Phase
2

Trade of Motor Mechanic

Module 5

Unit 1

Fuel Supply System

Produced by

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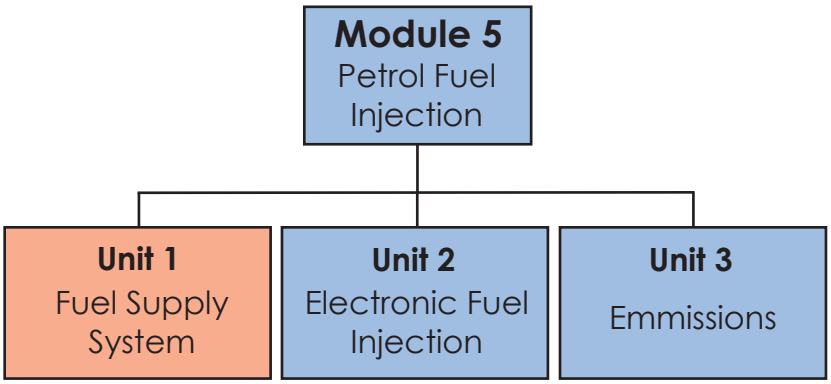
Introduction

There are 3 Units in this Module. Unit 1 focuses on Fuel Supply Systems, Unit 2 on Electronic Fuel Injection and Unit 3 on Emissions.



Module 5 of this course covers the Petrol Fuel Injection aspect of automotive technology. This is the first unit in module 5 and introduces the Fuel Supply System.

The purpose of any fuel supply system is to deliver fuel to the engine in a form in which it can mix with air to form a combustible mixture. The components related to the fuel supply system will be covered in this unit. Health and safety issues related to this unit will also be covered.

Unit Objective

By the end of this unit each apprentice will be able to:

- State and apply the health, safety and environmental awareness and precautionary procedures applicable to working on petrol fuel supply systems Identify the correct fire extinguishers required for various types of petrol fuel fires
- Describe the structure of a fuel tank and the appropriate cleaning/repair methods
- Test the operation of a fuel level gauge using a potentiometer
- On a fuel injected vehicle/training unit, locate and identify each component involved in the return-type fuel supply system
- State the function and describe the principles of operation of the return-type fuel supply system components
- Describe the structure and operating principle of the externally-mounted electric fuel pump (rotary type)
- Remove and refit external and/or submerged fuel pumps
- Remove and replace petrol fuel filters
- Specify the typical fuel system pressures applicable to single-point (throttle body) and multi-point fuel injection systems
- Explain why a constant pressure differential needs to be maintained between the fuel distribution rail and the inlet manifold
- Draw a typical electrical circuit for the fuel supply system
- Remove, test and refit fuel pump relays
- Outline the NCT/DoT VTM requirements applicable to the fuel tank, filter, fuel lines and air filter of a petrol engine

1.0 Health, Safety and Environmental Awareness

Key Learning Points

- Health, safety and environmental awareness issues and procedures relating to personal and fire hazards from fuel spillage/leakage/ storage, sparks/ignition sources (including static electricity and mobile phones) and system pressure during component removal/ replacement; precautions necessary to avoid damage to catalytic converter due to unburned fuel etc.
- Identification of the correct fire extinguishers required for various types of petrol fuel fires

1.1 Health and Safety

Improper storage, leaks and spillage of fuel could lead to fire due to sparks/ignition sources (including static electricity and mobile phones) Instruction is given on the correct and safe storage of fuel (use of correct container etc.) leaks repaired and mopped as soon as they occur and disposed in an environmental friendly manner.

Pressurised fuel can be sprayed out when components are being removed or replaced , this could lead to injury to eyes, face etc. also fire. Instruction is given on the correct and safe method for removing and replacing components also the correct use and type of fire extinguisher.

Safety precautions need also be applied to prevent damage to the catalytic converter as un-burnt fuel will damage the unit.

1.2 Petrol fire Classification

"B" class fires involve flammable liquids such as petrol.

Carbon dioxide fire extinguishers are most effective when used against "B" "C" and "E" class fires. The gas is heavier than air and provides an inert blanket that smothers the fire. A carbon dioxide fire extinguisher will spray small ice particles with the gas. This is normal.

Dry Powder fire extinguishers contain a fine powder usually sodium bicarbonate held under pressure by an inert gas. The extinguisher smothers the fire with a fine powder. These extinguishers are good to fight any fuel or liquid fire.

Foam fire extinguishers contain a chemical that forms a soft foam that floats over the target area and smothers the fire.

2.0 Fuel Tank Structure

Key Learning Points

- Fuel tank structure and materials, methods of filling
- Fuel tank cleaning and repair methods

2.1 Fuel Tanks

Where the tank is mounted depends on where the engine is and on space and styling. Safety demands that it is positioned well away from heated components and outside the passenger compartment. Most tanks are made of tinned sheet steel that has been pressed into shape. Some passenger car tanks are made of non-metallic materials. Aluminium or steel is used on commercial vehicles. Today's modern petrol car has a smaller filling hole than that of diesel this is to insure only unleaded fuel is put into the tank.

The tank is usually in 2 parts, joined by a continuous weld around the flanges where the parts fit together. Baffles make the tank more rigid. They also stop surging of fuel and ensure fuel is available at the pickup-tube. Fuel expands and contracts as temperature rises and falls. So fuel tanks are vented to let them breathe. Modern emission controls prevent tanks being vented directly to the atmosphere. They must use evaporative control systems. Vapour from the fuel tank is trapped in a charcoal canister and stored there, until it is burned in the engine. A vapour or vent line with a check valve connects the space above the liquid fuel with the canister. This valve opens when pressure starts to rise and lets vapour through, but not liquid. Liquid fuel closes the check valve and blocks the line, stopping liquid fuel reaching the charcoal. Some systems have a small container, called a liquid-vapour separator, above the fuel tank. It also prevents liquid fuel reaching the charcoal filter.

