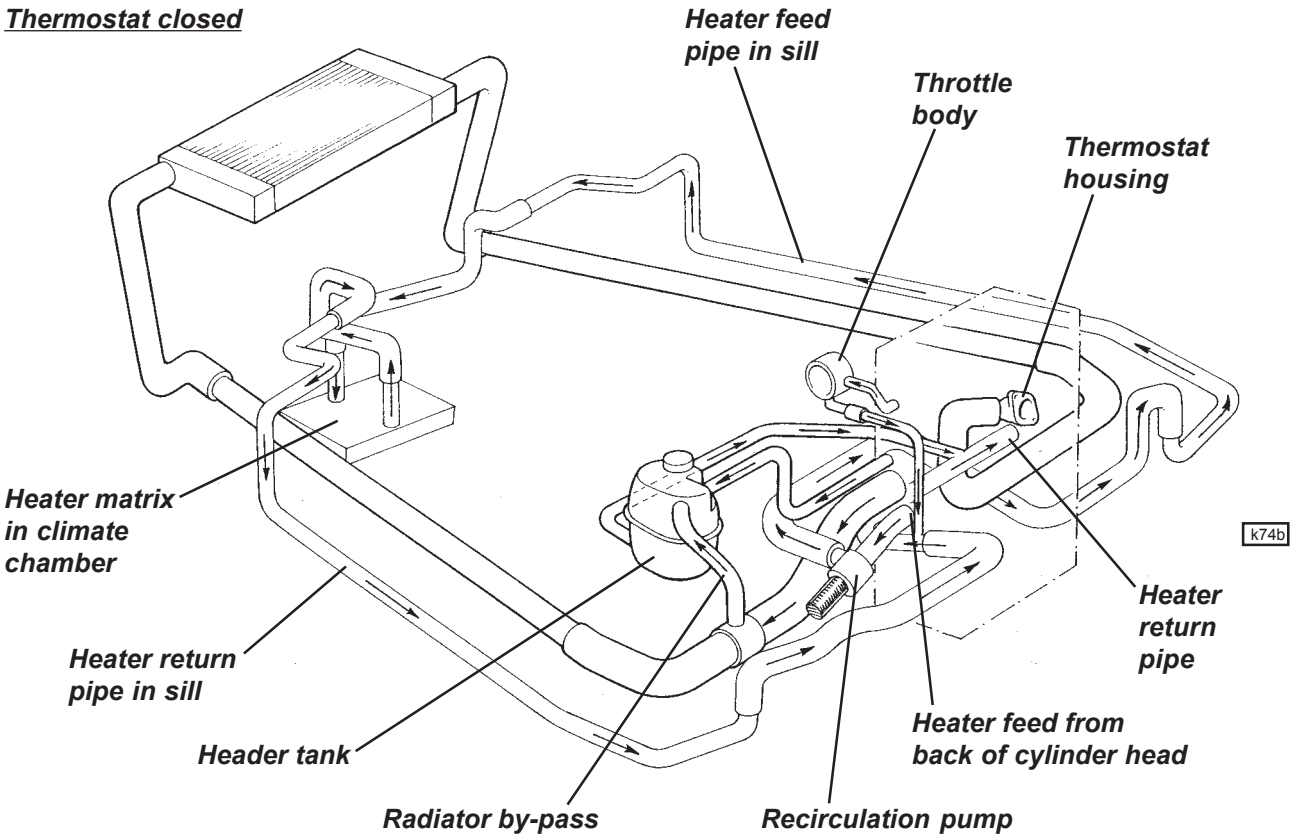
ENGINE COOLING

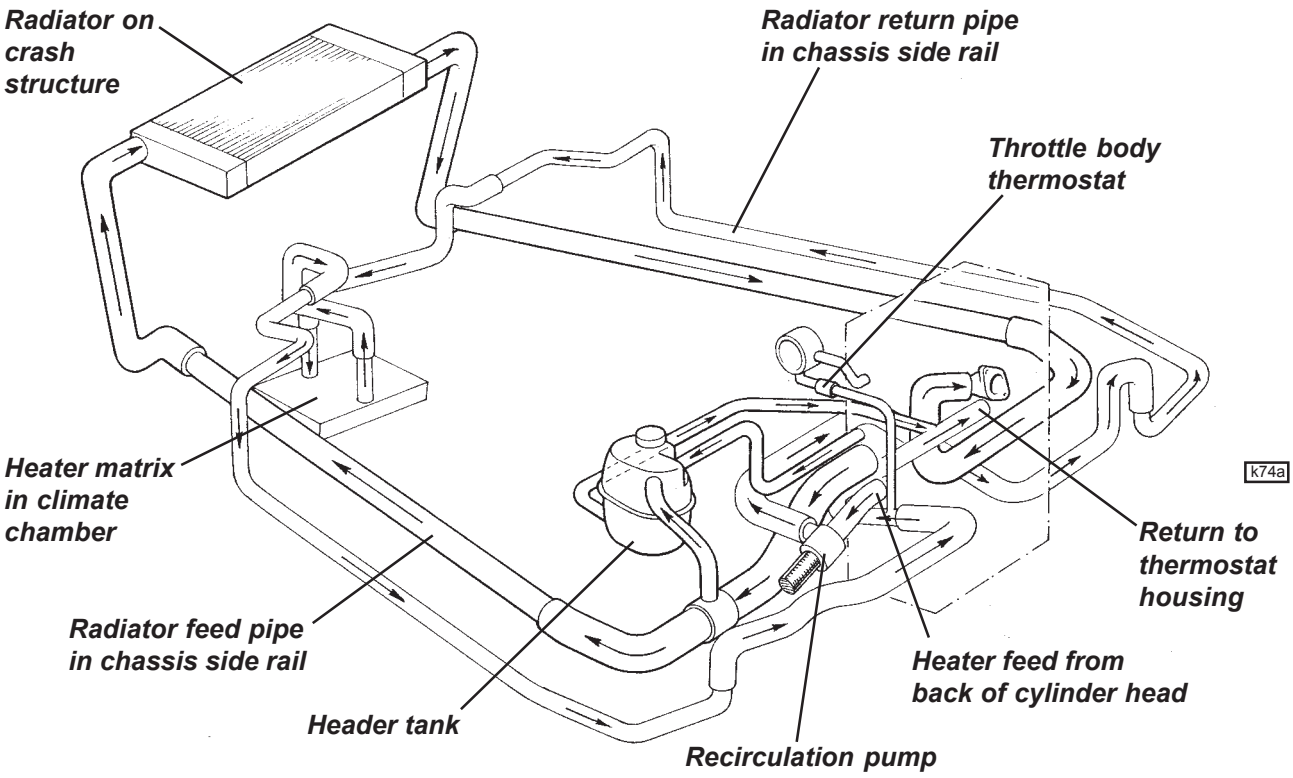
SECTION KH

Coolant Flow Circuits

Thermostat closed



Thermostat open



KH.1 - GENERAL DESCRIPTION

The engine cooling system comprises an engine driven water pump, a front mounted radiator with electric cooling fan(s), a header tank, re-circulation pump and associated ducting, pipework and controls.

The centrifugal water pump is mounted on the front face of the cylinder block, and is driven by the smooth 'back' side of the multi-rib auxiliary drive belt. Water is discharged from the pump into the front of the cylinder block, around the cylinder liners and up into the cylinder head, before exiting the engine via an outlet spigot on the rear of the head.

Radiator open circuit:

From the main outlet on the rear face of the cylinder head, a moulded hose connects with the main radiator feed pipe which runs inside the left hand chassis side rail, before feeding the front mounted radiator. The engine cooling radiator is of aluminium construction with plastic end tanks and is horizontally mounted on top of the glass fibre composite 'crash structure' which also serves as a duct to direct airflow from the body nose air intake, to the underside of the radiator. Twin 100 mm diameter electric cooling fans are fitted to the underside of the radiator to supplement, when required, the ram air flow, and a moulded deflector panels direct air exhausting from the top of the radiator through outlet grilles in the front bonnet. On cars equipped with air conditioning, the condenser is sandwiched between the radiator and crash structure, with the cooling fans attached to underside of the condenser.

The right hand, outlet spigot on the radiator feeds a return pipe routed down the inside of the chassis right hand side rail, which is then connected to the thermostat housing on the left hand side of the block. Coolant flowing through the open thermostat enters the water pump to commence another circuit.

Heater circuit:

A second outlet spigot on the rear of the head is used to supply the heater circuit. Water flows via a re-circulation pump, into an aluminium pipe routed along the outside of the right hand chassis siderail, within the composite sill member. The front end of this pipe rises over the end of the scuttle, penetrates the plenum/scuttle baffle panel, and connects to the heater matrix mounted in the chassis front climate chamber. The heater return circuit is similarly routed along the left hand side of the chassis, to join a steel heater return pipe at the back of the cylinder head, and running beneath the inlet manifold to the underside of the thermostat housing.

In conditions of 'heat soak', after stopping a hot engine, the re-circulation pump is energised under engine ECU control to pump coolant through the heater circuit and limit the potential for localised boiling within the cylinder head.

Radiator by-pass circuit:

When the thermostat is closed, the radiator return circuit is shut off, and coolant leaving the cylinder head is forced to flow through a by-pass circuit which links the engine outlet hose to the header tank and then to the heater return pipe.

