LONG BEACH
CITY COLLEGE

Heavy Duty Entry Level Technician Course

Diesel Engine Components Theory & Maintenance

Created by:

Mark D. Adair

3.8.2016

Course Instructor

- Mark D. Adair
- Experience
- Over 30 years working in the diesel technology field.
- Factory certified technician for Cummins, Caterpillar & Detroit Diesel Engines.
- Manager of numerous EPA and ARB engine test cells and emission laboratories.
- Participated in the development of the first SCR, DPF ,Bio Diesel fuel & Ethanol fuel technologies ever sold in USA.

3.8.2016

Sign-In Sheet

- Restrooms
- Parking Passes
- Sign-In Sheet
- Participant Form
- Smoking Area

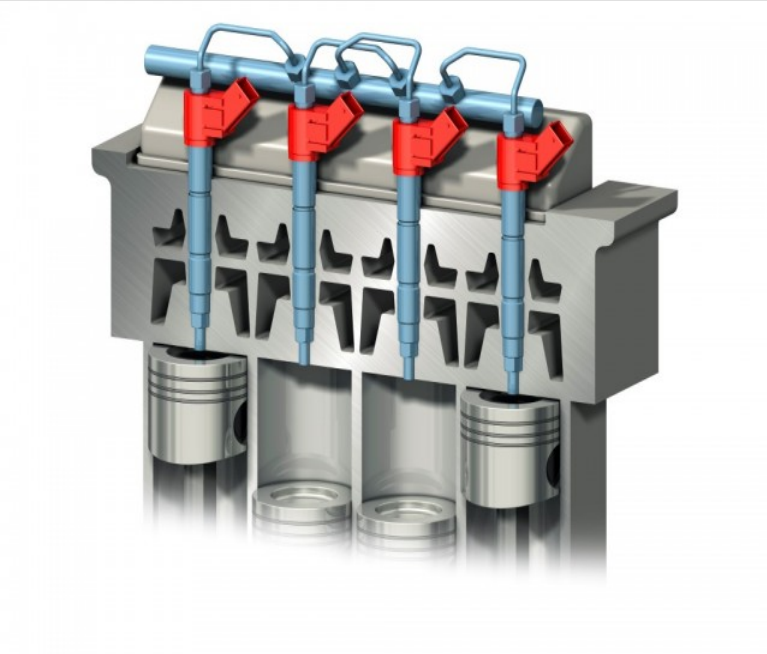
Note: Put your name in your book

Class Introductions

- Name
- Title
- Type of Vehicles in Fleet
- Experience with Diesel Engines
- Prior Diesel classes taken
- Military Experience

LONG BEACH
CITY COLLEGE

Diesel Engine Component Identification & Function



Disclaimer

The Material presented here is intended for instructional purposes only. Please be sure to follow manufacturer's latest bulletins and procedures as the ultimate source.

Instructional Objectives

By the end of this course the student will be able to:

- Identify diesel engine components
- Understand the function of engine components
- Perform an engine leak down test
- Perform an engine blow by test
- Perform an air induction restriction test
- Perform an exhaust back pressure test
- Perform an engine oil pressure test
- Perform a cooling system pressure testing
- Perform a preventive maintenance Inspection of a diesel engine
- Perform a PM A / PM B service on a heavy duty truck engine

Agenda

- Component identification & function
- Engine leak down Test
- Engine blow by test
- Air induction restriction test
- Exhaust back pressure test
- Engine oil pressure test
- Engine cooling system pressure test
- Engine preventive maintenance inspection

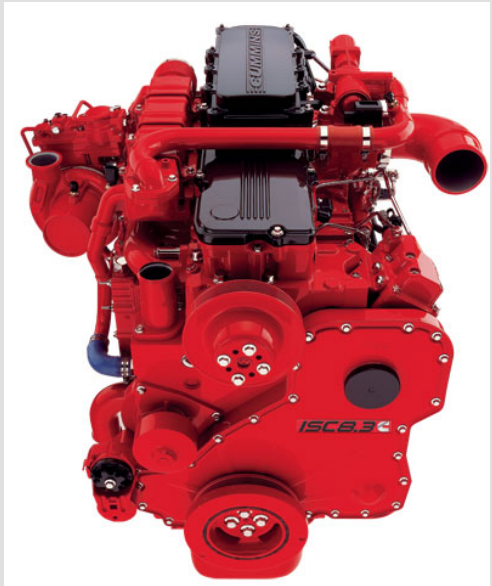
Tech Tip: Bring a USB Memory Drive to Level 2 to obtain bonus electronic handout materials.

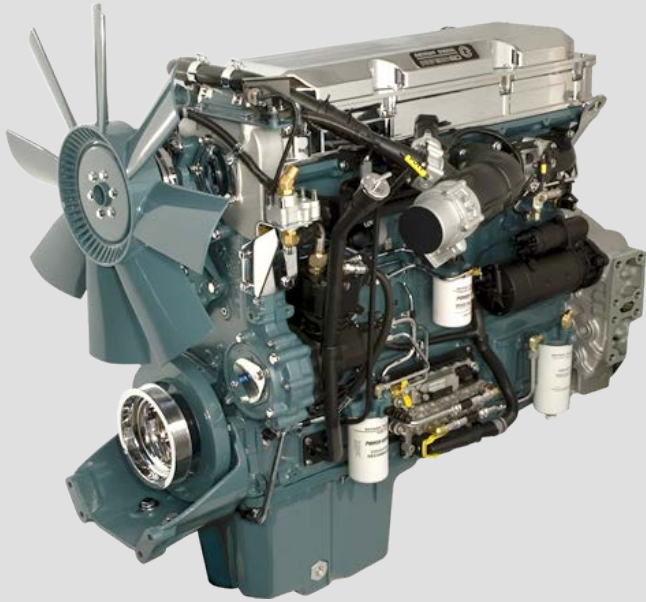
Module One

Engine examples used for this course and testing procedures;

Cummins ISG

Cummins ISC





Detroit Diesel
Series 60

Theory

Component identification & function

What is a compression ignited engine:

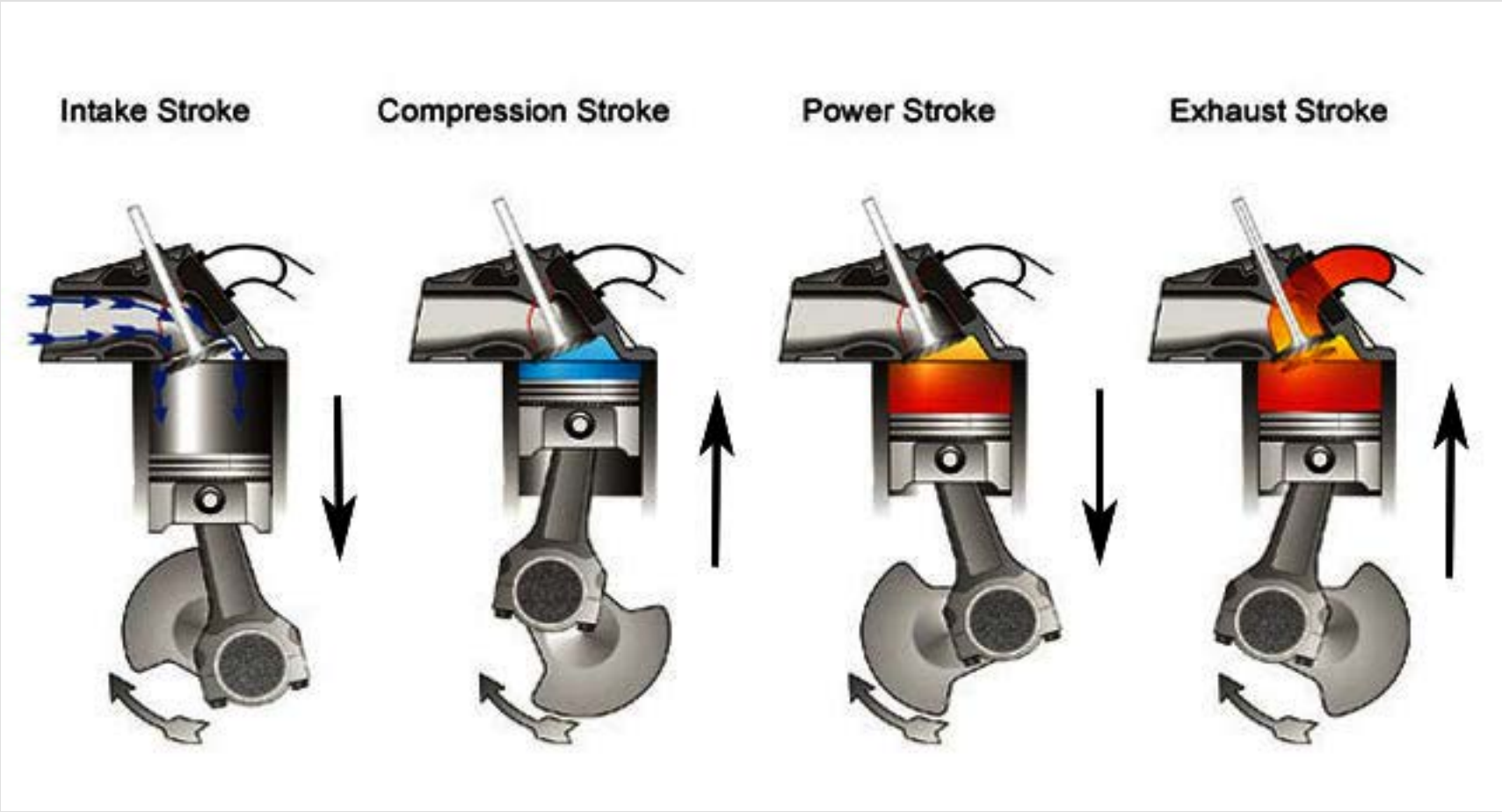
The **compression-ignition** or CI engine is and internal combustion engine in which ignition of the fuel that has been injected or fumigated into the combustion chamber is ignited by the high temperature which a gas achieves when greatly compressed.