The cap on the petrol tank also stops petrol vapour escaping and polluting the atmosphere. This is important for petrol which is very volatile and vaporizes easily, especially in warmer climates. Some petrol caps have a low pressure valve built-in. It keeps a balance between the pressure in the tank and the outside atmospheric pressure.

As petrol in the tank is used, the air space above the fuel increases. This causes a fall in pressure, compared to outside atmospheric pressure. The valve then opens and lets more air into the tank. A fall in temperature can cause a fall in the pressure in the tank. The valve opens to admit more air until inside and outside pressures equalize again.

The fuel gauge shows how much fuel is still in the tank. It has a gauge unit on the dash and a sender unit in the tank. This unit indicates the level of fuel in the tank and transmits this information to the gauge in the dash-panel.

2.2 Tank Repairs

Most vehicle manufacturer's recommend no repairs are to be carried out on fuel tanks. Damaged or leaking tanks should be replaced with an original manufacturer's replacement tank. If the tank has to be cleaned it should be removed from the vehicle and correct safety and environmental precautions observed. Tanks that are empty of fuel are extremely dangerous as they contain highly explosive fuel vapours. Any sparks or external heat source may cause an explosion! Be very careful of fuel tanks; always consult vehicles manufactures data for precise information on the service or removal/fitting of automobile fuel tanks.

2.3 Filler Pipe

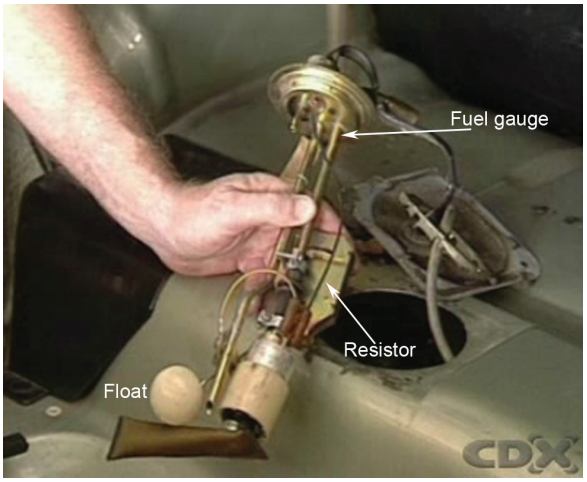
On unleaded petrol vehicles with catalytic converters, the filler neck is designed to prevent leaded fuel being added. Its diameter is smaller than those on leaded vehicles and a trapdoor inside the filler can only be opened by the nozzle of the unleaded petrol spout.

3.0 Testing Fuel Level Gauge Using a Potentiometer

Key Learning Points

- Use of a potentiometer to test the operation of a fuel level gauge

3.1 Fuel Gauge



A fuel gauge is used to indicate the level of fuel contained in a tank.

The sending unit usually uses a float connected to a variable resistor. When the tank is full, the resistor is set to its low resistance value. As the tank empties the float drops and slides a moving contact along the resistor, increasing its resistance, finally reaching its highest value when the tank is empty.

Meanwhile, the indicator unit mounted on the instrument panel is measuring and displaying the amount of electrical current flowing through the sending unit. When the tank level is high and maximum current is flowing, the needle points to full indicating a full tank. When the tank is empty and the least current is flowing, the needle points to empty indicating an empty tank. The testing of a fuel gauge sender has to be carried out in strict accordance with manufactures instructions.

Fuel Gauge Operation

A potentiometer is a mechanically variable resistor which, in EFI applications, is normally a film-type. This type of unit is usually fitted in the fuel tank and is known as a fuel gauge or sender unit.

- It can be linear, or circular, in construction and has 3 electrical connecting points. Two are at the ends of the resistor and a third is attached to a centre sliding contact, arranged to move across the resistor. A reference voltage is applied to the resistor so that a steady current flows through it.
- As the centre sliding contact moves across the resistor, it measures the voltage at the point it is in contact with and provides a reference voltage for that position.

Practical Task

Fuel gauge testing can only be done following manufactures recommended procedures.Please refer to your instructor for additional information, which is available from the automotive technical manuals.

4.0 Return-Type Fuel Supply System Components

Key Learning Points

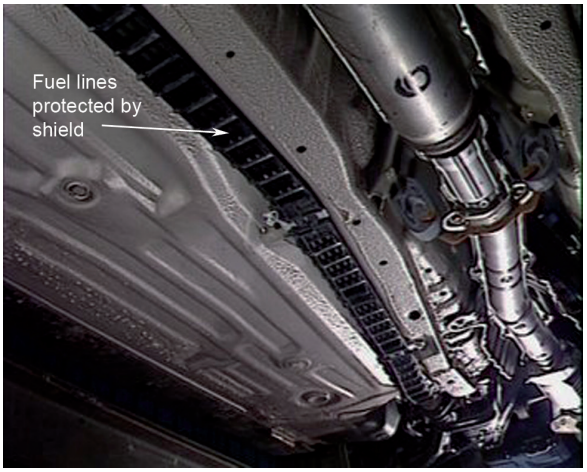
- Function and principles of operation of each return-type fuel supply system component

4.1 Return-Type Fuel Supply System

This is called the 'standard' system; fuel is supplied to the engine mounted, fuel distribution rail with the injectors, the pressure regulator which is fitted to this rail controls the fuel pressure and excess fuel is carried back to the tank.

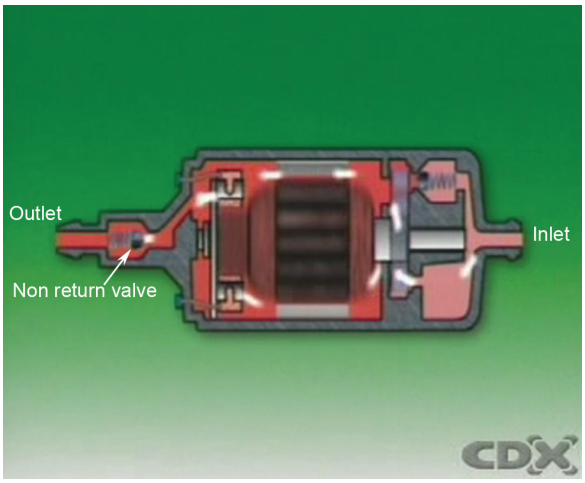
4.2 Fuel Lines

Fuel lines are usually made of metal tubing or synthetic materials. A fuel supply line carries fuel from the tank to the engine. A return line may also be provided to allow excess fuel to return to the tank. This helps prevent the formation of vapour that can occur in the fuel supply during hot conditions.



