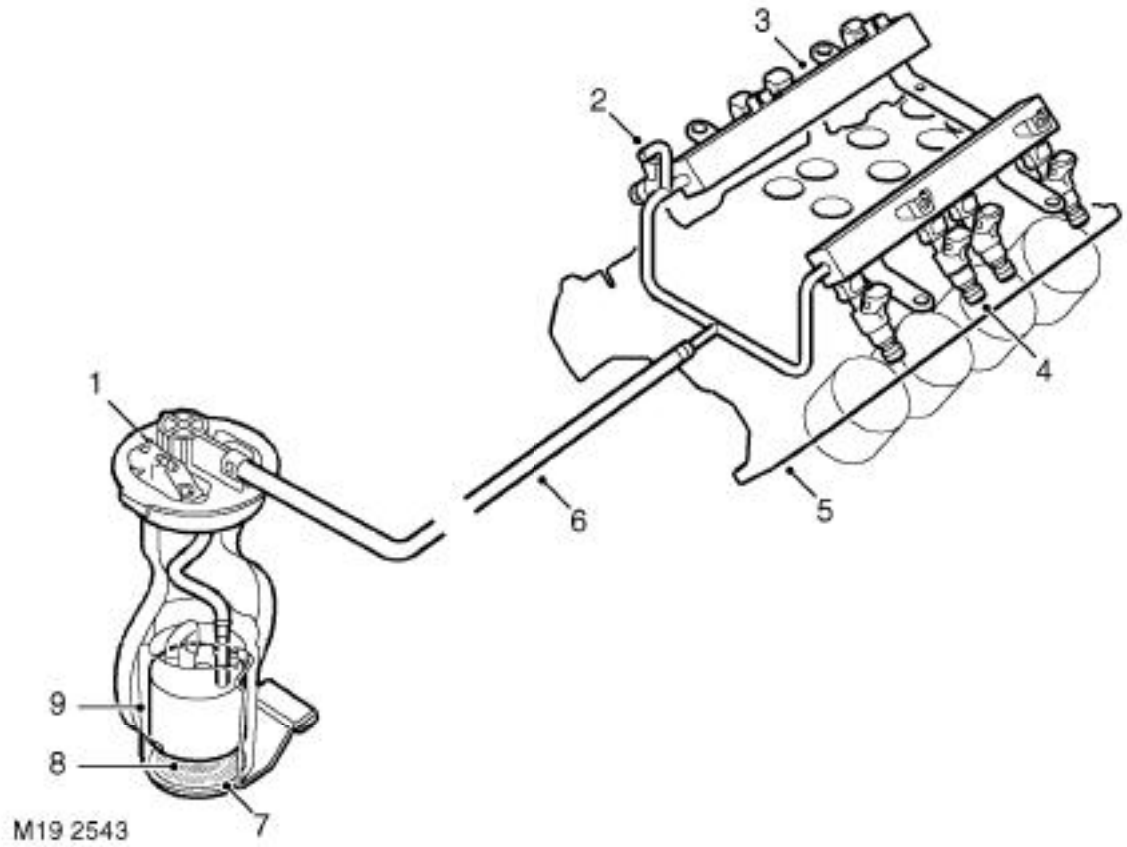
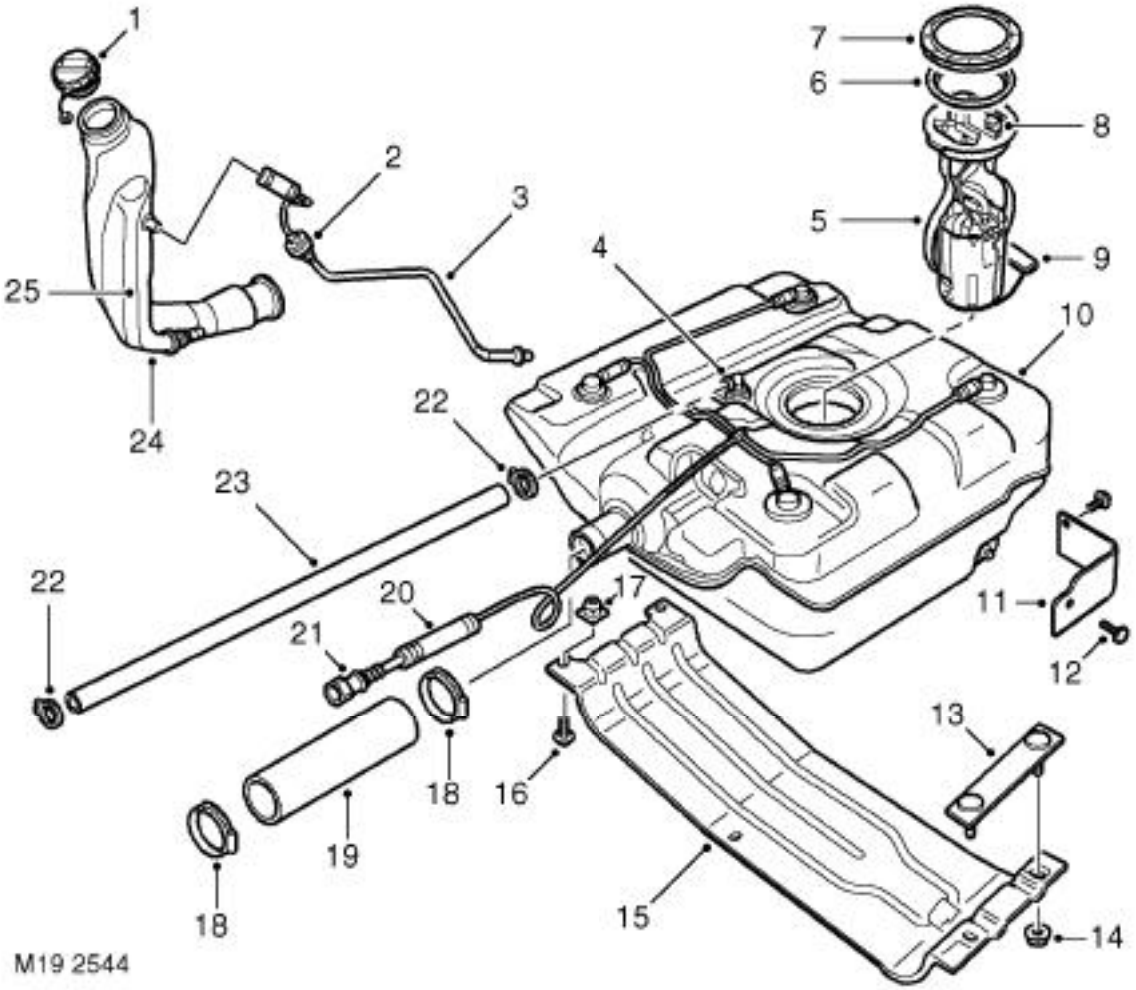
Fuel delivery system