Including

1. Natural gas
2. Propane gas
3. Diesel fuel
4. Bio Diesel fuel

Theory

Component identification & function

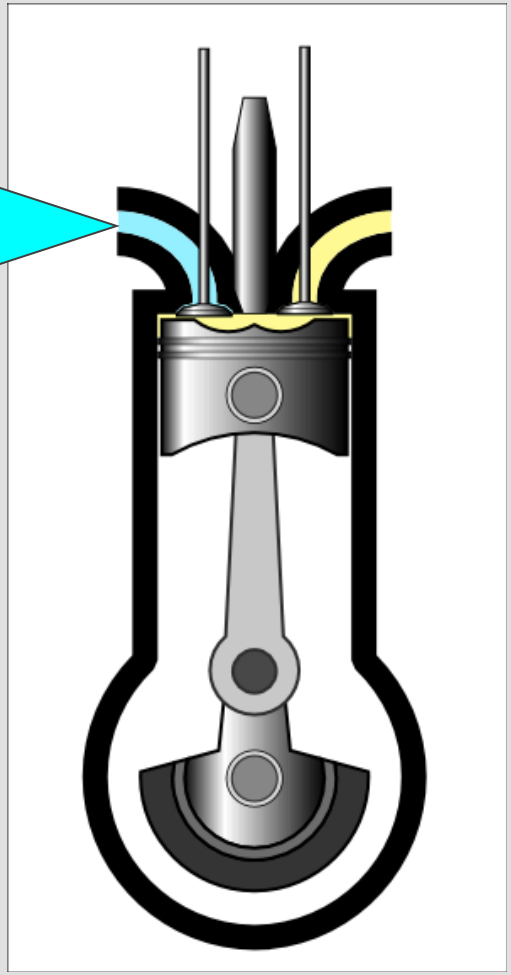


Four stoke engine operation

Natural gas or propane fumigation through the intake of CI engine

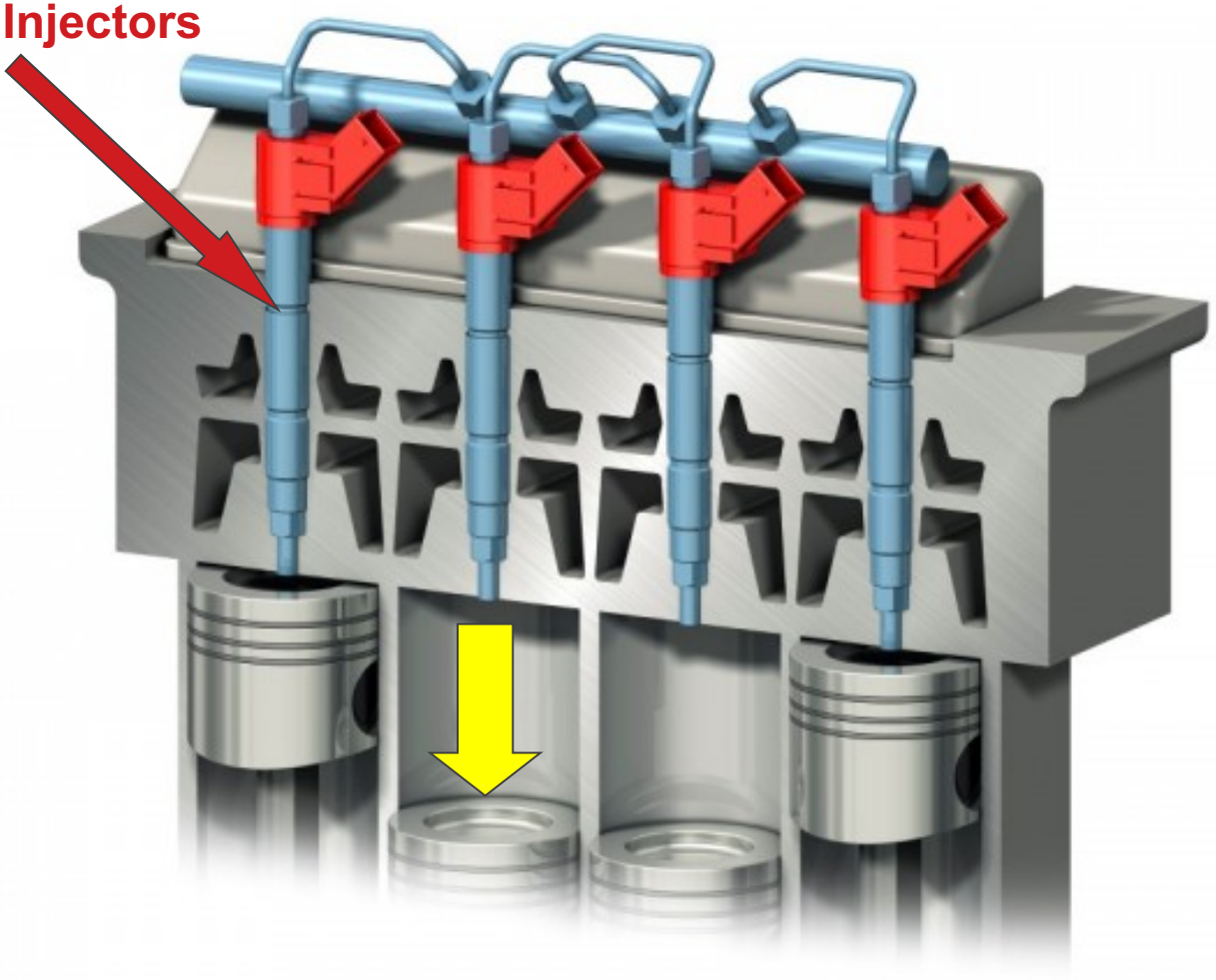
Fumigation

A gaseous fuel flowing into the CI engine air intake



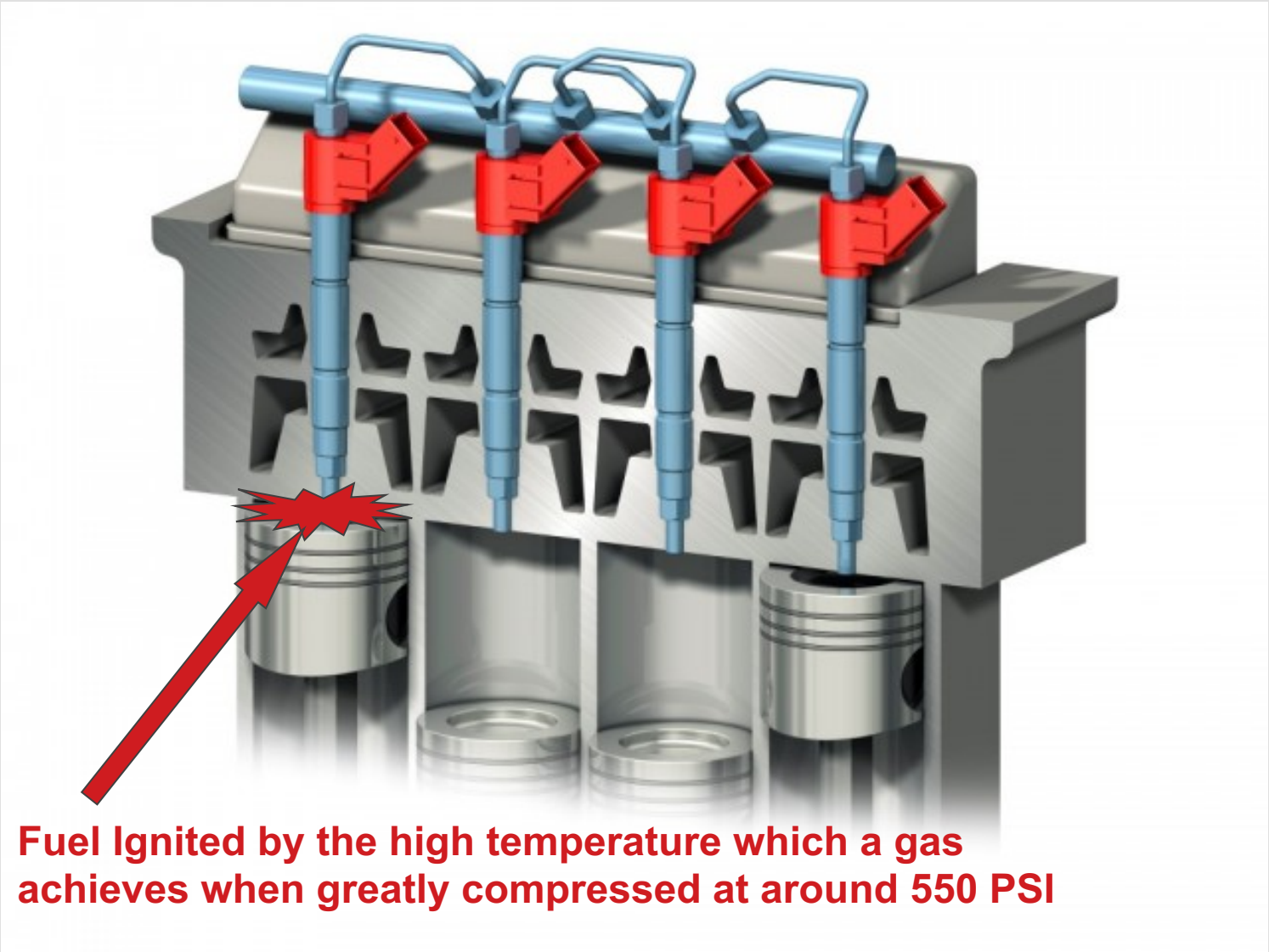
Diesel Engine Component Theory & Maintenance

Diesel Fuel Injectors



Diesel fuel injected into the combustion chamber

Diesel Engine Component Theory & Maintenance



Fuel Ignited by the high temperature which a gas achieves when greatly compressed at around 550 PSI

Theory

Component identification & function :

YOUTUBE Click on Hyperlink below

CI Engine , How it works

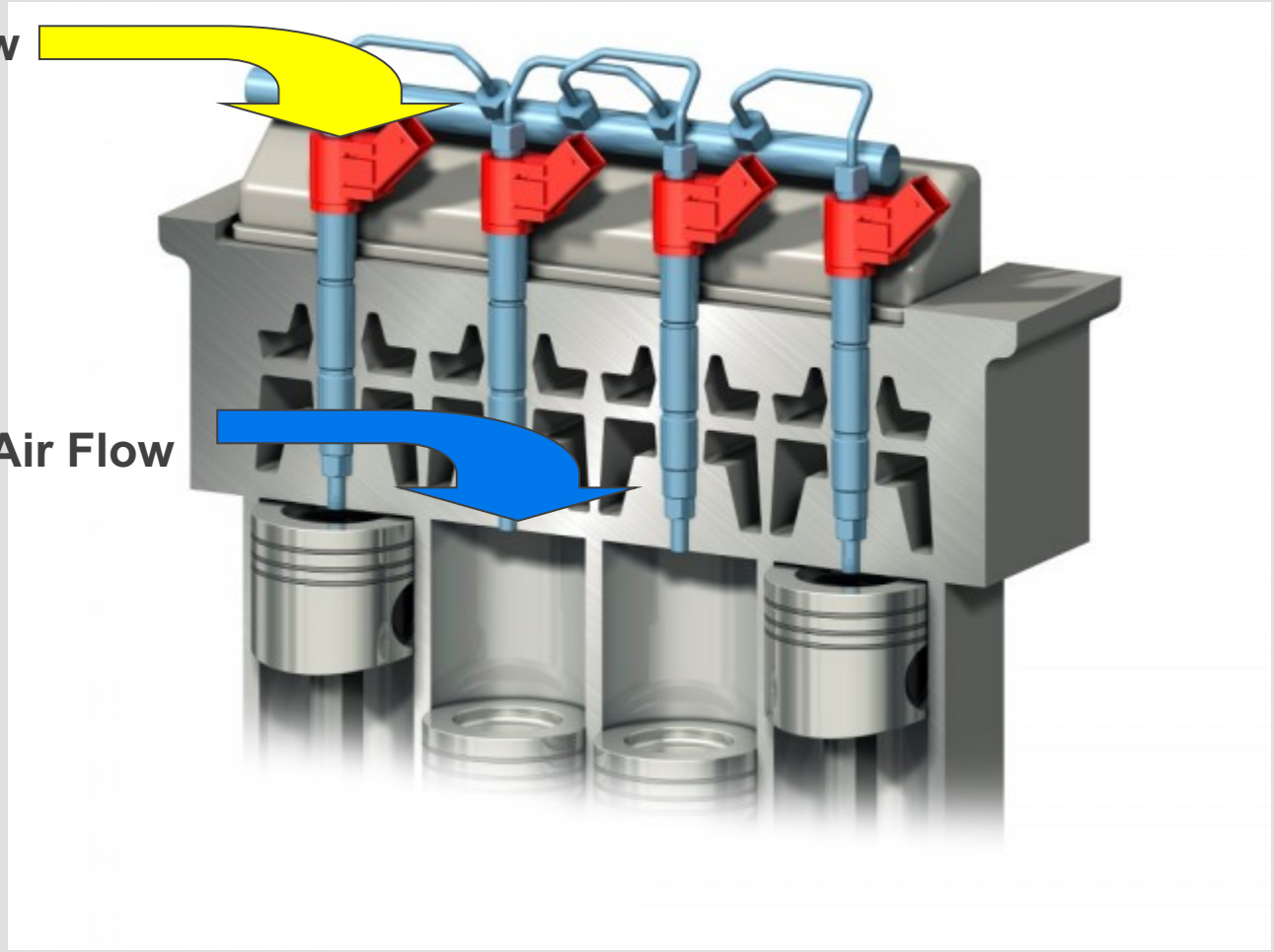
Video length 6:20 minutes

Diesel Engine Component Theory & Maintenance

What a Diesel engine needs to operate properly ?

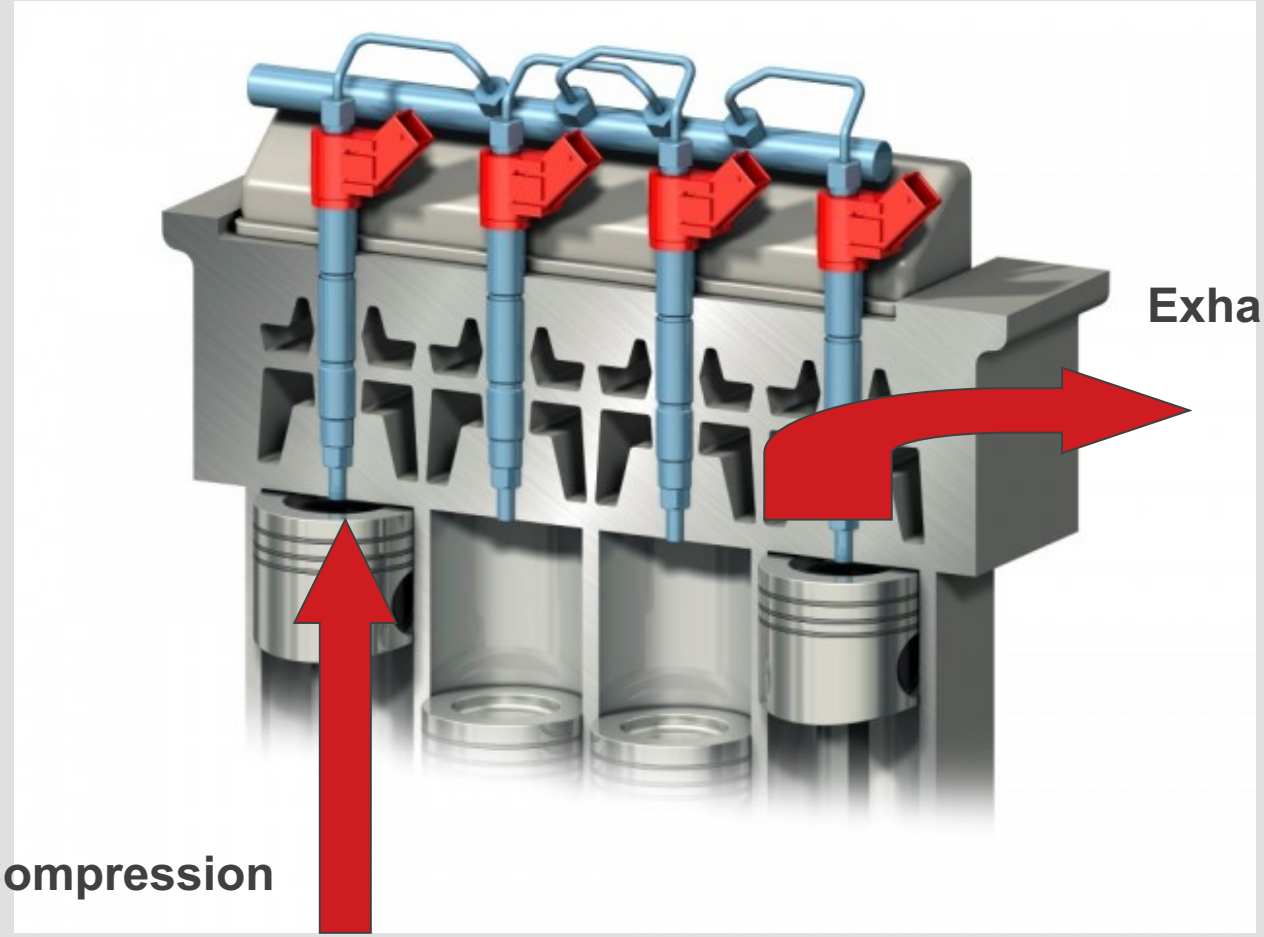
Fuel Pressure & Flow

Intake Air Flow



Diesel Engine Component Theory & Maintenance

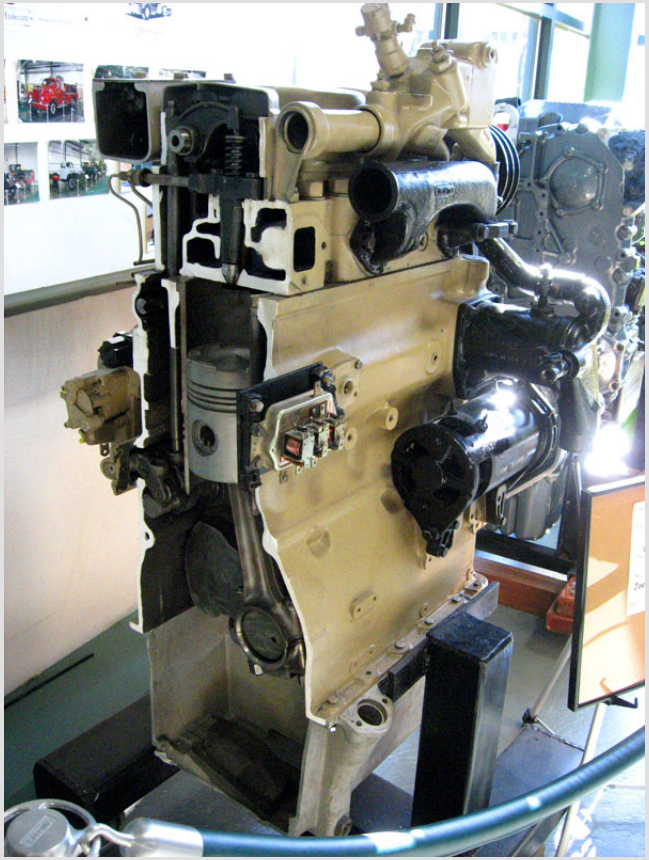
What does a Diesel engine need to operate properly ?