4.3 Fuel Pump Motor

An electric rotary pump can be located inside the tank, but may be fitted externally, particularly on older models. Petrol enters at one end and leaves at the other so it is always full. This lubricates the pump motor and keeps it cool.

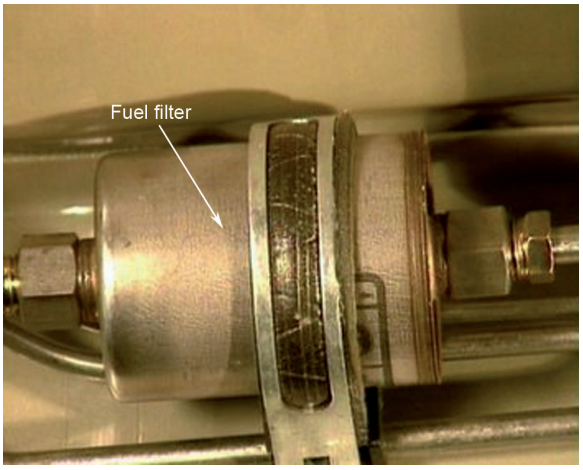


Lack of oxygen inside the pump eliminates the dangers of fire/ explosion and spark-suppression elements may be fitted in the end plate.

4.4 The Fuel Pump Relay

This is the relay that responds to the voltage signal from the ECU to switch on the pump to develop fuel pressure. When the ignition is first turned on, the pump will run for some seconds to build this fuel pressure but the control unit will then switch off this relay until a signal from the crankshaft position sensor indicates to the ECU that the engine is rotating and starting and the relay will be energised once again. This relay can be located in the main fuse box.

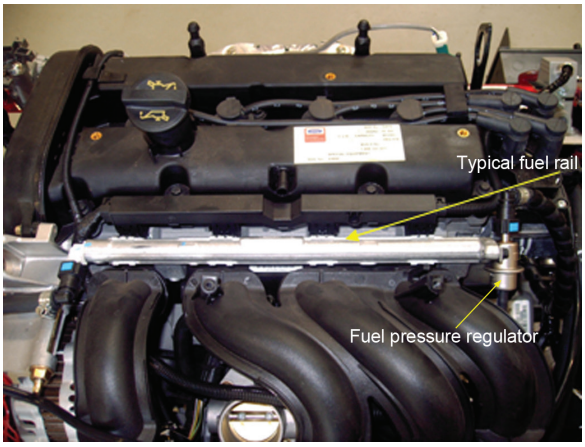
4.5 Fuel Filters



It is very important to supply clean fuel to the fuel rail in EFI systems. Small particles of dirt can block an injection nozzle and cause an irregular spray pattern. Any water in the fuel will corrode the inside of the injector - especially if the engine stands unused for long periods.

The first filtering occurs with a strainer or fine gauze in the fuel tank. The next time filtering occurs at the in-line filter, on the high-pressure side of the pump. This is a large-capacity filter encased, in a steel shell or aluminium housing. This housing must be rigid, to withstand the high pressures in the system. The filter is a pleated paper type with pore size of about 10 microns. A fluted support plate keeps the filter stable in the housing. The filter is directional and it must be fitted in the direction of fuel flow. Due to the pressure in the system it is important to depressurise the system before changing fuel filters. Removing and replacing fuel filters should be carried out according to manufactures specifications. Final filtering occurs with a small conical filter at the fuel entry to the injector.

4.6 Fuel Rail



The fuel rail is a large diameter pipe used to carry the high pressure fuel to the individual injectors of multi-point injection systems. All injectors are attached to this 'rail' and therefore all have equal fuel line pressure. A fuel pressure 'damper' may be fitted to the 'rail' to steady out the small pressure oscillations in the fuel due to the pump and injector actions. Single point systems have the fuel delivered from the filter directly to the single or central injector.

4.7 Fuel Pressure Regulator

Typical Fuel pressures for a single point injection system is approx. 3 bar. For multi injection it is higher between 4 and 5bar. Please refer to manufactures data when checking each system.

In multi-point injection systems, the fuel pressure regulator is located on the outlet from the fuel rail. Fuel circulates continuously, but the fuel pressure regulator controls the quantity of fuel returning to the tank. This in turn controls the pressure in the fuel rail. It consists of a metal housing with a spring-loaded diaphragm between the 2 halves of a steel pressed shell. A valve attached to the diaphragm controls the exposure of the opening to the return line.

With the pump operating, fuel pressure builds up on the underside of the diaphragm and raises it against the force of the spring. The central valve is carried with it, which lets fuel return to the tank. Fuel in the rail is now kept under pressure that's determined by the force in the spring. Further control is needed as fuel pressure has to stay at a constant value above manifold pressure. Otherwise, the fuel quantity delivered won't be accurate. Examples of fuel system pressure for single and multi point injection can be obtained in the Autodata® CD from your instructor.

The spring housing above the diaphragm is sealed and connected to the intake manifold. Low pressure in the manifold then acts on the diaphragm and helps its movement against the spring. As a result, fuel pressure is continually corrected in step with changes in manifold pressure.

When manifold pressure is low, as at idle, fuel pressure will be lowered. When manifold pressure is high i.e. at full throttle the fuel pressure increases. As a result, the quantity of fuel injected into the engine is set solely by the duration of the electrical pulse from the control unit.

