AUTOMOTIVE INDUSTRY TRAINING
RETAIL, SERVICE AND REPAIR
AUR05

Learning & Assessment Resource

AURT203170A

SERVICE PETROL FUEL SYSTEMS

Automotive Training Board nsw

NEW SOUTH WALES DEPARTMENT OF EDUCATION AND TRAINING
State Training Services

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Acknowledgement

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Contents

AURT203170A SERVICE PETROL FUEL SYSTEMS

Pre Requisite Units of Competence

Nil

Overview

This unit covers the competence required to carry out servicing on mechanical and electric/electronic petrol fuel system/components in an automotive retail, service and/or repair context.

The unit includes identification and confirmation of work requirement, preparation for work, servicing of petrol fuel system components and completion of work finalisation processes, including clean-up and documentation.

All work and work practices must be undertaken to regulatory and legislative requirements. It is applicable in both a learning and assessment pathway and an assessment only pathway.

This competence is performed in the context that all materials and equipment needed to carry out this function have been provided, including learning materials, learning programs and learning resources.

Elements of Competence

To achieve competency in this unit you must demonstrate your ability to:

1. Prepare to service petrol fuel system components;
2. Service petrol fuel system components; and
3. Prepare fuel system for normal operation.

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Steps to take

A stepwise process needs to be developed, for example:

- Decide who will do it.
- Identify the dangerous goods in use and storage and the associated hazards.
- Identify areas and persons at risk.
- Review information, including relevant MSDS and other sources of advice such as relevant Australian Standards.
- Identify external hazards and how these could impinge on the dangerous goods.
- Estimate risks in each situation.
- Reach conclusions about risks.
- Identify and evaluate suitable control measures.
- Adopt control measures.
- Review the effectiveness of control measures.

Controlling the risk

Controlling dangerous goods occurs at three levels:

Level 1	Containment – the first level of control is to contain the dangerous goods to prevent escape. Effective containment will eliminate some risks.
Level 2.	Spill or leak control – these are the controls that function if an escape does occur to contain or limit the effects of the escape (eg bunding to limit the spread of a liquid; warning devices that detect a petrol leak).
Level 3.	Fire control and emergency response – these are the steps to be taken if containment fails, and in case the level 2 controls fail to prevent a serious incident.

The hierarchy of control measures is listed below in order of effectiveness. Work through the sequence, starting with (a) which represents the highest level. Determine the control from the highest level reasonably practicable, and develop each control measure for each risk identified. The term “reasonably practicable” is explained in section 8.2.

(a) Substituting the system of work, substance or plant for something less hazardous (eg change the type or reducing quantities of goods kept on site).

(b) Isolating the hazard (e.g. introduce a restricted work area or enclosing the system, separate goods from other hazards or segregate incompatible substances).

(c) Introducing engineering controls (e.g. forced ventilation to remove fumes).

(d) Administrative controls – examples are:

- modifying the system of work (e.g. changing the times at which certain tasks are done);
- hazard warning signs, specific training and work instructions.

(e) Personal protective equipment (PPE), such as eye, respiratory and hand protection to protect the worker.

In some situations a combination of control measures may be needed.

Administrative controls require frequent reviews of the risks and systems of work. Workers should be trained to implement all relevant controls. When adopting administrative controls, training of workers about each control is important to ensure that workers know how to implement these.

Supervision is necessary to ensure that workers use controls.

1.0 A Car Fuel System

The function of the fuel system is to store and supply fuel to the cylinder chamber where it can be mixed with air, vaporized, and burned to produce energy. The fuel, petrol, is stored in a fuel tank. A fuel pump draws the fuel from the tank through fuel lines and delivers it through a fuel filter to either a carburettor or fuel injector, then delivered to the cylinder chamber for combustion.

1.1 Petrol

Petrol is a complex blend of carbon and hydrogen compounds. Additives are then added to improve performance. All petrol is basically the same, but no two blends are identical. The two most important features of petrol are volatility and resistance to knock (octane). Volatility is a measurement of how easily the fuel vaporizes. If the petrol does not vaporize completely, it will not burn properly (liquid fuel will not burn).

If the petrol vaporizes too easily the mixture will be too lean to burn properly. Since high temperatures increase volatility, it is desirable to have a low volatility fuel for warm temperatures and a high volatility fuel for cold weather. The blends will be different for summer and winter fuels. Vapour lock which was a persistent problem years ago, exists very rarely today. In today's cars the fuel is constantly circulating from the tank, through the system and back to the tank. The fuel does not stay still long enough to get so hot that it begins to vaporize. Resistance to knock or octane is simply the temperature the petrol will burn at. Higher octane fuel requires a higher temperature to burn. As compression ratio or pressure increases so does the need for higher octane fuel. Most engines today are low compression engines therefore requiring a lower octane fuel (92). Any higher octane than required is just wasting money. Other factors that affect the octane requirements of the engine are: air/fuel ratio, ignition timing, engine temperature, and carbon build up in the cylinder. Many automobile manufacturers have installed exhaust petrol recirculation systems to reduce cylinder chamber temperature. If these systems are not working properly, the car will have a tendency to knock. Before switching to a higher octane fuel to reduce knock, make sure to have these other causes checked.

1.2 Fuel Tank

Tank location and design are always a compromise with available space. Most automobiles have a single tank located in the rear of the vehicle. Fuel tanks today have internal baffles to prevent the fuel from sloshing back and forth. If you hear noises from the rear on acceleration and deceleration the baffles could be broken. All tanks have a fuel filler pipe, a fuel outlet line to the engine and a vent system. All catalytic converter cars are equipped with a filler pipe restrictor so that leaded fuel, which is dispensed from a thicker nozzle, cannot be introduced into the fuel system. All fuel tanks must be vented. Before 1970, fuel tanks were vented to the atmosphere, emitting hydrocarbon emissions. Since 1970 all tanks are vented through a charcoal canister, into the engine to be burned before being released to the atmosphere. This is called evaporative emission control and will be discussed further in the emission control section.

1.3 Fuel Lines

Steel lines and flexible hoses carry the fuel from the tank to the engine. When servicing or replacing the steel lines, copper or aluminium must never be used. Steel lines must be replaced with steel. When replacing flexible rubber hoses, proper hose must be used. Ordinary rubber such as used in vacuum or water hose will soften and deteriorate. Be careful to route all hoses away from the exhaust system.

1.4 Fuel Pumps

Two types of fuel pumps are used in automobiles; mechanical and electric. All fuel injected cars today use electric fuel pumps, while most carburetted cars use mechanical fuel pumps. Mechanical fuel pumps are diaphragm pumps, mounted on the engine and operated by an eccentric cam usually on the camshaft. A rocker arm attached to the eccentric moves up and down flexing the diaphragm and pumping the fuel to the engine. Because electric pumps do not depend on an eccentric for operation, they can be located anywhere on the vehicle. In fact they work best when located near the fuel tank.

Many cars today, locate the fuel pump inside the fuel tank. While mechanical pumps operate on pressures of 28 – 40 kPa, electric pumps can operate on pressures of 200 – 275 kPa. Current is supplied to the pump immediately when the key is turned. This allows for constant pressure on the system for immediate starting. Electric fuel pumps can be either low pressure or high pressure. These pumps look identical, so be careful when replacing a fuel pump that the proper one is used. Fuel pumps are rated by pressure and volume. When checking fuel pump operation, both specifications must be checked and met.

1.5 Fuel Filters

The fuel filter is the key to a properly functioning fuel delivery system. This is more true with fuel injection than with carburetted cars. Fuel injectors are more susceptible to damage from dirt because of their close tolerances, but also fuel injected cars use electric fuel pumps. When the filter clogs, the electric fuel pump works so hard to push past the filter, that it burns itself up. Most cars use two filters. One inside the petrol tank and one in a line to the fuel injectors or carburettor. Unless some severe and unusual condition occurs to cause a large amount of dirt to enter the petrol tank, it is only necessary to replace the filter in the line.