Theory

Component identification & function

Discussion of cut away diesel engine module and the function of the internal components.



Review Questions 1

1. What part allows the cold air to flow into the cylinder ?
2. What part allows the pressurized fuel to enter the cylinder ?
3. What part compresses the fuel / air mixture in the cylinder ?
4. What part allows the hot exhaust gas to flow out of the cylinder ?
5. What part is powered by the piston moving up and down from the fuel / air mixture being compressed and ignited ?

Review Questions 1

1. What part allows the cold air to flow into the cylinder ?

Intake valve

2. What part allows the pressurized fuel to enter the cylinder ?

Fuel Injector

3.What part compresses the fuel / air mixture in the cylinder ?

Piston

4.What part allows the hot exhaust gas to flow out of the cylinder ?

Exhaust valve

5.What part is powered by the piston moving up and down from the fuel / air mixture being compressed and ignited ?

Crankshaft

Theory

Engine Leak Down Test

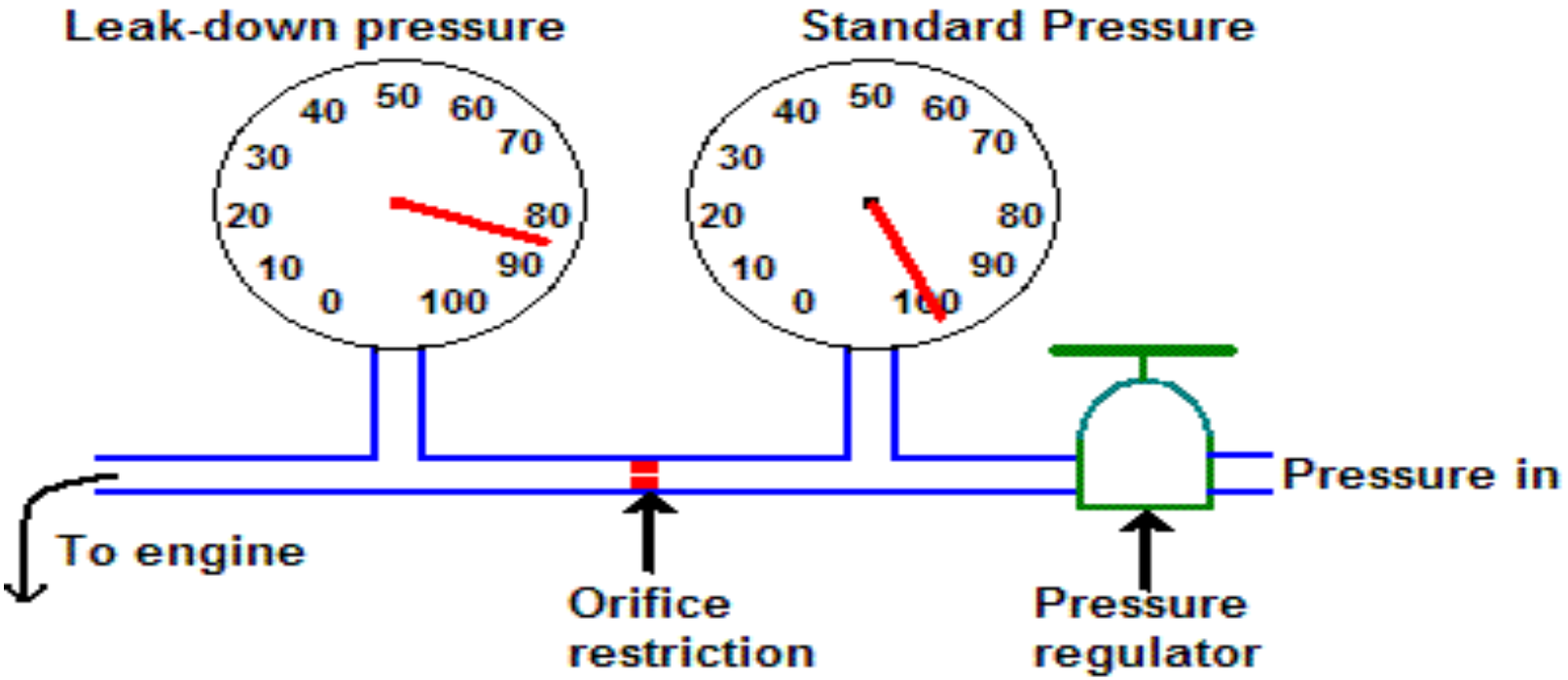
Determines there is a loss of compression in the cylinder.

Diagnose:

- **Loss of compression in cylinder through the valves**
- **Loss of compression in the cylinder past the piston rings**
- **Loss of compression entering the cooling system**

Theory

Engine Leak Down Test

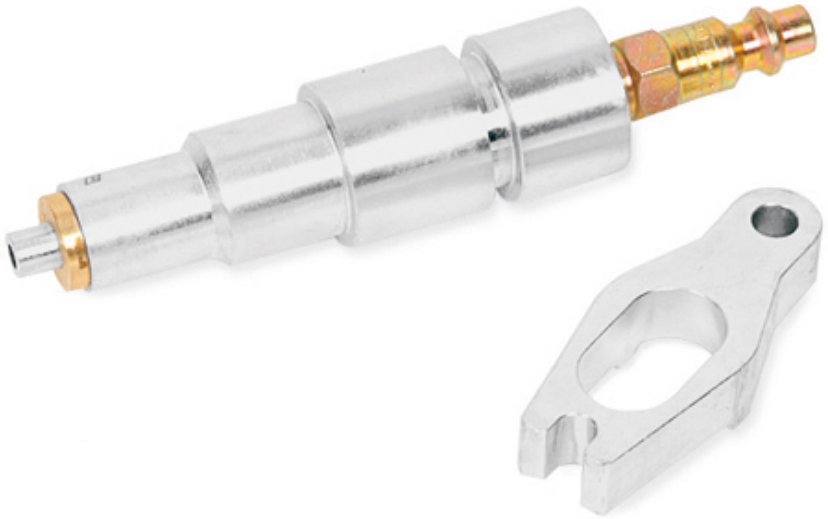


Lab Activity: 1.1 (cont.)

Engine Leak Down Test

Engine Leak down tester

Injector adaptor



Injector adaptor
hold down clamp

Lab Activity: 1.1 (cont.)

Engine Leak Down Test :

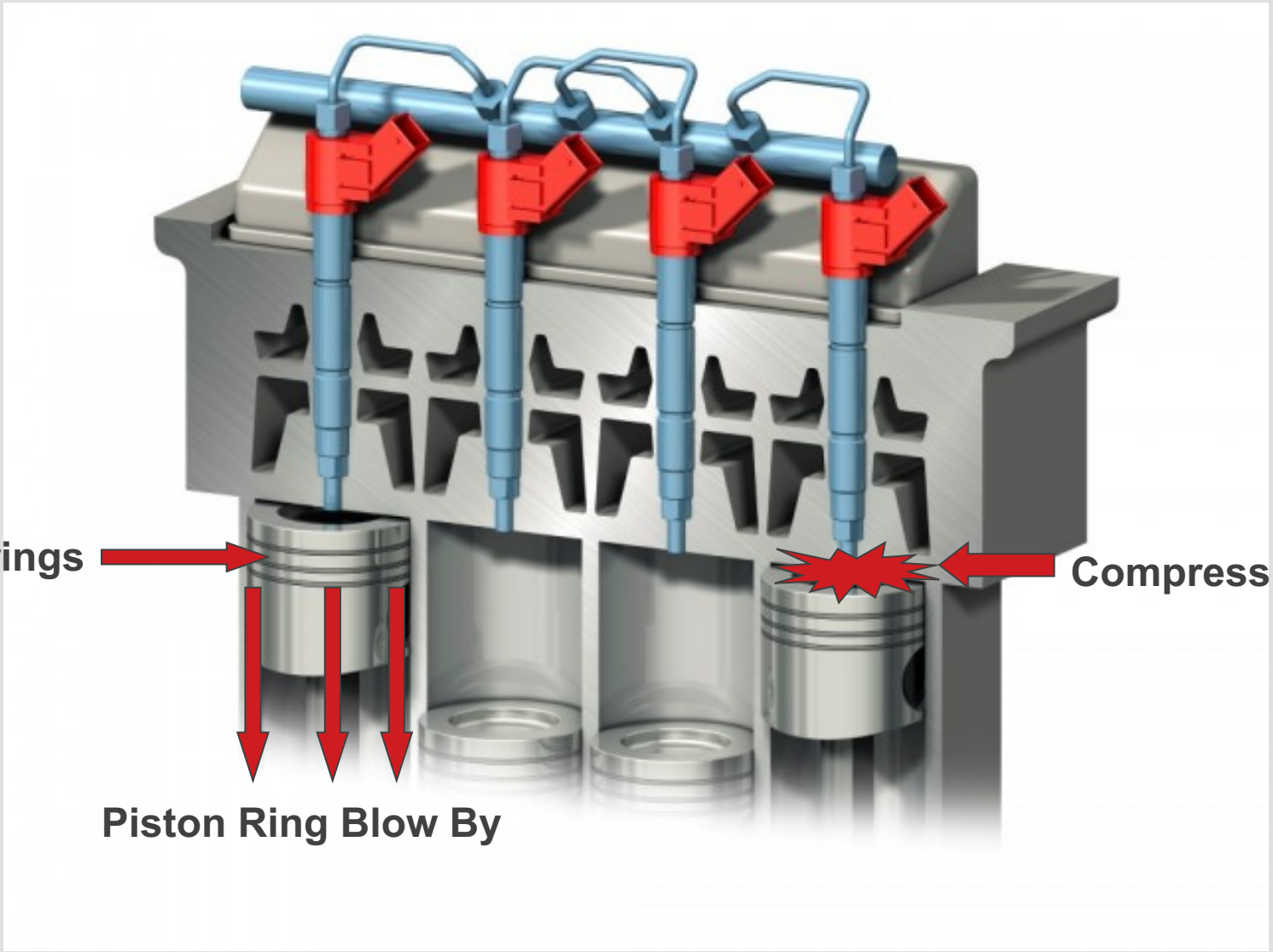
YOUTUBE Click on Hyperlink below

Cylinder Leak Testing & Diagnosis

Note: Start video at 7:49
Video length 5:39 minutes

Theory

Loss of compression in the cylinder



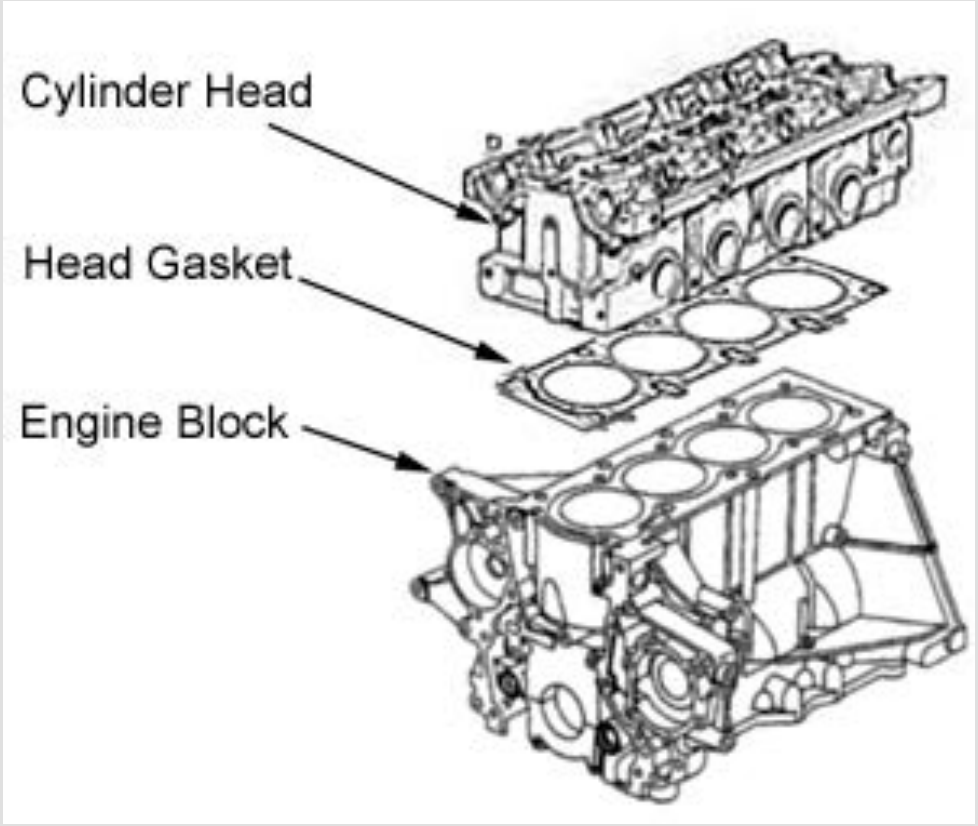
Theory Loss of compression in the cylinder (cont.)