Header tank:

The top RH spigot on the header tank is connected to an air bleed on the back of the cylinder head; the top rear spigot to the engine outlet hose; and the bottom port to a hose joining the heater return pipe immediately before its termination at the thermostat housing.

Throttle body and oil/water heat exchanger

The throttle body is water heated to prevent icing, drawing a supply from the back of the cylinder head, and returning via an in-line thermostat, into the heater return pipe. On cars not fitted with front mounted air/oil coolers, an oil/water heat exchanger is sandwiched between the oil filter and cylinder block. Coolant is fed from a water jacket spigot on the left hand side of the cylinder block into the exchanger, with the outlet pipe connecting into the heater return pipe.

KH.2 - MAINTENANCE

Under normal operating conditions, the engine cooling system, being a closed circuit, should not require any topping up between services. As a precaution however, every week, the level of coolant in the engine cooling header tank should be checked. The header tank is mounted at the left hand side of the engine bay, with a hose from its underside connecting with the heater return rail near the thermostat housing. An air bleed hose connects the header tank air space with the radiator by-pass circuit and a cylinder head spigot at the front end of the inlet manifold. The tank is fitted with a 110 kPa (15 lb/in²) pressure cap to raise the boiling point of the coolant to over 120°C. The transluscent header tank is marked with both cold and hot level indicators. The

level of coolant will rise as the engine warms up and the coolant expands, and will fall again as it cools down.

WARNING: Do NOT remove the cap or bleed plug from the engine cooling header tank when the engine is warm, as serious scalding could result from boiling water and/or steam.

When fully cold, the level of coolant should be up to the 'cold' mark moulded on the header tank. If overfilled, the excess coolant will be ejected when the engine is warm, and if the level is allowed to fall too low, overheating may result. If necessary, top up the system using an approved coolant mixture (see below) to maintain full protection from freezing damage and corrosion.

Anti-Freeze/Corrosion Inhibitor

It is necessary that the coolant contains an anti-freeze with corrosion inhibitor to protect the engine and heat exchangers from both frost damage, and corrosion of the metallic elements. In order to protect against these dangers as well as raising the boiling point of the coolant, the Elise is factory filled with a 50% concentration of Havoline XLC, which is a mono-ethylene glycol coolant using organic acid technology (OAT) to provide increased corrosion protection compared with conventional coolant additives. A yellow label around the header tank neck identifies the coolant type used. The corrosion inhibiting carboxylic acids in the OAT coolant tend to remain in solution rather than being deposited on the internal surfaces of the cooling system, thus improving heat transfer and extending service life. Havoline XLC is the only recommended coolant product, and at 50% concentration provides freezing protection down to approximately - 40°C. Even in warm climates it is recommended that the concentration is not allowed to fall below 25%, in order to maintain full corrosion protection.

The simplest means of checking the antifreeze concentration is to measure the specific gravity (density) of the coolant at a known temperature, using a hydrometer. The following table provides a general guide:

	Density @	
Concentration	***20°C***	***60°C***
25%	1.039	1.020
33%	1.057	1.034
50%	1.080	1.057

The coolant density reflects the effective level of mono-ethylene glycol, and not the level of corrosion inhibitors present, whose effectiveness diminishes over a period of time. The coolant should therefore be renewed every 4 years to ensure optimum corrosion protection.

In areas where the tap water is extremely hard (exceeding 250 parts per million), use of this water will lead to 'furring up' of the system over a period of time. In such areas, distilled, de-ionised or filtered rain water should be used.

Radiator Fin Cleaning

At service intervals, the matrix of the engine cooling radiator should be checked for clogging by insects, leaves and other debris. If necessary, use a water jet from both above and below to clean the fins, taking care not to damage the fragile tubes or distort the finning. At the same time, check the integrity of all cooling system joints, and the condition of all flexible hoses. In snowy conditions, ensure the radiator air exit is cleared of snow before driving the car.

KH.3 - DRAIN/REFILL PROCEDURE

To drain the engine cooling system:

1. Remove the undertray from beneath the nose of the car.

2. Disconnect the radiator feed and return hoses from the front ends of the thro' chassis pipes, and collect the draining coolant. Remove the header tank cap to speed the operation.

3. Open the drain tap at the right hand rear of the cylinder block.

Note that draining of the heater matrix is not easily possible with the unit 'in situ', and that if draining for the purpose of coolant change, this volume should be disregarded.

To refill the system:

1 Refit the hoses to the feed and return pipes and close the cylinder block drain tap.

2. Remove the right hand front wheelarch liner and open the air bleed plug on the radiator outlet hose. From within the engine bay, open the air bleed plug in the heater return hose at the left hand rear of the engine bay.

