ENGINE PERFORMANCE

1. ENGINE OPERATION: Four cycle, internal combustion, aircraft engines.

   A. Are primarily air cooled by air circulation over the cylinders.
   B. Are internally cooled by the circulation of lubricating oil.

2. Aircraft engines can be made to exceed their normal operating temperatures by:

   A. Climbing too steeply, particularly in hot weather, thus retarding the flow of air over the cylinders.
   B. Using too much power for the given conditions of flight.
   C. Having too low an oil quantity. Note: Too high an oil pressure will not cause overheating.
   D. Having too low an oil pressure, thus there is not enough oil circulating friction.
   E. Using a grade of fuel lower than prescribed for the engine.
   F. Running the engine with the mixture set too lean.

3. REMEDIES FOR AN OVERHEATED ENGINE

   A. Reduce your climb angle thus speeding up the airflow over the cylinders.
   B. Reduce power if necessary to bring temperatures back within normal limits.
   C. Make sure oil quantity is sufficient prior to flight.
   D. Make sure that pressure indicates normal prior to flight during runup.
   E. Use the proper grade of fuel. If not available, use the next highest octane but never use a lower grade of fuel or automobile fuel.

4. CONSEQUENCES OF AN OVERHEATED ENGINE

   A. Loss of power
   B. Excessive oil consumption
   C. Detonation of fuel rather than even burning
   D. Possible permanent internal engine damage

5. MIXTURE CONTROL

   The mixture control in your aircraft is a knob which you can adjust in order to vary the amount of fuel that mixes with the air in the carburetor of your aircraft. If you understand why a carburetor jet in a car needs to be regulated for the altitude in which the automobile operates, then your understanding of the mixture control will be simple for you to understand. As the airplane gains altitude and the air becomes thinner, the mixture control must be leaned out so that not so much fuel is available for burning since there is not much air available. As the airplane descends to a lower altitude, the mixture control must be enrichened in order to provide more fuel to burn since there is more air available.

IF THE MIXTURE IS TOO RICH:

1. Spark plugs will foul.
2. Engine will lose power.
3. Operating temperatures will drop.
4. Engine will run roughly.
5. You will burn more fuel than is necessary.

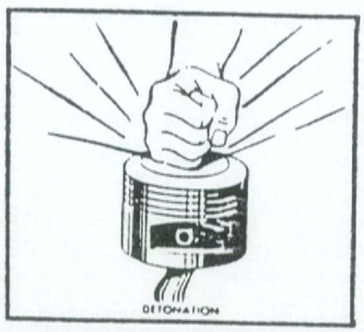
IF THE MIXTURE IS TOO LEAN:

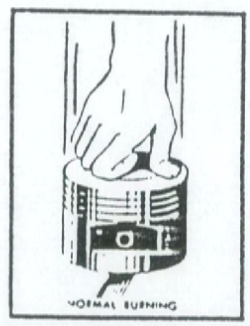
1. Engine will run roughly.
2. Engine will lose power.
3. Engine will overheat.
4. Fuel will detonate instead of burn.
5. Damage to the engine can occur due to overheating.

6. DETONATION - is the process by which fuel explodes in the cylinders rather than burn evenly and can cause great damage since this exploding can take place when the piston is in the wrong position.

   You can prevent detonation in the following ways:

   A. Do not use fuel of a lower octane rating than specified. If the proper fuel is not available use the next higher grade.
   B. Avoid rapid, abrupt, throttle control. Be smooth with the power.
   C. Do not run the engine too lean. A richer mixture will help to prevent detonation.
   D. Excessive engine temperatures can bring about detonation. Excessive engine temperatures are caused by climbing steeply, lean mixture, and lower than specified fuel grade.
   E. Detonation can be detected by a "pinging" sound, similar to an automobile than "pings".





7. AIRCRAFT ENGINE FUEL

   Aircraft engine fuel is specially blended to meet criterias of engine octane, compression, use at altitude, etc. Therefore, never use automotive fuel in your airplane.

   To eliminate the possibility of contaminated fuel:

   A. Fill the tanks after each flight. This prevents air from entering the fuel cells. The air cools at night and the water in the air condences on the walls of the fuel cell. This causes water to form in the tanks (fuel cells).
   B. Prior to every flight, drain fuel from the bottom of the tanks and from the fuel sump. This will allow you to visually check for water and to take appropriate action if there is water in your fuel.