Piston rings sealing properly. Showing a good ring seal and no compression entering crankcase area

Failed piston rings showing compression entering the crankcase area

Theory

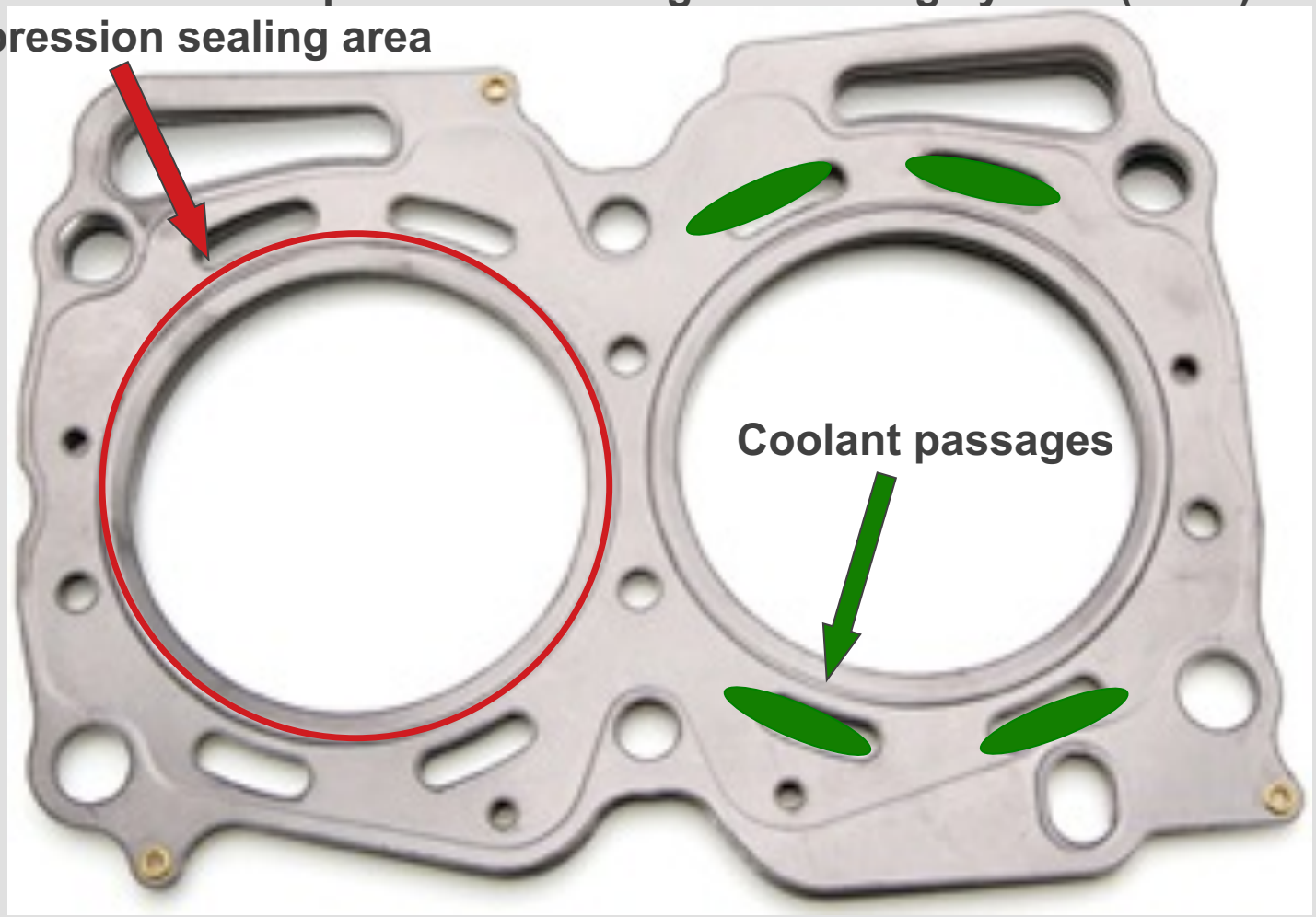
Loss of compression entering the cooling system



- Head gasket forms a seal between the engine block and the cylinder head
- Seals both the combustion chamber and the coolant passages in the engine

Theory

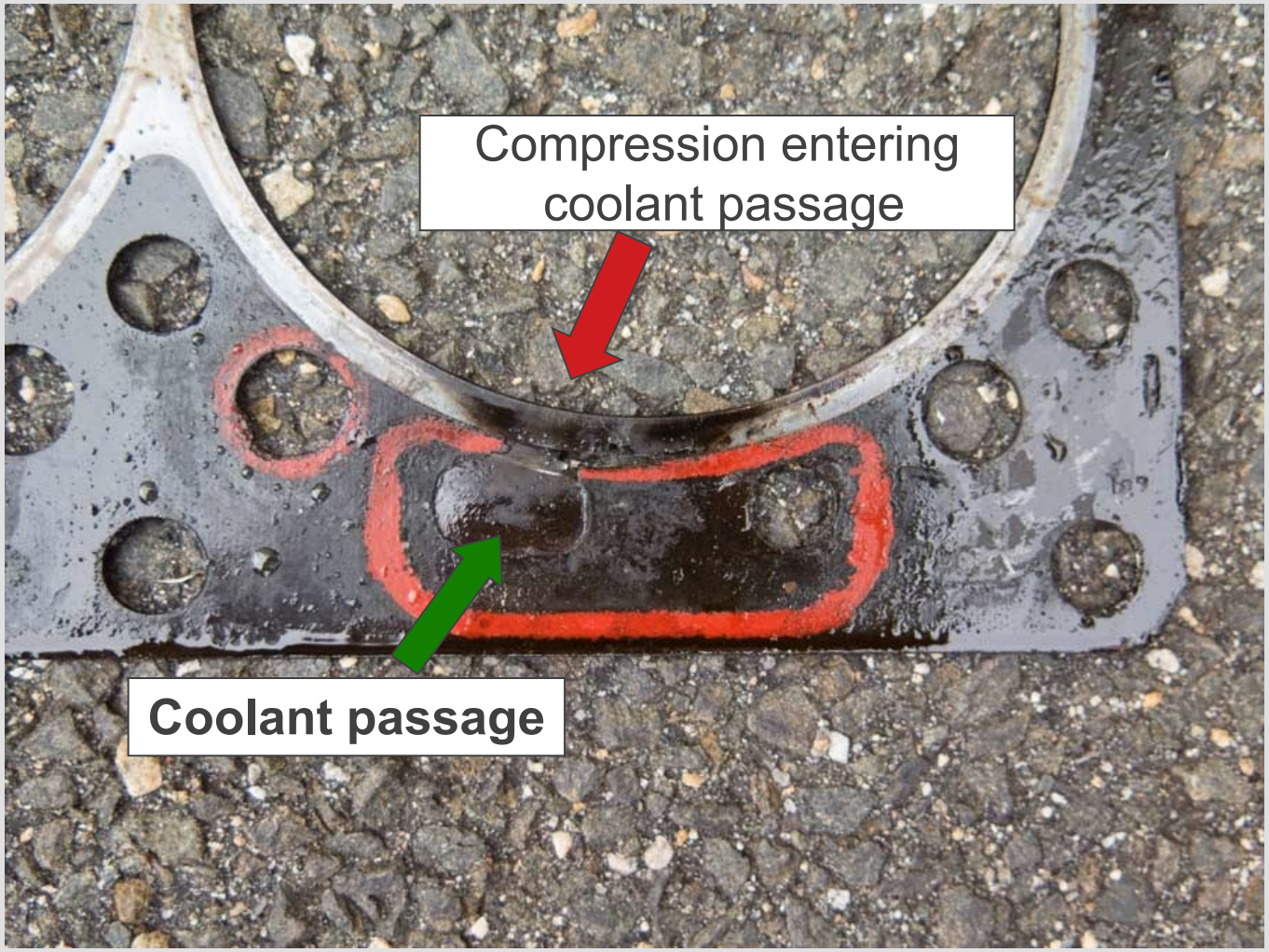
Loss of compression entering the cooling system (cont.)



Head Gasket

Theory

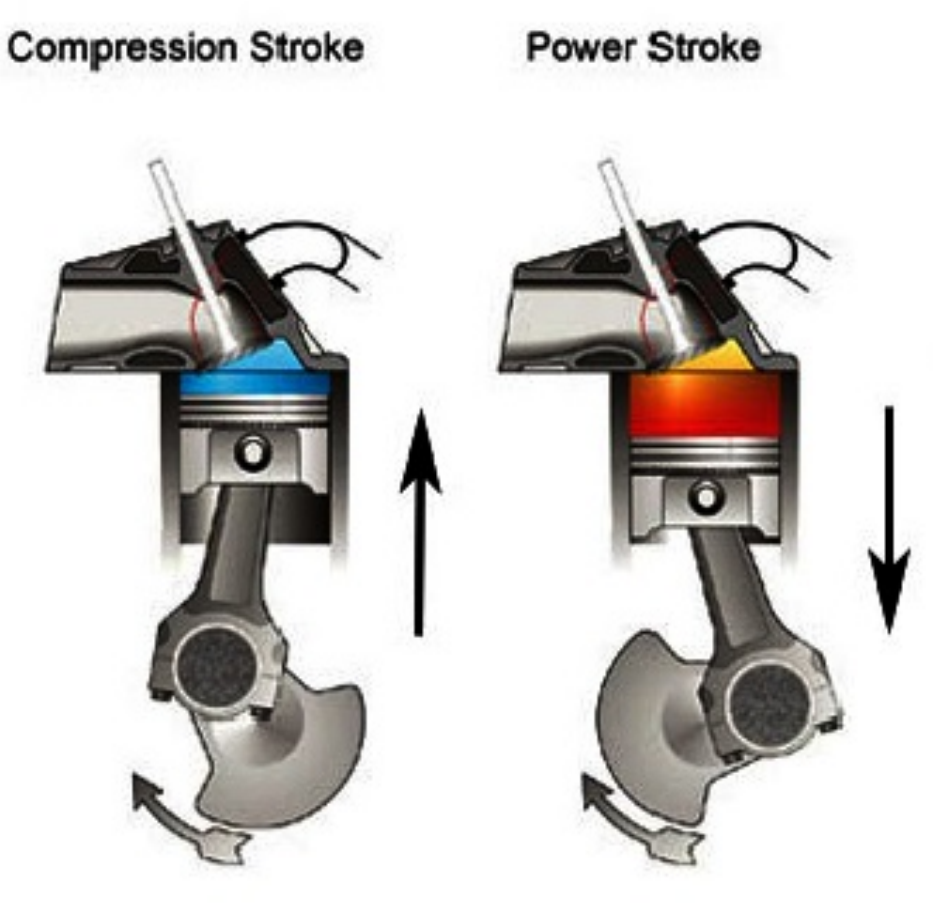
Loss of compression entering the cooling system (cont.)



Head gasket failure

Theory

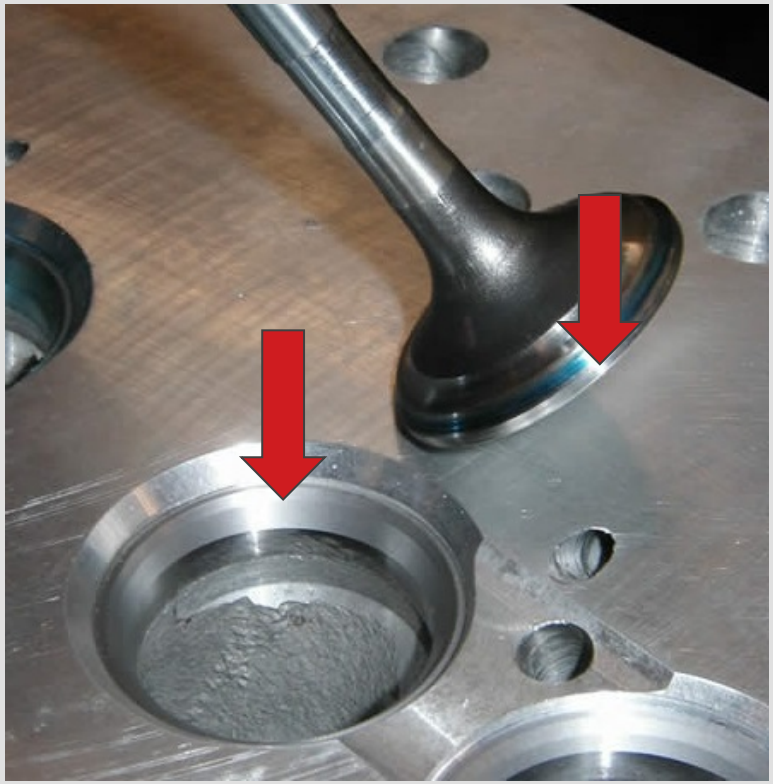
Loss of compression leaking past cylinder head valves



Cylinder head valves must seal properly during the compression & power stroke cycles

Theory

Loss of compression leaking past cylinder head valves (cont.)



Valve seat seating areas

Worn cylinder head valves showing excessive blow by

Lab Activity: 1.1 (cont.)

Engine Leak Down test

You will need:

- Large ¾ drive ratchet & socket to fit engine front crankshaft bolt.
- Engine leak down tester
- Engine leak down injector adaptor
- Hand tools to remove the injector
- Shop service air hose
- Safety glasses
- Task Sheet 1.1
- Worksheet: test results

Review Questions 1 (cont.)

1. What is the maximum allowable air flow during the leak down test ?
2. What part is leaking if there is air leakage in the intake manifold ?
3. What part is leaking if there is air leakage in the exhaust manifold ?
4. What part is leaking if there is air leakage in the cooling system ?
5. What part is leaking if is air leakage in the crankcase ?