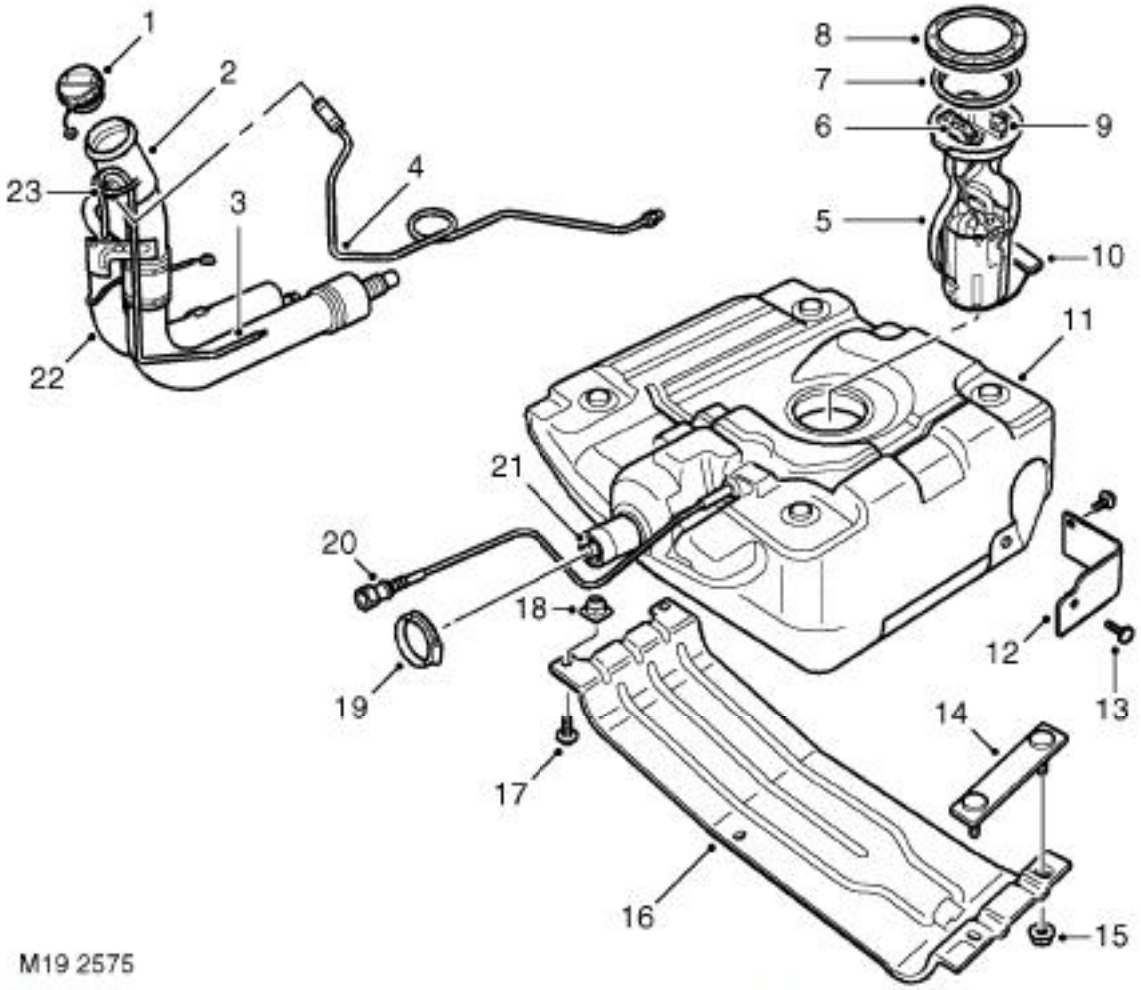
1 Fuel pressure regulator (hidden)
2 Schraeder valve
3 Fuel rail
4 Injectors
5 Engine block
6 Fuel feed pipe
7 Coarse filter
8 Fine filter
9 Fuel pump and fuel gauge sender assembly

