AUTOMOTIVE INDUSTRY TRAINING
RETAIL, SERVICE AND REPAIR
AUR05

Learning & Assessment Resource

AURT202170A
Inspect & Service Cooling Systems

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Contents

AURT202170A Inspect and Service Cooling Systems

Pre Requisite Units of Competence

Nil

Overview

This unit covers the competence required to carry out the inspection and service of air and liquid cooling systems in an automotive retail, service and/or repair context.

The unit includes identification and confirmation of work requirement, preparation for work, inspection, analysis and servicing of cooling systems 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 undertake the inspection of cooling systems;
2. Inspect cooling systems and analyse results;
3. Prepare to service cooling systems;
4. Carry out servicing; and
5. Prepare equipment for use or storage.

1.0 How a Car Engine Works

Have you ever opened the hood of your car and wondered what was going on in there? A car engine can look like a big confusing jumble of metal, tubes and wires to the uninitiated.

Figure 1

You might want to know what's going on simply out of curiosity. Or perhaps you are buying a new car, and you hear things like "3.0 litre V-6" and "dual overhead cams" and "tuned port fuel injection." What does all of that mean?

In this resource, we'll discuss the basic idea behind an engine and then go into detail about how all the pieces fit together, what can go wrong and how to increase performance.

The purpose of a petroleum car engine is to convert petroleum into motion so that your car can move. Currently the easiest way to create motion from petroleum is to burn the petroleum inside an engine. Therefore, a car engine is an internal combustion engine - combustion takes place internally. Two things to note:

- There are different kinds of internal combustion engines. Diesel engines are one form and gas turbine engines are another. Variations include HEMI engines, rotary engines and two-stroke engines. Each has its own advantages and disadvantages.
- There is such a thing as an external combustion engine. A steam engine in old-fashioned trains and steam boats is the best example of an external combustion engine. The fuel (coal, wood, oil, whatever) in a steam engine burns outside the engine to create steam, and the steam creates motion inside the engine. Internal combustion is a lot more efficient (takes less fuel per kilometre) than external combustion, plus an internal combustion engine is a lot smaller than an equivalent external combustion engine. This explains why we don't see any cars from Ford and GM using steam engines.

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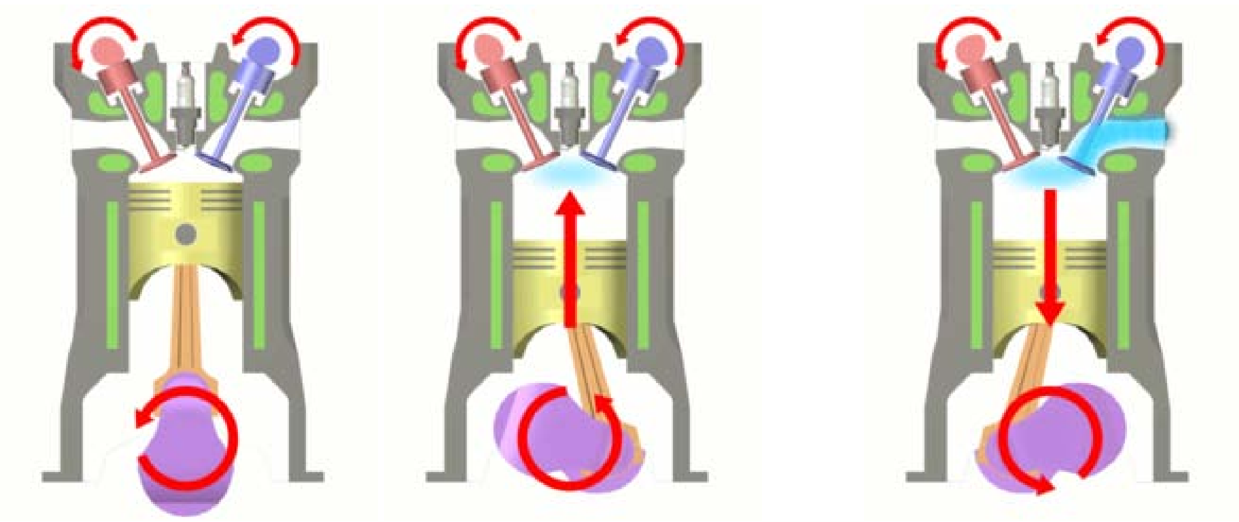
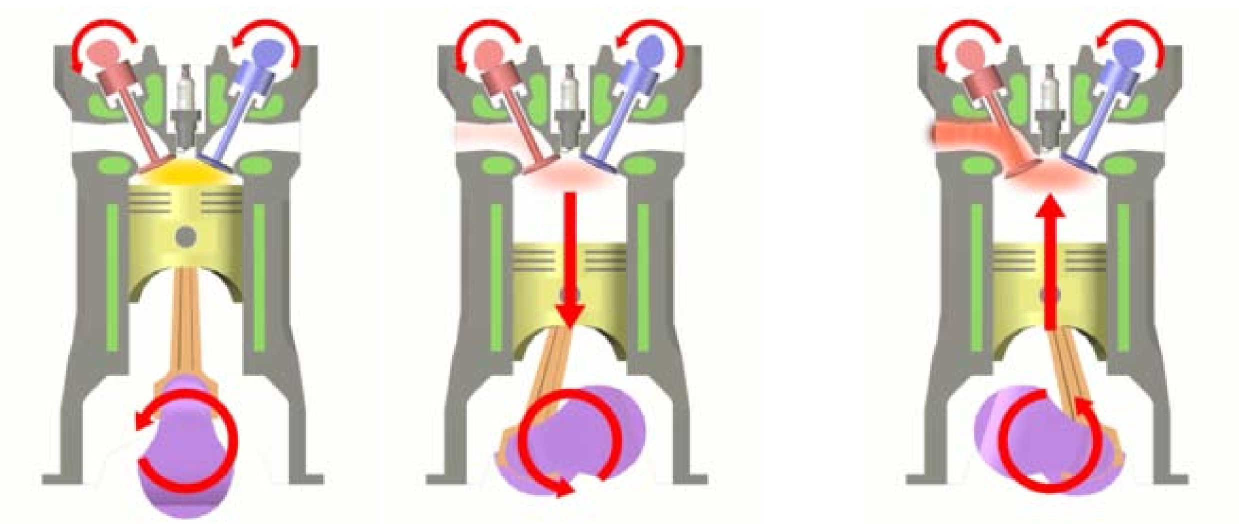
2.0 Internal Combustion

The potato cannon uses the basic principle behind any reciprocating internal combustion engine: If you put a tiny amount of high-energy fuel (like gasoline) in a small, enclosed space and ignite it, an incredible amount of energy is released in the form of expanding gas. You can use that energy to propel a potato 150 metres. In this case, the energy is translated into potato motion. You can also use it for more interesting purposes. For example, if you can create a cycle that allows you to set off explosions like this hundreds of times per minute, and if you can harness that energy in a useful way, what you have is the core of a car engine!