Review Questions 1 (cont.)

1. What is the maximum allowable air flow during the leak down test ?

20%

2. What part is leaking if there is air leakage in the intake manifold ?

Intake valve

3. What part is leaking if there is air leakage in the exhaust manifold ?

Exhaust valve

4. What part is leaking if there is air leakage in the cooling system ?

Head gasket

5. What part is leaking if is air leakage in the crankcase ?

Piston rings

Theory

Engine Crankcase Blow By Test

Test to determine there is excessive pressure in the crankcase.

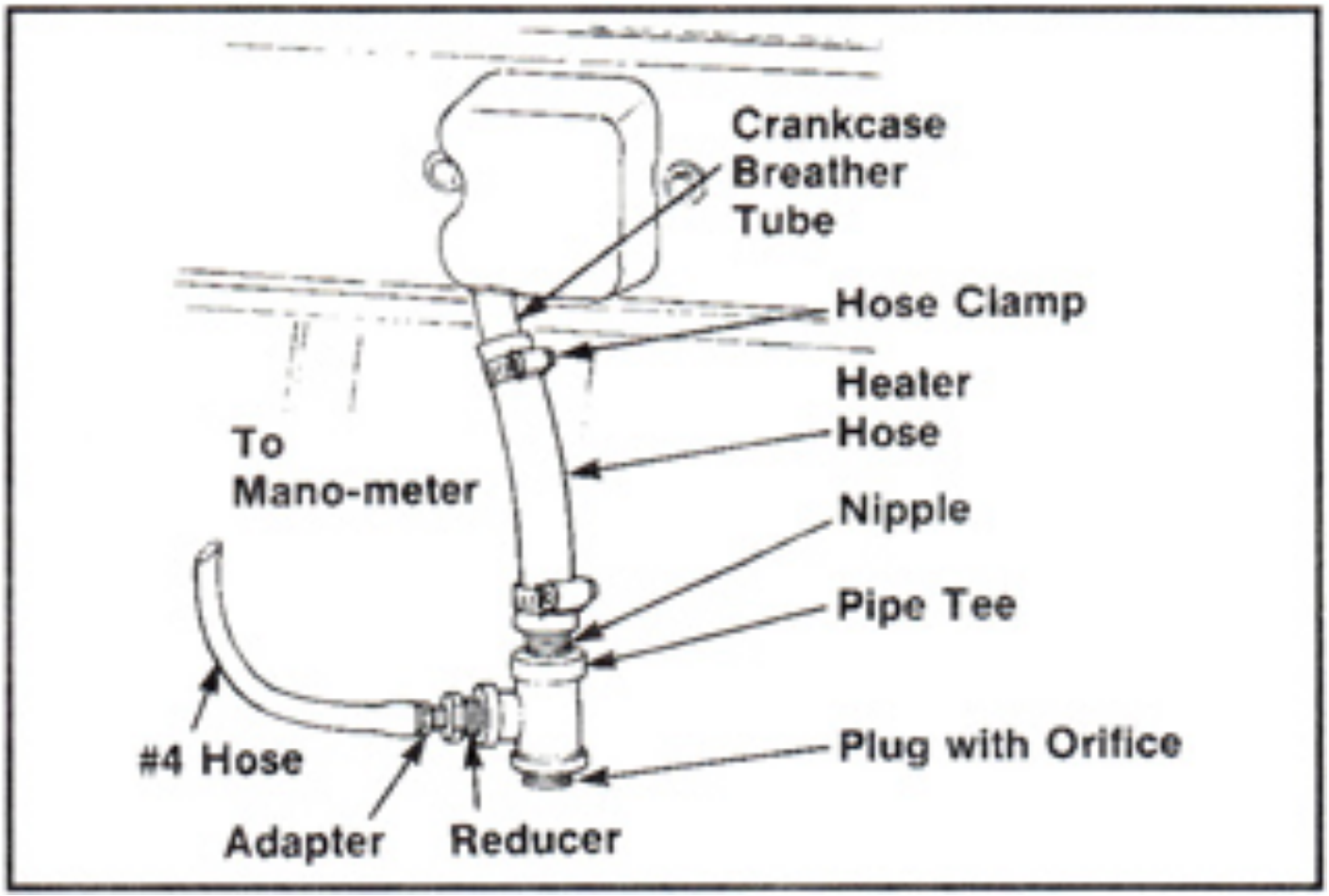
Using a measurement crankcase pressure will determine:

- Excessive crank case pressure
- Worn piston rings and bore
- Holes in piston
- Cracked or failed pistons

Lab Activity: 1.2 (cont.)

Crankcase Blow By Test

Connections

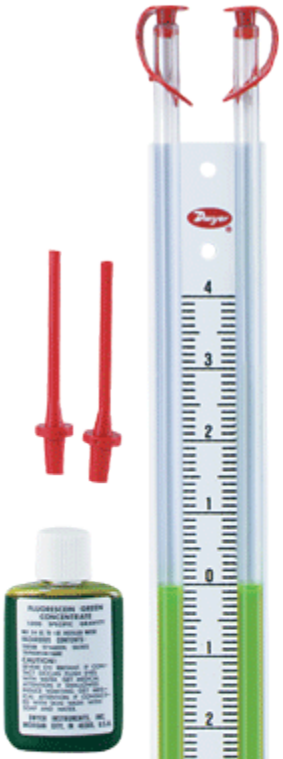


Lab Activity: 1.2 (cont.)

Crankcase Blow By Test

Gauges & Momometers

Differential Pressure gauge
Reading Inches of H20



Indicating Fluid

Slack Tube Monometer

Lab Activity: 1.2 (cont.)

Crankcase Blow By Test :

YOUTUBE Click on Hyperlink below

Crankcase Blow By Instructional Video

Video length 14:40 minutes

Lab Activity: 1.2 (cont.)

Crankcase Blow By Test

You will need:

- Adaptor to fit crankcase ventilation tube
- Slack tube water monometer
- Connection tubing from monometer to crankcase ventilation tube adaptor
- Flat tip screwdriver
- Hose clamps
- Mechanics creeper
- 4 wheel chocks
- Task sheet 1.2
- Safety glasses

Review Questions 2

1. What part does the compression flow past to create excessive blow by in the crank case ?
2. What is the symptoms of a engine with compression entering the engine cooling system ?
3. What part does the compression flow past to create excessive blow by in the cooling system ?
4. What part does the compression flow past to create excessive blow by in the intake manifold ?
5. What part does the compression flow past to create excessive blow by in the exhaust manifold ?
6. What color exhaust smoke whould a engine be showing if there was a loss of compression and excessive crankcase blow by.

Review Questions 2

1. What part does the compression flow past to create excessive blow by in the crank case ?

Piston or pistons rings

2. What is the symptoms of a engine with compression entering the engine cooling system ?

Air bubbles in cooling system

3. What part does the compression flow past to create excessive blow by in the cooling system ? **Head gasket**

4. What part does the compression flow past to create excessive blow by in the intake manifold ? **Intake valve**

5. What part does the compression flow past to create excessive blow by in the exhaust manifold ? **Exhaust valve**

6. What color exhaust smoke whould a engine be showing if there was a loss of compression and excessive crankcase blow by. **White smoke**

Theory

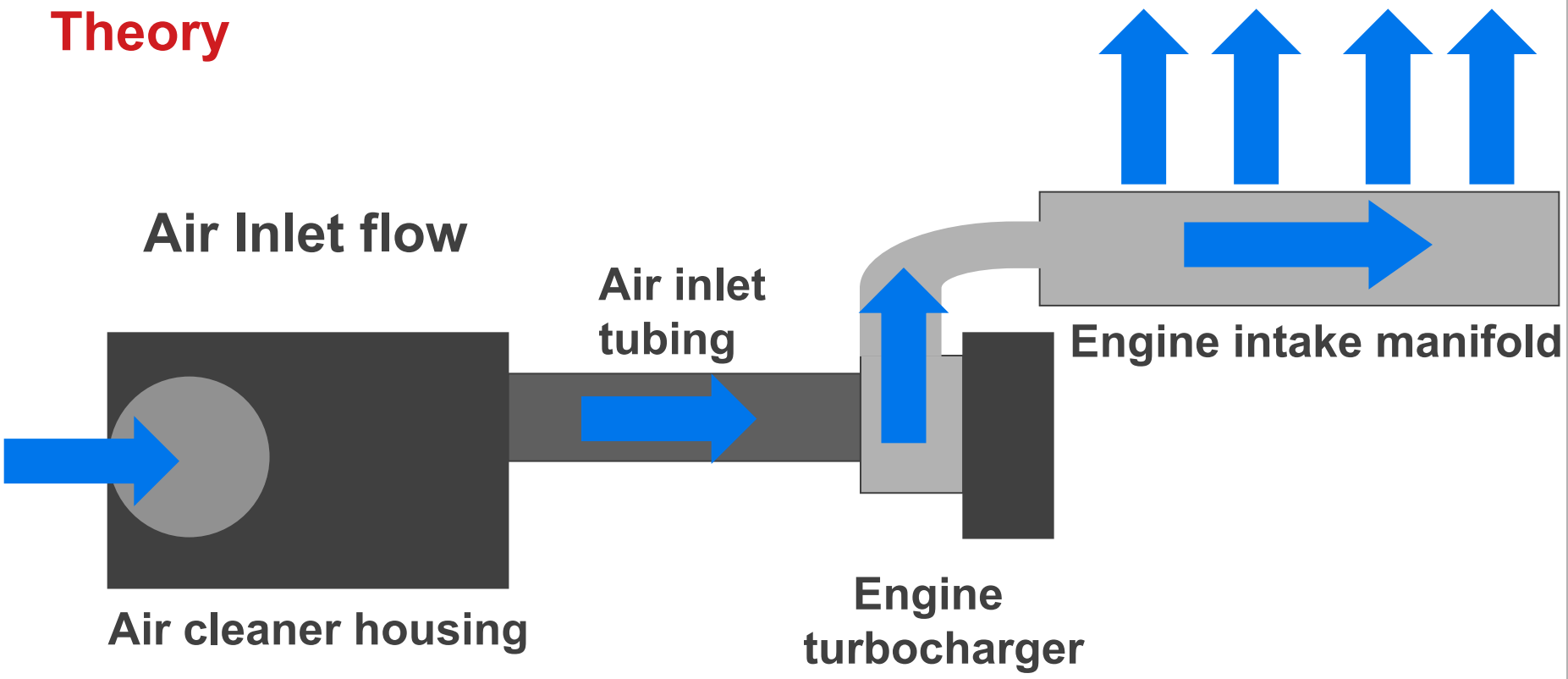
Air Induction Restriction Test

Manifold vacuum is an effect of a piston's movement on the induction stroke. **Air Induction Restriction Test** is a measurement of the amount of restriction of airflow to the engine. This measurement on a diesel engine is measured by the unit inches H2O.

Performing a Air Restriction test will determine:

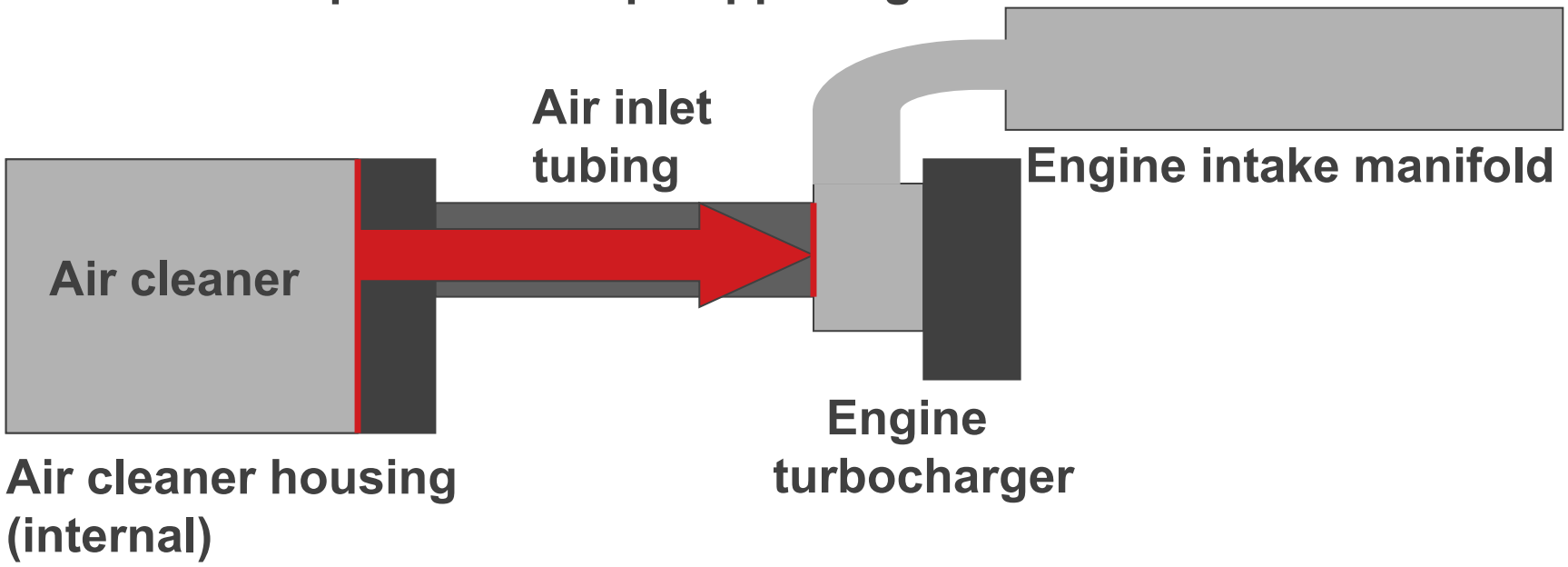
- Air cleaners operating above proper specifications (dirty or clogged)
- Restricted inlet tubing
- Black smoke diagnosis
- Low power diagnosis

Theory



Theory

Where is the air inlet restriction or pressure drop happening ?



The air inlet restriction is after the air cleaner prior to the turbocharger. So a air restriction measurement can be made anywhere at the air cleaner housing after the air cleaner or on air inlet tubing.