4.8 Inertia Switches

A safety device is fitted to automatically switch off the electrical supply to the fuel pump in the event of the vehicle being involved in a collision or a severe 'bump'. This is called an 'inertia' or 'impact' safety switch. This is to avoid the possibility of petrol that is under working pressure (up to 3.0 bar) being sprayed indiscriminately through a leaking pipe/fuel line or fractured component that may cause fire. The switch should not be reset until the fuel system has been fully checked for possible leaks. Access to this switch is in the interior of vehicle, usually in the driver or front passenger, footwell.

Operation of the Inertia Fuel Cut Off Switch

This switch uses a mechanical device consisting of a steel ball in a funnel. The ball is held in place by a magnet. When subjected to shock, the ball breaks away from the magnet and rolls up the side of the funnel, hitting an actuating arm of the switch mechanism. When this happens, the linkage in the switch 'opens' the electrical circuit and cuts off current to the pump. The switch remains 'open' until it is reset.

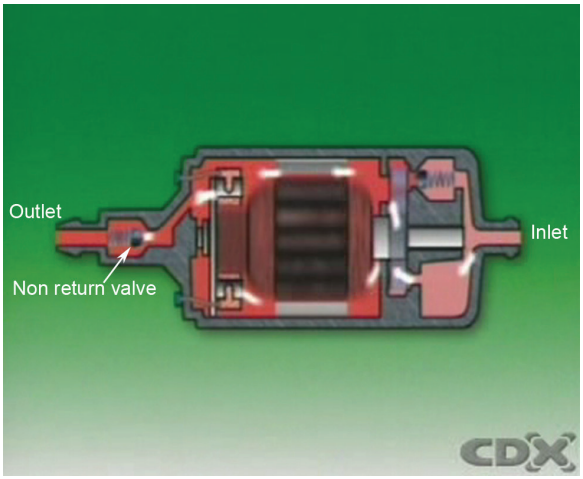
5.0 The Electric Fuel Pump (Rotary Type)

Key Learning Points

- Structure and operating principle of the externally mounted electric fuel pump (rotary type) including purpose of pressure relief valve and non-return valve

5.1 Fuel Pumps

In an electronic fuel-injected engine, the fuel for the injectors must be pressurized before the engine can be started, so an electric fuel pump is necessary.



An electric rotary pump can be located in the tank, or externally, on the underside of the body and should be checked and replaced according to manufactures recommendations. Petrol enters at one end and leaves at the other, so it is always full. This lubricates the pump motor and keeps it cool. The pumping element is a roller-cell device driven by an electric motor. A rotor disc is mounted eccentrically in the pump housing. It has recesses around its edge, containing metal rollers. As the disc rotates, centrifugal force pushes them outward. This forms a rotating seal and fuel is carried round in the cavities formed between the rollers. Because of the eccentric mounting of the disc, these cavities expand as they pass the inlet and contract passing the outlet. This pressurises the fuel and forces it into the fuel line.

For a short time after an engine is switched off, engine temperature keeps rising and that can cause excess vapour in the fuel lines.

This pump stops this, with a non-return valve on its outlet, which maintains the pressure in the fuel line during that short time.

If a fuel blockage occurs further along the fuel line, it can overload the pump motor and make it overheat. So a high-pressure relief valve inside the pump lets fuel keep circulating.

When the pump is mounted externally, a low-pressure pump can be used to supply fuel to the main pump's inlet. This low-pressure pump is mounted in the fuel tank. It's an electrical centrifugal type and it operates in the same way as the other high-pressure pump.

6.0 Removal and Refitting of Fuel Pumps

Key Learning Points

- Removing/refitting external and/or submerged fuel pumps using manufacturer's recommended procedures

Practical Task

Please refer to your instructor for additional information, which is available from the automotive technical manuals.

7.0 Removing and Replacing Petrol Fuel Filters

Key Learning Points

- Removing/replacing fuel filters using manufacturer's recommended procedures; importance of regular fuel filter replacement

7.1 Changing the Fuel Filter

The fuel pump has a one-way valve on the fuel output side and this maintains a residual pressure on the fuel when the engine is not running and therefore it is important to depressurise the system before opening any fuel line. Removing and replacing fuel filters should be carried out according to manufactures recommended procedures. Always beware of the danger of imminent and future fire! Therefore, always examine the fully pressurised system carefully for possible leaks after fitting a replacement filter.

7.2 Replacing a Fuel Filter

Preparation and Safety

Objective

Remove and replace a fuel filter.

Personal Safety

Whenever you perform a task in the workshop you must use personal protective clothing and equipment that is appropriate for the task and which conforms to your local safety regulations and policies. Among other items, this may include:

- Work clothing - such as coveralls and steel-capped footwear
- Eye protection - such as safety glasses and face masks
- Ear protection - such as earmuffs and earplugs
- Hand protection – such as rubber gloves and barrier cream
- Respiratory equipment – such as face masks etc.

If you are not certain what are appropriate or required, ask your instructor

Safety Check

- Petrol fuel, in particular petrol vapour, is explosive and highly flammable. Be careful not to spill any fuel onto a hot engine component where it could ignite and start a fire. Be careful not to cause any sparks while you are changing a fuel filter.
- Collect the petrol waste in a metal container and dispose of it in an environmentally prescribed way.
- Always make sure that you wear the appropriate personal protection equipment before starting the job. It is very easy to hurt yourself even when the most exhaustive protection measures are taken.

- Always make sure that your work area/environment is as safe as you can make it. Do not use damaged, broken or worn out workshop equipment.
- Always follow any manufacturer's personal safety instructions to prevent damage to the vehicle you are servicing.
- Make sure that you understand and observe all legislative and personal safety procedures when carrying out the following tasks. If you are unsure of what these are, ask your supervisor.

Points to Note

- There are a variety of fuel filters, so before you start always check the shop manual for the correct type of filter for the vehicle and the specific procedure for removing and replacing it.

