Photos: Rpi Engineering

RANGE ROVER V8 LOSING ITS COOL? DON'T BLOW YOUR TOP

Chris Crane of Rpi Engineering explains what's happening at the heart of the eight-pot legend

OUCH! A CRACKED engine block on a P38 Range Rover V8 is guaranteed to be painful for all concerned – and, worryingly, the problem can occur regardless of how the car is driven or maintained.

Investigations by my colleagues and me at Rpi (**01603 710832**) point to a weak fuel mix at low engine speeds which, under conditions of high load (with knock sensors preventing the engine from pinking), induces very hot cylinder temperatures that can cause cracking in the block. Unlike coolant and oil temperatures that can be displayed on the dashboard, there is no way of monitoring the cylinder metal temperatures.

The Rover V8's all-aluminium construction was unusual among British-made engines, though the material is fairly common in modern-day units. Aluminium is not that wear-resistant so, unlike cast-iron cylinder blocks in which pistons move inside bores machined directly into the block material, the V8's pistons run inside cast-iron liners, sleeved into the aluminium block.

The current-model Range Rover's 4.4-litre V8 is a totallly different engine, unaffected by any of the problems we're considering here. It's also aluminium, but the cylinders are bored directly into the block material and given a hard-wearing Nikasil coating.

The older Rover V8's cylinder liners have caused very few problems over the years, save for the rare occasion where the liner could break free and move about inside the engine, causing a tapping sound.

Coolant passages inside the Rover block casting are designed to run as close as possible to the cylinder liner in order to maximise heat transfer from cylinder to coolant. This means the wall of the block, where the liner slides in, is relatively thin.

3.9 AND 4.2 VERSIONS

The larger-capacity variants of the original 3.5-litre engine were brought about by increasing the bore size from 89.5mm to 94mm. In doing so, the thickness of the block behind the cylinder liner was reduced.

After about eight years of service many of these engines in the Range Rover have suffered water loss, a loose cylinder liner – or maybe even both.

4.0 AND 4.6 VERSIONS

These later engines are far superior to the earlier 3.5-litre design, though the suitability of the block casting has been questioned. In fact, these large-capacity units still use the same 94mm bore (increased capacity being achieved through a longer piston stroke) but they suffer similar problems to those of the 3.9 and 4.2, but at an earlier age – and more frequently, too.

Head gasket failure on the large capacity V8s is more likely to be a result of cooland loss, rather than the cause

CORRECT DIAGNOSIS

Faced with the problem of coolant loss and/or overheating, and having first checked all the associated parts such as radiator, hoses, thermostat, water pump and heater, the next item to come under scrutiny is often the head gaskets.

Head gaskets do fail but, if the root problem is with either the engine block or the liners, then expensive top-end rebuilds will be in vain, no matter how well the job has been carried out. As such, accurate diagnosis is essential to avoid unnecessary expense and work.

It's often suggested – incorrectly, as it happens – that coolant loss is due to the engine block's porosity. The engine block is manufactured by casting molten aluminium alloy into a mould. Gases dissolve easily in molten metal so, as the casting cools and solidifies, the dissolved gas can re-form as tiny bubbles within the casting.

However, casting is a refined, controlled process that virtually eliminates it. The block

would need to have the porosity of an Aero bar for coolant to find a leak-path through it.

Nearly all suspect engines examined at Rpi Engineering have developed a crack in the bore of at least one cylinder, ie in the block material between the liner and water jacket.

This problem can be diagnosed – and the symptoms are altogether different from those of a head gasket failure.

However, if coolant loss is ignored until it causes cylinder head gasket failure, it is then too late to diagnose a block crack without stripping the engine for investigation.

ANY QUESTIONS...?

Well, yes, actually. For a start, how can I diagnose the problem before failure?
Unlike a head gasket failure, the only initial symptom of a block/liner problem will be a need to top up the coolant maybe once a month, then weekly and eventually daily.

If the block is cracked, why can't I see water in the engine oil?
Coolant and oil both pass through the head gasket so, if the head gasket fails, there is the possibility of coolant seeping into the oilway and vice versa. But the coolant space lower down in the block is well away from any oil galleries, so leaking coolant will not reach the oil system.

This section through a V8's cylinders shows the thickness of material between the coolant space and the cylinder wall against which the liner fits

My garage has checked for exhaust gas in the coolant, but it's all clear.
This is a common method of checking for head gasket or cylinder block failure. Vapour is drawn out of the coolant expansion tank and passed through a chemical that changes colour to indicate the presence of any combustion gases. However, this particular test is not reliable for detecting cracking in a Rover engine block because, although the coolant can leak into the cylinder, the cylinder combustion gases will not easily pass back into the coolant system – we'll look at this later.

I've sealed all the waterways and I've pressure-tested the block, but there's still no sign of leakage.
Unless the crack has been allowed to develop for a protracted period, it will only open when the block expands as the engine warms up. An engine that has been stripped for pressure test will be cold, and the crack will be closed up tight and unlikely to show any leakage. The only reliable way to detect cracking is by first heating the block up to its normal working metal temperature and then performing the pressure test.

Okay, the hot pressure test now shows a leak – but why is it showing from the top of the liner?
The crack is initially very small, so only a minute amount of coolant can begin to travel, and then only when the engine is at high temperature. The coolant leaks through the crack in the water jacket to reach the back of the liner. It can't flow down because the liners are well-sealed at the bottom, so upwards is the only way out. After reaching the top of the liner it encounters the small rim of the head gasket around the top of the liner. As you can imagine, from start to first indication can take quite a long time.

Could I have detected coolant in the cylinders by looking in the spark plug holes or in the exhaust?
Not necessarily. We've established that the engine needs to be hot before coolant can leak out. But when the engine is running, compression in the cylinder will hold the coolant back.