Theory

Examples of truck air cleaner housings

Almost all diesel engines have the same air restriction specifications;
Clean filter 10 inches of H2O
Dirty filter maximum 20 inches of H20

Theory

Air Cleaner Monitors

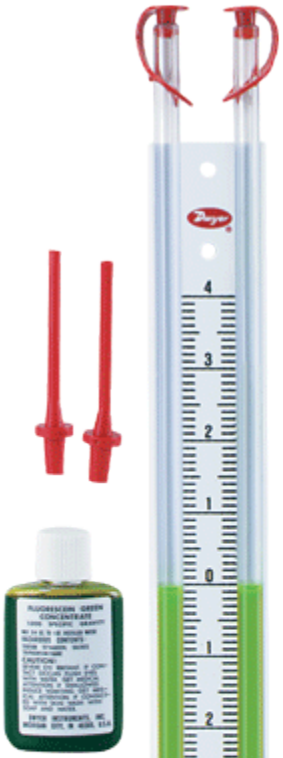
Air cleaner monitors are designed to also measure inches of H20 air inlet restrictions. They are located in the same location a technician would make the measurement using a slack to monometer or gauge.

Lab Activity: 1.3 (cont.)

Air Induction Restriction Test

Gauges & Momometers

Differential Pressure gauge
Reading Inches of H20



Indicating Fluid

Slack Tube Monometer

Lab Activity: 1.3 (cont.)

Air Induction Restriction Test : YOUTUBE

Click on Hyperlink below

Diesel Engine Air Restriction

Video length 7:55 minutes

Lab Activity: 1.3 (cont.)

Engine air induction restriction test

You will need:

- Slack tube water monometer
- Connection tubing from monometer to air cleaner housing
- Flat tip screw driver
- Hose clamps
- 4 wheel chocks
- Task sheet 1.3
- Safety glasses

Review Questions 3

1. What is the excessive smoke color of a diesel engine with an air induction restriction?
2. What is the clean filter specification for most diesel engines?
3. What is the dirty filter specification for most diesel engines?
4. Where is the best location to take air induction restriction measurement ?

Review Questions 3

1. What is the excessive smoke color of a diesel engine with an air induction restriction? **Black smoke**
2. What is the clean filter specification for most diesel engines?

10 inches of water

3. What is the dirty filter specification for most diesel engines?

20 inches of water

4. Where is the best location to take air induction restriction measurement ?

After the aircleaner before the turbocharger

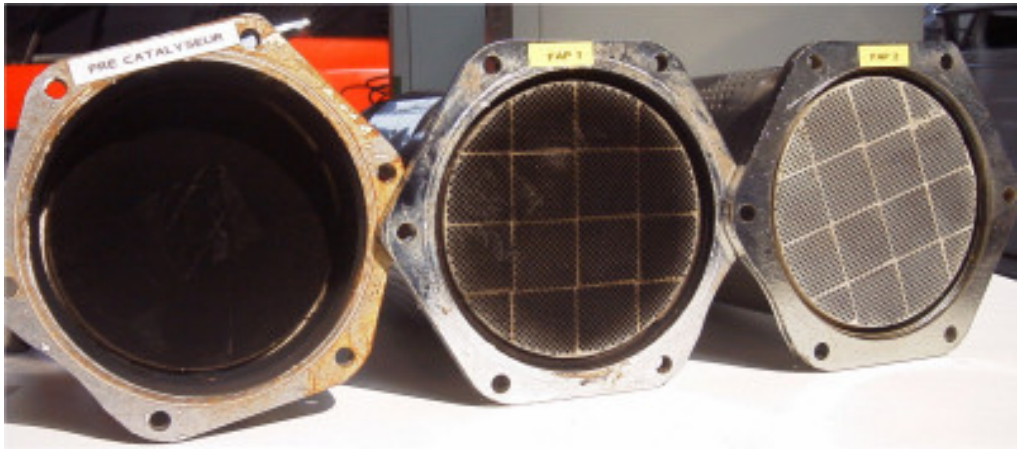
Theory

Exhaust Back Pressure Test

Testing of a engine exhaust back pressure must be taken after the turbocharger and prior to the first restriction in the exhaust tubing using a Inches of mercury (Hg) measuring instrument.

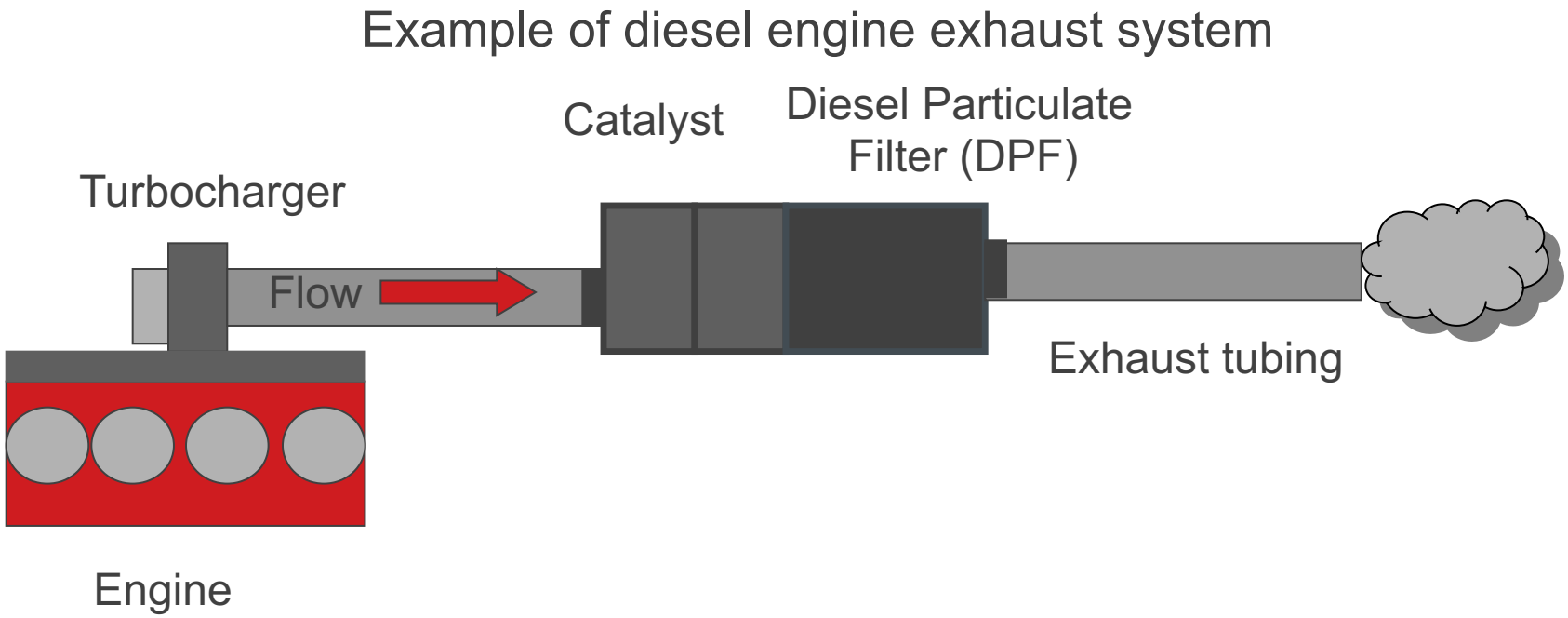
Exhaust back pressure caused by the exhaust system restriction will cause:

- Decrease of power
- Increased fuel consumption
- Excessive black smoke
- High exhaust gas temperatures



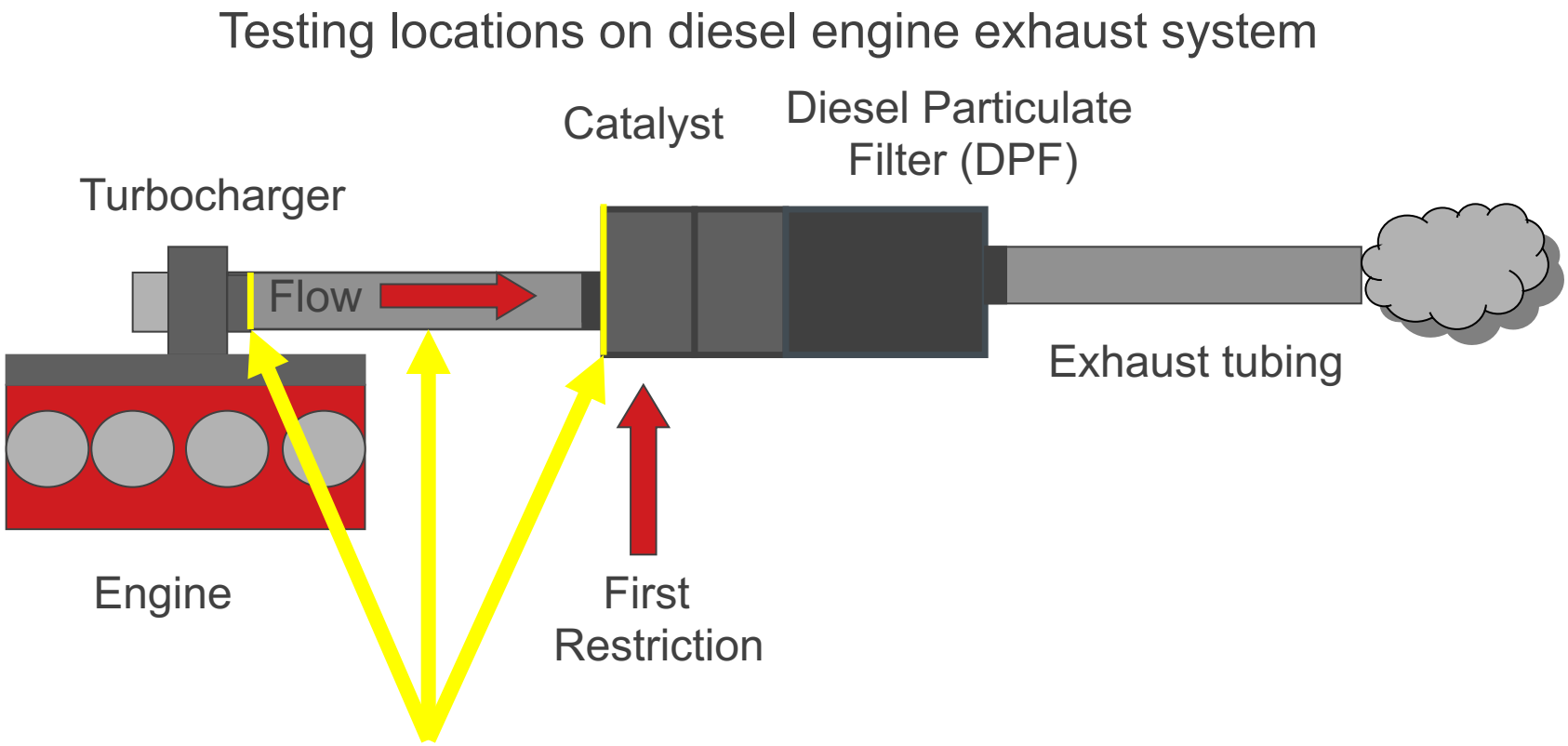
Lab Activity: 1.4 (cont.)

Engine air induction restriction test



Lab Activity: 1.4 (cont.)

Engine air induction restriction test



Testing locations on exhaust tubing anywhere prior to first exhaust restriction after turbocharger

Lab Activity: 1.4 (cont.)

Exhaust Back Pressure Test

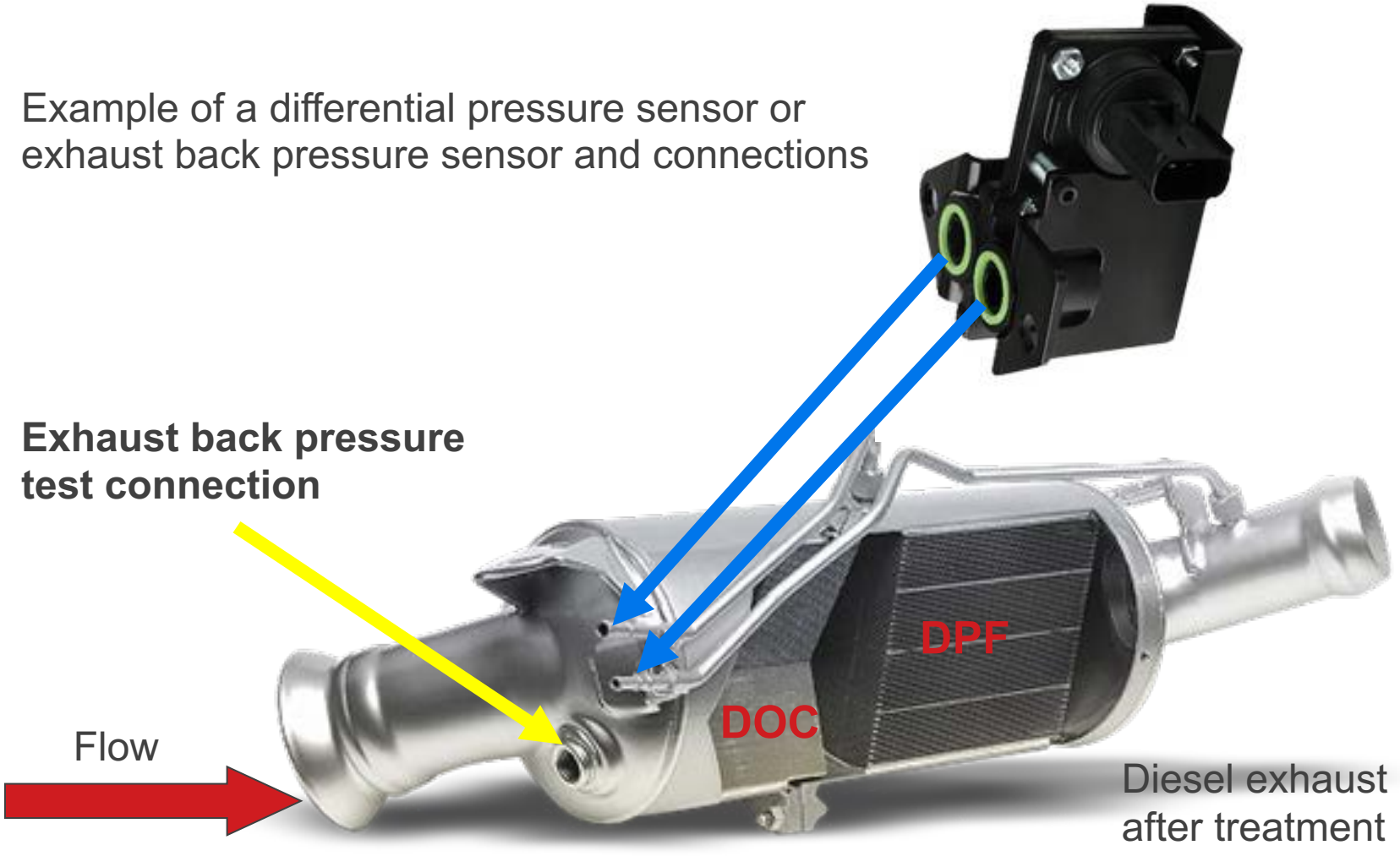
Gauges and fittings

Unit measurement “inches of Hg”

Lab Activity: 1.4 (cont.)