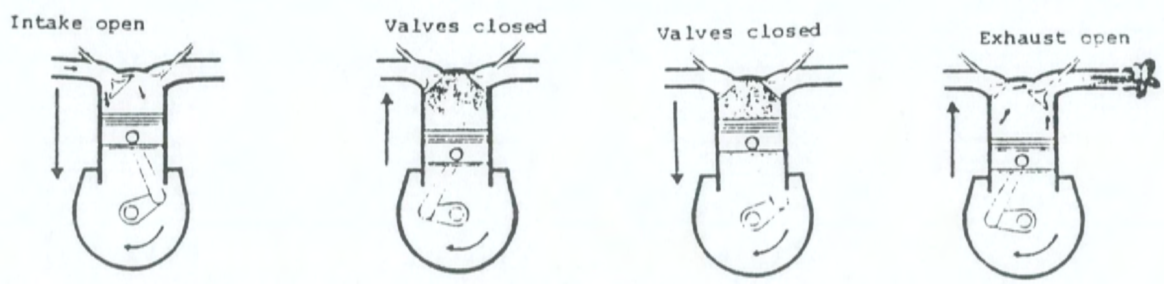
BASIC OPERATION OF A FOUR CYCLE INTERNAL COMBUSTION ENGINE

You will be asked on your examination to inspect some diagrams portraying cylinders and valves on top of these cylinders in varying positions. You must then decide what is going on in the engine.

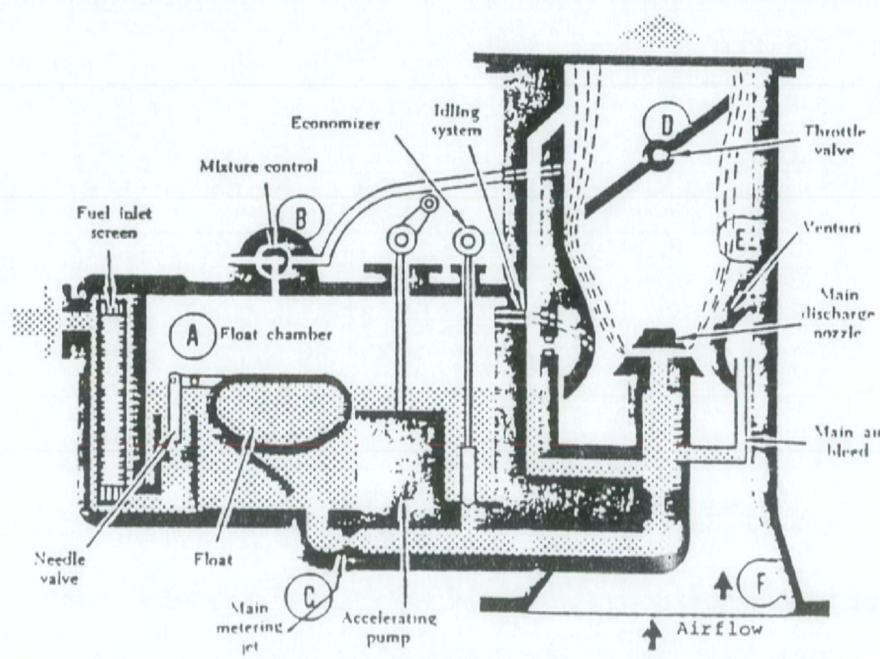
1. If the piston is going down with a valve open - this is the intake cycle.
2. If the piston is going up with all valves closed - this is the compression cycle.
3. If the piston is going down with all valves closed - this is the power cycle.
4. If the piston is going up with a valve open - this is the exhaust cycle.

FOUR STROKE PISTON CYCLE

INTAKE | COMBUSTION | POWER | EXHAUST



Note: Rapid opening and closing of the throttle may cause damage to the crankshaft.



FLOAT-TYPE CARBURETOR

CARBURETOR ICING

Carburetors in normally aspirated aircraft engines can develop ice, thus causing the engine to quit running, due to starvation of adequate fuel to the engine.