Fuel tank and breather components (all except NAS)



1 Fuel filler cap
2 Relief valve
3 Vent to EVAP canister
4 Tank breather connection
5 Fuel pump, regulator and fuel gauge sender assembly
6 Seal
7 Locking ring
8 Fuel feed connection
9 Fuel gauge sender float
10 Fuel tank and breather assembly
11 Heat shield
12 Scrivet 2 off
13 Stud plate
14 Nut 2 off
15 Cradle
16 Bolt 2 off
17 Nut plate 2 off
18 Hose clip 2 off
19 Hose
20 Vent hose
21 Vent hose coupling
22 Hose clip 2 off
23 Hose
24 Filler tube
25 Liquid Vapour Separator (LVS)

Fuel tank and breather components (NAS)



M19 2575

1 Fuel filler cap
2 Filler tube
3 OBD pressure sensor atmospheric pipe
4 Vent pipe to EVAP canister
5 Fuel pump, regulator and fuel gauge sender assembly
6 OBD pressure sensor (vacuum type, EVAP system leak detection capability only)
7 Seal
8 Locking ring
9 Fuel feed connection
10 Fuel gauge sender float
11 Fuel tank and breather assembly
12 Heat shield
13 Scrivet 2 off
14 Stud plate
15 Nut 2 off
16 Cradle
17 Bolt 2 off
18 Nut plate 2 off
19 Hose clip
20 LVS vent pipe
21 Tank breather connection
22 Liquid vapour separator (LVS)
23 Anti-trickle fill valve

Description

General

The fuel delivery system comprises a fuel tank, fuel pump and regulator and eight injectors. The system is controlled by the Engine Control Module (ECM) which energises the fuel pump relay and controls the operation and timing of each injector solenoid.