2.0 What is petrol?

Petrol is known as an aliphatic hydrocarbon. In other words, petrol is made up of molecules composed of nothing but hydrogen and carbon arranged in chains. Petrol molecules have from seven (7) to 11 carbons in each chain.

2.1 Typical molecules found in petrol

When you burn petrol under ideal conditions, with plenty of oxygen, you get carbon dioxide (from the carbon atoms in petrol), water (from the hydrogen atoms) and lots of heat. A litre of petrol contains about 34,700 kJ of energy, which is equivalent to 36,650 watt-hours:

- If you took a 1,500-watt bar heater and left it on full blast for 24 hours, that's about how much heat is in a litre of petrol.

- If it were possible for human beings to digest petrol the energy in a litre of petrol is equivalent to the energy in about 30 McDonalds hamburgers!

2.2 Where does petrol come from?

Petrol is made from crude oil. The crude oil pumped out of the ground is a black liquid called petroleum. This liquid contains hydrocarbons, and the carbon atoms in crude oil link together in chains of different lengths.

It turns out that hydrocarbon molecules of different lengths have different properties and behaviours. For example, a chain with just one carbon atom in it (CH4) is the lightest chain, known as methane. Methane is a petrol so light that it floats like helium. As the chains get longer, they get heavier.

The first four chains - CH4 (methane), C2H6 (ethane), C3H8 (propane) and C4H10 (butane) - are all petroles, and they boil at -107, -67, -43 and -18 degrees C. The chains up through C18H32 or so are all liquids at room temperature, and the chains above C19 are all solids at room temperature.

The different chain lengths have progressively higher boiling points, so they can be separated out by distillation. This is what happens in an oil refinery -- crude oil is heated and the different chains are pulled out by their vaporization temperatures.

The chains in the C5, C6 and C7 range are all very light, easily vaporized, clear liquids called naphthas. They are used as solvents -- dry cleaning fluids can be made from these liquids, as well as paint solvents and other quick-drying products.

The chains from C7H16 through C11H24 are blended together and used for petrol. All of them vaporize at temperatures below the boiling point of water. That's why if you spill petrol on the ground it evaporates very quickly.

Next is kerosene, in the C12 to C15 range, followed by diesel fuel and heavier fuel oils (like heating oil for houses).

Next come the lubricating oils. These oils no longer vaporize in any way at normal temperatures. For example, engine oil can run all day at 121 degrees C without vaporizing at all. Oils go from very light (like 3 – in - 1 oil) through various thicknesses of motor oil through very thick gear oils and then semi-solid greases. Vasoline falls in there as well.

Chains above the C20 range form solids, starting with paraffin wax, then tar and finally asphaltic bitumen, which used to make asphalt roads.

All of these different substances come from crude oil. The only difference is the length of the carbon chains!

2.3 What is octane?

Almost all cars use four-stroke petrol engines. One of the strokes is the compression stroke, where the engine compresses a cylinder-full of air and petrol into a much smaller volume before igniting it with a spark plug. The amount of compression is called the compression ratio of the engine. A typical engine might have a compression ratio of 8 – to - 1.

The octane rating of petrol tells you how much the fuel can be compressed before it spontaneously ignites. When petrol ignites by compression rather than because of the spark from the spark plug, it causes knocking in the engine. Knocking can damage an engine, so it is not something you want to have happening. Lower-octane petrol (like "regular unleaded" 92 - octane petrol) can handle the least amount of compression before igniting.

The compression ratio of your engine determines the octane rating of the petrol you must use in the car. One way to increase the kilowatts of an engine of a given displacement is to increase its compression ratio. So a "high-performance engine" has a higher compression ratio and requires higher-octane fuel. The advantage of a high compression ratio is that it gives your engine a higher kilowatt rating for a given engine weight -- that is what makes the engine "high performance." The disadvantage is that the petrol for your engine costs more.

The name "octane" comes from the following fact: When you take crude oil and "crack" it in a refinery, you end up getting hydrocarbon chains of different lengths. These different chain lengths can then be separated from each other and blended to form different fuels. For example, methane, propane and butane are all hydrocarbons. Methane has a single carbon atom. Propane has three carbon atoms chained together. Butane has four carbon atoms chained together. Pentane has five, hexane has six, heptane has seven and octane has eight carbons chained together.

It turns out that heptane handles compression very poorly. Compress it just a little and it ignites spontaneously. Octane handles compression very well - you can compress it a lot and nothing happens. Ninety Two octane petrol is petrol that contains 92% octane and 8% heptane (or some other combination of fuels that has the same performance of the 92/8 combination of octane/heptane). It spontaneously ignites at a given compression level, and can only be used in engines that do not exceed that compression ratio.

2.4 Petrol additives

During WWI, it was discovered that you can add a chemical called tetraethyl lead to petrol and significantly improve its octane rating. Cheaper grades of petrol could be made usable by adding this chemical. This led to the widespread use of "ethyl" or "leaded" petrol. Unfortunately, the side effects of adding lead to petrol are:

- Lead clogs a catalytic converter and renders it inoperable within minutes.
- The Earth became covered in a thin layer of lead, and lead is toxic to many living things (including humans).

When lead was banned, petrol got more expensive because refineries could not boost the octane ratings of cheaper grades any more. Airplanes are still allowed to use leaded petrol, and octane ratings of 115 are commonly used in super-high-performance piston airplane engines (jet engines burn kerosene, by the way).

Another common additive is MTBE. MTBE is the acronym for methyl tertiary butyl ether, a fairly simple molecule that is created from methanol. MTBE gets added to petrol for two reasons:

- It boosts octane.

- It is an oxygenate, meaning that it adds oxygen to the reaction when it burns. Ideally, an oxygenate reduces the amount of unburned hydrocarbons and carbon monoxide in the exhaust.

"The fuel additive MTBE (methyl tertiary butyl ether) recently emerged as an issue of concern for the Australian water industry, a few months after the approval of the Fuel Standards Act in December 2000. The Act specifies new requirements for petrol and diesel fuels to be phased in over a four year period beginning in January 2002. These changes are designed to reduce air pollution levels in urban areas, and will bring Australian standards for fuel quality into line with changes in international standards. This is expected to result in a reduction in rates of respiratory illnesses and lower cancer risks, with an estimated saving of up to $3 billion in health costs in Australia over the next 20 years."

Health Stream Article - Issue 23 September 2001

The most likely thing to replace MTBE in petrol is ethanol - normal alcohol. It is somewhat more expensive than MTBE, but it is not a cancer threat.

2.5 Problems with Petrol

Petrol has two problems when burned in car engines. The first problem has to do with smog and ozone in big cities. The second problem has to do with carbon and greenhouse petroles.

When cars burn petrol, they would ideally burn it perfectly and create nothing but carbon dioxide and water in their exhaust. Unfortunately, the internal combustion engine is not perfect. In the process of burning the petrol, it also produces:

- Carbon monoxide, a poisonous petrol
- Nitrogen oxides, the main source of urban smog
- Unburned hydrocarbons, the main source of urban ozone

Catalytic converters eliminate much of this pollution, but they aren't perfect either. Air pollution from cars and power plants is a real problem in big cities.

Carbon is also a problem. When it burns, it turns into lots of carbon dioxide petrol. Petrol is mostly carbon by weight, so a litre of petrol might release 0.6 kg of carbon into the atmosphere.