Exhaust Back Pressure Test

Example of a differential pressure sensor or exhaust back pressure sensor and connections



Lab Activity: 1.4 (cont.)

Exhaust Back Pressure Test

Diesel Particulate Filter (DPF)
exhaust back pressure sensor location

Exhaust back pressure test connections

Flow

Diesel exhaust after treatment

Lab Activity: 1.4 (cont.)

Exhaust Back Pressure test

You will need:

- Hg Vacuum gauge
- Connection tubing and fittings from gauge to exhaust tubing
- Wrenches
- Mechanics creeper
- 4 wheel chocks
- Never seize compound
- Task sheet 1.4
- Safety glasses

Review Questions 4

1. What symptom will the engine have with excessive exhaust back pressure?

2. What value is exhaust back pressure measured in?

3. Where is the best location the take the exhaust back pressure measurements?

Review Questions 4

1. What symptom will the engine have with excessive exhaust back pressure?

Low power, blacksmoke, high exhaust gas temperature

2. What value is exhaust back pressure measured in?

Inches of mecury or HG

3. Where is the best location the take the exhaust back pressure measurements?

After the turbo before the first exhaust rescrition

Theory

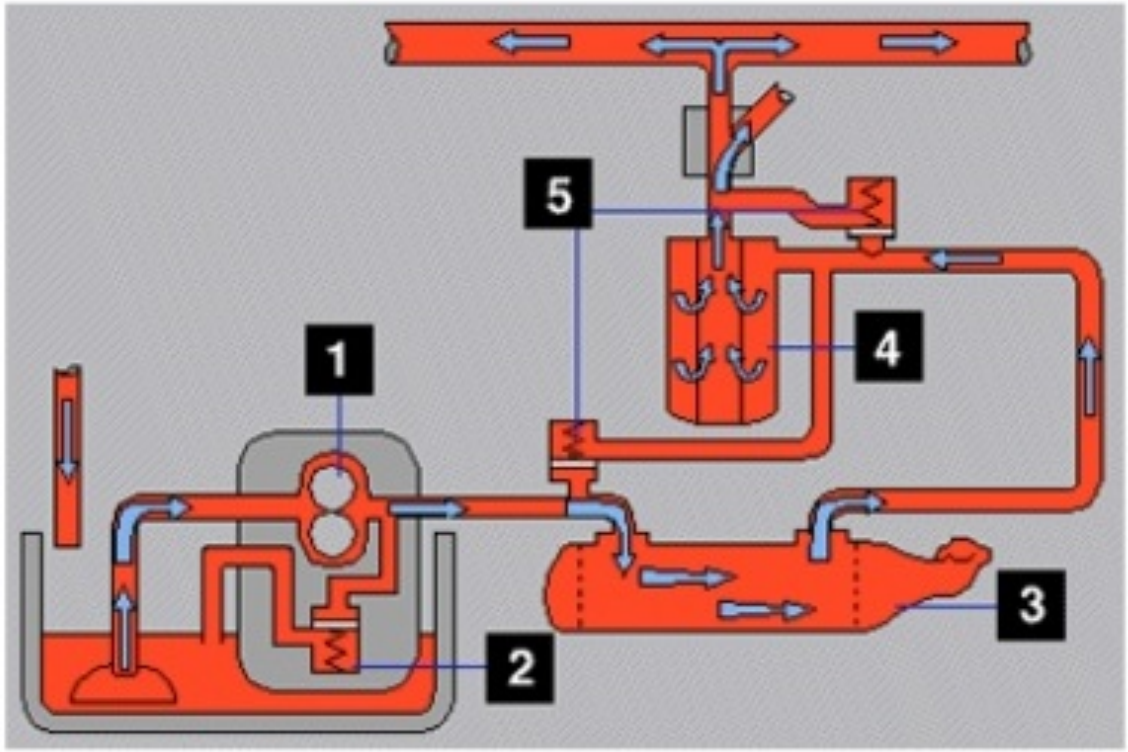
Oil Pressure Test

The testing of engine oil pressure is done by using a mechanical fluid pressure gauge. The unit of measurement is in “pounds per square inch” (PSI)
Most diesel engines operate between 50 PSI to 100 PSI depending on the manufactures specifications.

Theory

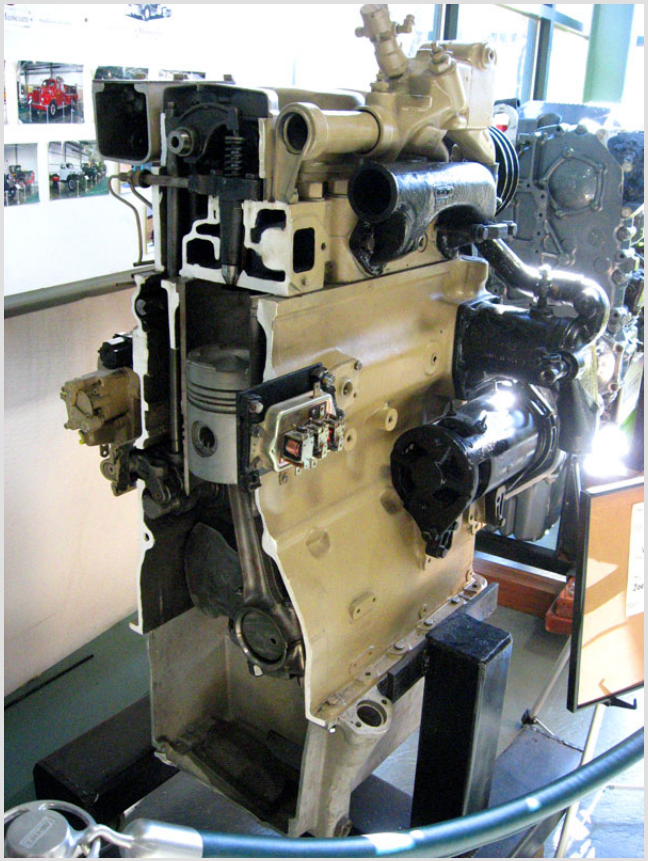
Lubrication System Components

1 Oil Pump
2 Relief Valve
3 Oil Cooler
4 Oil Filter
5 Bypass Valves
6 Oil Level Gauge (Dipstick)
7 Oil Pressure Gauge
8 Oil Pan



Theory

Discussion of cut away diesel engine module and the function of the internal components.



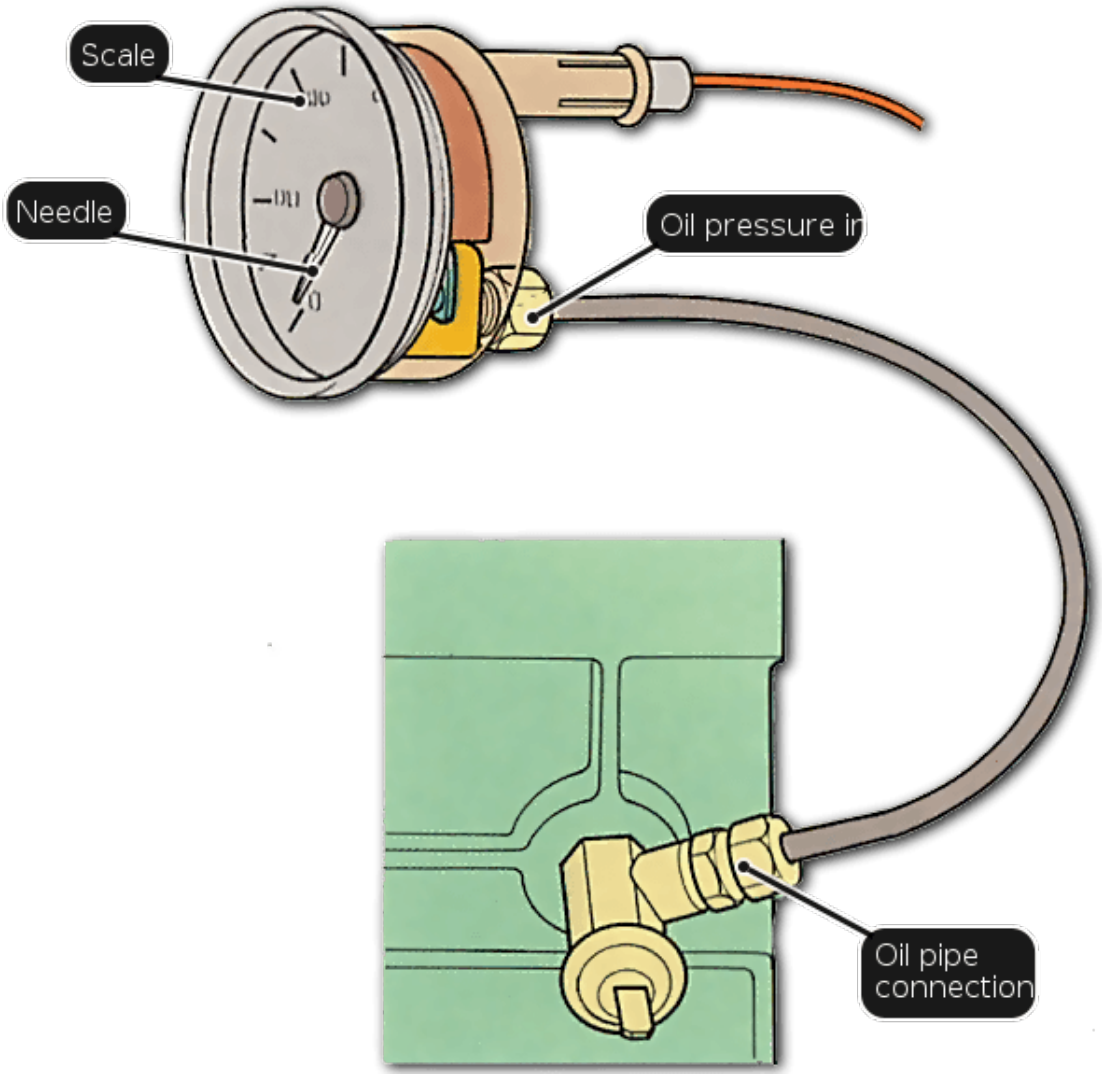
Lab Activity: 1.5

Oil Pressure Test Gauges

Unit measurement “pounds per square inch” (PSI)

Lab Activity: 1.5

Oil Pressure Test



Lab Activity: 1.5 (cont.)

Oil Pressure Test :

YOUTUBE
Click on Hyperlink below

Oil Pressure Test

Video length 6:20 minutes

Lab Activity: 1.5 (cont.)

Oil Pressure test

You will need:

- Oil Pressure gauge
- Connection tubing and fittings from gauge to engine block
- Wrenches & sockets
- Mechanics creeper
- 4 wheel chocks
- Teflon tape or liquid thread sealer
- Task sheet 1.5
- Safety glasses

Review Questions 5

1. What is the value of measurement used to measure engine oil pressure?

2. What is the best location to connect the oil pressure gauge to for the measurement ?

3. What is the most common range of oil pressure seen on a diesel engine at full throttle or RPM ?

4. What are the engine symptoms for excessive oil pressure ?

5. What are the engine symptoms for low oil pressure ?

Review Questions 5

1. What is the value of measurement used to measure engine oil pressure?

Pounds per sqaure inch (PSI)

2. What is the best location to connect the oil pressure gauge to for the measurement ?

Where the oil pressure sending unit is located

3. What is the most common range of oil pressure seen on a diesel engine at full throttle or RPM ?

50 to 100 PSI

4. What are the engine symptoms for excessive oil pressure ?

Blue smoke

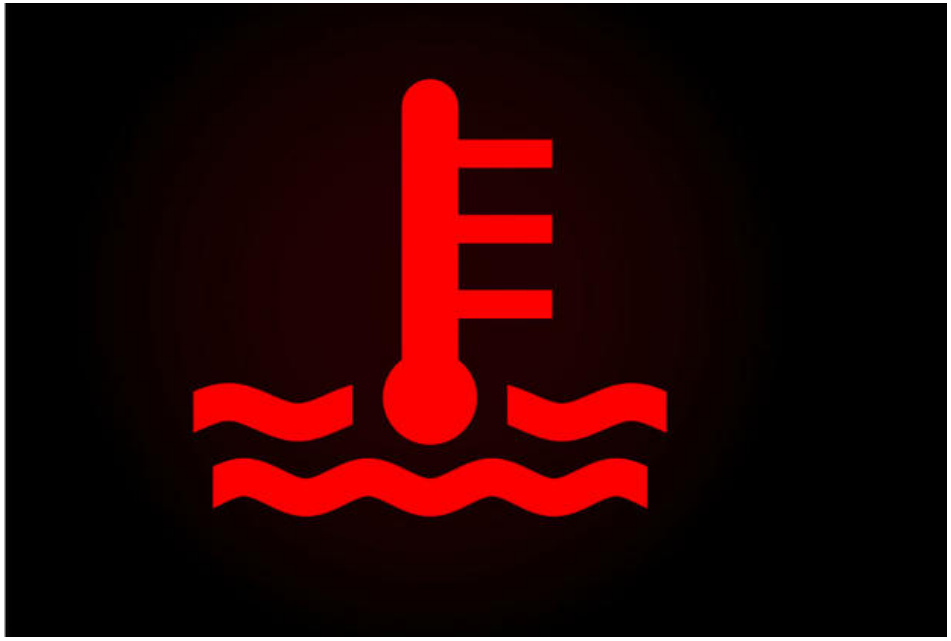
5. What are the engine symptoms for low oil pressure ?