3. Fill with the recommended coolant mix via the header tank and close the bleed plugs when a steady stream of coolant is expelled.

4. Start the engine and allow to idle, and periodically open the bleed plugs to allow any trapped air to be expunged. Top up the header tank when necessary, and fit the pressure cap when required to prevent overflow. When the cooling fans have cut in and then out, stop the engine and allow to cool. Recheck coolant level when fully cold.

KH.4 - RADIATOR & COOLING FAN

The aluminium cored radiator is positioned horizontally on top of the composite 'crash structure' in the front services compartment. A composite moulding is used to mount the radiator, and also, via extensions at each side, to provide a mounting point for the inside front of the clamshell wheelarch. The radiator must be removed for access to the cooling fans.

To Remove Radiator

1. Remove the front clamshell (see section BR).

2. Drain the coolant and disconnect the feed and return hoses from the radiator.

3. If the car is equipped with air conditioning, de-pressurise the system and recover the refrigerant via the service ports near the evaporator.

4. Remove the two radiator outlet air deflector panels, release all tie wraps and fixings securing wiring hanesses and pipes to the radiator mounting panel, and disconnect the radiator fan harness plugs.

5. If the car is fitted with front mounted oil coolers, disconnect the feed and return hoses from both coolers and plug all ports to limit oil spillage. Remove the mounting brackets from the coolers and crash structure.

6. Release the single fixing at the bottom of each side extension securing the mounting panel to the bottom flange of the crash structure.

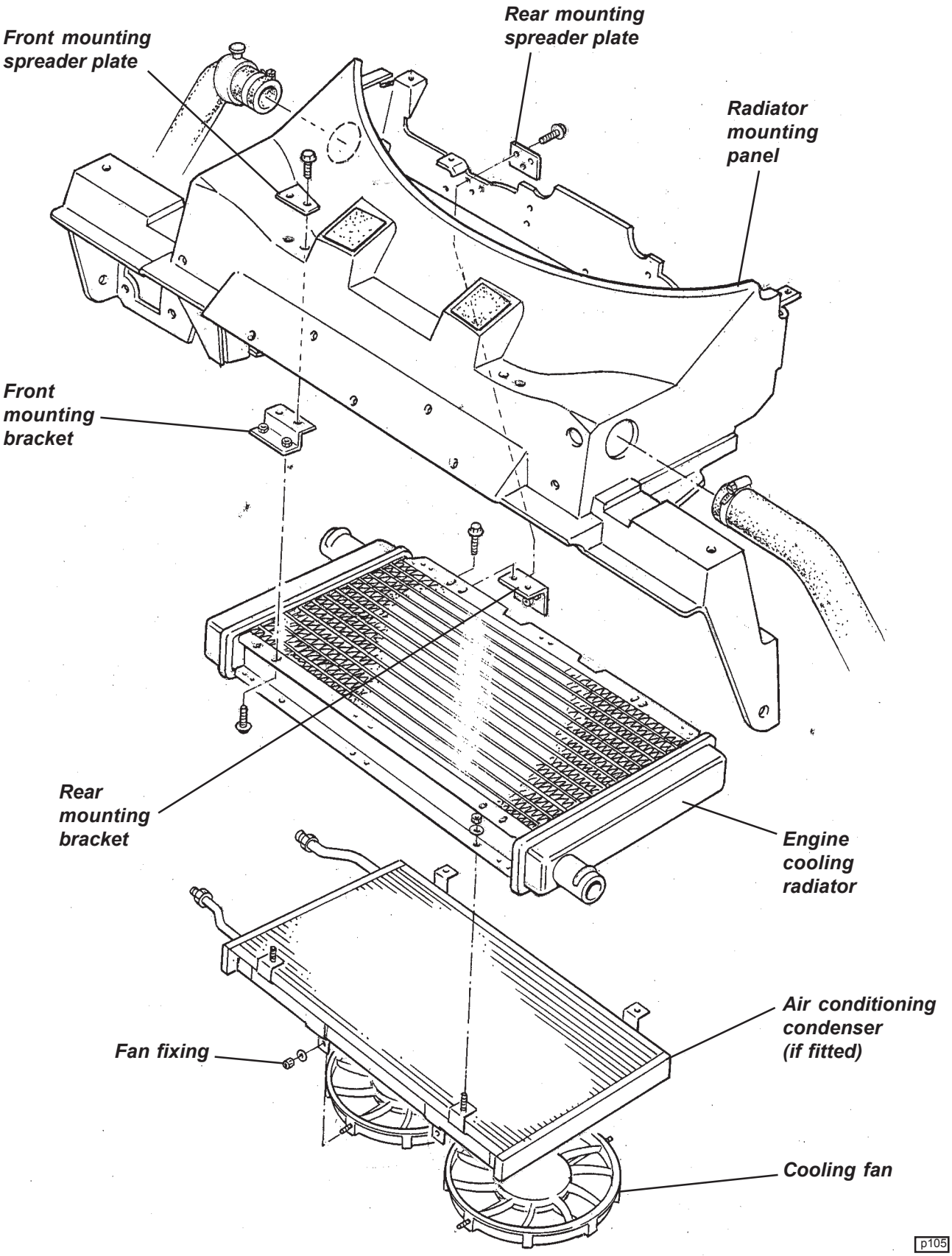
7. Release the three fixings securing the back edge of the mounting panel to the vertical flange on the crash structure, and the three fixings along the front edge of the panel.