Almost all cars currently use what is called a four-stroke combustion cycle to convert petroleum into motion. The four-stroke approach is also known as the Otto cycle, in honour of Nikolaus Otto, who invented it in 1867. The four strokes are:



Starting position, *intake stroke,* *compression stroke.*



Ignition of fuel, *power stroke,* *exhaust stroke.*

Figure 2

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You can see in Figure 2 that a device called a piston replaces the potato in the potato cannon. The piston is connected to the crankshaft by a connecting rod. As the crankshaft revolves, it has the effect of "resetting the cannon." Here's what happens as the engine goes through its cycle:

- The piston starts at the top, the intake valve opens, and the piston moves down to let the engine take in a cylinder-full of air and petroleum. This is the intake stroke. Only the tiniest drop of petroleum needs to be mixed into the air for this to work;
- Then the piston moves back up to compress this fuel/air mixture. Compression makes the explosion more powerful; and
- When the piston reaches the top of its stroke, the spark plug emits a spark to ignite the petroleum. The petroleum charge in the cylinder explodes, driving the piston down. Once the piston hits the bottom of its stroke, the exhaust valve opens and the exhaust leaves the cylinder to go out the tailpipe.

Now the engine is ready for the next cycle, so it intakes another charge of air and gas.

The motion that comes out of an internal combustion engine is rotational, while the motion produced by a potato cannon is linear (straight line). In an engine the linear motion of the pistons is converted into rotational motion by the crankshaft. The rotational motion is nice because we plan to turn (rotate) the car's wheels with it anyway.

3.0 Basic Engine Parts

The core of the engine is the cylinder, with the piston moving up and down inside the cylinder. The engine described above has one cylinder. That is typical of most lawn mowers, but most cars have more than one cylinder (four, six and eight cylinders are common). In a multi-cylinder engine, the cylinders usually are arranged in one of three ways: inline**,** V or flat (also known as horizontally opposed or boxer), as shown in the following figures.

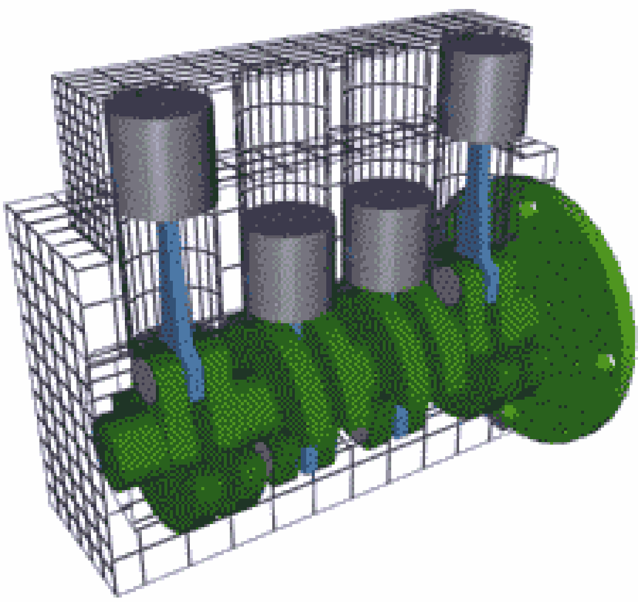

Figure 3 Inline - The cylinders are arranged in a line in a single bank.

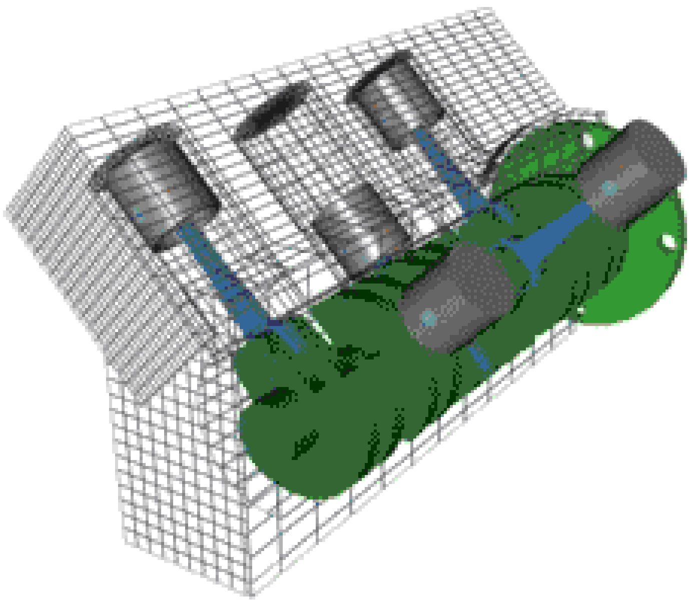

Figure 4 V - The cylinders are arranged in two banks set at an angle to one another

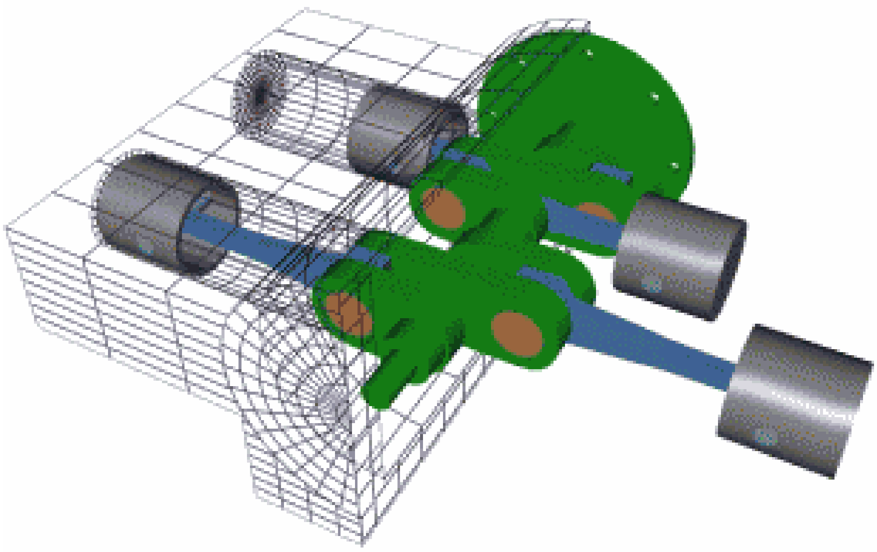

Figure 5 Flat - The cylinders are arranged in two banks on opposite sides of the engine

Different configurations have different advantages and disadvantages in terms of smoothness, manufacturing cost and shape characteristics. These advantages and disadvantages make them more suitable for certain vehicles.

3.1 Spark plug

The spark plug supplies the spark that ignites the air/fuel mixture so that combustion can occur. The spark must happen at just the right moment for things to work properly.

3.2 Valves

The intake and exhaust valves open at the proper time to let in air and fuel and to let out exhaust.

Note that both valves are closed during compression and combustion so that the combustion chamber is sealed.

3.3 Piston

A piston is a cylindrical piece of metal that moves up and down inside the cylinder.

3.4 Piston rings

Piston rings provide a sliding seal between the outer edge of the piston and the inner edge of the cylinder. The rings serve two purposes:

- They prevent the fuel/air mixture and exhaust in the combustion chamber from leaking into the sump during compression and combustion.
- They keep oil in the sump from leaking into the combustion area, where it would be burned and lost.
- Most cars that "burn oil" and have to have a quart added every 1,500 kilometres are burning it because the engine is old and the rings no longer seal things properly.