If it were solid carbon, it would be extremely noticeable. The carbon dioxide coming out of every car's tailpipe is a greenhouse petrol. The ultimate effects are unknown, but it is a strong possibility that, eventually, there will be dramatic climate changes that affect everyone on the planet (for example, sea levels may rise, flooding or destroying coastal cities). For this reason, there are growing efforts to replace petrol.

3.0 Taking Care of a Petrol Fuel System

The basic servicing care of a petrol fuel system involves two (2) "F's"; filters and fuel. It is important to replace the fuel filter on a carburetted engines periodically so that they don't block up with debris and stop fuel flowing. Sintered metallic filters mounted right at the carburettor's fuel inlet are sometime prone to this. Interestingly most carburetted engines don't have fuel filters between the fuel tank and the fuel pump.

WARNING

When replacing a fuel filter on:

- **A carburetted engine, some minor fuel spillage can occur when the fuel line is disconnected to change the filter.**
- **On a fuel injected engine it operates at very high fuel pressures. Opening or disconnecting any fuel system component without fully depressurising the system is extremely dangerous. Many fuel filters require a special tool to disconnect fuel lines.**

3.1 Fuel Filter Changes

Fuel filters on injected engines are even more critical. These filters are typically quite large in size and volume, and are mounted in, at or close to the fuel tank itself. The fuel filter traps debris, crud and even water from the fuel and it should be changed every 45,000 kms. If the filter begins to clog, its resistance to fuel flow increases, which in turn works the electric fuel pump in the tank much harder. A $15.00 fuel filter is a much simpler, less expensive service that $500 - $800.00 to replace the fuel pump itself. And, of course a clogged fuel filter or failed fuel pump will absolutely and positively leave a vehicle dead on the side of the road until the problem is fixed. You can't limp a fuel injected vehicle with a clogged fuel system; the engine will not run.

3.2 Air Filter Changes

In addition to a fuel filter change one more filter needs to be serviced on a regular basis; the air filter. Keep it simple; change you air filter once per year. If the vehicle is used in a dusty environment or on dirt roads it is suggested to change it more frequently; perhaps every six (6) months. Any serious restriction of air flow through the air filter will significantly decrease the fuel economy of any vehicle. The restriction virtually strangles the vehicle.

Perhaps a question is: Why filter the air at all? To clean it, of course. Well, the filter doesn't really clean the air itself but it does remove the fine particles of dust, dirt and debris from the air before it is ingested by the engine. Any type of debris entering the engine acts like sandpaper on the cylinder walls, increasing the rate of wear on the pistons, rings and cylinder walls resulting in a shortening of the life of the engine.

4.0 History & Development of the Carburettor

The carburettor was invented by the Hungarian engineer Donát Bánki in 1893. Frederick William Lanchester of Birmingham, England experimented early on with the wick carburettor in cars. In 1896 Frederick and his brother built the first petrol driven car in England, a single cylinder 4 kW internal combustion engine with chain drive. Unhappy with the performance and power, they re-built the engine the next year into a two cylinder horizontally opposed version using his new wick carburettor design. This version completed a 1600 km tour in 1900 successfully incorporating the carburettor as an important step forward in automotive engineering.

Carburettors were the usual fuel delivery method for almost all engines up until the mid-1980s, when fuel injection became the preferred method of automotive fuel delivery. In the US market, the last carbureted car was the 1991 Ford Crown Victoria Police Interceptor equipped with the 5.8 L engine, and the last carbureted light truck was the 1994 Isuzu. Elsewhere, Lada cars used carburettors until 1996. A majority of motorcycles still utilize carburettors due to lower cost and throttle response problems with early injection set ups, but as of 2005, many new models are now being introduced with fuel injection. Carburettors are still found in small engines and in older or specialized automobiles, such as those designed for stock car racing.

4.1 Principles

The carburettor works on Bernoulli's principle: the faster air moves, the lower its static pressure, and the higher its dynamic pressure. The throttle (accelerator) linkage does not directly control the flow of liquid fuel. Instead, it actuates carburettor mechanisms which meter the flow of air being pulled into the engine. The speed of this flow, and therefore its pressure, determines the amount of fuel drawn into the airstream.

When carburettors are used in small aircraft with piston engines, special designs and features as found in e.g. the Bendix carburettor are needed to avoid fuel starvation under high g-forces.

Most carburetted (as opposed to fuel-injected) engines have a single carburettor, though some engines use multiple carburettors. Older engines used updraft carburettors, where the air enters from below the carburettor and exits through the top. This had the advantage of never "flooding" the engine, as any liquid fuel droplets would fall out of the carburettor instead of into the intake manifold; it also lent itself to use of an oil bath air cleaner, where a pool of oil below a mesh element below the carburettor is sucked up into the mesh and the air is drawn through the oil covered mesh; this was an effective system in a time when paper air filters did not exist.

Beginning in the late 1930s, downdraft carburettors were the most popular type for automotive use in the United States. In Europe, the sidedraft carburettors replaced downdraft as free space in the engine bay decreased and the use of the SU-type carburettor (and similar units from other manufacturers) increased. Some small propeller-driven aircraft engines still use the updraft carburettor design, however many use more modern designs such as the Constant Velocity (CV) Bing(TM) carburettor.

4.2 Operation

Figure 1 - A high performance 4-barrel carburettor

4.2.1 Fixed-venturi, in which the varying air velocity in the venturi alters the fuel flow; this architecture is employed in most downdraft carburettors found on American and some Japanese cars.

4.2.2 Variable-venturi, in which the fuel jet opening is varied by the slide (which simultaneously alters air flow). In "constant depression" carburettors, this is done by a vacuum operated piston connected to a tapered needle which slides inside the fuel jet. A simpler version exists, most commonly found on small motorcycles and dirt bikes, where the slide and needle is directly controlled by the throttle position. These types of carburettors are commonly equipped with accelerator pumps to make up for a particular shortcoming of this design. The most common variable venturi (constant depression) type carburettor is the sidedraft SU carburettor and similar models from Hitachi, Zenith-Stromberg and other makers. The UK location of the SU and Zenith-Stromberg companies helped these carburettors rise to a position of domination in the UK car market, though such carburettors were also very widely used on Volvos and other non-UK makes. Other similar designs have been used on some European and a few Japanese automobiles. These carburettors are also referred to as "constant velocity" or "constant vacuum" carburettors. An interesting variation was Ford's VV (Variable Venturi) carburettor, which was essentially a fixed venturi carburettor with one side of the venturi hinged and movable to give a narrow throat at low rpm and a wider throat at high rpm. This was designed to provide good mixing and airflow over a range of engine speeds, though the VV carburettor proved problematic in service.

Under all engine operating conditions, the carburettor must:

- Measure the airflow of the engine
- Deliver the correct amount of fuel to keep the fuel/air mixture in the proper range (adjusting for factors such as temperature)
- Mix the two finely and evenly

This job would be simple if air and petrol were ideal fluids; in practice, however, their deviations from ideal behavior due to viscosity, fluid drag, inertia, etc. require a great deal of complexity to compensate for exceptionally high or low engine speeds. A carburettor must provide the proper fuel/air mixture across a wide range of ambient temperatures, atmospheric pressures, engine speeds and loads, and centrifugal forces:

- Cold start;
- Hot start;

- Idling or slow-running;
- Acceleration;
- High speed / high power at full throttle; and
- Cruising at part throttle (light load).

In addition, modern carburettors are required to do this while maintaining low rates of exhaust emissions.

To function correctly under all these conditions, most carburettors contain a complex set of mechanisms to support several different operating modes, called circuits.