High oil temeperature or worn parts

Theory

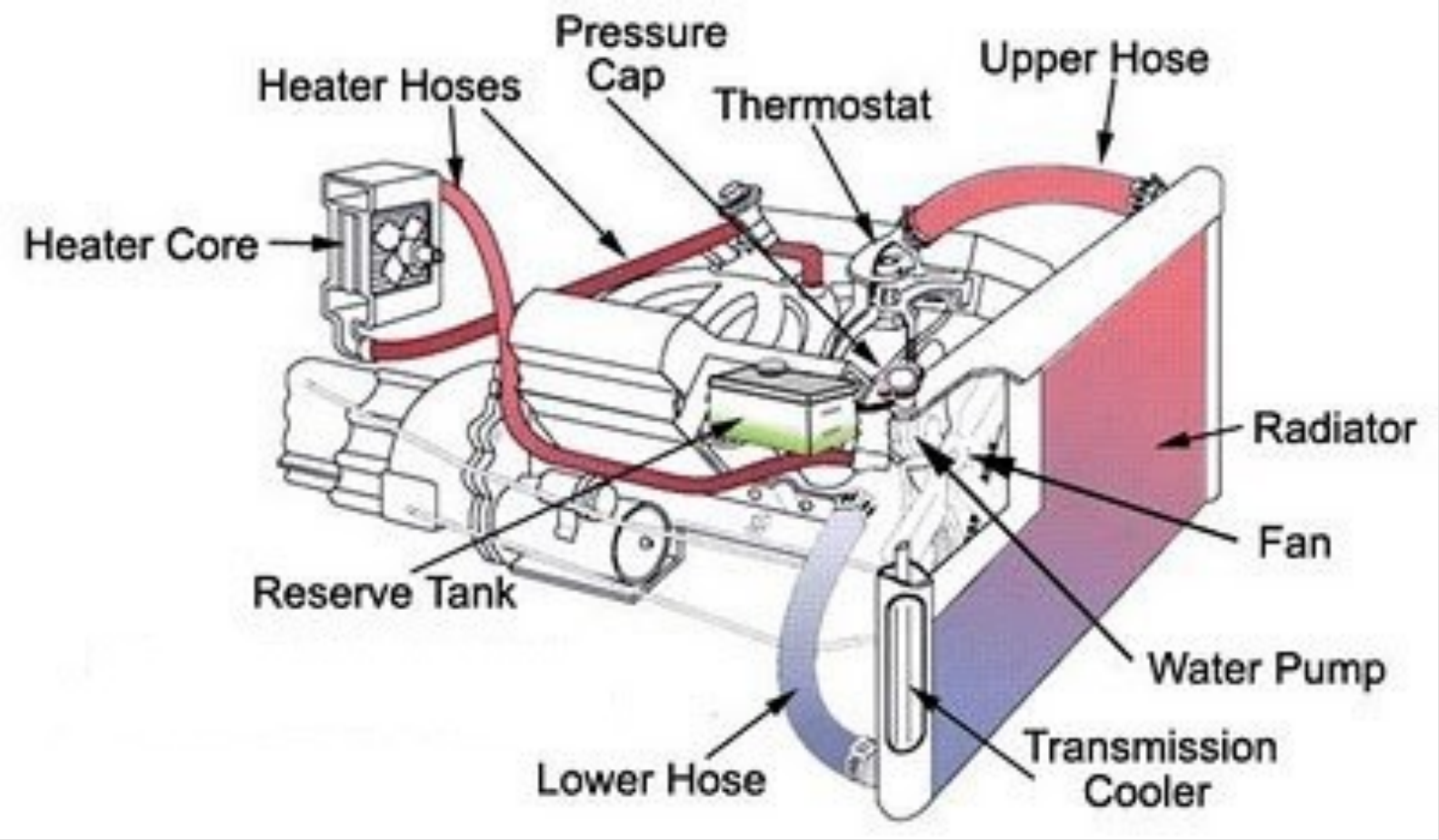
Engine testing: Cooling System Pressure Test

Failure of any of the engine cooling system components will cause the engine to over heat. A coolant pressure test can be made to test part of the components are working properly. The units of measure that are used to measure the coolant pressure are “pounds per square inch” (PSI)



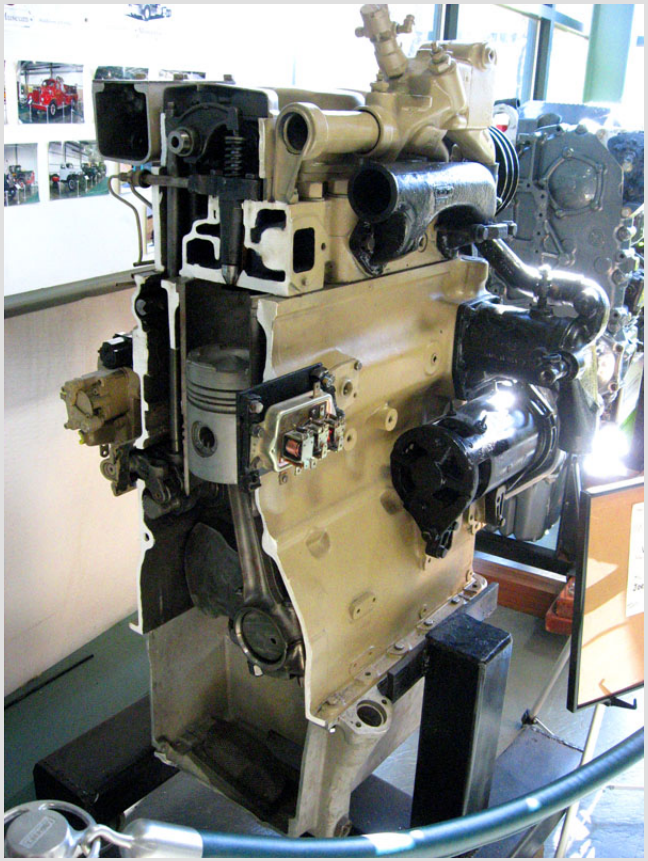
Theory

Basic example of a engine cooling system



Theory

Discussion of cut away diesel engine module and the function of the internal components.



Lab Activity: 1.6

Coolant Pressure Test Gauges & Adaptors

Unit measurement “pounds per square inch” (PSI)

Lab Activity: 1.6

Coolant Pressure Test

Radiator test

Radiator cap test

A coolant pressure tester can test the radiator as well as the radiator cap

Lab Activity: 1.6 (cont.)

Coolant Pressure Test :

YOUTUBE
Click on Hyperlink below

Coolant Pressure Test

Video length 3:35 minutes

Lab Activity: 1.6 (cont.)

Coolant pressure test

You will need:

- Radiator coolant pressure test kit
- 4 wheel chocks
- Mechanics creeper
- Task sheet 1.6
- Safety glasses

Review Questions 6

1. What is the value of measurement used to measure coolant pressure?
2. Where is the cooling system pressure rating located at?
3. How long the pressure should be observed during the test?
4. What are the engine symptoms for low coolant pressure?
5. What are the engine symptoms for coolant leaks?
6. What part regulates the coolant pressure?
7. What is a water pump weep hole?

Review Questions 6

1. What is the value of measurement used to measure coolant pressure?

Pounds per sqaure inch (PSI)

2. Where is the cooling system pressure rating located at?

On the radiator cap

3. How long should the pressure be observed during the test?

20 minutes

4. What are the engine symptoms for low coolant pressure?

Overheating engine

5. What are the engine symptoms for coolant leaks?

Overheating engine

6. What part regulates the coolant pressure?

Radiator cap

7. What is a water pump weep hole?

An inspection hole at the bottom of water pump

Theory

Engine Preventive Maintenance Inspection

Preventive maintenance Inspection (PMI) is the key to any successful maintenance program for commercial motor vehicles. Through preventive maintenance, vehicles are inspected, repaired, and maintained in such a way that defects are prevented from surfacing in the first place, before a violation or accident can occur.

Theory (cont.)

Engine Preventive Maintenance Inspection

PM schedules

The actual maintenance portion of PM is composed of scheduled and standardized inspections and maintenance. This is sometimes referred to as the vehicles' "scheduled service," or simply "service." PM services are commonly designated as A, B, C, D, etc. As you move down the alphabet from A to B and so on, the PM service (and time required) increases in complexity.

Theory (cont.)

Engine Preventive Maintenance Inspection

•**PM A** service is also known as a “maintenance check-out” or “safety inspection” and generally consists of a safety check and lubrication as well as:

•Checks of key components such as brakes, lights, tire condition and inflation, and fluids.
•It also includes checking and adjusting high-wear components.
•The normal interval for “A” service is between 1,500 and 2,500 miles on light vehicles, and between 5,000 and10,000 miles on medium- and heavy-duty vehicles.

Typically, these PM As are scheduled at half of the oil change interval of the vehicle.

Theory (cont.)

Engine Preventive Maintenance Inspection

B

PM Bs normally include all PM A items, and also include:

- An oil and filter change as well as more in-depth checks of the engine and driveline.
- The normal interval for “B” service is 3,000 to 5,000 for light-duty vehicles and 10,000 to 20,000 for medium- and heavy duty vehicles.
- A PM B should also include a download of the ECM and action on any trouble codes or problems reported by the ECM (if applicable).

Theory (cont.)

Engine Preventive Maintenance Inspection

C

PM C service calls for both PM A and PM B service and more extensive service includes:

•Alignment, scheduled component replacement
•DOT annual inspection
• Other scheduled engine and driveline component inspection or replacement.

Normally, “C” services are scheduled annually. To make sure they are done in a timely manner, it is not unusual for carriers to actually schedule them at an 11-month interval.

Theory (cont.)

Engine Preventive Maintenance Inspection

D

PM D service is either a scheduled rebuild or replacement of a major component:

- engine
- transmission
- Axles
- Winterization
- Summarization

Scheduling of D services varies by company. The “D” designation may or may not be used, depending on the company.

Companies continue the lettering system based on their needs.

Some companies go as far as PM L.

Lab Activity: 1.7

Engine Preventive Maintenance Inspection Engine PM A :

1. Students will be walked through the 14 items with the instructor to identify each component to be inspected and how they are serviced if needed.

2. Students will then be given a 14 item checklist to inspect or service the items on a 1991 Series 60 Detroit Diesel engine in a Freightliner truck. The status of the inspection or service will be checked off by the students on worksheet 1.7.

Lab Activity: 1.7 (cont.)

Engine Preventive Maintenance Inspection Engine PM A

Battery terminal cleaner

Grease gun

Lab Activity: 1.7 (cont.)

Engine Preventive Maintenance Inspection Engine PM A

YOUTUBE
Click on Hyperlink below

DI Electric Grease

Video length 2:18 minutes

Cordless Grease Gun

Video Length 1:55

Lab Activity: 1.7 (cont.)

Engine Preventive Maintenance Inspection Engine PM A

You will need:

- Radiator coolant pressure test kit
- 4 wheel chocks
- Mechanics creeper
- Grease gun
- DI-electric compound
- Task sheet 1.7
- Rubber gloves
- Safety glasses

Lab Activity: 1.8

Engine Preventive Maintenance Inspection: Engine PM B

1. Students will be walked through the 6 items with the instructor to identify each component to be inspected and how they are serviced if needed.

2. Students will then be given a 6 item checklist to inspect or service the items on a 1991 Series 60 Detroit Diesel engine in a Freightliner truck. The status of the inspection or service will be checked off by the students on worksheet 1.8.

Lab Activity: 1.8 (cont.)

Engine Preventive Maintenance Inspection Engine PM B

Fuel filters

Coolant refractor

Oil drain pan

Funnel

Davco fuel filter wrench

Diesel fuel can

Power steering fluid

Lab Activity: 1.8 (cont.)

Engine Preventive Maintenance Inspection Engine PM B :

YOUTUBE
Click on Hyperlink below

How to test coolant

Video length 9:57 minutes

Davco Fuel filter change

Video length 3:25 minutes

Lab Activity: 1.8 (cont.)

Engine Preventive Maintenance Inspection Engine PM B:

You will need:

- Fuel filters
- 5 gallon bucket
- Diesel fuel can
- Small funnel
- Davco fuel filter wrench
- 4 wheel chocks
- Drain pan
- Power steering fluid
- Refractor
- Mechanics creeper
- Task sheet 1.8
- Work sheet 1.8
- Work sheet
- Rubber gloves
- Safety glasses

Review Questions 7

1. What is a refractometer used for?
2. Where is Davco wrench used for?
3. What is the difference between a primary fuel filter and a secondary fuel filter?
4. Which is better reactionary maintenance or preventive maintenance?
5. Typically how many PM A inspections happen in between engine oil changes?
6. Typically how many times a year does a PM C happens in a year?

Review Questions 7

1. What is a refractometer used for?

To test the qaulity of the coolant

2. Where is Davco wrench used for?

To remove or service the fuel filter

3. What is the difference between a primary fuel filter and a secondary fuel filter?

The primary filter has larger holes

4. Which is better reactionary maintenance or preventive maintenance?

Preventive maintenance

5. Typically how many PM A inspections happen in between engine oil changes? **Two**

6.Typically how many times a year does a PM C happens in a year?

Annually

LONG BEACH
CITY COLLEGE

Please complete an evaluation

Thank You