.13.
- The discrepancies appeared after the use of MOGAS was unresolved within the management.

1 "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 National Transportation Safety Committee had received and accepts safety actions resulting from this occurrence from PT Aviasi Solusi Prima (FlyBest Flight Academy).

The safety action of the PT. Aviasi Solusi Prima (FlyBest Flight Academy) on 12 December 2013 is as follows:

- Flight operation training to all instructors had been conducted to emphasize the leaning mixture procedure on takeoff could contribute the deterioration of engine component/parts; and to make sure that the takeoff procedure shall use the Cessna 152 Pilot Operation Handbook.
- The engines of PK-KFA, PK-KFB, PK-KFF had been inspected.
- Fuel MOGAS D-439 had been tested at LEMIGAS Laboratory to find out the RON, MON and AKI numbers, and for finding the best mixture with AVGAS, as an option.
- In the meantime waiting LEMIGAS result, FlyBest will use only AVGAS.

Hire an auditor specialist to ensure that the maintenance and alteration was performed and recorded properly."

5 SAFETY RECOMMENDATIONS

Base on the examination of the factual data and the findings that contributed to the accident, there were safety issues where the process of procedures did not implement as required by the CASR subpart 43.13, furthermore there was internal prolong unresolved discrepancies in respect to the opinion of the fuel changed policies.

According to the aforesaid safety issues, the National Transportation Safety Committee issued several safety recommendations addressed to:

5.1 PT. Aviasi Solusi Prima (FlyBest Flight Academy)

a. To ensure safety risk assessment is performed and approval from the authority when required, to any alteration or policy differ from manufacturer procedures.

b. To resolve discrepancy within the management in order to eliminate hazard that may exist.

5.2 Directorate General of Civil Aviation (DGCA)

a. To provide guidance related to the use of MOGAS for light aircraft operation to consider the weather phenomenon and other issues in Indonesia as required by CASR Part 43.13.

b. To ensure KNKT recommendations to PT. Aviasi Solusi Prima (FlyBest Flight Academy) are well implemented.

6 APPENDICES

6.1 Preventive & Improvement program taken By PT Aviasi Solusi Prima (FlyBest Flight Academy).

FLYBEST aviasi solusi prima

December 12, 2013

[FINAL REPORT OF PREVENTIVE & IMPROVEMENT PROGRAM PASCA PK-KFC INCIDENT]

I. FOLLOW-UP INTERNAL INVESTIGATION 16 SEPTEMBER 2013

NO	PREVENTIVE ACTION PLAN	IMPLEMENTATION REPORT	REALISATION
A	All engine of PK-KFA, PK-KFB, PK-KFF will be inspected. For not stop flying too long, one of those aircraft could use our new engine spare. And PK-KFE is not priority to be checked, because not yet using Mogas 100%, since it's prepared for I/R Training.	1. Special inspection of PK-KFF (C152): Found leak at ring piston. We could only change the ring piston, but we replace all 4 cylinders and 4 pistons, instead. At 27 September 2013, PK-KFF is stated back into service. 2. Special inspection of PK-KFE (C172): Did not find any abnormal condition on visual check; then did compression check, the result is within standard. Then we changed its intercom with the new, it is part of plan not related to preventive action; so that PK-KFE is back into service delayed to 7th October 2013. 3. Special inspection of PK-KFB & PK-KFA (C152) were conducted quite long after incident, because we have to wait until the spares we bought come from USA: Both PK-KFA & PK-KFB we also found slightly leak at ring piston, but we decided to also change their all cylinders and pistons. PK-KFB is back in to service at 21st October 2013, but PK-KFA is still on ground-run check.	27 September 2013 7 October 2013 22 October 2013
B	Fuel sample of Mogas D-439 will be sent to LEMIGAS Lab to find out the RON, MON, and AKI numbers, and for finding the best mixture with AVGAS, as an option.	We sent the fuel sample to two-lab, Lemigas and PT Catur Bangun Putra, who have different approach in testing, but the result usually slightly different, especially for AVGAS. The testing method at Lemigas is more precisions for AVGAS than at PT Catur; but for MOGAS, it is more or less same. So for testing the mixture when MOGAS is higher than AVGAS, the result of two lab are usually about same (Lemigas result is usually higher). PT Catur, we got the result at 30 September 2013 as attached: • If 100% MOGAS, the AKI No.: 91.1 (In STC min AKI No.91). • If 75% MOGAS-25% AVGAS, the AKI No: 92.4.	01 November 2013