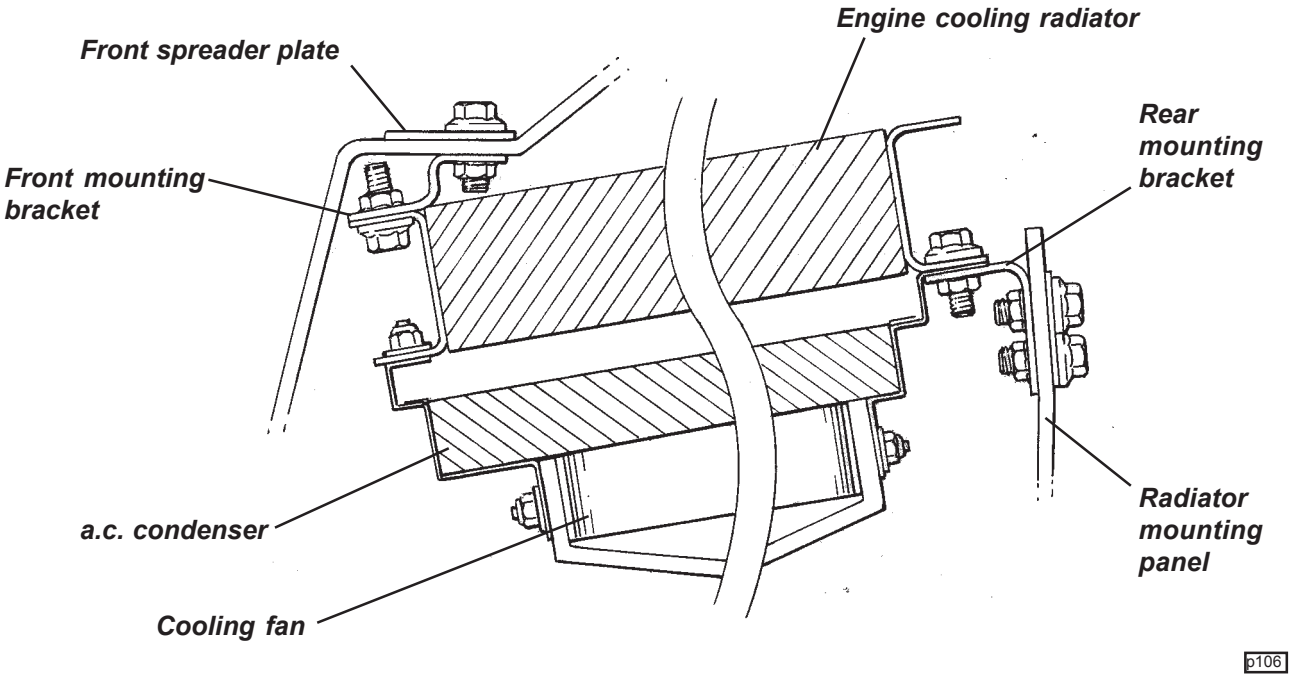
8. Withdraw the radiator mounting panel with radiator/(condenser)/cooling fans assembly.

9. Each cooling fan is secured two studs and nuts to either the radiator flange bracket, or, on a.c. cars to the condenser. The condenser is secured to the radiator lower flange by two studs at the front edge, and by two pairs of screws at the rear edge. The radiator is fixed to the mounting panel by brackets at the front and rear. Note the foam packing used between the radiator and mountign panel to ensure that all ducted air flows through the radiator matrix.

10. Refit the radiator in reverse order to removal, ensuring that the foam packing is re-installed. Refill with coolant and bleed as detailed in sub-section KH.3. Re-charge refrigerant system.

Radiator Mounting





KH.5 - RADIATOR FAN & RE-CIRC. PUMP CONTROL

The two cooling fans are fitted beneath the radiator or (with a.c.) condenser/radiator package, and the coolant re-circulation pump is mounted below the header tank. Both the fans and pump are controlled by the engine management ECU using data provided by the engine coolant temperature sensor mounted in the back of the cylinder head.

