Land Rover

Rover 3.5 litre

V8 Engine Head Rebuild

May 2012

Index

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Rimmer Bros for all Rover V8 spares (http:// www.rimmerbros.co.uk)

Objective

To confirm and then resolve a problem causing the engine to burn excessive oil especially when first started resulting in a substantial plume of unpleasant blue smoke.

Introduction

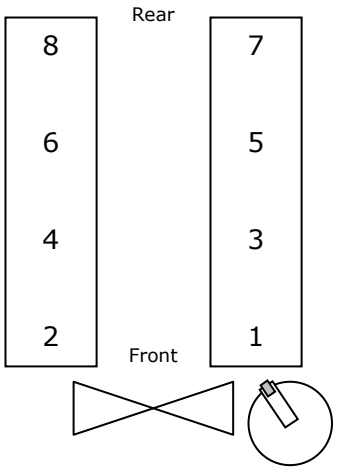
The Land Rover is fitted with a Rover V8 petrol engine originally running twin carburettors but now running fuel injection and which was originally taken from a Range Rover Classic dating from around 1974. It was rebuilt as part of the overall restoration of the vehicle by the previous owner, but no major parts were changed at that time. The engine number is prefixed with 34 and ends (after the serial number) with the letter "F". It turns out that it is an 8.13:1 compression ratio engine fitted with hardened valve seats, but not originally fitted with hardened valves.

This smoke problem has been going on since I bought the vehicle, but it is definitely worse now than it used to be. The general running characteristics of the engine are good. It feels like a strong engine and pulls well under load. However, it has relatively high oil consumption and also the exhaust smells quite oily. It has a strong pre-emission smell – almost like it has no PCV running. Throttling down when running doesn't produce a plume of smoke, but starting the engine after it has been sitting, even for as short as 10 or 15 minutes after a run, always results in a large plume of blue smoke. Additional observations occurring over the last year or so include a single oil fouled plug (cylinder 7) and varied compressions across all eight cylinders (no major difference, but some were a little lower than others).

All of these symptoms point to a valve problem – either with the seats, stems, guides, oil seals or all four. I'm guessing that the cylinders, pistons and rings will be relatively ok – but the only way to be sure is to pull the heads and inspect.

Work commenced: 5th May 2012 on what was a fairly nasty rainy bank holiday.

Engine plug and distributor orientation



Distributor – removed when the electrode was pointing to the rear at about 11 o'clock.

Alternator wiring

The wiring is straightforward. Looking at the rear of the unit the insulated plastic section contains a spade connector and a nut/bolt connector. Connect the heavy battery cable to the nut/bolt. Connect the loom brown/yellow cable to the spade. They are the only two connections required.

Fan belts

Alternator (and water pump) belt is the longer of the two, and marked AVX 10x1235 manufactured by Optibelt. Note that it uses the front pulley on the crankshaft.

The power steering belt is the shorter of the two, and uses the rear most pulleys of the crank and PAS pump. (As far as I can see this actually has a land rover part number stamped on its outer edge – although the print is very difficult to read I think it says ERC 0675).

Start – 5th May 2012

The work began by jacking up the car, and removing both road wheels, and then resting back on stands located under the front axle. With the tyres out of the way, extra clearance is gained for removing the exhaust down pipes. Keep in mind that the heads are fitted with log manifolds, so once the downpipes are disconnected, either the heads and manifolds can be separated, or the two can be removed from the vehicle in one lump – not 100% sure yet of the best way to tackle that.

With the vehicle secured on stands…

1. The cooling system was drained to the bottom of the radiator.
2. The round silver air intake, MAF sensor and air filter were removed.
3. The spark plug cables, and distributor was removed (the electrode was pointing towards the rear of the vehicle (at about 11 o'clock). Note that the securing plate and bolt are fixed back on the engine, and a plastic bag has been used to plug the distributor shaft hole.
4. The alternator was then loosened, and both the thick and thin spade cable was removed.
5. The mounting plate (which is an odd shaped triangular solid structure) for the alternator was then removed.
6. When left in the garage, the mounting plate and alternator were loosely reassembled to help the reassembly process.

7. The power steering pump was then loosened with the intention of removing the fan belt and hanging gently to one side. However a problem was immediately spotted. The pump is encased in a steel bracket which has three mounting bolts used to fix the pump to the head and block of the engine. The upper most front mount is a threaded shaft which appears to have been braised into the pump bracket. This shaft passes through a second mounting bracket fixed to the engine, and a nut is fitted to secure. Unfortunately the braised shaft sheered while the pump was being removed. This would have failed at some time in the near future anyway, so arguably this is the perfect time to find and fix it. In order to completely remove the pump and bracket I had to unscrew the pressure power steering hose and after removing the two jubilee clips, cut open the input feed hose to the underside, which means that that short section of hose will need to be replaced. The fluid was then allowed to drain into an oil pan (with thankfully very little spillage). On the bench, the front pulley was removed, along with the mounting bracket (which was secured via three 10mm small bolts). The braising was drilled out to 8mm. A galvanised steel bolt was machined to remove most of its head, and was then MIG welded to fix it into position. You can see the thread and nut in the picture below.