3.5 Connecting rod

The connecting rod connects the piston to the crankshaft. It can rotate at both ends so that its angle can change as the piston moves and the crankshaft rotates.

3.6 Crankshaft

The crankshaft turns the piston's up and down motion into circular motion just like a crank on a jack-in-the-box does.

3.7 Sump

The sump surrounds the crankshaft. It contains some amount of oil, which collects in the bottom of the sump (the oil pan).

4.0 Engine Problems

So you go out one morning and your engine will turn over but it won't start... What could be wrong? Now that you know how an engine works, you can understand the basic things that can keep an engine from running. Three fundamental things can happen: a bad fuel mix, lack of compression or lack of spark. Beyond that, thousands of minor things can create problems, but these are the "big three." Based on the simple engine we have been discussing, here is a quick rundown on how these problems affect your engine:

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4.1 Bad fuel mix

A bad fuel mix can occur in several ways:

- You are out of gas, so the engine is getting air but no fuel.
- The air intake might be clogged, so there is fuel but not enough air.
- The fuel system might be supplying too much or too little fuel to the mix, meaning that combustion does not occur properly.
- There might be an impurity in the fuel (like water in your gas tank) that makes the fuel not burn.

4.2 Lack of compression

- If the charge of air and fuel cannot be compressed properly, the combustion process will not work like it should. Lack of compression might occur for these reasons:
- Your piston rings are worn (allowing air/fuel to leak past the piston during compression).
- The intake or exhaust valves are not sealing properly, again allowing a leak during compression.
- There is a hole in the cylinder.
- The most common "hole" in a cylinder occurs where the top of the cylinder (holding the valves and spark plug and also known as the cylinder head) attaches to the cylinder itself. Generally, the cylinder and the cylinder head bolt together with a thin gasket pressed between them to ensure a good seal. If the gasket breaks down, small holes develop between the cylinder and the cylinder head, and these holes cause leaks.

4.3 Lack of spark

The spark might be nonexistent or weak for a number of reasons:

- If your spark plug or the wire leading to it is worn out, the spark will be weak;
- If the wire is cut or missing, or if the system that sends a spark down the wire is not working properly, there will be no spark; and
- If the spark occurs either too early or too late in the cycle (i.e. if the ignition timing is off), the fuel will not ignite at the right time, and this can cause all sorts of problem.

Many other things can go wrong. For example:

- If the battery is dead, you cannot turn over the engine to start it;
- If the bearings that allow the crankshaft to turn freely are worn out, the crankshaft cannot turn so the engine cannot run;
- If the valves do not open and close at the right time or at all, air cannot get in and exhaust cannot get out, so the engine cannot run;
- If someone sticks a potato up your tailpipe, exhaust cannot exit the cylinder so the engine will not run;

- If you run out of oil, the piston cannot move up and down freely in the cylinder, and the engine will seize; and
- In a properly running engine, all of these factors are within tolerance.

As you can see, an engine has a number of systems that help it do its job of converting fuel into motion. We'll look at the different subsystems used in engines in the next few sections.

4.4 Engine Valve Train and Ignition Systems

Most engine subsystems can be implemented using different technologies, and better technologies can improve the performance of the engine. Let's look at all of the different subsystems used in modern engines, beginning with the valve train.

The valve train consists of the valves and a mechanism that opens and closes them. The opening and closing system is called a camshaft (Figure 6). The camshaft has lobes on it that move the valves up and down.

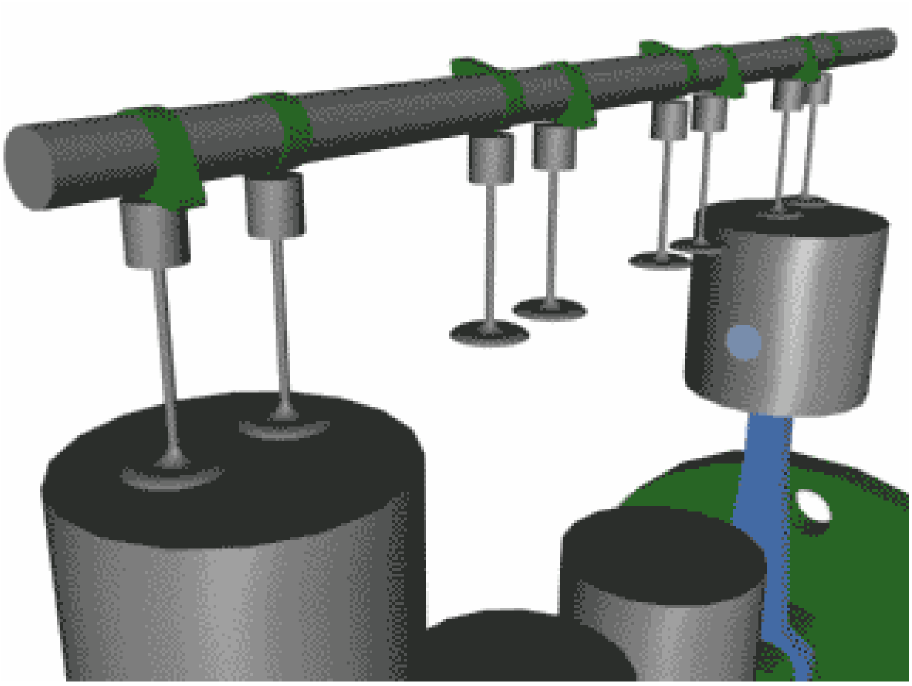


Figure 6 The camshaft

Most modern engines have what are called overhead cams**.** This means that the camshaft is located above the valves, as you see in Figure above. The cams on the shaft activate the valves directly or through a very short linkage. Older engines used a camshaft located in the sump near the crankshaft. Rods linked the cam below to valve lifters above the valves. This approach has more moving parts and also causes more lag between the cam's activation of the valve and the valve's subsequent motion. A timing belt or timing chain links the crankshaft to the camshaft so that the valves are in sync with the pistons. The camshaft is geared to turn at one-half the rate of the crankshaft. Many high-performance engines have four valves per cylinder (two for intake, two for exhaust), and this arrangement requires two camshafts per bank of cylinders, hence the phrase "dual overhead cams."

The ignition system (Figure 7) produces a high-voltage electrical charge and transmits it to the spark plugs via ignition wires. The charge first flows to a distributor, which you can easily find under the hood of most cars. The distributor has one wire going in the centre and four, six, or eight wires (depending on the number of cylinders) coming out of it. These ignition wires send the charge to each spark plug. The engine is timed so that only one cylinder receives a spark from the distributor at a time. This approach provides maximum smoothness.