		LEMIGAS, we got the result at 1st November 2013 as attached: • If 100% MOGAS, the AKI No: 93.8. • If 75% MOGAS-25% AVGAS, the AKI No: 96.1.	
C	In the meantime waiting LEMIGAS result, Flybest will use only AVGAS which expected arrive on Monday next-week.	Because we change all Cylinders and pistons, then we have to use AVGAS only and mineral oil up to min 100hours. Up to now, we are still using AVGAS 100%. After reach 100hours we will use 60% MOGAS – 40% AVGAS.	Estimated per end of January 2014
D	Hire specialist to audit maintenance record, maintenance program implementation, and factors related; and make improvement program.	We are hiring independent advisor/consultant: [redacted], to help us audit and improve quality of all maintenance program and implementation. We did special clinic to discuss incident we faced and how the preventive maintenance program to avoid the same issue. We make special assignment and responsibility for each technician we have, and improvement plan for increasing their quality. The continuous process for improvement will never stop.	1 October 2013
E	Audit internally operation in general.	After the incident we checked all process we have done and make continues improvement Flybest procedure and initiate additional activity : • Updating all data and evaluate emergency response system, which will be applied in TPM; • Train the students about sea survival, and schedule them for swimming lesson every 1 or 2 weeks; • Evaluate emergency procedure for ditch landing; • Redefine dispatch center function. • Flight Operation Training Procedure: emphasize refreshing leaning mixture procedure to all Instructor, as this could contribute to engine component/parts deteriorate; and make sure that as Cessna POH and	Target: 31 December 2013

		Lycomming engine reference.	
F	Do preventive grounding after accident procedure for Lidia for 14-days.	We received preventive grounding release from DAAO at 17th October 2013	17 October 2013

II. FURTHER ACTION TAKEN

NO	CAUSE	ACTION
1	Finding Chief Instructor suggestion to do slightly leaning when take-off, in condition when feeling the engine too rough.	Fact: • Could not find the suggestion by Chief in writing. • Chief admitted that he gave the suggestion. • Instructor admit that did the suggestion in very slightly action and when needed. • No reference: POH and lycoming engine manuals which supported the procedure. • Text book theory of piston engine which specifically installed in C152, conclude that it would contribute to engine deteriorate. Action: • 21 September 2013: Principal summon Chief Instructor [redacted] to be never suggest or make any procedure which have not formal reference from manufacture, or regulator; and said will recruit Quality & CASO which will control all operation procedures & implementation. At the same time Principal informed Chief, his position as Chief is under evaluated until March 2014 as the latest. He have to focus make training operation will be more effective and make sure the standard quality of students will be achieved. No deviation he could make without Quality/CASO in charge and Principal approval. At the time, he accept that summon, and said had revoke the procedure. • Prepare replacement for Chief Instructor, target: January 2014. Ex chief will be act as regular Instructor, but will be given a special task in project which be decided later.

2	Finding lack of the Senior Engineer leadership and lower confidence because of the incident.	Fact: • Lack of senior engineer specialized in piston engine in Indonesia. • Foreign experience engineer price is very high, could be higher than Instructor price. Action: Target January 2014: Find replacement of existing Senior Engineer who is function as Chief Engineer, with more experience and good leadership.
3	Quality & CASO person in-charge	Fact: • CASO is not part of key-person in Pilot School certification, but for airlines/charter operator. • Learn from the incident, we need independent person who could be spend more time in making procedure, controlling the implementation and making improvement program. Action: • Since December 2013, have recruited [redacted], to act as Quality & CASO. Targeted on January 2014 he has already work full as Quality & CASO of Flybest.

Jakarta 12 December 2013

FLYBEST FLIGHT ACADEMY

6.2 Internal Corespondence

xxxxx, 25 October, 2013

I thought much about our discussion with regards to the 3 packets of information about the MOGAS that I gave to you on Tuesday 22 October. Considering that the fuel was received in June and can only be stored only a few weeks before it goes bad I cannot allow the MOGAS we have in stock to be used in the aircraft no matter what we mix it with. There will be no way to guarantee the safety of flight with such fuel in the aircraft. The reports I showed you give every indication we have seen in our aircraft since we first started using the fuel in June.

PK-KFA:

On June9, June 10, June 11 and 12 the aircraft was squawked for loss of power. The cause of the loss of power was the sparkplugs had deposits on them and needed to be cleaned. On 12 June the aircraft also had high oil temperatures.

On August 1 the aircraft was grounded for high oil temperatures and we removed and replaced the Oil Cooler as we thought that may be the issue. PK-KFA continued to have high oil temperatures after the new oil cooler was installed.

PK-KFB

On 30 August the aircraft was squawked for a rough running engine and the plugs were cleaned.

On 11 September the aircraft was squawked for rough engine and the spark plugs were removed and cleaned.

PF-KFC

On 7 September the aircraft was grounded for loss of power and the Sparkplugs were cleaned.

On 11 September the aircraft was squawked for loss of 200 RPM during the run up. Maintenance replaced 2 sparkplugs and cleaned the others due to deposits on the sparkplugs.

On 12 September PK-KFC went down due to engine failure which was caused by detonation.