5.0 The Basic Carburettor

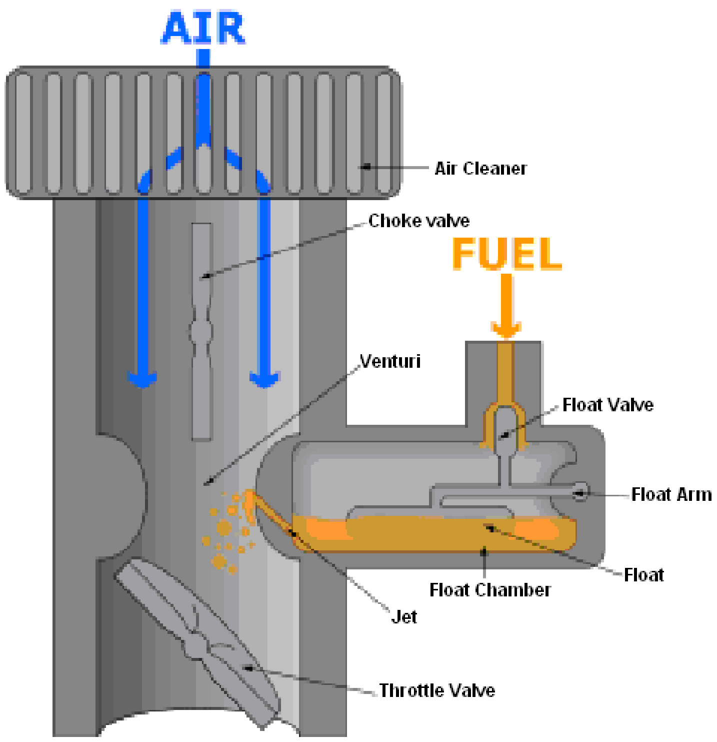

Figure 2

A carburettor (Figure 2) basically consists of an open pipe, a "throat" or "barrel" through which the air passes into the inlet manifold of the engine. The pipe is in the form of a venturi: it narrows in section and then widens again, causing the airflow to increase in speed in the narrowest part. Below the venturi is a butterfly valve called the throttle valve — a rotating disc that can be turned end-on to the airflow, so as to hardly restrict the flow at all, or can be rotated so that it (almost) completely blocks the flow of air. This valve controls the flow of air through the carburettor throat and thus the quantity of air/fuel mixture the system will deliver, thereby regulating engine power and speed. The throttle is connected, usually through a cable or a mechanical linkage of rods and joints or rarely by pneumatic link, to the accelerator pedal on a car or the equivalent control on other vehicles or equipment.

Fuel is introduced into the air stream through small holes at the narrowest part of the venturi. Fuel flow in response to a particular pressure drop in the venturi is adjusted by means of precisely-calibrated orifices, referred to as jets, in the fuel path.

5.1 Off-idle circuit

As the throttle is opened up slightly from the fully closed position, the throttle plate uncovers additional fuel delivery holes behind the throttle plate where there is a low pressure area created by the throttle plate blocking air flow; these allow more fuel to flow as well as compensating for the reduced vacuum that occurs when the throttle is opened, thus smoothing the transition to metering fuel flow through the regular open throttle circuit.

5.2 Main open-throttle circuit

As the throttle is progressively opened, the manifold vacuum is lessened since there is less restriction on the airflow, reducing the flow through the idle and off-idle circuits. This is where the venturi shape of the carburettor throat comes into play, due to Bernoulli's principle (i.e., as the velocity increases, pressure falls). The venturi raises the air velocity, and this high speed and thus low pressure sucks fuel into the airstream through a nozzle or nozzles located in the center of the venturi. Sometimes one or more additional booster venturis are placed coaxially within the primary venturi to increase the effect.

As the throttle is closed, the airflow through the venturi drops until the lowered pressure is insufficient to maintain this fuel flow, and the idle circuit takes over again, as described above.

Bernoulli's principle, which is caused by the momentum of the fluid, is a dominant effect for large openings and large flow rates, but since fluid flow at small scales and low speeds (low Reynolds number) is dominated by viscosity, Bernoulli's principle is ineffective at idle or slow running and in the very small carburettors of the smallest model engines. Small model engines have flow restrictions ahead of the jets to reduce the pressure enough to suck the fuel into the air flow. Similarly the idle and slow running jets of large carburettors are placed after the throttle valve where the pressure is reduced partly by viscous drag, rather than by Bernoulli's principle. The most common rich mixture device for starting cold engines was the choke, which works on the same principle.

5.3 Power valve

For open throttle operation a richer mixture will produce more power, prevent detonation, and keep the engine cooler. This is usually addressed with a spring-loaded "power valve", which is held shut by engine vacuum. As the throttle opens up, the vacuum decreases and the spring opens the valve to let more fuel into the main circuit. On two-stroke engines, the operation of the power valve is the reverse of normal - it is normally "on" and at a set rpm it is turned "off". It is activated at high rpm to extend the engine's rev range, capitalizing on a two-stroke's tendency to rev higher momentarily when the mixture is lean.

Alternative to employing a power valve, the carburettor may utilize a metering rod or step-up rod system to richen the fuel mixture under high-demand conditions. Such systems were originated by Carter Carburetor in the 50's for the primary two venturis of their four barrel carburettors, and step-up rods were widely used on most 1-, 2-, and 4-barrel Carter carburettors through the end of production in the 1980s. The step-up rods are tapered at the bottom end, which extends into the main metering jets. The tops of the rods are connected to a vacuum piston and/or a mechanical linkage which lifts the rods out of the main jets when the throttle is opened (mechanical linkage) and/or when manifold vacuum drops (vacuum piston). When the step-up rod is lowered into the main jet, it restricts the fuel flow. When the step-up rod is raised out of the jet, more fuel can flow through it. In this manner, the amount of fuel delivered is tailored to the transient demands of the engine. Some 4-barrel carburettors use metering rods only on the primary two venturis, but some use them on both primary and secondary circuits, as in the Rochester Quadrajet.

5.4 Accelerator Pump

The greater inertia of liquid petrol, compared to air, means that if the throttle is suddenly opened, the airflow will increase more rapidly than the fuel flow, causing a temporary "lean" condition which causes the engine to "stumble" under acceleration (the opposite of what is normally intended when the throttle is opened). This is remedied by the use of a small mechanical pump, usually either a plunger or diaphragm type actuated by the throttle linkage, which propels a small amount of petrol through a jet, wherefrom it is injected into the carburettor throat. This extra shot of fuel counteracts the transient lean condition on throttle tip-in. Most accelerator pumps are adjustable for volume and/or duration by some means. Eventually the seals around the moving parts of the pump wear such that pump output is reduced; this reduction of the accelerator pump shot causes stumbling under acceleration until the seals on the pump are renewed.

The accelerator pump is also used to prime the engine with fuel prior to a cold start. Excessive priming, like an improperly-adjusted choke, can cause flooding. This is when too much fuel and not enough air are present to support combustion. For this reason, carburettors are equipped with an unloader mechanism: The accelerator is held at wide open throttle while the engine is cranked, the unloader holds the choke open and admits extra air, and eventually the excess fuel is cleared out and the engine starts.

5.5 Choke

When the engine is cold, fuel vaporizes less readily and tends to condense on the walls of the intake manifold, starving the cylinders of fuel and making the engine difficult to start; thus, a richer mixture (more fuel to air) is required to start and run the engine until it warms up. A richer mixture is also easier to ignite.

To provide the extra fuel, a choke is typically used; this is a device that restricts the flow of air at the entrance to the carburettor, before the venturi. With this restriction in place, extra vacuum is developed in the carburettor barrel, which pulls extra fuel through the main metering system to supplement the fuel being pulled from the idle and off-idle circuits. This provides the rich mixture required to sustain operation at low engine temperatures.
In addition, the choke is connected to a "fast idle cam" or other such device which prevents the throttle from closing fully, which could starve the venturis of vacuum and cause the engine to stall. This also serves as a way to help the engine warm up quickly by idling it at a higher than normal speed. In addition, it increases airflow throughout the intake system which helps to better atomize the cold fuel and smooth out the idle.