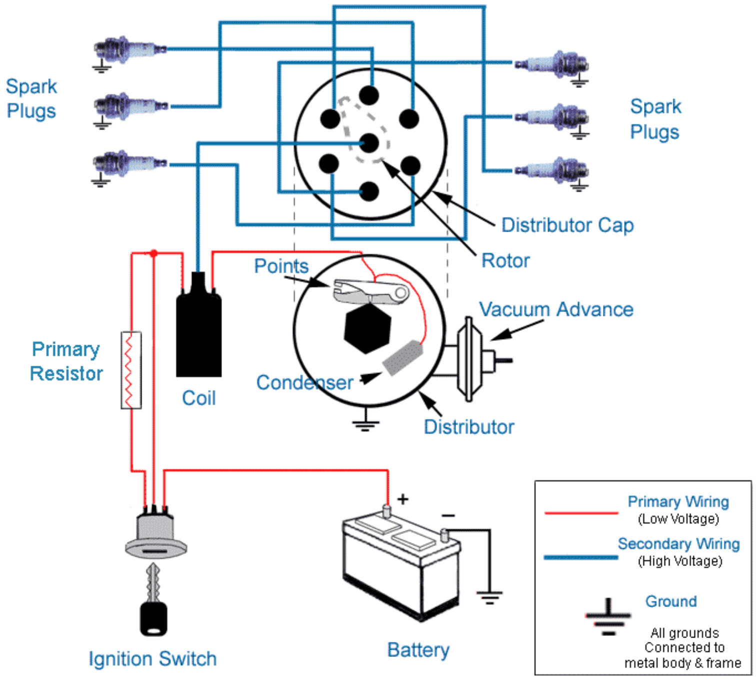


Figure 7 The ignition system

5.0 Engine Cooling, Air-intake and Starting Systems

The cooling system in most cars consists of the radiator and water pump. Water circulates through passages around the cylinders and then travels through the radiator to cool it off. In a few cars (most notably Volkswagen Beetles), as well as most motorcycles and lawn mowers, the engine is air-cooled instead (You can tell an air-cooled engine by the fins adorning the outside of each cylinder to help dissipate heat.). Air-cooling makes the engine lighter but hotter, generally decreasing engine life and overall performance.

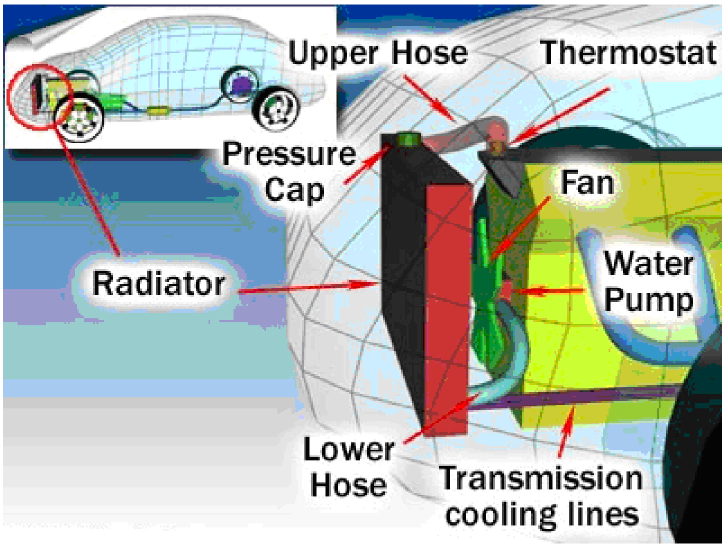


Figure 8 Diagram of a cooling system showing how all the plumbing is connected

So now you know how and why your engine stays cool. But why is air circulation so important? Most cars are normally aspirated, which means that air flows through an air filter and directly into the cylinders. High-performance engines are either turbocharged or supercharged, which means that air coming into the engine is first pressurized (so that more air/fuel mixture can be squeezed into each cylinder) to increase performance. The amount of pressurization is called boost**.** A turbocharger uses a small turbine attached to the exhaust pipe to spin a compressing turbine in the incoming air stream. A supercharger is attached directly to the engine to spin the compressor.

Figure 9 Turbocharger

Increasing your engine's performance is great, but what exactly happens when you turn the key to start it? The starting system consists of an electric starter motor and a starter solenoid. When you turn the ignition key, the starter motor spins the engine a few revolutions so that the combustion process can start. It takes a powerful motor to spin a cold engine. The starter motor must overcome:

- All of the internal friction caused by the piston rings
- The compression pressure of any cylinder(s) that happens to be in the compression stroke
- The energy needed to open and close valves with the camshaft
- All of the "other" things directly attached to the engine, like the water pump, oil pump, alternator, etc.

Because so much energy is needed and because a car uses a 12-volt electrical system, hundreds of amps of electricity must flow into the starter motor. The starter solenoid is essentially a large electronic switch that can handle that much current. When you turn the ignition key, it activates the solenoid to power the motor.

5.1 Engine Lubrication, Fuel, Exhaust and Electrical Systems

When it comes to day-to-day car maintenance, the first concern is probably the amount of petroleum in your car. How does the petroleum that you put in power the cylinders? The engine's fuel system pumps petroleum from a tank and mixes it with air so that the proper air/fuel mixture can flow into the cylinders. Fuel is delivered in three common ways: carburetion, port fuel injection and direct fuel injection.

In carburetion, a device called a carburettor mixes gas into air as the air flows into the engine. In a fuel-injected engine, the right amount of fuel is injected individually into each cylinder either right above the intake valve (port fuel injection) or directly into the cylinder (direct fuel injection).

Oil also plays an important part. The lubrication system makes sure that every moving part in the engine gets oil so that it can move easily. The two main parts needing oil are the pistons (so they can slide easily in their cylinders) and any bearings that allow things like the crankshaft and camshafts to rotate freely. In most cars, oil is sucked out of the oil pan by the oil pump, run through the oil filter to remove any grit, and then squirted under high pressure onto bearings and the cylinder walls. The oil then trickles down into the sump, where it is collected again and the cycle repeats.

Now that you know about some of the stuff that you put in your car, let's look at some of the stuff that comes out of it. The exhaust system includes the exhaust pipe and the muffler. Without a muffler, what you would hear is the sound of thousands of small explosions coming out your tailpipe. A muffler dampens the sound. The exhaust system also includes a catalytic converter.

The emission control system in modern cars consists of a catalytic converter, a collection of sensors and actuators, and a computer to monitor and adjust everything. For example, the catalytic converter uses a catalyst and oxygen to burn off any unused fuel and certain other chemicals in the exhaust. An oxygen sensor in the exhaust stream makes sure there is enough oxygen available for the catalyst to work and adjusts things if necessary.

Besides gas, what else powers your car? The electrical system consists of a battery and an alternator. The alternator is connected to the engine by a belt and generates electricity to recharge the battery. The battery makes 12-volt power available to everything in the car needing electricity (the ignition system, radio, headlights, windshield wipers, power windows and seats, computers, etc.) through the vehicle's wiring.

6.0 How Car Cooling Systems Work

Although petroleum engines have improved a lot, they are still not very efficient at turning chemical energy into mechanical power. Most of the energy in the gasoline (perhaps 70%) is converted into heat, and it is the job of the cooling system to take care of that heat. In fact, the cooling system on a car driving down the freeway dissipates enough heat to heat two average-sized houses! The primary job of the cooling system is to keep the engine from overheating by transferring this heat to the air, but the cooling system also has several other important jobs.

The engine in your car runs best at a fairly high temperature. When the engine is cold, components wear out faster, and the engine is less efficient and emits more pollution. So another important job of the cooling system is to allow the engine to heat up as quickly as possible, and then to keep the engine at a constant temperature.