1. CAUSES OF CARBURETOR ICING:

   A. Vaporization of fuel when going through the carburetor lowers air temperatures in the carburetor thus freezing the moisture in the air.
   B. The shape of the carburetor itself, especially where constrictions called Venturi exist, can speed up airflow, thus cooling its temperature and freezing moisture.
   C. Carburetor ice is most prevalent at low power settings due to the closed position of the throttle valve which increases the speed of the airflow, thus dropping its temperature and freezing the moisture in the air.
   D. Ice collects principally at the throttle valve and in the Venturi.
   E. Visible moisture need not be present in the air to get carburetor icing.
   F. Carburetor air temperatures can be 60 degrees farenheit colder than outside air temperature.

2. REMEDIES OF CARBURETOR ICING:

   A. Apply full hot carburetor heat to remove the existing ice, then follow the manufacturers recommendation. If carburetor ice is present when you apply carburetor heat, the RPM or manifold pressure will drop then rise as the ice melts. When you push the carburetor heat to the cold position the RPM or manifold pressure will return to its original condition before the ice was present.

   B. Carburetor heat reduces the density of the air by heating it and this makes the mixture richer. If you apply carb heat and no ice is present the RPM or manifold pressure will drop and remain at the lower indication.

3. FUEL INJECTION vs. CARBURETOR

   Carburetors mix the fuel and air together. Fuel injection injects the fuel directly to the cylinders.

   A. ADVANTAGES:

      1. Reduction in evaporative icing
      2. Better fuel flow
      3. Precise control of mixture
      4. Better fuel distribution
      5. Easier cold weather starts

B. <u>DISADVANTAGES</u>:

1. Difficulty in starting a hot engine
2. Vapor locks during ground operations on hot days
3. Problems associated with restarting an engine that quits because of fuel starvation.

PROPELLERS

1. FIXED PITCH PROPELLERS

Angle of the blade cannot be changed. Indication of engine power is found only in the tachometer measuring RPM.

2. CONSTANT SPEED PROPELLERS

Angle of the blade can be changed manually and will change itself automatically in the event of reduced power output. Therefore, engine power must be determined from the manifold pressure gauge and not the tachometer.

If <u>increasing</u> power, first, decrease blade angle thus increasing the RPM (low pitch) then increase the manifold pressure (throttle).

If <u>decreasing</u> power, first, reduce the manifold pressure (throttle) then increase the blade angle reducing RPM (high pitch).

THE ELECTRICAL SYSTEM OF THE AIRCRAFT

1. The electrical system in the airplane contains a battery, master switch, alternator or generator, voltage regulator, and all the accessories such as lights, electric flaps, avionics (radios, navigation radios, etc.)

2. If you suspect electrical system trouble due to a blown fuse, breaker, ozone smoke, etc. merely shut off the master switch. Diagnose the offending component and isolate it from the circuit and go on about your business.

3. The master switch and the other components of the electrical system have nothing to do with the operation of the engine.

4. The <u>ignition system</u> of the aircraft engine is totally separate from the electrical system. The ignition system is powered by two magnetos which generate spark to the plugs, thus causing them to fire, and the engine to run. These magnetos fire two spark plugs to each cylinder, thus giving you twin ignition and almost fool-proof regularity of operation, regardless of the condition of the electrical system of the aircraft.

581. Excessively high engine temperatures, either in the air or on the ground, will

P02 1- cause damage to heat-conducting hoses and warping of the cylinder cooling fins.

2- cause loss of power, excessive oil consumption, and possible permanent internal engine damage.

3- not appreciably affect an aircraft engine in either environment.

4- increase fuel consumption and may increase power due to the increased heat.

582. For internal cooling, reciprocating aircraft engines are especially dependent on

P02 1- a properly functioning thermostat.

2- air flowing over the exhaust manifold.

3- the circulation of lubricating oil.

4- a lean fuel/air mixture.

583. What change occurs in the fuel/air mixture when carburetor heat is applied?

P01 1- A decrease in RPM results from the lean mixture.

2- No change occurs in the fuel/air mixture.

3- The fuel/air mixture becomes leaner.

4- The fuel/air mixture becomes richer.

584. In comparison to fuel injection systems, float-type carburetor systems are generally considered to be

P01 1- equally susceptible to icing as a fuel injection unit.

2- susceptible to icing only when visible moisture is present.

3- more susceptible to icing than a fuel injection unit.

4- less susceptible to icing than a fuel injection unit.

585. In comparing a fuel injection system with a float-type carburetor system, the carburetor equipped aircraft engine is generally considered to be

P01 1- less susceptible to icing than a fuel injection unit.