- There are several ways to relieve the static pressure in the fuel system before removing the fuel lines. For example, some fuel injection systems have a valve specifically to bleed off pressure. Other methods include bypassing the fuel pump relay with a jumper wire, or removing the fuel pump fuse and running the engine until it uses up the remaining fuel in the system and stops. Refer to the shop manual for the recommended method for your vehicle.

- If the fuel lines are flexible hoses rather than metal lines, check their condition to determine whether it is necessary to replace the hoses and clamps when you replace the filter. Some replacement filters come with these items and when they are supplied you should always use them. If these are not supplied, but you need to replace them anyway, obtain a sufficient length of new fuel line and suitable clamps.

- There are different types of clamps for flexible fuel lines -- spring type, worm type or rolled edge. You will need to obtain and use the appropriate tool when installing new clamps on the hoses.

Step-by-Step Instruction

1. *Locate fuel filter*: Refer to the vehicle service manual to identify the location and type of fuel filter and the correct procedure for removing and replacing it.

2. *Remove static pressure from fuel system*: If the engine is fitted with an electric fuel pump, locate the fuel pump fuse using the service manual and remove it. Start the engine and wait for it to stop as it runs out of fuel. Switch the ignition off.

3. *Obtain correct replacement*: Obtain the correct replacement filter and components. If the vehicle has a carburetted fuel system, new intake and outlet hoses may have been supplied with the filter. If so, then attach them to the new filter before you disconnect the old one.

4. *Using correct equipment, remove fuel filter*: Loosen the clamps on the fuel line on the engine side of the filter at the outer end of the hose and disconnect it. If necessary drain any excess fuel into the fuel proof container.

5. *Install carburetted system filter:* Connect the new filter hose and tighten the clamp. Make sure that you have the filter facing in the right direction, with the flow indicator arrow pointing towards the engine. Then remove the old filter and reconnect the new one to the fuel intake. If you do this quickly, very little of the residual fuel in the line should leak from the system.

6. *Remove old EFI system filter:* In a fuel injected system, the fuel is under greater pressure, so the fuel lines are normally made of metal, which are not replaced at the same time as the filter. Using the correct tool, loosen the metal line connectors and remove the filter, catching any leaking fuel in a fuel-proof container.

7. *Install EFI system filter:* Connect the new filter and tighten the line connectors. Make sure that you have the filter facing in the right direction, with the flow indicator arrow pointing towards the engine. Finally, remember to replace the fuel pump fuse.

8.0 Return-Type Fuel Supply System Components

Key Learning Points

- Location and identification of return-type fuel supply system components including fuel pump relay, fuel filter, fuel supply and return pipes, fuel distribution rail, fuel pressure regulator, inertia/impact/collision switch

Practical Task

Please refer to your instructor for additional information, which is available from the automotive technical manuals.

9.0 Fuel Injection Pressures

Key Learning Points

- Fuel system pressures applicable to single-point (throttle-body) and multi-point injection systems

Practical Task

Please refer to your instructor for additional information, which is available from the automotive technical manuals.

9.1 Typical Fuel Pressures

For a single point injection system is approx. 3 bar. For multi point injection it is higher between 4 and 5 bar. Please refer to manufactures data when checking each system.

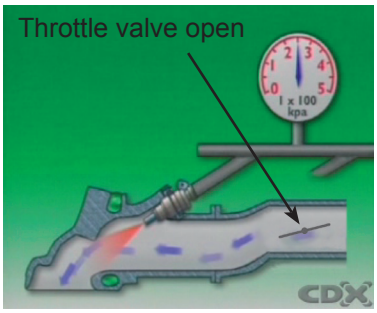
10.0 Fuel Distribution Rail and Inlet Manifold Pressures

Key Learning Points

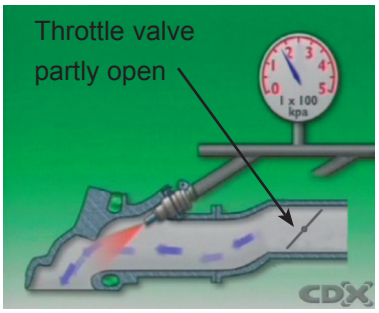
- Purpose of constant pressure differential between fuel distribution rail and inlet manifold

10.1 Fuel Pressure Versus Inlet Manifold Vacuum

This is because a 'constant pressure differential must be maintained between the fuel distribution rail and the inlet manifold pressure'. 'Constant' means 'steady' or 'the same'. The difference in value between the fuel pressure in the distribution rail (approx. 3 bar) and the inlet manifold pressure (e.g. -0.5 bar) must be maintained at a constant or steady value at all times and under all operating conditions because, the quantity of fuel released by the injector for combustion is determined by the length of time that the ECU transmits the 'injector open signal' and the most accurate matching of this fuel quantity is required so that the engine can meet its exhaust emission targets.



When the throttle valve is fully open there is high air/ gas pressure (low vacuum)



When the throttle valve is closed or partly open there is low air/gas pressure (high vacuum)

Fuel distribution rail, pressure gauge

10.2 Constant Pressure Difference Explained

The fuel pressure available at the injector is produced by the pump and controlled by the pressure regulator, but the level of vacuum in the inlet manifold is determined by the throttle valve position and engine speed but, the quantity of fuel being injected at any time is determined as you have seen, by the injector opening time, which is controlled by the *pre-set parameters in the 'map' of the ECU.

The injectors of multi-point injection systems inject their fuel below the throttle valve and therefore, the level of vacuum in that area of the inlet manifold is affected by the action of that valve.

Therefore, in times of low levels of inlet manifold vacuum (air pressure close to normal atmospheric air pressure) e.g. open throttle valve, a relatively high level of air/fuel vapour pressure would be acting externally on the injector nozzle to resist the exit of fuel, but in periods of high inlet manifold vacuum e.g. light load, the low level of atmospheric air/vapour pressure acting externally against the fuel exit nozzle would support the exit of fuel, i.e. it would help draw an excess of fuel from the injector.