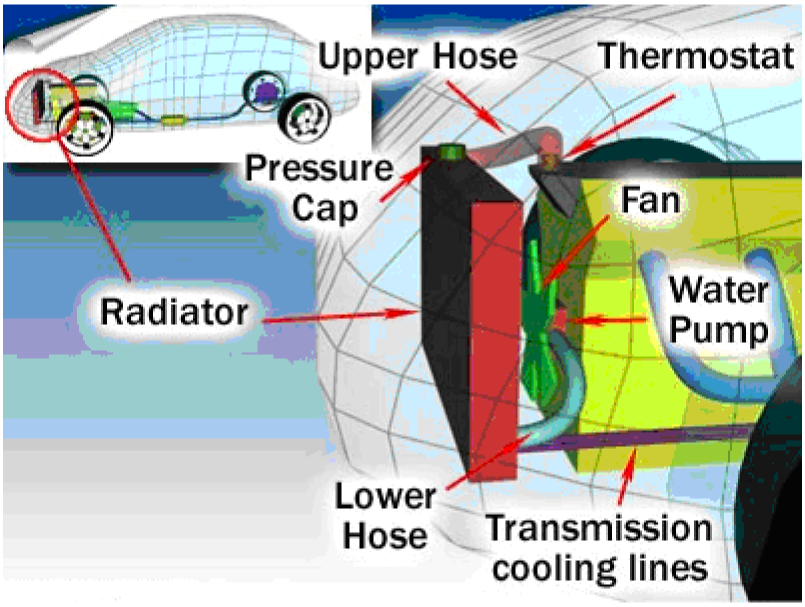


Diagram of a cooling system: how the plumbing is connected

6.1 The Basics

Inside your car's engine, fuel is constantly burning. A lot of the heat from this combustion goes right out the exhaust system, but some of it soaks into the engine, heating it up. The engine runs best when its coolant is about 200 degrees Fahrenheit (93 degrees Celsius). At this temperature:

- The combustion chamber is hot enough to completely vaporize the fuel, providing better combustion and reducing emissions.
- The oil used to lubricate the engine has a lower viscosity (it is thinner), so the engine parts move more freely and the engine wastes less power moving its own components around.
- Metal parts wear less.

There are two types of cooling systems found on cars: liquid-cooled and air-cooled.

6.2 Liquid Cooling

The cooling system on liquid-cooled cars circulates a fluid through pipes and passageways in the engine. As this liquid passes through the hot engine it absorbs heat, cooling the engine. After the fluid leaves the engine, it passes through a heat exchanger, or radiator, which transfers the heat from the fluid to the air blowing through the exchanger.

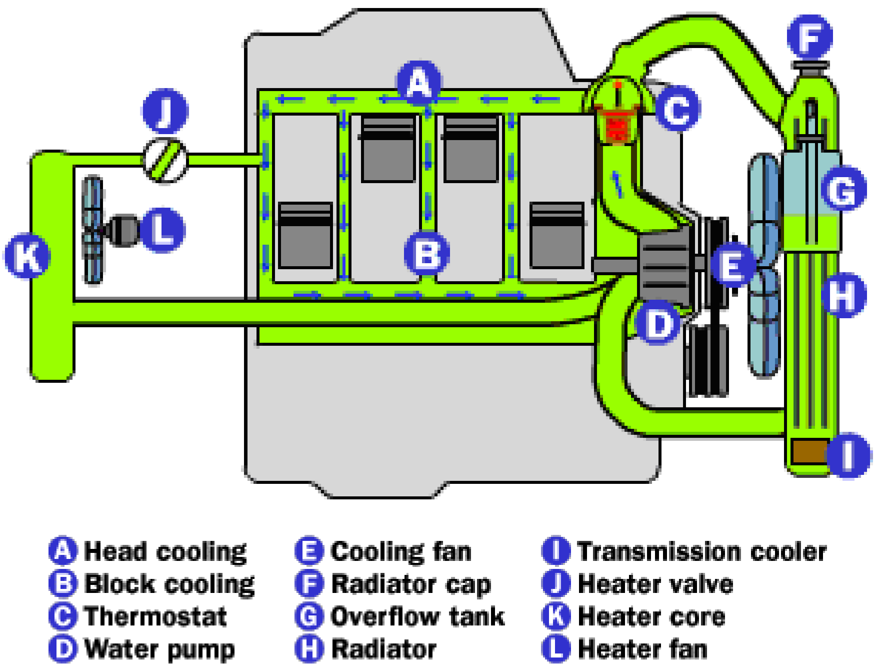
6.3 Air Cooling

Some older cars, and very few modern cars, are air-cooled. Instead of circulating fluid through the engine, the engine block is covered in aluminium fins that conduct the heat away from the cylinder. A powerful fan forces air over these fins, which cools the engine by transferring the heat to the air.

6.4 Plumbing

The cooling system in your car has a lot of plumbing. We'll start at the pump and work our way through the system, and in the next sections we'll talk about each part of the system in more detail.

The pump sends the fluid into the engine block, where it makes its way through passages in the engine around the cylinders. Then it returns through the cylinder head of the engine. The thermostat is located where the fluid leaves the engine. The plumbing around the thermostat sends the fluid back to the pump directly if the thermostat is closed. If it is open, the fluid goes through the radiator first and then back to the pump.
There is also a separate circuit for the heating system. This circuit takes fluid from the cylinder head and passes it through a heater core and then back to the pump.



On cars with automatic transmissions, there is normally also a separate circuit for cooling the transmission fluid built into the radiator. The oil from the transmission is pumped by the transmission through a second heat exchanger inside the radiator.

6.5 Fluid

Cars operate in a wide variety of temperatures, from well below freezing to well over 100 F (38 C). So whatever fluid is used to cool the engine has to have a very low freezing point, a high boiling point, and it has to have the capacity to hold a lot of heat.
Water is one of the most effective fluids for holding heat, but water freezes at too high a temperature to be used in car engines. The fluid that most cars use is a mixture of water and ethylene glycol ($C_2H_6O_2$), also known as antifreeze. By adding ethylene glycol to water, the boiling and freezing points are improved significantly.

	Pure Water	50/50 $C_2H_6O_2$/Water	70/30 $C_2H_6O_2$/Water
Freezing Point	0 C / 32 F	-37 C / -35 F	-55 C / -67 F
Boiling Point	100 C / 212 F	106 C / 223 F	113 C / 235 F

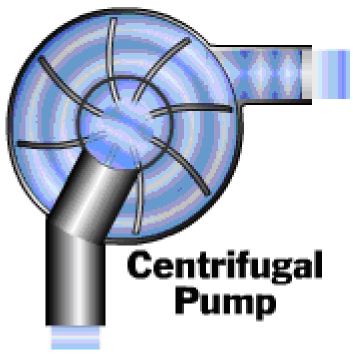
The temperature of the coolant can sometimes reach 250 to 275 F (121 to 135 C). Even with ethylene glycol added, these temperatures would boil the coolant, so something additional must be done to raise its boiling point.

The cooling system uses pressure to further raise the boiling point of the coolant. Just as the boiling temperature of water is higher in a pressure cooker, the boiling temperature of coolant is higher if you pressurize the system. Most cars have a pressure limit of 14 to 15 pounds per square inch (psi), which raises the boiling point another 45 F (25 C) so the coolant can withstand the high temperatures.