2- susceptible to icing only when visible moisture is present.

3- equally susceptible to icing as a fuel injection unit.

4- more susceptible to icing than a fuel injection unit.

586. Compare carburetor equipped engines with fuel injection equipped engines. Select the true statement concerning these systems.

P01 1- The carburetor system provides easier cold weather starts and a more precise control of mixture.

2- The fuel injection system is generally considered to be less susceptible to icing.

3- The carburetor equipped engine provides better fuel distribution and faster throttle response.

4- With a fuel injection system, it is usually less difficult to start a hot engine and there is less chance of a vapor lock.

587. Concerning torque effect on a single-engine propeller-driven airplane, in which of the following airspeed and power conditions would torque effect be the greatest?

023 1- High airspeed; low power.
2- Low airspeed; high power.
3- High airspeed; high power.
4- Low airspeed; low power.

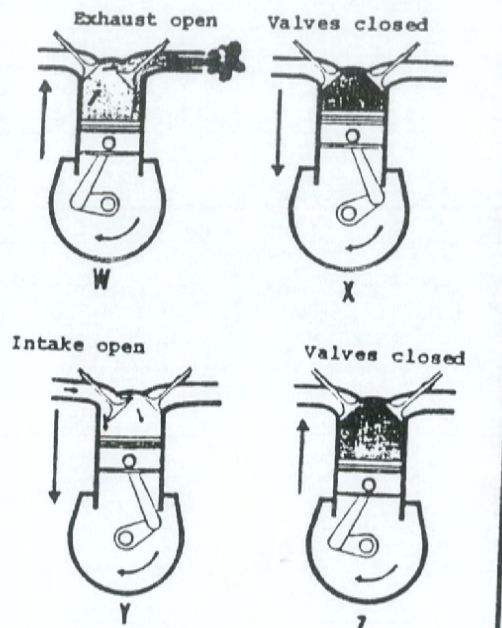
588. Which statement is true relative to trimming a single-engine propeller-driven airplane to compensate for the effects of torque?

023 1- If power is reduced (airspeed constant), right rudder trim must be added.

2- If power is increased (airspeed constant), left rudder trim must be added.

3- If airspeed is decreased (power constant), right rudder trim must be added.

4- If airspeed is increased (power constant), right rudder trim must be added.



FOUR-STROKE CYCLE

589. Refer to the diagram above. Which illustration depicts the power stroke?

P02
1- W.
2- X.
3- Y.
4- Z.

590. Refer to the diagram above. Which illustration depicts the exhaust stroke?

P02
1- X.
2- Y.
3- W.
4- Z.

591. Refer to the diagram above. Illustration "X" depicts the

P02
1- compression stroke.
2- ignition stroke.
3- power stroke.
4- fuel injection stroke.

592. Refer to the illustration above. What is the proper sequence of the four strokes of the piston of a gasoline engine?

P02
1- Y, Z, X, W.
2- W, Y, X, Z.
3- Z, X, Y, W.
4- X, W, Z, Y.

593. Refer to the diagram to the left. Which illustration depicts the compression stroke?

P02
1- X.
2- Y.
3- W.
4- Z.

594. During the runup at a high elevation airport you note a slight engine roughness that is not affected by the magneto check, but grows worse during the carburetor heat check. Under these circumstances, which of the following would be the most logical initial action?

P04
1- Check the results obtained with a leaner setting of the mixture control.
2- Taxi back to the flight line for a maintenance check.
3- Reduce manifold pressure to control detonation.
4- Check to see that the mixture control is in the full rich position.

595. The basic purpose of adjusting the fuel/air mixture control at altitude is to

P04
1- decrease the amount of fuel in the mixture in order to compensate for increased air density.
2- decrease the fuel flow in order to compensate for decreased air density.
3- increase the amount of fuel in the mixture to compensate for the decrease in pressure and density of the air.
4- increase the fuel/air ratio for flying at altitude.

596. Assume that on your runup at an airport where the elevation is 6,000 feet MSL, you note a slight engine roughness that is not significantly affected by the magneto check but grows worse during the carburetor heat check. Under these circumstances, which of the following would be your most logical initial action?

P04
1- Check to see that the mixture control is in the full rich position.
2- Reduce manifold pressure to control detonation.
3- Taxi back to the flight line for a maintenance check.
4- Check the results obtained with a leaner setting of the mixture control.