(*Control units can carry out 'adaptation' to outputs on certain circuits, under certain circumstances, see manufacturer's manuals for further information)

10.3 Maintaining Constant Pressure Differential

A constant difference in these pressures is achieved by the fitting of a 'vacuum reference pipe' from a point inside the throttle valve of the inlet manifold to the sealed spring housing of the regulator. The differing levels of low pressure in the manifold then act on the diaphragm and help its movement against the spring. As a result, fuel pressure is continually corrected in step with changes in manifold pressure, e.g. low air pressure (partial vacuum) will assist the fuel pressure to raise the regulator valve and this then reduces the fuel pressure relative to the inlet manifold pressure.

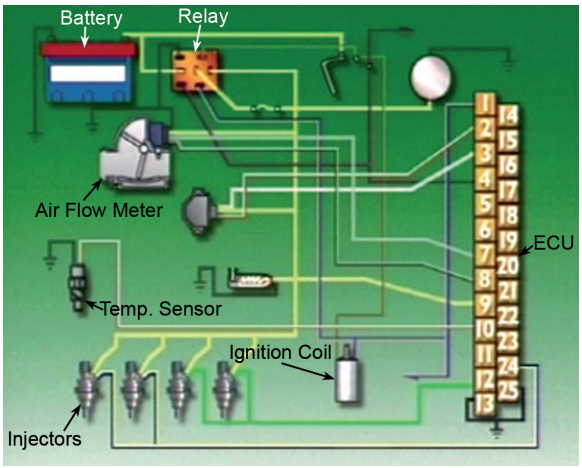
11.0 Electrical Circuit for the Fuel Supply System

Key Learning Points

- Draw a Electrical circuit for fuel supply system (to include pump, pump relay, ECU and inertia/impact/collision switch)

Please refer to your instructor for additional information, which is available from the automotive technical manuals.

11.1 EFI Wiring Diagram

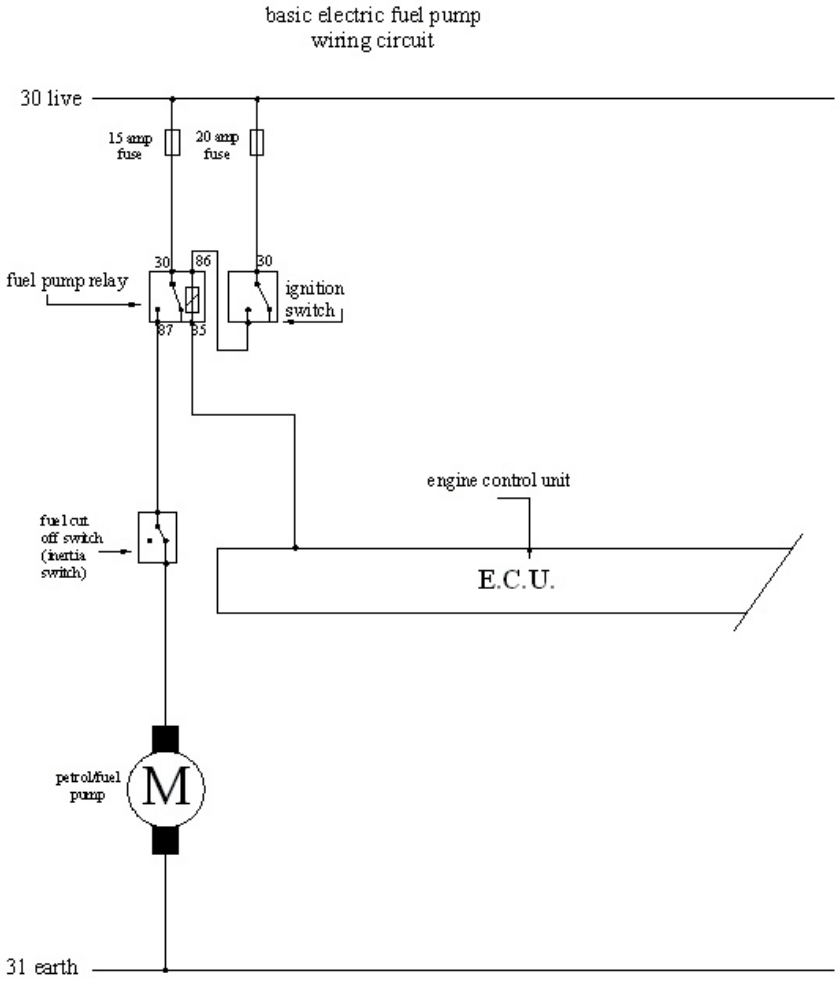


The battery is grounded to the vehicle frame at the negative terminal. Its positive terminal is connected to a tachometric relay and to the ignition switch.

A connecting wire runs from the tachometric relay, to the positive terminal on the fuel pump. A fuse in the connecting wire protects the circuit.

The fuel pump circuit is completed by grounding the fuel pump negative terminal to the frame of the vehicle. When the fuel pump operates current flows from the battery to the petrol pump. It flows through the pump to rotate the armature and completes the circuit by flowing from the negative terminal, through the vehicle frame, to the battery negative terminal. Testing of this circuit is done according to manufactures recommendations.

Positive connections are made to a number of components from the tachometric relay. The relay only operates when the engine is cranking, or running, so no current flows in any connecting wires at other times. More wiring diagrams are available from automotive technical manuals.



Basic Electric Fuel Pump Wiring Circuit

12.0 Servicing Fuel Pump Relays

Key Learning Points

- Testing fuel pump relays using manufacturer's recommended procedures

Practical Task

Please refer to your instructor for additional information, which is available from the automotive technical manuals.

13.0 Applicable NCT/DoT VTM Requirements

Key Learning Points

- NCT/DoT VTM requirements applicable to the fuel tank, fuel filter systems, fuel lines and air filter assembly of petrol powered engines
- Use of data manuals/manufacturer's manuals/NCT/DoT VTM Manual

13.1 NCT/Dot VTM Requirements

Please refer to the item number 50 of the (2004) NCT manual for the relevant specifications.