With regards to the accident of PK-KFC and the question of leaning procedures, the density altitude the time of the accident was 1700 feet. When the engine experienced the detonation it was at 1500 feet AGL which would have put the aircraft at a density altitude of 3200 feet. Lycoming recommends leaning the engine above 3000 feet. During the investigation by the insurance company the investigator noticed that there was no scoring or scratches on the inside of the number 2 cylinder which was caused due to the fact that the engine stopped running instantly after the detonation happened and did not happen during the climb or over a long period of time. The loss of power was reported the day before as noted above. In the report from the Light Aircraft Association it states "*If on the other hand the fuel vapourises from some hot spot or low pressure area in the fuel system but does not become entrapped, a stream of vapour bubbles will enter the carburettor along with the fuel, causing raised EGTs, lean running and reduced power, which in the typical fixed pitch propeller installation is* *evidenced by a loss in indicated rpm and possibly puffs of white smoke in the exhaust. "* The procedure of leaning of the engine was not the issue of the detonation or engine failure of the engine. The procedure of leaning the engine has been in place since the school started operating in January and none of these symptoms began until June when we began using the MOGAS.

PK-KFF

On 28 July PK-KFF was grounded for right magneto dropping to many RPM during the run up prior to take off. The mechanics replaced 4 spark plugs due to residue on them.

Synopsis

Every aircraft was noted to have a reduction in performance later as the fuel was continued to be used. All the pilots and maintenance noticed the fuel was sticky and had a funny smell to it when we first started using the MOGAS fuel from the first day of use.

Maintenance said that when the MOGAS fuel drums arrived they had corrosion and looked very old and faded.

Since we started using the MOGAS we have replaced a total of 12 Sparkplugs due to deposits on the sparkplugs.

All of the symptoms stated above are from old fuel and started when we started using the MOGAS we have in stock. All the squawks are from the aircraft journey logbooks and Flight Schedule Pro maintenance discrepancies. Every symptom associated with old fuel is present in the historical data of the aircraft and it all started in June through September using both mixed MOGAS/AVGAS and straight MOGAS. The mixing of AVGAS into the fuel we have now cannot be done as we cannot prove that it will make the fuel safe for use. According to the information we have this practice will not fix the issue as the report from the Light Aircraft Association states "*Assuming that your aircraft is cleared for use with both unleaded Mogas and with Avgas 100LL, there is no problem with mixing fuel of both types in your tank. "Note however that even with just a small proportion of Mogas in the tank, the vapour pressure of the mixture will be almost as high as that of pure Mogas, so all running on a mixture containing Mogas must be carried out observing the operating limitations for unleaded Mogas alone."*

Prior to the use of the MOGAS we had no indication of abnormal engine operations. There were several other instances where the maintenance was alerted to a rough running engine and they cleaned the sparkplugs after the use of the MOGAS began. Almost every flight we had to clear the magnetos due to a rough running engine to remove deposits from the sparkplugs.

When I asked you how long it took for fuel to arrive from the time it was ordered you said it takes about a week. If you want to test the fuel and the results take another week that will put the use of fuel to only one week until we have to dispose of it due to the end of its shelf life of 2 to 3 weeks. I cannot verify the date of manufacture of the fuel we have received so far.

Since we have switched back to pure AVGAS we have had only one issue of power loss from an aircraft and that was during flight when power was reduced below 2000 RPM during a day with very high humidity which caused the carburetor to develop carburetor icing. No student pilots or instructors have had to clear the magnetos to burn any deposits off the spark plugs since we have changed to pure AVGAS.

Conclusion

With this knowledge and the research I have given to you by Light Aircraft Aviation group *1 and Shell Oil Company *2 and the Civil Aviation Authority of the UK *3 stating that the fuel should not be used above 20°C due to the volatility being higher, and the chance of vapor lock happening as well as carburetor icing, the symptoms of old fuel, and the fact that the fuel we have in stock was received in June, we cannot use of the MOGAS we have in stock and a different solution needs to be found.

The argument of financial savings for the company using MOGAS instead of using AVGAS weighs heavily towards AVGAS. During the months of January until we started using the MOGAS we never had an aircraft down or squawked for engine issues. Since we have started using MOGAS and a mix of AVGAS and MOGAS we have lost a total of 99 flying days due to aircraft on the ground. That is a loss of around 400 flight hours. The cost of 12 sparkplugs of $29.83 each or, a total of around $358 and around 400 man hours due to the use of the MOGAS and the loss of an aircraft reducing our fleet by 20% is not efficient and is actually very expensive.

As the Chief Flight Instructor here at FlyBest Flight Academy I cannot allow the use of MOGAS fuel in our aircraft since it is an obvious risk to the safety of our students and instructors. The fuel MOGAS may be usable to other climates with cooler temperatures and faster delivery times but it cannot be done so here.
I hope you can understand why I have taken this position with regards to the use of the MOGAS fuel. I have the responsibility to the students, staff and company to prevent anything that has to do with safety from affecting the outcome of any flight or training the students will receive here at FlyBest. I do understand the concept of saving costs and being as efficient as possible.

Sincerely,

Chief Flight Instructor
FlyBest Flight Academy