597. With regard to the use of aviation gasoline, which statement is true?

P05

1- Use of a higher-than-specified grade of fuel usually results in lower-than-normal cylinder head temperatures.

2- Use of the next higher-than-specified grade of fuel is permissible if the specified grade of fuel is not available.

3- Use of the next lower-than-specified grade of fuel is permissible and it is usually not harmful to the engine.

4- Use of a lower-than-specified grade of fuel may result in a reduced power output but is usually less harmful than higher rated fuel.

598. Aircraft engine crankshafts are very susceptible to overstress. A detuning of engine crankshaft counterweights is a source of overstress that may be caused by

P04

1- carburetor ice forming on the throttle valve.

2- rapid opening and closing of the throttle.

3- operating with an excessively rich fuel/air mixture.

4- extended glides with reduced power.

599. Assume that while cruising at 9,500 feet MSL the fuel/air mixture is properly adjusted. If a descent to 4,500 feet MSL is made without readjusting the mixture control

P04

1- the fuel/air mixture may become excessively lean.

2- there will be more fuel in the cylinders than is needed for normal combustion, and the "excess fuel" will absorb heat and cool the engine.

3- the excessively rich mixture will create higher cylinder head temperatures and may cause detonation.

4- the fuel/air mixture may become excessively rich.

638. Applying carburetor heat will

P18

1- result in more air going through the carburetor.

2- not affect the mixture.

3- enrich the fuel/air mixture.

4- lean the fuel/air mixture.

600. Concerning the use of the proper grade of aviation gasoline, select the true statement from the following:

P05

1- Use of a higher-than-specified grade usually results in lower-than-normal cylinder head temperatures.

2- Use of the next higher-than-specified grade is permissible if the specified grade is not available.

3- Use of the next lower-than-specified grade is permissible and it is usually not harmful to the engine.

4- Use of a lower-than-specified grade may result in a reduced power output but is usually less harmful than higher grade fuel.

601. Select the true statement regarding the use of the proper grade of gasoline specified for a particular engine.

P05

1- The use of a grade higher than specified improves engine operation because of the higher octane or performance number.

2- Most aircraft engines would be difficult or perhaps impossible to start when a grade lower than specified is used.

3- Using the next lower-than-specified grade fuel is usually more harmful to an aircraft engine than using the next higher-than-specified grade fuel.

4- It is recommended that the next higher grade of automotive gasoline be used when aviation fuel is not available.

602. If the grade of fuel used in an aircraft engine is lower than specified for the engine, it will most likely cause

P05

1- a mixture of fuel and air that is not uniform in all cylinders.

2- lower cylinder head temperatures.

3- an increase in power which could overstress internal engine components.

4- detonation.

632. If an airplane engine continues to run after the ignition switch is turned to the "OFF" position, the probable cause may be

P16

1- the mixture is too lean and this causes the engine to diesel.

2- the voltage regulator points are sticking closed.

3- a broken magneto ground wire.

4- fouled spark plugs.

603. An abnormally high engine oil temperature indication may be caused by

P10

1- the oil level being too low.

2- a defective bearing.

3- operating with an excessively rich mixture.

4- the oil level being too high.

604. The primary reason for filling the fuel tanks to capacity after the last flight of the day is to reduce the airspace in the tanks so that

P09

1- moisture would not condense and create water in the fuel system.

2- evaporation of leaded fuel would not leave a chemical residue and contaminate the remaining fuel.

3- air or vapor could not enter the fuel lines and cause vapor lock.

4- vaporization of the fuel, or fuel fumes, could not create a fire hazard.

605. Filling the fuel tanks after the last flight of the day is considered a good operating procedure because this will

P09

1- force any existing water to the top of the tank away from the fuel lines to the engine.

2- prevent expansion of the fuel by eliminating airspace in the tanks.

3- prevent moisture condensation by eliminating airspace in the tanks.

4- eliminate vaporization of the fuel.

606. Detonation occurs in a reciprocating aircraft engine when

P08

1- the spark plugs are "fouled" or "shorted out" or the wiring is defective.

2- hot spots in the combustion chamber ignite the fuel/air mixture in advance of normal ignition.

3- there is too rich a fuel/air mixture.

4- the unburned charge in the cylinders explodes instead of burning normally.

607. If you suspect that the engine (with a fixed-pitch propeller) is detonating during climb-out after takeoff, normally the corrective action to take would be to

P08

1- increase the rate of climb.