Self Assessment

Q1: Baffles in the fuel tank are fitted in order to: (Tick ONE box only)

- ❑ 1. Increase tank volume
- ❑ 2. Strengthen the fuel tank
- ❑ 3. Reduce fuel surge
- ❑ 4. Provide vapour space

Q2: How is a submersible electric fuel pump lubricated? (Tick ONE box only)

- ❑ 1. Cool air surrounding the pump
- ❑ 2. By the fuel
- ❑ 3. Oil sealed within the pump
- ❑ 4. No lubrication is required

Q3: Technician A says that when changing a fuel filter on an EFI system it must be depressurized first; Technician B says that because the engine in switched off the system is already depressurized to the point that the filter can be changed. Who is correct? (Tick ONE box only)

- ❑ 1. Technician A
- ❑ 2. Technician B
- ❑ 3. Both Technician A and Technician B
- ❑ 4. Neither Technician A nor Technician B

Q4 The purpose of the Inertia Switch is to? (Tick ONE box only)

- ❑ 1. Trigger the air bag system
- ❑ 2. Open the vehicle doors
- ❑ 3. Switch off the power supply to the fuel pump
- ❑ 4. Operate the cooling fan

Q5: All fuel tanks can be repaired (Tick ONE box only)

- ❑ 1. True
- ❑ 2. False

Q6: In multi-point EFI systems, fuel is transferred from the tank to the fuel rail by the: (Tick one box only)

- ❑ 1. Fuel filter
- ❑ 2. Fuel pump
- ❑ 3. Fuel regulator
- ❑ 4. Fuel accumulator

Suggested Exercises

1. Use an electronic data facility to procure manufacturer's appropriate data for use with practical exercises
2. Test the operation of a fuel level gauge using a potentiometer
3. Locate and identify each component in the return-type fuel supply system on a fuel injected vehicle/training unit
4. Remove and refit external and/or submerged fuel pumps using manufacturer's recommended procedures
5. Remove and replace petrol fuel filters using manufacturer's recommended procedures
6. Remove and test fuel pump relay with ohmmeter across winding circuit (86/85)
7. Energise relay and test contact circuit (30/87) with ohmmeter

Training Resources

- Fuel injected vehicles/training units, Multimeters, data manuals, manufacturer's manuals, NCT/DoT VTM manual, video/multimedia resources
- Potentiometers
- Selection of fuel supply system components including fuel level sender units, fuel level gauges, electric fuel pumps, fuel pump relays, sectioned fuel filters, fuel supply and return pipes, fuel distribution rails, fuel pressure regulators, inertia/impact/collision switches
- Appropriate petrol storage containers and fire extinguishers

Task Sheets

Replacing a Fuel Filter

Preparation and Safety

Objective

Remove and replace a fuel filter.

Personal Safety

Whenever you perform a task in the workshop you must use personal protective clothing and equipment that is appropriate for the task and which conforms to your local safety regulations and policies. Among other items, this may include:

- Work clothing - such as coveralls and steel-capped footwear
- Eye protection - such as safety glasses and face masks
- Ear protection - such as earmuffs and earplugs
- Hand protection – such as rubber gloves and barrier cream
- Respiratory equipment – such as face masks etc.

If you are not certain what are appropriate or required, ask your instructor

Safety Check

- Petrol, in particular petrol vapour, is explosive and highly flammable. Be careful not to spill any fuel onto a hot engine component where it could ignite and start a fire. Be careful not to cause any sparks while you are changing a fuel filter.
- Collect the petrol waste in a metal container and dispose of it in an environmentally prescribed way.

- Always make sure that you wear the appropriate personal protection equipment before starting the job. It is very easy to hurt yourself even when the most exhaustive protection measures are taken.
- Always make sure that your work area/environment is as safe as you can make it. Do not use damaged, broken or worn out workshop equipment.
- Always follow any manufacturer's personal safety instructions to prevent damage to the vehicle you are servicing.
- Make sure that you understand and observe all legislative and personal safety procedures when carrying out the following tasks. If you are unsure of what these are, ask your supervisor.

Points to Note

- There are a variety of fuel filters, so before you start always check the shop manual for the correct type of filter for the vehicle and the specific procedure for removing and replacing it.

- There are several ways to relieve the static pressure in the fuel system before removing the fuel lines. For instance, some fuel injection systems have a valve specifically to bleed off pressure. Other methods include bypassing the fuel pump relay with a jumper wire, or removing the fuel pump fuse and running the engine until it uses up the remaining fuel in the system and stops. Refer to the shop manual for the recommended method for your vehicle.

- If the fuel lines are flexible hoses rather than metal lines, check their condition to determine whether it is necessary to replace the hoses and clamps when you replace the filter. Some replacement filters come with these items and when they are supplied you should always use them. If these are not supplied, but you need to replace them anyway, obtain a sufficient length of new fuel line and suitable clamps.

- There are different types of clamps for flexible fuel lines -- spring type, worm type or rolled edge. You will need to obtain and use the appropriate tool when installing new clamps on the hoses.

Step-by-Step Instruction

1. *Locate fuel filter*: Refer to the vehicle service manual to identify the location and type of fuel filter and the correct procedure for removing and replacing it.

2. *Remove static pressure from fuel system*: If the engine is fitted with an electric fuel pump, locate the fuel pump fuse using the service manual and remove it. Start the engine and wait for it to stop as it runs out of fuel. Switch the ignition off.

3. *Obtain correct replacement*: Obtain the correct replacement filter and components. If the vehicle has a carburetted fuel system, new intake and outlet hoses may have been supplied with the filter. If so, then attach them to the new filter before you disconnect the old one.

4. *Using correct equipment, remove fuel filter*: Loosen the clamps on the fuel line on the engine side of the filter at the outer end of the hose and disconnect it. If necessary drain any excess fuel into the fuel proof container.

5. *Install carburetted system filter:* Connect the new filter hose and tighten the clamp. Make sure that you have the filter facing in the right direction, with the flow indicator arrow pointing towards the engine. Then remove the old filter and reconnect the new one to the fuel intake. If you do this quickly, very little of the residual fuel in the line should leak from the system.