☞ **ENGINE MANAGEMENT SYSTEM - V8, DESCRIPTION AND OPERATION, Description - engine management.**

The multiport fuel injection system is a returnless system with the fuel pressure maintained at a constant level by a fuel pressure regulator. The regulator is located in the fuel pump housing and returns excess fuel directly from the pump to the tank.

An electrically operated fuel pump is located in the top of the fuel tank and supplies fuel at pressure to two fuel rails via a flexible hose. The hose is attached to the feed pipe on the fuel rail at the rear of the engine and the fuel pump with sealed quick release couplings.

A moulded fuel tank is located at the rear underside of the vehicle between the chassis longitudinals. The tank provides the attachment for the fuel pump and fuel gauge sender unit which is located inside the tank. The fuel system is pressurised permanently with pressurised fuel vapour venting to an EVAP canister.

☞ **EMISSION CONTROL - V8, DESCRIPTION AND OPERATION, Emission Control Systems.**

Fuel tank and breather

The fuel tank and breather system is a major part of the fuel delivery system. The fuel tank and breathers are located at the rear of the vehicle between the chassis longitudinals.

Fuel tank

The moulded fuel tank is made from High Molecular Weight (HMW) High Density Polyethylene (HDPE). Continuous layers of nylon additive are used during the moulding process. The nylon layers give an improved limit of fuel permeation through the tank wall and are also resistant to alcohol based fuels used in the NAS market.

The tank is retained in position by a metal cradle which is secured to the chassis with two nut plates and bolts at the rear and a stud plate and two nuts at the front. A strap above the tank is bolted to the chassis and restrains the tank from moving upwards. The fuel tank has a useable capacity of approximately 95 litres (25 US Gallons).

An aperture in the top surface of the tank allows for the fitment of the fuel pump, regulator and fuel gauge sender unit which is retained with a locking ring.

A reflective metallic covering is attached to the tank with two scrivets to shield the tank from heat generated by the exhaust system.

The fuel filler is located in the right hand rear quarter panel, behind an access flap. The flap is opened electrically using a switch on the fascia.

The filler is closed by a threaded plastic cap which screws into the filler neck. The cap has a ratchet mechanism to prevent over tightening and seals against the filler neck to prevent the escape of fuel vapour. The filler cap has a valve which relieves fuel pressure to atmosphere at approximately 0.12 to 0.13 bar (1.8 to 2.0 lbf.in^2) and opens in the opposite direction at approximately 0.04 bar (0.7 lbf.in^2) vacuum.

All markets except NAS: A moulded filler tube, made from HMW HDPE with no additional additives, connects the filler to the tank via a flexible rubber hose. The filler tube is connected at its top end behind the filler flap.

NAS markets: A fabricated filler tube, made from stainless steel, connects the filler to the tank via a flexible rubber hose. The filler tube is connected at it's top end behind the filler flap.

On all vehicles that use unleaded fuel, the filler neck is fitted with an inhibitor. The inhibitor is a tapered nozzle in the mouth of the filler neck which will only allow the use of a standard unleaded fuel filler gun. A spring loaded flap valve prevents the incorrect fuel from being trickle filled from an incorrect filler gun.

Fuel tank breather system (all markets except NAS)

The filler tube incorporates a tank vent which allows air and fuel vapour displaced from the tank when filling to vent to atmosphere via the filler neck. A relief valve in the vent line to the EVAP canister prevents vapour escaping through the canister during filling. This prevents the customer overfilling the tank and maintains the correct fuel cut-off level.