In older carbureted cars, the choke was controlled by a cable connected to a pull-knob on the dashboard operated by the driver. In most carbureted cars produced from the mid 1960s onward (mid 1950s in the United States) it is usually automatically controlled by a thermostat employing a bimetallic spring, which is exposed to engine heat. This heat may be transferred to the choke thermostat via simple convection, via engine coolant, or via air heated by the exhaust. More recent designs use the engine heat only indirectly: A sensor detects engine heat and varies electrical current to a small heating element, which acts upon the bimetallic spring to control its tension, thereby controlling the choke. A choke unloader is a linkage arrangement that forces the choke open against its spring when the vehicle's accelerator is moved to the end of its travel. This provision allows a "flooded" engine to be cleared out so that it will start.

Some carburettors do not have a choke but instead use a mixture enrichment circuit, or enrichener. Typically used on small engines, notably motorcycles, enricheners work by opening a secondary fuel circuit below the throttle valves. This circuit works exactly like the idle circuit, and when engaged it simply supplies extra fuel when the throttle is closed.

Classic British motorcycles, with side-draft slide throttle carburettors, used another type of "cold start device", called a "tickler". This is simply a spring-loaded rod that, when depressed, manually pushes the float down and allows excess fuel to fill the float bowl and flood the intake tract. If the "tickler" was held down too long it also flooded the outside of the carburettor and the crankcase below, and was therefore a fire hazard.

5.6 Other Elements

The interactions between each circuit may also be affected by various mechanical or air pressure connections and also by temperature sensitive and electrical components. These are introduced for reasons such as response, fuel efficiency or automobile emissions control. Various air bleeds (often chosen from a precisely calibrated range, similarly to the jets) allow air into various portions of the fuel passages to enhance fuel delivery and vaporization. Extra refinements may be included in the carburettor/manifold combination, such as some form of heating to aid fuel vaporization such as an early fuel evaporator.

6.0 Fuel supply

6.1 Float chamber

Figure 3 - Holley "Visi-Flo" model #1904 carburettors from the 1950s, factory equipped with transparent glass bowls

To ensure a ready mixture, the carburettor has a "float chamber" (or "bowl") that contains a quantity of fuel at near-atmospheric pressure, ready for use. This reservoir is constantly replenished with fuel supplied by a fuel pump. The correct fuel level in the bowl is maintained by means of a float controlling an inlet valve, in a manner very similar to that employed in toilet tanks. As fuel is used up, the float drops, opening the inlet valve and admitting fuel. As the fuel level rises, the float rises and closes the inlet valve. The level of fuel maintained in the float bowl can usually be adjusted, whether by a setscrew or by something crude such as bending the arm to which the float is connected. This is usually a critical adjustment, and the proper adjustment is indicated by lines inscribed into a window on the float bowl, or a measurement of how far the float hangs below the top of the carburettor when disassembled, or similar. Floats can be made of different materials, such as sheet brass soldered into a hollow shape, or of plastic; hollow floats can spring small leaks and plastic floats can eventually become porous and lose their flotation; in either case the float will fail to float, fuel level will be too high, and the engine will not run well unless the float is replaced.

The valve itself becomes worn on its sides by its motion in its "seat" and will eventually try to close at an angle, and thus fails to shut off the fuel completely; again, this will cause excessive fuel flow and poor engine operation. Conversely, as the fuel evaporates from the float bowl, it leaves sediment, residue, and varnishes behind, which clog the passages and can interfere with the float operation. This is particularly a problem in automobiles operated for only part of the year and left to stand with full float chambers for months at a time; commercial fuel stabilizer additives are available that reduce this problem.

Usually, special vent tubes allow air to escape from the chamber as it fills or enter as it empties, maintaining atmospheric pressure within the float chamber; these usually extend into the carburettor throat. Placement of these vent tubes can be somewhat critical to prevent fuel from sloshing out of them into the carburettor, and sometimes they are modified with longer tubing. Note that this leaves the fuel at atmospheric pressure, and therefore it cannot travel into a throat which has been pressurized by a supercharger mounted upstream; in such cases, the entire carburettor must be contained in an airtight pressurized box to operate. This is not necessary in installations where the carburettor is mounted upstream of the supercharger, which is for this reason the more frequent system. However, this results in the supercharger being filled with compressed fuel/air mixture, with a strong tendency to explode should the engine backfire; this type of explosion is frequently seen in drag races, which for safety reasons now incorporate pressure releasing blow-off plates on the intake manifold, breakaway bolts holding the supercharger to the manifold, and shrapnel-catching ballistic nylon blankets surrounding the superchargers.

If the engine must be operated in any orientation (for example a chain saw), a float chamber cannot work. Instead, a diaphragm chamber is used. A flexible diaphragm forms one side of the fuel chamber and is arranged so that as fuel is drawn out into the engine the diaphragm is forced inward by ambient air pressure. The diaphragm is connected to the needle valve and as it moves inward it opens the needle valve to admit more fuel, thus replenishing the fuel as it is consumed. As fuel is replenished the diaphragm moves out due to fuel pressure and a small spring, closing the needle valve. A balanced state is reached which creates a steady fuel reservoir level, which remains constant in any orientation.

6.2 Multiple carburettor barrels

Figure 4 - Holley model #2280 2-barrel carburettor

Figure 5 - Colombo Type 125 "Testa Rossa" engine in a 1961 Ferrari 250TR Spyder with six Weber two-barrel carburettors inducting air through 12 air horns; one individually adjustable barrel for each cylinder.

While basic carburettors have only one venturi, many carburettors have more than one venturi, or "barrel". Two barrel and four barrel configurations are commonly used to accommodate the higher air flow rate with large engine displacement. Multi-barrel carburettors can have non-identical primary and secondary barrel(s) of different sizes and calibrated to deliver different air/fuel mixtures; they can be actuated by the linkage or by engine vacuum in "progressive" fashion, so that the secondary barrels do not begin to open until the primaries are almost completely open. This is a desirable characteristic which maximizes airflow through the primary barrel(s) at most engine speeds, thereby maximizing the pressure "signal" from the venturis, but reduces the restriction in airflow at high speeds by adding cross-sectional area for greater airflow. These advantages may not be important in high-performance applications where part throttle operation is irrelevant, and the primaries and secondaries may all open at once, for simplicity and reliability; also, V configuration engines, with two cylinder banks fed by a single carburettor, may be configured with two identical barrels, each supplying one cylinder bank. In the widely seen V8 and 4-barrel carburettor combination, there are often two primary and two secondary barrels.
Multiple carburettors can be mounted on a single engine, often with progressive linkages; four two-barrel carburettors were frequently seen on high performance American V8s, and multiple four barrel carburettors are often now seen on very high performance engines. Large numbers of small carburettors have also been used (see photo), though this configuration can limit the maximum air flow through the engine due to the lack of a common plenum; with individual intake tracts, not all cylinders are drawing air at once as the engine's crankshaft rotates.

6.3 Carburetor Adjustment

Too much fuel in the fuel-air mixture is referred to as too **rich**, and not enough fuel is too **lean**. The mixture is normally adjusted by one or more needle valves on an automotive carburettor, or a pilot-operated lever on piston-engined aircraft (since mixture is air density (altitude) dependent). The (stoichiometric) air to petrol ratio is 14.7:1, meaning that for each weight unit of petrol, 14.7 units of air will be consumed. Stoichiometric mixture are different for various fuels other than petrol.