The cooling fans are switched as a pair, and will operate at half speed (connected in series) when coolant temperature reaches 98°C on rise, and switch off at 94°C on fall. The fans will also operate at half speed irrespective of coolant temperature if the a.c. is switched on and the compressor is running. If coolant temperature rises to 103°C, the fans will switch to full speed (connected in parallel), reverting to half speed at 98°C.

The fans will also run at half speed, unless high coolant temperature dictates otherwise, when the a.c. is switched on and the compressor is running, or if the engine management system detects a fault with the inlet air temperature or coolant temperature circuits.

At road speeds in excess of 85 mph (135 km/h), equating to the fan stall speed, all fan functions are switched off.

Heat Soak

In order to help control engine temperature after switching off an engine whose temperature is over 88°C, the ECU will remain powered for a period of 20 minutes to allow heat soak management.

A coolant re-circulation electric pump is mounted below the coolant header tank and is plumbed into the heater supply line. When energised, the pump circulates coolant through the engine and heater system, drawing coolant from the back of the cylinder head, and pumping it through the heater matrix to the heater return pipe and back into the thermostat housing. The pump functions only with ignition off in conditions where the ECU remains live. The pump is then activated at coolant temperatures over 110°C, switching off at 100°C on fall. If temperature should rise to 115°C, the pump will be supplemented by the two cooling fans running at half speed, switching off at 110°C on fall.

Fan Control Module

The cooling fans, re-circ. pump and a.c. compressor are controlled by a relay module mounted to the top of the passenger side wheelarch liner. **Important Note:** The a.c. relay module is identical in appearance to the engine relay module, but the function of the two modules is different and they must not be transposed. The a.c. relay module A117M0038F has a brown label marked YWB100800; The engine relay module A111E6024F has a white label marked YWB100970.

If the ECM receives a signal voltage outside of the acceptable range, a default setting equating to 60°C will be substituted, and the cooling fan energised.

KH.6 - RADIATOR FEED & RETURN PIPES

The radiator feed and return pipes are routed through the chassis main side rails, feed on the left, and return on the right. Each pipe is located by a grommet in the chassis front closing panel, and by a pair of shaped foam blocks inserted into the rear end of each chassis rail.

On initial build, the water pipes are fitted before the crash structure is bonded to the front of the chassis. A new chassis assembly is supplied with both water pipes and the crash structure pre-fitted. If a pipe is to be replaced in service without the crash structure being removed:

WARNING: The machined edges of the chassis extrusions and the ends of the drive fasteners can present sharp edges and points representing a potentially serious health hazard. It is strongly recommended that industrial gloves are worn, and other suitable precautions taken to provide protection from cuts and abrasions.

1. Drain the coolant and remove the front clamshell (see section BR).

2. To release the hoses from the rear ends of the water pipes requires that the fuel tank be removed. Access is available only via apertures in the inner walls of the chassis siderails within the fuel tank bay. To remove the tank refer to sub-section LJ.4. The hoses are secured to the rear ends of the water pipes by spring clamps requiring a suitable tool to release.

3. Release the hoses from the front end of the water pipe.

4. Using the access provided from within the fuel tank bay, push the water pipe forwards until obstructed by the crash structure. It is recommended that a suitable hole be cut in the flat vertical face of the crash structure, adjacent to the fog lamp harness grommet, in order to allow the pipe to be withdrawn forwards.

5. To refit, retrieve the two support foams from inside the chassis rail. Fit the grommet into the hole in the chassis front closing plate, and smear with rubber grease. Feed the pipe through the access hole and grommet, and position with 35 - 40 mm of pipe protruding.

5. At the rear end of the pipe, fit two foam support blocks onto the pipe, and push into the chassis rail ahead of the fuel tank bay aperture.

6. Refit the hoses to the front and rear ends of the pipes and manipulate the pipe to check for absence of chassis contact 'knock'.

7. Blank off the access hole in the crash structure with a suitable grommet.

KH.7 - OIL COOLERS

Depending on market territory and date of build, cars may be fitted with either an engine mounted water/oil heat exchanger, or a single LH front mounted air/oil cooler, or twin front mounted air/oil coolers. The water/oil heat exchanger or single front mounted oil cooler is entirely adequate for all normal conditions of road use, but for cars used on closed circuit tracks or driven in a competitive manner (note; such use may invalidate vehicle warranty), or if full vehicle performance is to be exploited for an extended period (especially in hot ambient temperatures), it is recommended that twin front mounted coolers be fitted for optimum control of oil temperature.