The filler tube also incorporates an integral Liquid Vapour Separator (LVS). During normal driving excess fuel vapour is passed via the vent line into the EVAP canister. To prevent the canister from being overloaded with fuel vapour, especially in hot climates, the vapour is given the opportunity to condense in the LVS. Fuel which condenses in the LVS flows back into the tank through the ROV's.

A breather spout within the tank controls the tank 'full' height. When fuel covers the spout it prevents fuel vapour and air from escaping from the tank. This causes the fuel to 'back-up' in the filler tube and shuts off the filler gun. The position of the spout ensures that when the filler gun shuts off, a vapour space of approximately 10% of the tanks total capacity remains. This vapour space ensures that Roll Over Valves (ROV's) are always above the fuel level and the vapour can escape and allow the tank to breathe.

The pressure relief valve fitted in the vent line to the EVAP canister prevents the customer trickle filling the tank. Trickle filling greatly reduces the vapour space in the tank which in turn affects the tank's ability to breathe properly, reducing engine performance and safety. When filling the tank, the pressures created are too low to open the pressure relief valve, preventing the customer from trickle filling the tank. Vapour pressures created during driving are higher and will open the valve allowing vapour to vent to the EVAP canister.

Four ROV's are welded onto the top surface of the tank. Each ROV is connected by a tube to the main vent line to the EVAP canister. The ROV's allow fuel vapour to pass through them during normal vehicle operation. In the event of the vehicle being overturned the valves shut-off, sealing the tank and preventing fuel from spilling from the vent line.

Fuel tank breather system (NAS)

The filler tube incorporates a tank vent which allows air and fuel vapour displaced from the tank when filling to vent to atmosphere via the filler neck. A filler cap operated valve within the fuel filler neck prevents vapour escaping through the EVAP canister during filling. This prevents the customer overfilling the tank and maintains the correct fuel cut-off level.

The filler tube also has an 'L' shaped, stainless steel Liquid Vapour Separator (LVS). During normal driving excess fuel vapour is passed via the vent line into the EVAP canister. To prevent the canister from being overloaded with fuel vapour, especially in hot climates, the vapour is given the opportunity to condense in the LVS. Fuel which condenses in the LVS flows back into the tank via the LVS vent line and through the Roll Over Valves (ROV's).

For NAS vehicles with vacuum type EVAP system leak detection capability, a small tube is located alongside the filler tube and terminates near to the filler neck. The tube is connected to the On Board Diagnostics (OBD) pressure sensor in the fuel pump and provides the sensor with a reading of atmospheric pressure to compare against the tank pressure.

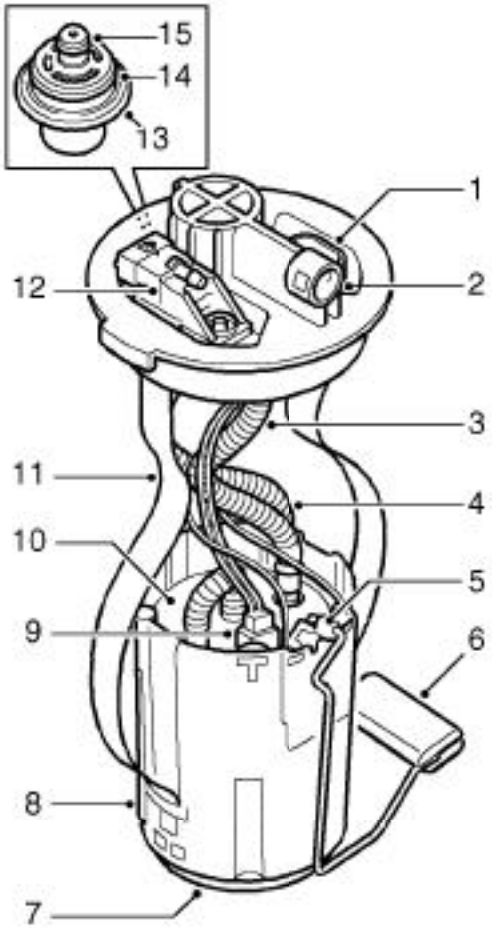
☞ **EMISSION CONTROL - V8, DESCRIPTION AND OPERATION, Emission Control Systems.**

A breather spout within the tank controls the tank 'full' height. When fuel covers the spout it prevents fuel vapour and air from escaping from the tank. This causes the fuel to 'back-up' in the filler tube and shuts off the filler gun. The position of the spout ensures that when the filler gun shuts off, a vapour space of approximately 10% of the tanks total capacity remains. This vapour space ensures that the ROV's are always above the fuel level and the vapour can escape to the LVS and allow the tank to breathe.