Ways to check carburettor mixture adjustment include: measuring the carbon monoxide, hydrocarbon, and oxygen content of the exhaust using a petrol analyzer, or directly viewing the colour of the flame in the combustion chamber through a special glass-bodied spark plug sold under the name "Colortune" for this purpose. The flame colour of stoichiometric burning is described as a "bunsen blue", turning to yellow if the mixture is rich and whitish-blue if too lean.

The mixture can also be judged after engine running by the state and color of the spark plugs: black, dry sooty plugs indicate a too rich mixture, white to light gray deposits on the plugs indicate a lean mixture. The correct color should be a brownish gray. See also reading spark plugs.

In the early 1980s, many American-market vehicles used special "feedback" carburettors that could change the base mixture in response to signals from an exhaust petrol Oxygen sensor. These were mainly used to save costs (since they worked well enough to meet 1980s emissions requirements and were based on existing carburettor designs), but eventually disappeared as falling hardware prices and tighter emissions standards made fuel injection a standard item.
Where multiple carburettors are used the mechanical linkage of their throttles must additionally be adjusted to synchronism for smooth engine running.

7.0 How Fuel Injection Systems Work

In trying to keep up with emissions and fuel efficiency laws, the fuel system used in modern cars has changed a lot over the years. But fuel injection has been around since the 1950s, and electronic fuel injection was used widely on European cars starting around 1980.

7.1 The Fall of the Carburettor

For most of the existence of the internal combustion engine, the carburettor has been the device that supplied fuel to the engine. On many other machines, such as lawnmowers and chainsaws, it still is. But as the automobile evolved, the carburettor got more and more complicated trying to handle all of the operating requirements. For instance, to handle some of these tasks, carburettors had five different circuits:

- Main circuit - Provides just enough fuel for fuel-efficient cruising;
- Idle circuit - Provides just enough fuel to keep the engine idling;
- Accelerator pump - Provides an extra burst of fuel when the accelerator pedal is first depressed, reducing hesitation before the engine speeds up;
- Power enrichment circuit - Provides extra fuel when the car is going up a hill or towing a trailer; and
- Choke - Provides extra fuel when the engine is cold so that it will start.

In order to meet stricter emissions requirements, catalytic converters were introduced. Very careful control of the air-to-fuel ratio was required for the catalytic converter to be effective. Oxygen sensors monitor the amount of oxygen in the exhaust, and the engine control unit (ECU) uses this information to adjust the air-to-fuel ratio in real-time. This is called closed loop control - it was not feasible to achieve this control with carburettors. There was a brief period of electrically controlled carburettors before fuel injection systems took over, but these electrical carby’s were even more complicated than the purely mechanical ones.

At first, carburettors were replaced with throttle body fuel injection systems (also known as single point or central fuel injection systems) that incorporated electrically controlled fuel-injector valves into the throttle body. These were almost a bolt-in replacement for the carburettor, so the automakers didn't have to make any drastic changes to their engine designs.

Gradually, as new engines were designed, throttle body fuel injection was replaced by multi-port fuel injection (also known as port, multi-point or sequential fuel injection). These systems have a fuel injector for each cylinder, usually located so that they spray right at the intake valve. These systems provide more accurate fuel metering and quicker response.

7.2 When You Step on the Gas

The petrol pedal in your car is connected to the throttle valve (Figure 6) - this is the valve that regulates how much air enters the engine. So the petrol pedal is really the air pedal.

Figure 6

When you step on the petrol pedal, the throttle valve opens up more, letting in more air. The engine control unit (ECU, the computer that controls all of the electronic components on your engine) "sees" the throttle valve open and increases the fuel rate in anticipation of more air entering the engine. It is important to increase the fuel rate as soon as the throttle valve opens; otherwise, when the petrol pedal is first pressed, there may be a hesitation as some air reaches the cylinders without enough fuel in it.

Sensors monitor the mass of air entering the engine, as well as the amount of oxygen in the exhaust. The ECU uses this information to fine-tune the fuel delivery so that the air-to-fuel ratio is just right.

7.3 The Injector

A fuel injector is nothing but an electronically controlled valve (Figure 7). It is supplied with pressurized fuel by the fuel pump in your car, and it is capable of opening and closing many times per second.

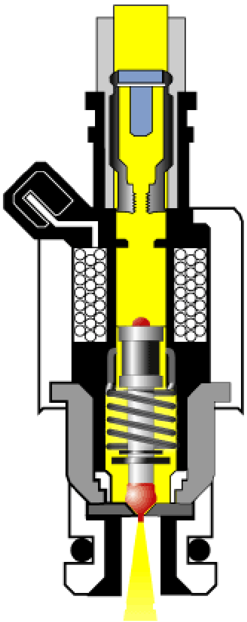

Figure 7

When the injector is energized, an electromagnet moves a plunger that opens the valve, allowing the pressurized fuel to squirt out through a tiny nozzle (Figure 8). The nozzle is designed to atomize the fuel -- to make as fine a mist as possible so that it can burn easily.

Figure 8

The amount of fuel supplied to the engine is determined by the amount of time the fuel injector stays open. This is called the pulse width, and it is controlled by the ECU.

Figure 9

The injectors are mounted in the intake manifold (Figure 9) so that they spray fuel directly at the intake valves. A pipe called the fuel rail (Figure 10) supplies pressurized fuel to all of the injectors.

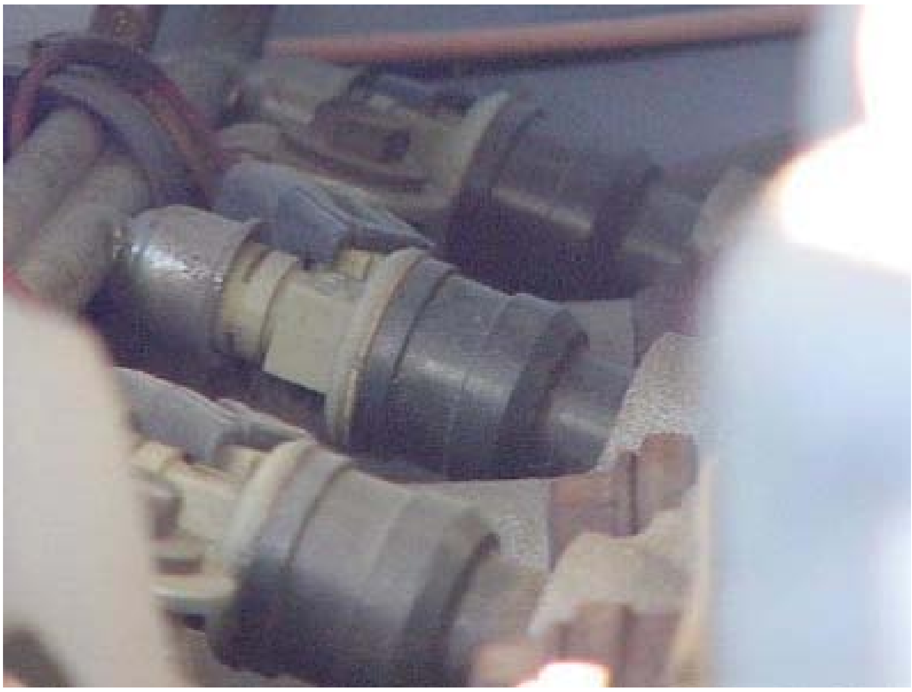

Figure 10

In order to provide the right amount of fuel, the engine control unit is equipped with a whole lot of sensors. Let's take a look at some of them.