2- retard the throttle.

3- lean the mixture.

4- apply carburetor heat.

608. Concerning detonation in an aircraft engine, select the true statement from the following:

P08

1- Detonation may be caused by opening the throttle abruptly when the engine is running at slow speeds.

2- Detonation is most likely to occur immediately after starting a cold engine.

3- Detonation is usually caused by too rich a mixture.

4- Detonation can easily be detected by a "pinging" sound.

609. The practice of running a fuel tank dry before switching tanks is considered unwise because

P06

1- the engine-driven fuel pump or electric fuel boost pump may draw air into the fuel system and cause vapor lock.

2- the engine-driven fuel pump is lubricated by fuel and operating on a dry tank may cause pump failure.

3- any foreign matter in the tank will be pumped into the fuel system.

4- the fuel pump is located above the bottom portion of the fuel tank.

610. Which statement is true regarding aircraft engines that are equipped with a fuel injection system instead of a carburetor?

P06

1- Slow throttle response is one of the disadvantages of fuel injection.

2- Fuel injection provides better fuel flow and fuel distribution to the engine.

3- A disadvantage of fuel injection is the difficulty experienced in cold weather starting.

4- Vapor locks during ground operations on hot days are less apt to occur with fuel injection.

630. Concerning the advantages of a generator or an alternator in an airplane's electrical system, select the true statement.

P16 1- A generator charges the battery during low engine RPM and therefore the battery has less chance to become fully discharged, as often occurs with an alternator.

2- An alternator provides more electrical power output at lower engine RPM than a generator.

3- A generator always provides more electrical current than an alternator.

4- An alternator provides electrical current and eliminates the need for an aircraft to be equipped with a battery.

631. What is the result of permitting an airplane engine to idle for a long period of time while on the ground?

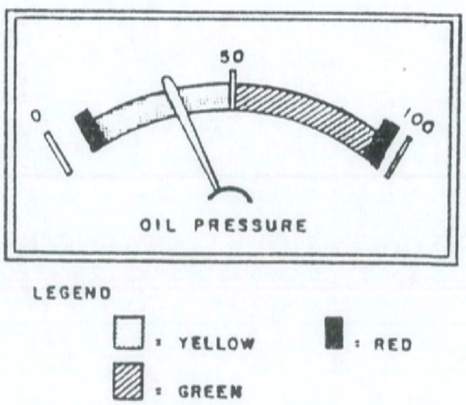
P16 1- A hydraulic lock may develop in one or more cylinders.

2- It may cause excessively high oil pressure.

3- The lean mixture may cause the engine to miss or quit.

4- The spark plugs may become fouled.

612. Suppose the engine oil temperature is normal, but the oil pressure has dropped below the normal operating range as indicated below.



If the engine is running smoothly, the best procedure to follow would be to

P10 1- check the circuit breakers to determine if you have lost electrical power, and enrich the mixture to lessen the chances of detonation.

2- continue to the nearest airport and land.

3- make a precautionary landing on the nearest stretch of straight highway.

4- declare an emergency on the frequency 121.5 MHz.

633. Suppose the cylinder head temperature and engine oil temperature gauges have exceeded their normal operating range during flight. One possible cause of this may be

P15 1- operating with higher-than-normal oil pressure.

2- climbing too steeply, particularly in hot weather.

3- using fuel that has a higher-than-specified fuel rating.

4- operating with an excessively rich mixture.

634. Which of the following would most likely cause the cylinder head temperature and engine oil temperature gauges to exceed their normal operating range?

P15 1- Using fuel that has a lower-than-specified fuel rating.

2- Using fuel that has a higher-than-specified fuel rating.

3- Operating with higher-than-normal oil pressure.

4- Operating with the mixture control set too rich.

635. During flight, suppose the engine oil temperature and cylinder head temperature gauges have exceeded their normal operating range. Select from the list below those conditions which might cause this problem.

A. Operating with too much power.
B. Using fuel that has a higher-than-specified fuel rating.
C. Operating with higher-than-normal oil pressure.
D. Climbing too steeply in hot weather.
E. Using fuel that has a lower-than-specified fuel rating.
F. Mixture control set too rich.

The possible causes of this problem are:

P15 1- A, D, E.
2- B, C, D, F.
3- A, B, C, D.
4- C, E, F.