The filler cap operated valve closes the vent line to the EVAP canister to prevent the customer trickle filling the tank. Trickle filling greatly reduces the vapour space in the tank which in turn affects the tank's ability to breathe properly, reducing engine performance and safety. When filling the tank, the removal of the filler cap closes the valve and the vent line preventing the customer from trickle filling the tank. When the cap is installed the valve is opened by the cap allowing vapour to vent to the EVAP canister.

The four ROV's are welded inside the top surface of the tank. Each ROV is connected internally in the tank by a tube to the LVS. The ROV's allow fuel vapour to pass through them during normal vehicle operation. In the event of the vehicle being overturned the valves shut-off, sealing the tank and preventing fuel from spilling from the vent line into the LVS.

Fuel pump, regulator and fuel gauge sender



M19 2545

1 Electrical connector
2 Fuel feed pipe coupling
3 Pump feed pipe
4 Fuel regulator return pipe
5 Fuel gauge sender unit
6 Float
7 Gauze filter
8 Swirl pot
9 Pump electrical connections
10 Pump
11 Spring 2 off
12 OBD pressure sensor (NAS vehicles with vacuum type EVAP system leak detection capability only)
13 Fuel pressure regulator
14 'O' ring
15 'O' ring

The fuel pump is a 'self priming' wet type pump which is immersed in fuel in the tank. The fuel pump operates at all times when the ignition switch is in position II. If the engine is not started, the ECU will 'time-out' after 2 seconds and de-energise the fuel pump relay to protect the pump. The pump receives a feed from the battery via fuse 10 in the engine compartment fusebox and the fuel pump relay. The relay is energised by the ECM when the ignition switch is moved to position II.

The fuel pump is retained with a locking ring and sealed with a rubber seal. The locking ring requires a special tool for removal and fitment. An access panel for the fuel pump is located in the loadspace floor below the loadspace carpet. The access panel is sealed to the floor with a rubber seal and retained by six self-tapping screws.

The fuel gauge sender is integral with the fuel pump. The sender is submerged in the fuel and is operated by a float which moves with the fuel level in the tank.

Fuel pump

The fuel pump assembly comprises a top cover which locates the fuel pressure regulator, electrical connector and fuel pipe coupling. The top cover is attached to a plastic cup shaped housing by two metal springs. The housing locates the pump and the fuel gauge sender unit.

The lower part of the housing is the swirl pot, which maintains a constant fuel level at the fuel pick-up. A feed pipe from the pump to the coupling connection and a return pipe from the regulator connect between the top cover and the housing.

A coarse filter is attached to the base of the housing and prevents the ingress of large contaminants into the swirl pot. A gauze filter prevents particles entering the fuel pump.

Surrounding the pump is a large fine paper filter element which further protects the fuel pressure regulator, engine and injectors from particulate contamination. The paper filter is not a serviceable item and removes the requirement for an external in-line filter.

A non-return valve is located in the base of the housing. When the fuel tank is full, fuel pressure keeps the valve lifted from its seat allowing fuel to flow into the swirl pot. As the tank level reduces, the fuel pressure in the tank reduces causing the valve to close. When the valve is closed fuel is retained in the swirl pot, ensuring that the swirl pot remains full and maintains a constant supply to the fuel pump.

A four pin electrical connector is located on the top cover of the pump and provides power feed and return for fuel pump and fuel gauge rotary potentiometer operation. A single quick release coupling connects the fuel feed pipe to the outer top surface of the pump.

Two metal springs are attached to the top cover and the housing of the pump. When the pump is installed it seats on the lower surface inside the tank. The springs exert a downward pressure on the pump and ensure that the pump is located positively at the bottom of the fuel tank.