7.4 Engine Sensors

In order to provide the correct amount of fuel for every operating condition, the engine control unit (ECU) has to monitor a huge number of input sensors. Here are just a few:

- Mass airflow sensor - Tells the ECU the mass of air entering the engine;

- Oxygen sensor(s) - Monitors the amount of oxygen in the exhaust so the ECU can determine how rich or lean the fuel mixture is and make adjustments accordingly;
- Throttle position sensor - Monitors the throttle valve position (which determines how much air goes into the engine) so the ECU can respond quickly to changes, increasing or decreasing the fuel rate as necessary;
- Coolant temperature sensor - Allows the ECU to determine when the engine has reached its proper operating temperature;
- Voltage sensor - Monitors the system voltage in the car so the ECU can raise the idle speed if voltage is dropping (which would indicate a high electrical load);
- Manifold absolute pressure sensor - Monitors the pressure of the air in the intake manifold The amount of air being drawn into the engine is a good indication of how much power it is producing; and the more air that goes into the engine, the lower the manifold pressure, so this reading is used to gauge how much power is being produced;
- Engine speed sensor - Monitors engine speed, which is one of the factors used to calculate the pulse width;

There are two main types of control for multi-port systems:

- The fuel injectors can all open at the same time, or each one can open just before the intake valve for its cylinder opens (this is called sequential multi-port fuel injection).
- The advantage of sequential fuel injection is that if the driver makes a sudden change, the system can respond more quickly because from the time the change is made, it only has to wait only until the next intake valve opens, instead of for the next complete revolution of the engine.

7.5 Engine Controls and Performance Chips

The algorithms that control the engine are quite complicated. The software has to allow the car to satisfy emissions requirements for 100,000 miles, meet EPA fuel economy requirements and protect engines against abuse. And there are dozens of other requirements to meet as well.

The engine control unit uses a formula and a large number of lookup tables to determine the pulse width for given operating conditions. The equation will be a series of many factors multiplied by each other. Many of these factors will come from lookup tables. We'll go through a simplified calculation of the fuel injector pulse width. In this example, our equation will only have three factors, whereas a real control system might have a hundred or more.

Pulse width = (Base pulse width) x (Factor A) x (Factor B)

In order to calculate the pulse width, the ECU first looks up the base pulse width in a lookup table. Base pulse width is a function of engine speed (RPM) and load (which can be calculated from manifold absolute pressure). Let's say the engine speed is 2,000 RPM and load is 4. We find the number at the intersection of 2,000 and 4, which is 8 milliseconds.

RPM	Load				
	1	**2**	**3**	**4**	**5**
1,000	1	2	3	4	5
2,000	2	4	6	8	10
3,000	3	6	9	12	15
4,000	4	8	12	16	20

In the next examples, **A** and **B** are parameters that come from sensors. Let's say that **A** is coolant temperature and **B** is oxygen level. If coolant temperature equals 100 and oxygen level equals 3, the lookup tables tell us that Factor A = 0.8 and Factor B = 1.0.

A	Factor A	B	Factor B
0	1.2	**0**	1.0
25	1.1	**1**	1.0
50	1.0	**2**	1.0
75	0.9	**3**	1.0
100	0.8	**4**	0.75

So, since we know that base pulse width is a function of load and RPM, and that pulse width = (base pulse width) x (factor A) x (factor B), the overall pulse width in our example equals:

8 x 0.8 x 1.0 = 6.4 milliseconds

From this example, you can see how the control system makes adjustments. With parameter B as the level of oxygen in the exhaust, the lookup table for B is the point at which there is (according to engine designers) too much oxygen in the exhaust; and accordingly, the ECU cuts back on the fuel.

Real control systems may have more than 100 parameters, each with its own lookup table. Some of the parameters even change over time in order to compensate for changes in the performance of engine components like the catalytic converter. And depending on the engine speed, the ECU may have to do these calculations over a hundred times per second.

7.6 Performance Chips

This leads us to our discussion of performance chips. Now that we understand a little bit about how the control algorithms in the ECU work, we can understand what performance-chip makers do to get more power out of the engine.

Performance chips are made by aftermarket companies, and are used to boost engine power. There is a chip in the ECU that holds all of the lookup tables; the performance chip replaces this chip. The tables in the performance chip will contain values that result in higher fuel rates during certain driving conditions. For instance, they may supply more fuel at full throttle at every engine speed. They may also change the spark timing (there are lookup tables for that, too). Since the performance-chip makers are not as concerned with issues like reliability, mileage and emissions controls as the carmakers are, they use more aggressive settings in the fuel maps of their performance chips.

8.0 When your vehicle is down

With all the complexity of modern vehicles nowadays, everyone needs accurate information on how to repair your vehicle. An auto repair manual will give that information to you if you know what to do. You can buy a printed manual near you or if you use the computer a lot, maybe download it from the Internet. Shown below are some criteria on how it done properly so you can get the exact information for your vehicle.

8.1 Printed Manuals

Using the type and model year of your vehicle, you can buy any of these printed manuals which are readily available in your nearest parts store.

- Haynes Manuals, good for the do it yourselfers; and
- Motor Manuals, good for the mechanics who have the training and tools

If you don’t want to pay for it, you can also go to the nearest public library and borrow the book for a small fee which you can keep for a week or two until you fixed the problem.

8.2 Online Auto Repair Manuals

If you Google the manual you are searching for like if you own a 2001 Ford Mustang and search that same keyword with the word “manual” beside it, you will get a list of manuals which you can download after you pay some downloading fee. Some services also offer CDs of the manual which can be mailed to you. But the beauty of the downloadable feature is instant access whereas the later one will take some shipping time.

All the above manuals can be bought depending on your situation like if you need the maintenance, operational or the most common, service manuals. The more detailed and comprehensive, the more expensive is your auto repair manual. At the end of the day, what you are looking for is the accurate information so you can fix your vehicle quick.

Auto Service Checklist					
Type of Automobile:	VIN Number:				
Year/Make/Model:	Recommended Oil:				
Tyre Pressure:	Grade/Type of Fuel Used:				
Scheduled Maintenance	Daily	Weekly	Monthly	Yearly
BRAKES:				
Inspect brake pads and lining. Replace.				
Turn drums, rotors. Replace linings				
Have bearings repacked				
Check fluid level in master cylinder				
TYRES:	**Daily**	**Weekly**	**Monthly**	**Yearly**
Rotate tyres				
Check tyre pressure and tyre stem				
Have tyres balanced/front end aligned				
Put on or take off snow tyres				
FUEL:	**Daily**	**Weekly**	**Monthly**	**Yearly**
Fill petrol tank and add petrol additives				
Replace fuel filter				
Perform tune-up/ plugs, filters				
BATTERY:	**Daily**	**Weekly**	**Monthly**	**Yearly**
Inspect battery and terminal cables. Clean.				
Adjust alternator belt. Check belt for cracks.				
OIL:				
Check oil level. Add if needed				
Change oil and oil filter (per manufacturer specification)				
EMISSION SYSTEM:	**Daily**	**Weekly**	**Monthly**	**Yearly**
Inspect exhaust pipes				
Have emission system and muffler checked.				