Antifreeze also contains additives to resist corrosion.

6.6 Water Pump

The water pump is a simple centrifugal pump driven by a belt connected to the crankshaft of the engine. The pump circulates fluid whenever the engine is running.



A centrifugal pump like the one used in your car

The water pump uses centrifugal force to send fluid to the outside while it spins, causing fluid to be drawn from the centre continuously. The inlet to the pump is located near the centre so that fluid returning from the radiator hits the pump vanes. The pump vanes fling the fluid to the outside of the pump, where it can enter the engine.
The fluid leaving the pump flows first through the engine block and cylinder head, then into the radiator and finally back to the pump.

6.7 Engine

The engine block and cylinder head have many passageways cast or machined in them to allow for fluid flow. These passageways direct the coolant to the most critical areas of the engine.

Note that the walls of the cylinder are quite thin, and that the engine block is mostly hollow.

Temperatures in the combustion chamber of the engine can reach 4,500 F (2,500 C), so cooling the area around the cylinders is critical. Areas around the exhaust valves are especially crucial, and almost all of the space inside the cylinder head around the valves that is not needed for structure is filled with coolant. If the engine goes without cooling for very long, it can seize. When this happens, the metal has actually gotten hot enough for the piston to weld itself to the cylinder. This usually means the complete destruction of the engine.

The head of the engine also has large coolant passageways.

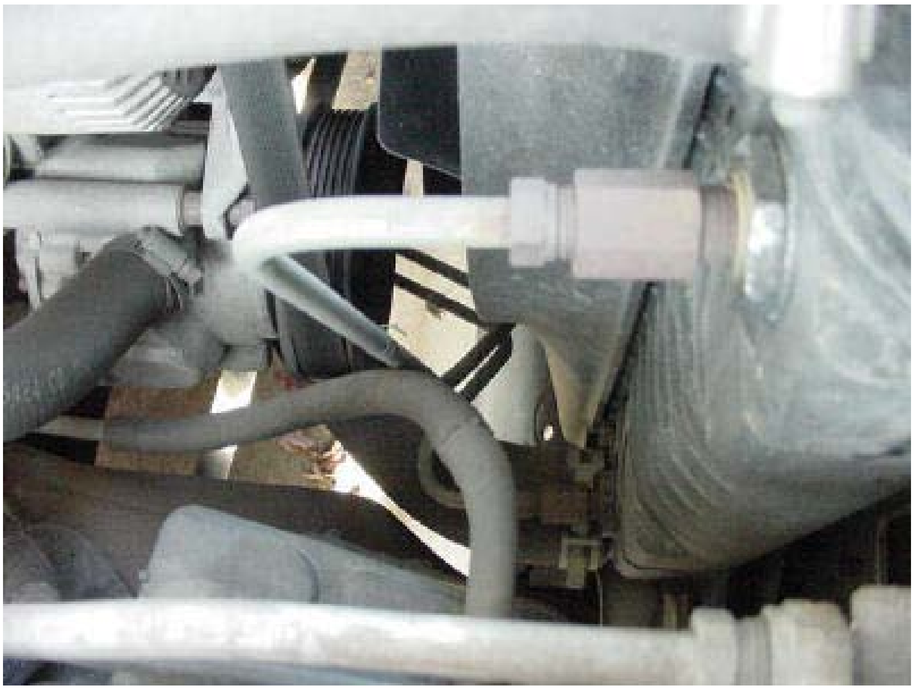
One interesting way to reduce the demands on the cooling system is to reduce the amount of heat that is transferred from the combustion chamber to the metal parts of the engine. Some engines do this by coating the inside of the top of the cylinder head with a thin layer of ceramic. Ceramic is a poor conductor of heat, so less heat is conducted through to the metal and more passes out of the exhaust.

6.8 Radiator

A radiator is a type of heat exchanger. It is designed to transfer heat from the hot coolant that flows through it to the air blown through it by the fan.

Most modern cars use aluminium radiators. These radiators are made by brazing thin aluminium fins to flattened aluminium tubes. The coolant flows from the inlet to the outlet through many tubes mounted in a parallel arrangement. The fins conduct the heat from the tubes and transfer it to the air flowing through the radiator.

The tubes sometimes have a type of fin inserted into them called a turbulator, which increases the turbulence of the fluid flowing through the tubes. If the fluid flowed very smoothly through the tubes, only the fluid actually touching the tubes would be cooled directly. The amount of heat transferred to the tubes from the fluid running through them depends on the difference in temperature between the tube and the fluid touching it. So if the fluid that is in contact with the tube cools down quickly, less heat will be transferred. By creating turbulence inside the tube, all of the fluid mixes together, keeping the temperature of the fluid touching the tubes up so that more heat can be extracted, and all of the fluid inside the tube is used effectively.

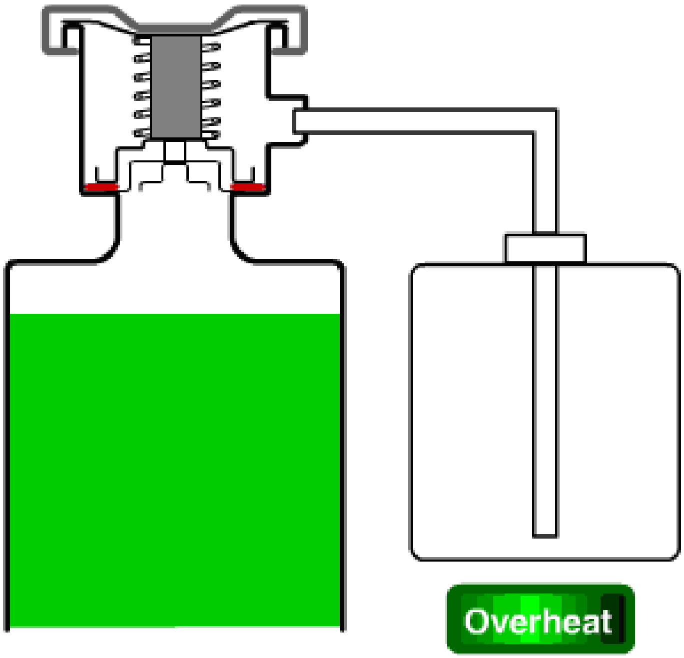


Picture of radiator showing side tank with cooler

Radiators usually have a tank on each side, and inside the tank is a transmission cooler. In the picture above, you can see the inlet and outlet where the oil from the transmission enters the cooler. The transmission cooler is like a radiator within a radiator, except instead of exchanging heat with the air, the oil exchanges heat with the coolant in the radiator.

6.9 Pressure Cap

The radiator cap actually increases the boiling point of your coolant by about 45 F (25 C). How does this simple cap do this? The same way a pressure cooker increases the boiling temperature of water. The cap is actually a pressure release valve, and on cars it is usually set to 15 psi. The boiling point of water increases when the water is placed under pressure.