When the engine is switched off, the coolant system will remain pressurised, but the cylinder will lose pressure through the partly open exhaust and/or inlet valves. Coolant can then leak into the cylinder under its own pressure to be vaporised by the residual heat in the cylinder. It then drifts through the valve ports, leaving no visible sign.

In extreme cases, where the crack has been allowed to develop, there would have been more obvious symptoms. The coolant level may have needed daily top-ups and a rough engine idle on cold start-up would

V8'S CYLINDER LINER PROBLEMS

The increase in metal temperature that leads to cylinder block cracking can also cause the cylinder liners to become loose.

The piston drag on a loose liner causes it to move up and down with the piston stroke, producing a tapping noise heard in the engine bay.

The noise is very similar to that made by a defective tappet, but there's a simple way to tell the difference: a tappet will be noisy when the engine is cold after start-up and will quieten down as the engine warms through.

The defective liner will be held tight and remain silent when the engine is cold but, as the block heats up, the liner will loosen and then be heard moving up and down. It will continue to produce noise until the engine is stopped and allowed to cool again.

Unfortunately, it's just not practical to replace a slack liner. If one liner has been loosened by overheating, it's a near certainty that the remaining liners will have been similarly affected and could break loose at any time.

It's not remotely cost-effective to replace and machine eight cylinder liners – the only realistic option is a replacement engine.

This engine was tilted while being pre-heated for a pressure test. Expansion of block made this loose cylinder liner slide part-way out

The centre piston here has been 'steam cleaned' by coolant escaping at the top of the liner and vaporising in the engine heat

A loose liner can be hard to detect. The top edge should be flush with the block surface – this one has dropped marginally lower

P38 COOLANT LOSS

Out off all the later long-stroke V8 motors, the 4.0-litre unit (above) appears less prone to cracking than the higher-torque 4.6-litre engine

indicate coolant left over in one or more cylinders – as would excessive water vapour from the exhaust tailpipes on start-up.

The starter motor may be unable to turn the engine because of coolant lying in a cylinder: unlike air/fuel mixture, coolant water is not compressible, so the starter cannot turn the engine over against this resistance. This level of leakage is also likely to cause continual overheating when driving.

Why do Range Rovers have such a weak fuel map at low engine speeds?

Fuel economy is important and is usually compromised with engine power and emissions. We reckon that the fuel map, while maximising economy at typical cruising speeds, can be a problem during hill climbing and load pulling – which Range Rovers do often. This seems prevalent in P38s, which are heavier than earlier Classics.

The problem does not arise in other Rover V8 installations, such as Morgan, MG, TVR and Marcos. This further suggests that weak mix, combined with high engine load and vehicle weight, is the cause of the cracking.

Why does the 4.6-litre suffer more than the 4.0 version?

These engines both use the same block casting. The key lies in the torque outputs: the longer-stroke 4.6 produces more torque than the 4.0-litre unit.

When towing a heavy trailer on a long climb, the less-potent 4.0-litre Range Rover would kick down a gear, putting the engine revs into the higher, safer range. But in a similar situation, the meatier 4.6 would tend to stay in a higher gear, therefore maintaining lower engine revs in the critical area of the fuel map and, subsequently, higher metal temperatures.

Do only high-mileage vehicles suffer?

No. We have come across this problem on engines that have covered anything from 38,000 to 120,000 miles, in various countries and climates around the world.

What's the cure?

Cracks elsewhere in the block may be repairable by welding, depending on their depth and complexity. But in this situation access is difficult and the bore in the block would need to be accurately re-machined before fitting the liner.

It's also likely that other cylinders will have latent defects from overheating, ready to show at any time. Ultimately, the cost of a brand-new engine is far cheaper.

How can I stop it happening again?

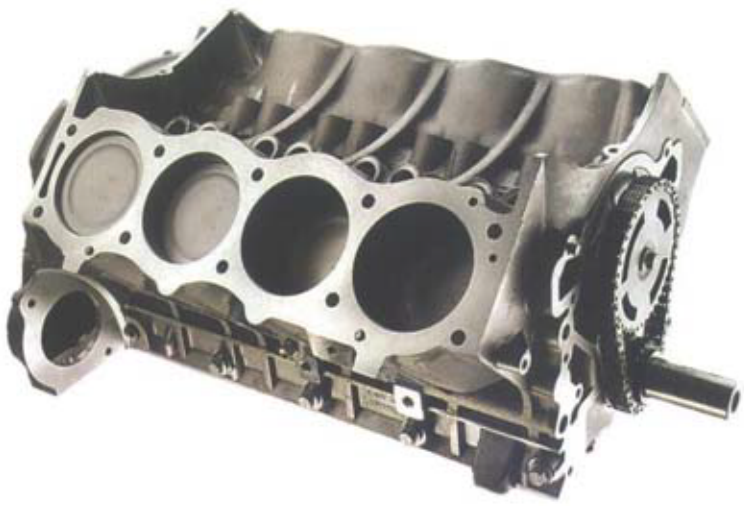
The problem can be prevented completely by re-chipping the electronic control unit (ECU) to modify the fuel mapping, giving all-round improvements in performance.

However, do be aware that this may not necessarily help an engine that already has a crack waiting to show.

DEFENDER AND DISCOVERY

The large-capacity V8s are also fitted to later Discovery models and the 50th Anniversary Defender 90 (Defenders are now available only with the Td5 diesel engine). But these vehicles appear to be far less affected by cracks and/or liner slippage than the P38.

On the comparatively rare occasions when coolant loss symptoms occur, the procedures of diagnosis and testing we've discussed here in relation to the Range Rover still apply.



Coolant leakage problems from cracks in the cylinder block are associated mainly with the large-capacity derivatives of the Rover V8