The fuel pump has a maximum current draw of 6.5 A at 12.5 V.

On NAS vehicles with vacuum type EVAP system leak detection capability only, the fuel pump top cover is fitted with an On Board Diagnostics (OBD) pressure sensor. This sensor has a three pin electrical connector which provides a connection between the sensor and the ECM. The sensor is sealed in the top cover with an 'O' ring and secured with a clip. The sensor monitors tank pressure during OBD tests of the fuel evaporation system integrity. A hose is connected to the sensor and is routed across the top of the fuel tank and terminates at the top of the fuel filler tube. The pipe is open to atmosphere and provides atmospheric pressure for the sensor operation.

☞ **ENGINE MANAGEMENT SYSTEM - V8, DESCRIPTION AND OPERATION, Description - engine management.**

Fuel pressure regulator

The fuel pressure regulator is located in the underside of the top cover. The regulator is sealed with two 'O' rings and retained with a clip.

The regulator is connected to the fuel feed pipe at the top of the pump housing and maintains the fuel pump delivery pressure to 3.5 bar (50 lbf.in^2). When the fuel delivery pressure exceeds 3.5 bar (50 lbf.in^2), the regulator opens and relieves excess pressure back to the swirl pot via a return pipe. The regulator ensures that the fuel rails and injectors are supplied with a constant pressure.

The fuel pump delivery pressure and pressure regulator operating pressure can be checked using a Schraeder type valve located at the rear of the engine on the fuel rail. The valve allows the pump delivery pressure to be measured using a suitable gauge and an adaptor and hose which are special tools.

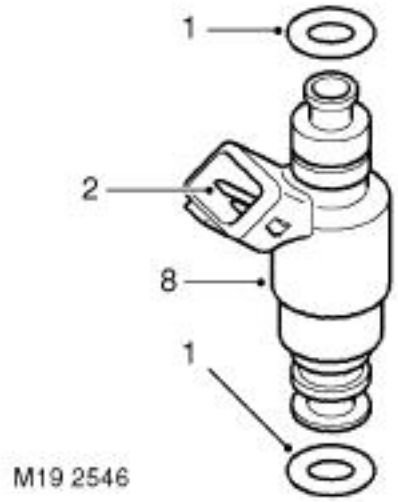
Fuel gauge sender

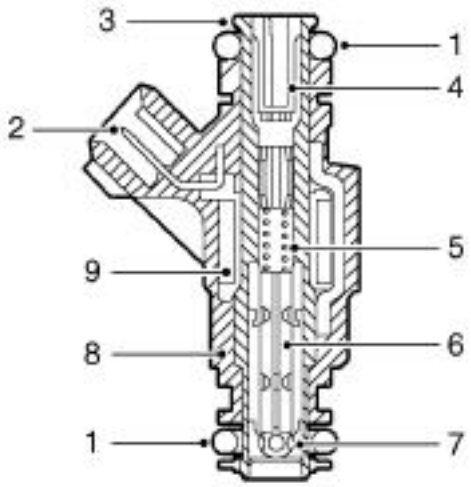
The fuel gauge sender unit comprises a rotary potentiometer operated by a float. The float rises and falls with the fuel level in the tank and moves the potentiometer accordingly.

Battery voltage is supplied to the potentiometer. The output voltage from the potentiometer varies according to the resistance through the potentiometer in relation to the fuel level. The output voltage is connected to the fuel gauge in the instrument pack. The fuel gauge receives a battery voltage input and this is compared with the output voltage from the potentiometer. The difference between the two voltages determines the deflection of the fuel gauge pointer.

Fuel gauge reading	Tank volume litres (US Gallons) *	Sender unit resistance ohms Ω
FULL	95 (25)	15
3/4	71 (18.8)	36
1/2	48 (12.7)	64
1/4	24 (6.4)	110
RESERVE (fuel light ON)	11 (2.9)	158
EMPTY	0 (0)	245
*Tank volumes are approximate.		