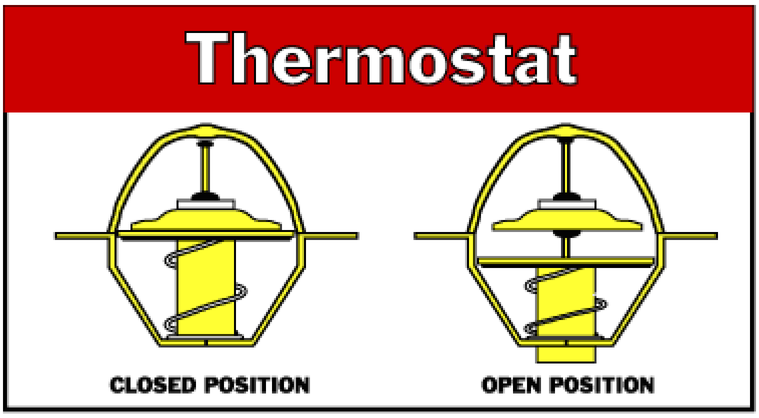


Cutaway of radiator cap and reservoir

When the fluid in the cooling system heats up, it expands, causing the pressure to build up. The cap is the only place where this pressure can escape, so the setting of the spring on the cap determines the maximum pressure in the cooling system. When the pressure reaches 15 psi, the pressure pushes the valve open, allowing coolant to escape from the cooling system. This coolant flows through the overflow tube into the bottom of the overflow tank. This arrangement keeps air out of the system. When the radiator cools back down, a vacuum is created in the cooling system that pulls open another spring loaded valve, sucking water back in from the bottom of the overflow tank to replace the water that was expelled.

6.10 Thermostat

The thermostat's main job is to allow the engine to heat up quickly, and then to keep the engine at a constant temperature. It does this by regulating the amount of water that goes through the radiator. At low temperatures, the outlet to the radiator is completely blocked - all of the coolant is recirculated back through the engine.



The open and closed positions of a thermostat

Once the temperature of the coolant rises to between 82 - 91 C (180 and 195 F), the thermostat starts to open, allowing fluid to flow through the radiator. By the time the coolant reaches 93 - 103 C (200 to 218 F), the thermostat is open all the way.

If you ever have the chance to test one, a thermostat is an amazing thing to watch because what it does seems impossible. You can put one in a pot of boiling water on the stove. As it heats up, its

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valve opens about an inch, apparently by magic! If you'd like to try this yourself, go to a car parts store and buy one for a couple of bucks.

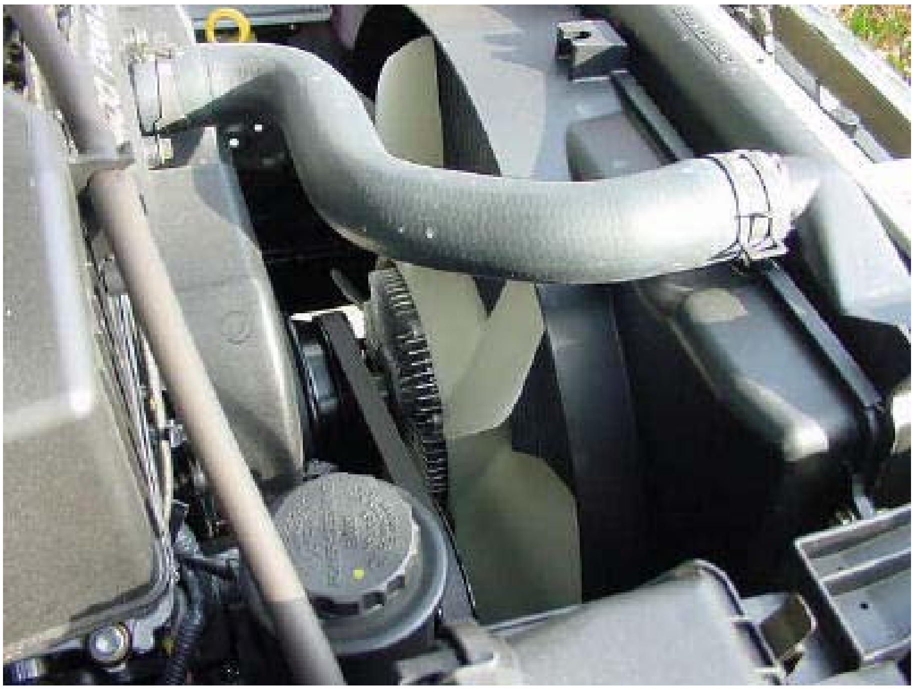
The secret of the thermostat lies in the small cylinder located on the engine-side of the device. This cylinder is filled with a wax that begins to melt at around 180 F (different thermostats open at different temperatures, but 180 F is a common one). A rod connected to the valve presses into this wax. When the wax melts, it expands significantly, pushing the rod out of the cylinder and opening the valve.

This same technique is used in automatic openers for greenhouse vents and skylights. In these devices, the wax melts at a lower temperature.

6.11 Fan

Like the thermostat, the cooling fan has to be controlled so that it allows the engine to maintain a constant temperature.

Front-wheel drive cars have electric fans because the engine is usually mounted transversely, meaning the output of the engine points toward the side of the car. The fans are controlled either with a thermostatic switch or by the engine computer, and they turn on when the temperature of the coolant goes above a set point. They turn back off when the temperature drops below that point.



Cooling fan

Rear-wheel drive cars with longitudinal engines usually have engine-driven cooling fans. These fans have a thermostatically controlled viscous clutch. This clutch is positioned at the hub of the fan, in the airflow coming through the radiator. This special viscous clutch is much like the viscous coupling sometimes found in all-wheel drive cars.

7.0 Heating System

You may have heard the advice that if you car is overheating, open all the windows and run the heater with the fan going at full blast. This is because the heating system is actually a secondary cooling system that mirrors the main cooling system on your car.

Heater plumbing

The heater core, which is located in the dashboard of your car, is really a small radiator. The heater fan blows air through the heater core and into the passenger compartment of your car.

A heater core looks like a small radiator.

The heater core draws its hot coolant from the cylinder head and returns it to the pump -- so the heater works regardless of whether the thermostat is open or closed.
For more information on car cooling systems and related topics, check out the links on the next page.

8.0 Cars Cooling System Service

Since the colder months will soon be upon us, there are several things considered critical in your vehicle's maintenance. And since the engine is the heart of your vehicle and directly affects its operation, here is what you can do to ensure proper engine life and performance. A vehicle's cooling system should be serviced seasonally to prevent premature engine wear due to extreme climate or engine temperature.

According to Everco Industries, a leading manufacturer of automotive cooling system parts, one sure way to prepare the engine's cooling system for these extreme climate conditions is to have your local service dealer perform a few basic preventive maintenance checks during your next routine servicing:

1. **Check for external leaks.** Usual areas of leakage are water manifolds, radiator seams, water pumps, freeze plugs and all hose connections. The condition of radiator hoses should be carefully scrutinized for possible deterioration from age and/or wear from rubbing against accessory brackets, etc. Be aware that in many cases radiator hoses wear from the inside out, so outside appearance can be deceiving.

2. **Check for internal leaks.** Pull the oil dipstick and check for evidence of coolant. It will show up as minute droplets or sludge and should be easy to spot. This could indicate a cracked head, block or blown head gasket.

3. **Check the radiator.** This is the one component in your vehicle's cooling system which can quickly diminish the efficiency and durability of the engine. Check for obstructed air flow and clean any debris from the fins. Also check the radiator mounting for loose bolts or cracked brackets from vibration and stress.