LUBRICATION:	Daily	Weekly	Monthly	Yearly
Have chassis lubricated (if it has grease fittings)				
Lubricate lock cylinders, door hinges, moving body hinges.				
COOLING SYSTEM:	**Daily**	**Weekly**	**Monthly**	**Yearly**
Inspect fan belt.				
Check coolant/anti-freeze with hydrometer.				
Flush radiator, cooling system Add coolant or water				
Inspect radiator pressure cap, thermostat				
Inspect radiator hoses/bulging (upper &lower)				
HEATING SYSTEM:	**Daily**	**Weekly**	**Monthly**	**Yearly**
Inspect heater hoses and valves for clogs				
Have air-conditioning serviced/recharged				
WHEELS:	**Daily**	**Weekly**	**Monthly**	**Yearly**
Inspect axles and bearings				
Replace shock absorbers (leakage)				
Inspect lug nuts (bolts) & retighten on wheels				
TRANSMISSION:	**Daily**	**Weekly**	**Monthly**	**Yearly**
Check transmission fluid level. Add or change				
Check power-steering fluid level				
Adjust bands and linkage				
Inspect/Lube U-Joints				
LIGHTS:	**Daily**	**Weekly**	**Monthly**	**Yearly**
Check/Align headlights				
Inspect and replace burned out bulbs				
CLEANING:	**Daily**	**Weekly**	**Monthly**	**Yearly**
Shampoo upholstery				
Vacuum interior				
Wash outside				
Wash windows				

9.0 Competency Based Training and Assessment Tool

- Are you ready for assessment? Yes ☐ No ☐
- Do you understand the assessment process? Yes ☐ No ☐
- Have you considered the Recognition of Prior Learning (RPL) process? Yes ☐ No ☐
- Do you understand the term evidence and how it is to be collected? Yes ☐ No ☐

If you have answered YES to these four questions you are ready to proceed to the assessment phase of this unit of competence. If you have answered NO you need to discuss your progress with a qualified assessor.

Introduction

Competency Based Training is always concerned with what a participant will be able to do at the end of training. What the inputs are or how the participant got there will vary, however it is critical that the participant achieves the listed competencies and that a quality assessment be undertaken by a competent trainer/assessor.

Assessment Coversheet

Participant Name			
Participant Email		**Telephone Number**	

Receipt of Assessment

Receiver's Signature		**Date**	
Signature of assessor		**Result**	

I certify that this assessment is my own work based on my personal study and /or research and that I have acknowledged all materials and resources used in the preparation of this assessment whether they are books, articles, reports, lecture notes and any other kind of document, electronic or personal communications. I also certify that the assessment has not previously been submitted for assessment in any award or course and that I have not copied in part or whole or otherwise plagarised the work of other students and/or persons. I can produce another hard/soft copy of this assessment within 24 hours if requested.

Participant Signature		**Date**	

This assignment/assessment will not be marked unless the the above declaration is signed

Please copy this page and attach it to each submission for assessment

Observation Report/Third Party Assessment

To be administered by an Assessor and/or a Workplace Supervisor

Purpose of the task

The purpose of the observations is to assess your competency in servicing petrol fuel systems.

Instructions for the observation component

You will be required to participate in servicing sessions whilst being observed by an assessor who is qualified in this unit of competency. You may use an assessor from your preferred registered training organisation, or alternatively, you may source your own assessor (this person must use the observation checklist and provided a certified copy of their qualifications).

You will need to be observed in a **minimum of three (3)** service sessions:

- These sessions can be conducted by a workplace supervisor but must be completed by an suitably qualified assessor from a Registered Training Organisation on at least one occasion if you are submitting this assessment for recognition towards a nationally recognised qualification.

You will be assessed on the following required skills and attributes:

- Customer service
- Oral communication and interpersonal skills
- OHS skills
- Workshop practice skills

Please refer to the observation checklist for specific observation requirements under the above skills groups. Competency will need to be demonstrated over a period of time reflecting the scope of the role, as reflected by all components of this unit.

Where assessment is part of a structured learning experience, the evidence collected must relate to a number of performances assessed at different points in time and separated by further learning and practice with a decision of competence only taken at the point when the assessor has complete confidence in the ability of the person.

Where assessment is for the purpose of recognition (RCC/RPL), the evidence provided will need to show that it represents competency demonstrated over a period of time and is current.

Evidence must show the ability to transfer skills to different environments.

Observation Report/Third Party Assessment

To be administered by an Assessor or a Workplace Supervisor

Candidate Name:	
RTO Assessor Name:	
Unit/s of Competency:	
Name of Workplace:	
Date of Assessment:	

During the Observation Assessment, did the candidate:	**PC**	**S**	**NS**
Identify and confirm the nature and scope of work requirements	1.1	☐	☐
Observe throughout the work OH&S requirements, including individual State/Territory regulatory requirements and personal protection needs	1.2	☐	☐
Source procedures and information such as workshop manuals and specifications and tooling required	1.3	☐	☐
Prepare in accordance with standard operating procedures methods appropriate to the circumstances	1.4	☐	☐
Identify and prepare the resources and support equipment required for servicing	1.5	☐	☐
Observe warnings in relation to working with petrol	1.6	☐	☐
Access and interprete the correct information from manufacturer/component supplier specifications	2.1	☐	☐
Conduct a service of petrol fuel system/components that are carried out in accordance with manufacturer/component supplier specifications	2.2	☐	☐
Complete, without causing damage to any component or system, a fuel system components service	2.3	☐	☐
Ensure that adjustments made during the service are in accordance with manufacturer/component supplier specifications	2.4	☐	☐
Run the engine run and test the petrol fuel system for correct operation	2.5	☐	☐
Complete all service schedule documentation	3.1	☐	☐
Ensure work is to workplace and safety expectations by completing a final inspection	3.2	☐	☐
Ensure that equipment is cleaned for use or storage to	3.3	☐	☐

workplace expectations			
Process the job card in accordance with workplace procedures	3.4	☐	☐

Legend

S	NS	**NS** = Not Satisfactory. The participant requires more training, instruction and/or experience prior to re assessment
		S = Satisfactory
		NOTE : Always indicate an outcome

Feedback Comments:

Result for Assessment:	☐ **Satisfactory (S)** ☐ **Not Satisfactory (NS)**		
Candidate Signature:		**Date:**	
RTO Assessor Signature:		**Date:**	

Portfolio of Evidence

To be completed by the candidate and submitted to the RTO Assessor

Candidate Name:	
RTO Assessor Name:	
Unit/s of Competency:	
Name of Workplace:	
Date of Assessment:	

This assessment covers components of the elements required for competency in:

Element 1 Prepare to service petrol fuel system components

Element 2 Service petrol fuel system components

Element 3 Prepare fuel system for normal operation

Purpose of the task

As you work through the steps in assessing competence, you must collect documentation or work samples that "prove" what you do.

Indicative examples of the type of evidence you should collect at different stages of your program are listed below. There may be other pieces of evidence that you could collect. You are encouraged to discuss any other options with your assessor.

Instructions

You are required to provide evidence of:

- Gather information about the use of OH&S and environmental regulations/requirements, equipment, material and personal safety requirements;
- Develop a list of some of the dangers of working with petrol;
- Detail the operating principles of mechanical and electronic fuel systems;
- Make a list of the different types of service procedures;
- Show the difference in vehicle safety procedures from vehicle models/makes to vehicle models/makes;
- Make a list of the different types and layout of service/repair manuals (hard copy and electronic);
- Provide your enterprise quality procedures; and
- Detail your work organisation and planning processes.

Legend

S	NS	**NS** = Not Satisfactory. The participant requires more training, instruction and/or experience prior to re assessment
		S = Satisfactory
		NOTE : Always indicate an outcome

Feedback Comments:

Result for Assessment:	☐ **Satisfactory (S)** ☐ **Not Satisfactory (NS)**		
Candidate Signature:		**Date:**	
RTO Assessor Signature:		**Date:**	

Sources of Acknowledgement

Boyce Automotive Data @ www.boyce.com.au

Haynes Chilton *Holley Carburettor Manual* 5th edition Veloce Publishing 2004

Gregory's *ACL Engine Manual* Gregory's 7th edition Gregory's Automotive Publications 2006

Gregory's *Automotive Mechanics Fundamentals* 6th edition Gregory's Automotive Publications 2005

Owen, Clifton E *Today's Technician* 4th edition Delmar Publishing 2007

J.Y. Wong *Theory of Ground Vehicles* 3rd edition John Wiley & Sons Inc 2001

www.yourautoadvisor.com/resources/servicemanual/manuals.html

www.repairmanual.com

www.wheelsdirectory.com/repair/repair.htm