Injectors





1 'O' ring 2 off
2 Electrical connector
3 Steel housing
4 Filter strainer
5 Spring
6 Valve needle and armature
7 Valve seat/spray orifice
8 Plastic housing
9 Solenoid winding

An injector for each cylinder is mounted externally in the lower inlet manifold on the engine. The injector protrudes into the inlet manifold tract, where it releases a controlled delivery of fuel into the manifold air inlet.

Each injector is sealed to the fuel rail and the inlet manifold with 'O' rings. Spring clips retain each injector to the fuel rail and the attachment of the fuel rail clamps the injectors in the lower manifold.

The injector housing is manufactured from plastic which encapsulates a high-alloy steel housing. The steel housing contains all components which come into contact with fuel. The plastic housing also provides the attachment for the engine harness connector for the injector. A solenoid is located between the two housings and moves a valve needle via an armature. The valve needle seats on a valve seat which incorporates a spray orifice plate. A filter strainer is fitted at the connection with the fuel rail to remove any particulate matter from the fuel before it enters the injector.

When the ECM energises the solenoid, the armature moves lifting the valve needle off its seat. This allows pressurised fuel from the fuel rail to pass through the injector housing and needle to the spray orifice. The spray orifice controls the spray shape and fuel metering. When the solenoid is de-energised, the valve needle returns to the valve seat, aided by a spring, closing off the injection of fuel into the inlet.

Each injector receives a battery supply voltage via a fuse in the engine compartment fusebox. The fuel delivery timing is controlled by the ECM, which, at a precisely timed interval, provides a ground path for the injector. The completion of the ground path operates the injector to allow fuel at pump pressure to be delivered from the fuel rail to the injector nozzle. Each injector sprays a finely atomized spray of fuel into the inlet, where it is mixed with the intake air prior to combustion.

☞ **ENGINE MANAGEMENT SYSTEM - V8, DESCRIPTION AND OPERATION, Description - engine management.**

Faults for each injector are stored in the ECM and can be retrieved using TestBook. Each injector can be checked across the two connector pins. For a correctly functioning injector a resistance of between 13.8 and 15.2 ohms at a temperature of 20°C (65°F) should be read across the pins.

Operation

When the ignition switch is moved to position II, the fuel pump relay in the engine compartment fusebox is energised by the ECM. Battery voltage is supplied from the fuel pump relay to the fuel pump which operates. If engine cranking is not detected by the ECU within a thirty second period, the ECU will 'time-out', de-energising the fuel pump relay.

☞ **ENGINE MANAGEMENT SYSTEM - V8, DESCRIPTION AND OPERATION, Description - engine management.**

The fuel pump draws fuel from the swirl pot and pumps it along the fuel feed pipe to the injector fuel rail on the engine. When the pressure in the fuel feed line reaches 3.5 bar (50 lbf.in^2) the fuel pressure regulator opens and relieves pressure by directing fuel back into the swirl pot. The pressure regulator is constantly opening and closing to maintain the pressure in the fuel feed pipe and the fuel rail at 3.5 bar (50 lbf.in^2).

The pressure is felt at each of the eight injectors connected to the fuel rail. The ECM controls the injection timing and energises each injector to allow a metered amount of fuel at pump pressure to be injected into the inlet tract of the inlet manifold. The atomised fuel from the injector is mixed with air from the inlet manifold before passing into the cylinder.

Fuel tank - drain

19.55.02

Drain

1. Disconnect both leads from battery.
   WARNING: Always disconnect the negative lead first. Disconnection of the positive lead while the negative lead is connected could result in a short circuit through accidental grounding and cause personal injury.
2. Connect TestBook to vehicle and depressurise fuel system.
3. Remove fuel pump.
   ☞ **FUEL DELIVERY SYSTEM - V8, REPAIRS, Pump - fuel.**
4. Using a fuel recovery appliance, drain the fuel from the tank into a sealed container. Follow the manufacturers instructions for the connection and safe use of the appliance.

Refill

1. Fit fuel pump unit.
   ☞ **FUEL DELIVERY SYSTEM - V8, REPAIRS, Pump - fuel.**
2. Refill fuel tank with extracted fuel.
3. Connect battery leads, positive lead first.