4. **Check the cooling fan.** If the vehicle is equipped with a centrifugal thermo-static type fan clutch, it is important to spot problems before they occur. Check for wear by moving the fan blade back and forth. Over 1/4" of play in either direction could point towards excessive bearing wear. You should also turn the fan by hand. If it free-wheels or there is a rough grating feel as the fan turns, this could mean excessive fluid loss or bearing wear respectively. If any of these conditions exist or there is evidence of fluid leakage, the fan clutch should be replaced. If the vehicle is equipped with an electric cooling fan, a quick performance check can be made by turning on the A/C and checking to make sure it operates without excess vibration or noise. Also check all electrical connections for signs of corrosion, or physical damage. With the engine hot, check to see if the fan is coming on at the correct temperature and operating properly.

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5. **Check the coolant level and conditions.** As a general rule the coolant level should be 1" to 2" below the radiator filler neck when cool. Use an antifreeze tester to determine the protection range of the coolant. It should be at least adequate for the geographic area where you live. If the coolant is over two years old or has rust in it, system flushing and refilling with new antifreeze solution is recommended and will be sufficient for most climates. The two year replacement interval is necessary to maintain proper rust inhibitor and other additive protection in the cooling system.

6. **Check the radiator cap.** If your cap is rusted or the rubber seal is dried out, it should be replaced. A pressure tester should be used to be sure the cap is operating at the recommended pressure level.

7. **Check the thermostat.** Remove the radiator cap and start the engine. Insert a suitable thermometer into the radiator neck. When the coolant level drops in the radiator, the thermostat has opened and is allowing circulation. Record the temperature on the thermometer and compare to the thermostat specifications. It should be no more than a few degrees either way of the actual thermostat setting. If you are not in the correct range, the thermostat will have to be replaced. Be sure to install a new gasket and inspect the thermostat seating area for corrosion and pitting.

8. **Check drives belts.** Visually inspect all belts for glazing or deterioration. These conditions usually are caused by wear but can be accelerated by improper adjustment, engine fluid spillage, lubricant leakage or improper belt sizing. Check the vehicle manufacturer's specification listing for proper belt size, tension and/or deflection specifications.

9. **Check heater operation.** A quick functional testing of the heater unit can save a lot of mid-season grief. Visually inspect all hoses for deterioration from age and wear. Also make sure hoses are not taut. This situation can cause leaks at the heater core. Check the floor under the heater assembly for signs of coolant loss. This could point towards a leaking heater core. Also make sure to check the heater valve. Check vacuum lines for leakage or deterioration. Lubricate all control cables, such as the heater valve control cable, etc. Last but not least, check all function switches and blower motor switches for proper operation. Having basic cooling system checks made during routine servicing can prevent costly breakdowns and inefficient operation of equipment during extreme climate conditions. Preventive maintenance is the key to being able to drive your car longer while reducing long term expenses.

9.0 Summary

Automotive cooling system servicing is a specialist task. The opening statement of this learning resource tells us “Have you ever opened the hood of your car and wondered what was going on in there? A car engine can look like a big confusing jumble of metal, tubes and wires to the uninitiated.” We as operators don’t really need to need to know as we can rely of the technicians’.

9.1 Servicing Documentation

Documentation provides valuable descriptions of an organisation's development, acquisition, and operating environments and significantly enhances an organisation's ability to administer, operate, and maintain technology systems. Primary advantages for technicians' involves having access to operation manuals and on-line application help features. Documentation enhances administrators' and technicians' ability to maintain and update systems efficiently and to identify and correct programming defects.

Developing and maintaining current, accurate documentation can be complicated, time consuming, and expensive. However, standardised documentation procedures and the use of automated documentation software can facilitate an organisation's ability to maintain accurate documentation.

9.2 Final Inspection

Consumers expectations are that they will receive their vehicle back in a serviceable condition and in a better operational condition than when it was delivered to the workshop. This expectation requires two (2) critical components:

- A final inspection must be completed by the service technician to ensure that all of the protective features for the braking system have been refitted is replaced to the required specifications; and
- A final inspection must be completed by the service technician to ensure that all of the work that was commenced on the system was completed to workplace, customer and manufacturers expectations.

9.3 For the Technician

There are some tasks that a technician will not carry out frequently. It would be unrealistic for a technician to have a detailed knowledge of seldom-performed procedures. In these circumstances, job cards or checklists are very useful as they give a step-by-step guide to follow whenever the rarely-used procedure needs to be performed. The required knowledge is often kept in manuals which may not be easily accessible. However, going through a large manual, possibly in front of a customer, does nothing for time effectiveness or professional image.

A job card is also used as the basis of a recording process for the organisation. In addition to refreshing the process for the technician it will be a list of the workplace expectations as well. It is suggested that the final task on a job card will be to ensure that the equipment is cleaned for use or storage.

End

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10.0 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

Date of assessment: ....

Purpose of the task

The purpose of the observations is to assess your competency in inspecting and servicing cooling 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	☐	☐
Methods appropriate to the circumstances are selected and prepared in accordance with standard operating procedures	1.4	☐	☐
Identify and prepare resources required for cooling system inspection are sourced and support equipment	1.5	☐	☐
Observe warnings in relation to working with pressurised cooling systems	1.6	☐	☐
Implement in accordance with workplace procedures and manufacturer/component supplier specifications cooling systems inspection	2.1	☐	☐
Indicate compliance or non-compliance with reference to the results by comparing them with manufacturer/component supplier specifications	2.2	☐	☐
Document the results with evidence and supporting information and recommendation(s)	2.3	☐	☐
Process a report in accordance with workplace procedures	2.4	☐	☐
Observe throughout the work OH&S requirements, including individual State/Territory regulatory requirements and personal protection needs	3.1	☐	☐

Identify and source procedures and information required	3.2	☐	☐
Identify and prepare resources and support equipment required for servicing cooling systems	3.3	☐	☐
Implement a service in accordance with workplace procedures and manufacturer/component supplier specifications	4.1	☐	☐
Ensure adjustments that are made during the service are in accordance with manufacturer/component supplier specifications	4.2	☐	☐
Complete servicing schedule documentation	5.1	☐	☐
Complete a final inspection to ensure protective guards, safety features and cowlings are in place	5.2	☐	☐
Complete a final inspection to ensure work is to workplace expectations	5.3	☐	☐
Ensure that equipment is cleaned for use or storage to workplace expectations	5.4	☐	☐
Process the job card in accordance with workplace procedures	5.5	☐	☐

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 undertake the inspection of cooling systems

Element 2 Inspect cooling systems and analyse results

Element 3 Prepare to service cooling systems

Element 4 Carry out servicing

Element 5 Prepare equipment for use or storage

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 OH&S and environmental regulations/requirements, equipment, material and personal safety requirements;
- Develop a list of the dangers of working with coolants;
- Detail the operating principles of cooling systems, components and their relationship to each other;
- Make a list of the different types and layout of service/repair manuals (hard copy and electronic);
- Provide a written description about cooling system analysis procedures;
- Make a list of the cooling system servicing procedures;
- Provide your enterprise quality procedures; and
- Detail your work organisation and planning processes.

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

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