Water/oil Heat Exchanger (if fitted)

On cars so fitted, the oil/water heat exchanger is sandwiched between the oil filter and cylinder block. Water hoses connect a tapping on the left hand side of the cylinder block to the heat exchanger, and from the

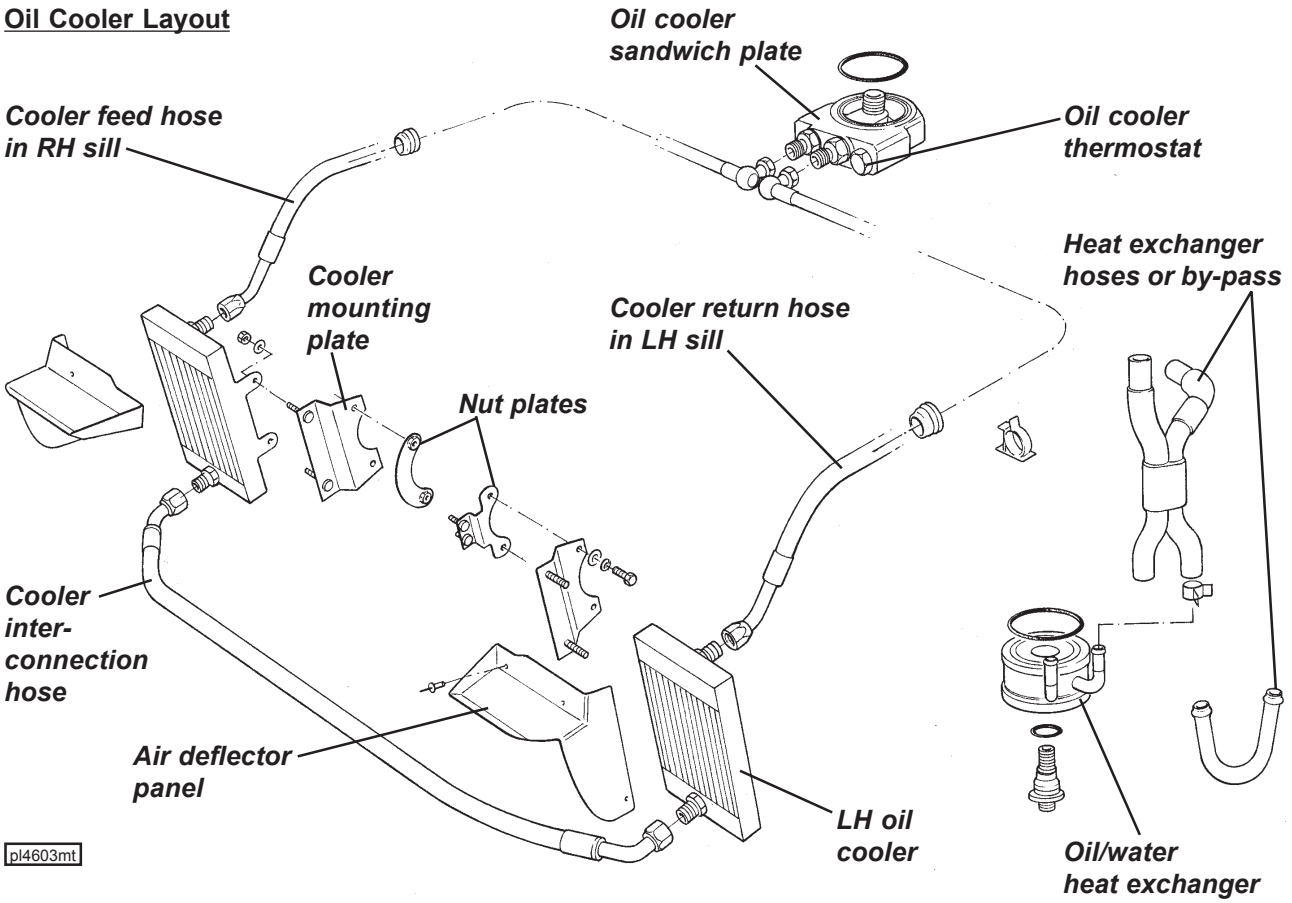
exchanger to the heater water return pipe. This device transfers heat from the engine coolant to the oil after a cold start, and conversely, in conditions of high oil temperature transfers heat from the oil to the coolant.

Front Mounted Air/Oil Coolers

On cars so fitted, front mounted oil/air radiators are mounted ahead of each front wheel arch and fed with air from intakes either side of the main engine radiator intake in the body nose. 'Single oil cooler' cars are equipped with an oil cooler ahead of only the LH front wheel, but use the same hoses as twin oil cooler cars, with a joiner union attached to a bracket in place of the symetrically opposite RH cooler.