6. *Remove old EFI system filter:* In a fuel injected system, the fuel is under greater pressure, so the fuel lines are normally made of metal, which are not replaced at the same time as the filter. Using the correct tool, loosen the metal line connectors and remove the filter, catching any leaking fuel in a fuel-proof container.

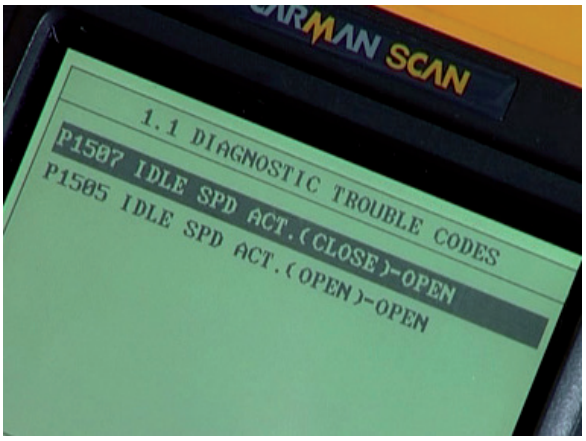
7. *Install EFI system filter:* Connect the new filter and tighten the line connectors. Make sure that you have the filter facing in the right direction, with the flow indicator arrow pointing towards the engine. Finally, remember to replace the fuel pump fuse.

Obtaining & Interpreting Scan Tool Data

Preparation and Safety

Objective

Retrieve, record and clear stored OBD I & II diagnostic trouble codes using a scan tool.



Personal Safety

Whenever you perform a task in the workshop you must use personal protective clothing and equipment that is appropriate for the task and which conforms to your local safety regulations and policies. Among other items, this may include:

- Work clothing - such as coveralls and steel-capped footwear
- Eye protection - such as safety glasses and face masks
- Ear protection - such as earmuffs and earplugs
- Hand protection – such as rubber gloves and barrier cream
- Respiratory equipment – such as face masks etc.

If you are not certain what are appropriate or required, ask your instructor.

Safety Check

- If the vehicle is to be run inside the workshop use exhaust extraction hoses.
- Output solenoids can be energized from the scan tool, activating components without warning. It is imperative that the operator should follow the service manual procedures.
- Make sure that you understand and observe all legislative and personal safety procedures when carrying out the following tasks. If you are unsure of what these are, ask your supervisor.

Points to Note

- Make sure that you follow service manual procedures for the vehicle you are working on.
- The standard procedure for retrieving codes for an OBD I vehicle, is to access the codes, write them down, clear the codes, start the vehicle and recheck for any codes that reset.
- The standard procedure for diagnosing an OBD II vehicle is different as it requires that the codes should NOT be cleared until the vehicle is repaired. Clearing the codes also clears all of the freeze frame data in the system that is useful for the diagnosis process.
- It may take several 'trips' for the code to reset, so with OBDII you must complete the diagnosis process first before clearing the codes.
- Always check for any applicable service bulletins when diagnosing computer related problems, as they can provide valuable information about new faults that emerge on vehicles as their operational characteristics change as the vehicles get older.

Step-by-Step Instruction

1. *Connect the scan tool*: Locate the scan tool access point and connect the scan tool using the appropriate connector for the vehicle. Turn on the vehicle ignition. Turn on the scan tool. Run the scan tool diagnostic program and navigate through each of the different systems in turn to access the diagnostic trouble codes from the vehicles electronic control module. Note your findings for each vehicle system.
2. *Check your findings:* Look up what each code means and present the information to your supervisor. Any fault indicated by the diagnostic trouble codes will need to be corrected before you clear the codes.
3. *Clear fault codes:* To clear the fault codes from the vehicle; select the delete codes option on the scan tool. Check that the codes have cleared and turn off the vehicle ignition.
4. *Recheck for fault codes:* Turn on the vehicle ignition. Run the scan tool diagnostic program and navigate through each system again to check the codes do not reactivate. If the fault codes reactivate, take your findings to your instructor. Turn off the vehicle ignition. Turn off the scan tool and disconnect from the access point.

Suggested Further Reading

- Advanced Automotive Diagnosis. Tom Denton. ISBN 0340741236
- Automobile Electrical and Electronic Systems (3rd Edition). Tom Denton. ISBN 0750662190
- Automotive Mechanics (10th Edition). William H. Crouse and Donald L. Anglin. ISBN 0028009436
- Bosch Automotive Electrics Automotive Electronics: Systems and Components (4th Edition). Robert Bosch. ISBN 0837610508
- Bosch Automotive Handbook (6th Edition). Robert Bosch. ISBN 1860584748
- Bosch Automotive Technology Technical Instruction booklet series (numerous titles)
- Hillier's Fundamentals of Motor Vehicle Technology: Book One (5th Edition). V.A.W. Hillier and Peter Coombes. ISBN 0748780823
- Hillier's Fundamentals of Motor Vehicle Technology: Book Two (5th Edition). V.A.W. Hillier and Peter Coombes. ISBN 0748780998
- Modern Automotive Technology. James E. Duffy. ISBN 1566376106
- Motor Vehicle Craft Studies - Principles. F.K. Sully. ISBN 040800133X
- National Car Test (NCT) Manual (Department of Transport, Vehicle Testers Manual - DoT VTM). Department of Transport
- Transmission, Chassis and Related Systems (Vehicle Maintenance and Repair Series: Level 3) (3rd Edition) John Whipp and Roy Brooks. ISBN 186152806X
- Vehicle and Engine Technology (2nd Edition). Heinz Heisler. ISBN 0340691867
- http://www.cdxglobal.com/
- http://auto.howstuffworks.com/
- http://www.autoshop101.com/
- http://www.cdxetextbook.com/
- Automotive Encyclopedia and Text Book Resource (CD version of e-textbook), Available from your instructor.

Notes

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