On all cars with front mounted oil cooler(s), the oil/water heat exchanger is replaced by a sandwich plate incorporating oil take-off feed and return unions, with the redundant coolant hoses interconnected by a 'U' pipe. A thermostat incorporated into the sandwich plate begins to open at 72ºC, and is fully open at 80ºC. When open, oil is directed from the sandwich plate via a flexible hose within the RH sill panel, over the front wheel arch liner to the top connection on the RH oil cooler (or joiner union on single oil cooler cars). From an outlet union at the bottom front of the cooler (or joiner union), another hose runs beneath the crash structure to the bottom of the LH cooler, from the top of which oil is returned via a third hose, running through the LH sill, back to the return union on the sandwich plate.

Oil Cooler Layout



Each cooler is secured by a two stud bracket to the side of the crash structure, and positioned immediately ahead of the engine radiator mounting panel side extensions, which incorporate airflow apertures and additional deflector panels on their front surfaces. Louvres in the wheelarch liner front sections allow air to exhaust from the coolers into the wheelarches.

Procedure for conversion from single to twin front mounted oil coolers

Parts Required		Part Number	Qty
Oil Cooler, RH, incl. foam seal		A120K0020F	1
Duct, oil cooler, RH	- Elise	A120B0090F	1
	- Exige	A122B0194F	1
Big Head Pop Rivet, duct fixing		A089W6297F	3

1. Remove the front clamshell (refer to sub-section BR.6).

2. Disconnect oil cooler hoses from joiner union ahead of RH front wheel using 2 off 1 1/8" spanners, and plug hose ends to minimise oil loss.

3. Remove hose joiner bracket and secure new oil cooler, with its pre-applied sealing foam, to mounting bracket using existing fixings. Torque tighten to 22 Nm.

4. Fit hoses to oil cooler. When tightening the union nut **it is essential that the oil cooler union is held using a 15/16 in. open end spanner** whilst torque tightening the hose union nut (1 1/8") to 40 Nm. Failing to follow this procedure may result in damage to the oil cooler.

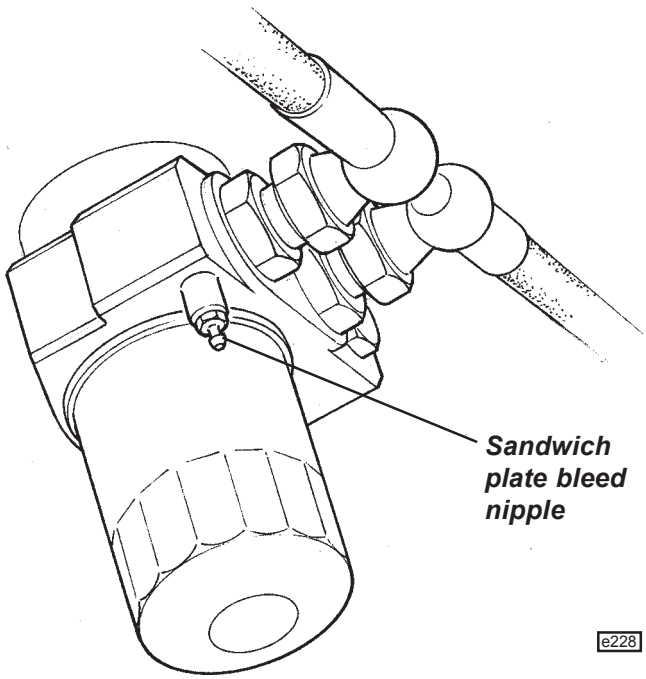
5. Start the engine and check for oil leaks.

6. Secure the new cooler duct with the three big head rivets to the radiator duct and refit the front clamshell.

Oil Cooler Circuit Bleeding

When carrying out routine oil changes, the oil quantity contained in the twin oil coolers and associated pipework is not disturbed and is considered perfectly satisfactory for routine maintenance operations. In instances of major engine failure where the oil system may be contaminated with metallic debris, all oil cooler lines should be thoroughly flushed out and the oil cooler radiators replaced.

If the oil cooler circuit is drained or replaced, the following procedure should be adopted to fill the cooler system before starting the engine:



1. Attach a tube to the bleed nipple on the sandwich plate between oil filter and engine block, and lead into a catch tank. Open the bleed nipple.

2. Disconnect the outlet hose from the top of the LH oil cooler, and pour engine oil into the cooler until oil reaches the bleed nipple (approx. 2.5 litres).
Close the bleed nipple, tightening to 8 Nm.

3. Connect the LH cooler outlet hose and tighten to 40 Nm.

4. Add a further 0.7 litres of oil into the engine to accommodate the volume of the return hose between LH oil cooler and engine.

5. After starting the engine, restrict running to idle speed for a minimum of 5 minutes, to allow the oil cooler lines to be purged of air. Stop engine and re-check oil level.