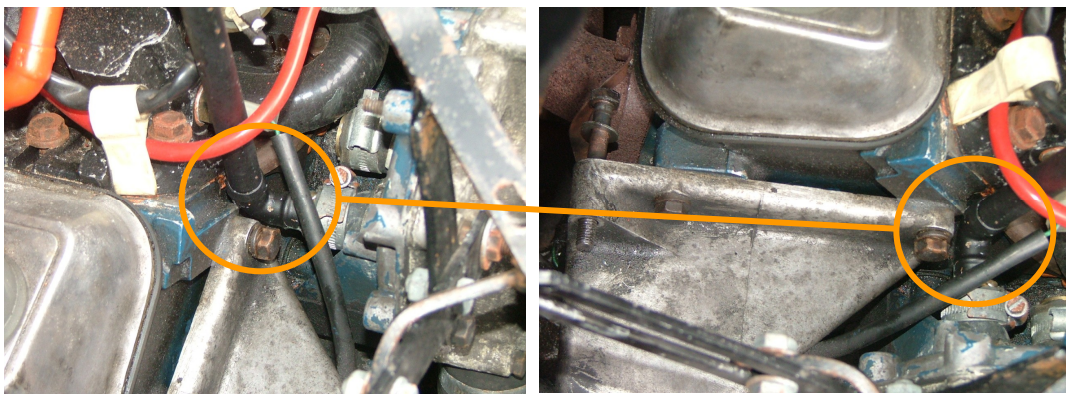
It works well even if the unit itself desperately needs a clean, and some fresh paint (something we can do when the heads are being machined). It was then loosely reassembled with all bolts in the right place, and bagged awaiting a cleanup.

At that point work stopped as the rain was getting very heavy indeed. The next step will be removing (a) the throttle cable, (b) the solid cooling pipe to the internal heater matrix (c) the plenum, and the ram pipes (trumpets) underneath. After that the intake can be tackled, allowing for the removal of the fuel feeds and the electrical connections.

During the strip down the following important reminders are worthy of note. The fan belts are shown in the following picture

Note how the short belt (going to the right – passenger side) connects the crank to the power steering pulley using the back pulley on both. The long belt going to the left (drivers side) connects the crank to the water pump, and then to the alternator.

A problem engine connection we've faced in the past is the pipe linking the return feed of the heater matrix to the water pump – and which has a clearance issue (one we may be able to assist if not resolve when the heads are off) demonstrated nicely in the following pair of close ups.



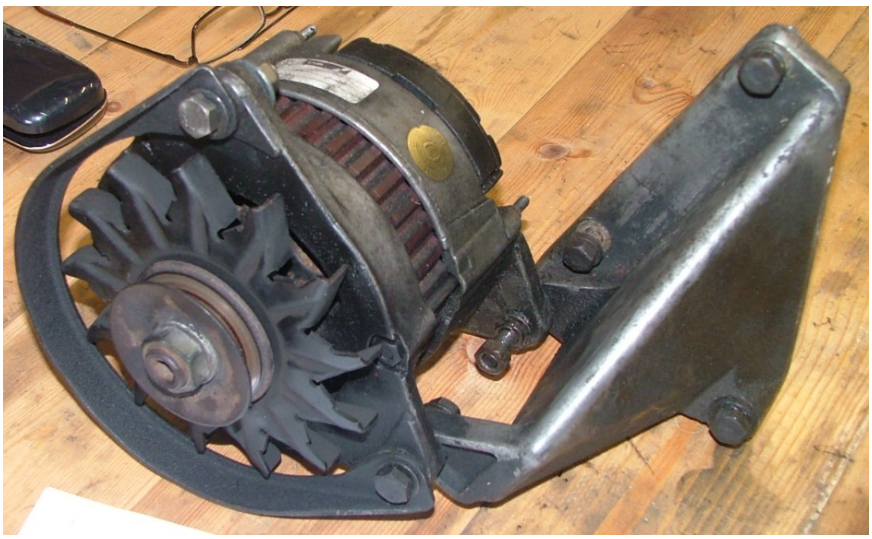
I've never liked this connection – even though the path that the coolant takes is both correct and works. It's the lack of technical elegance I object to – and so this strip down is the perfect opportunity to revisit this aspect of the fuel injection engine coolant design.

7th May 2012

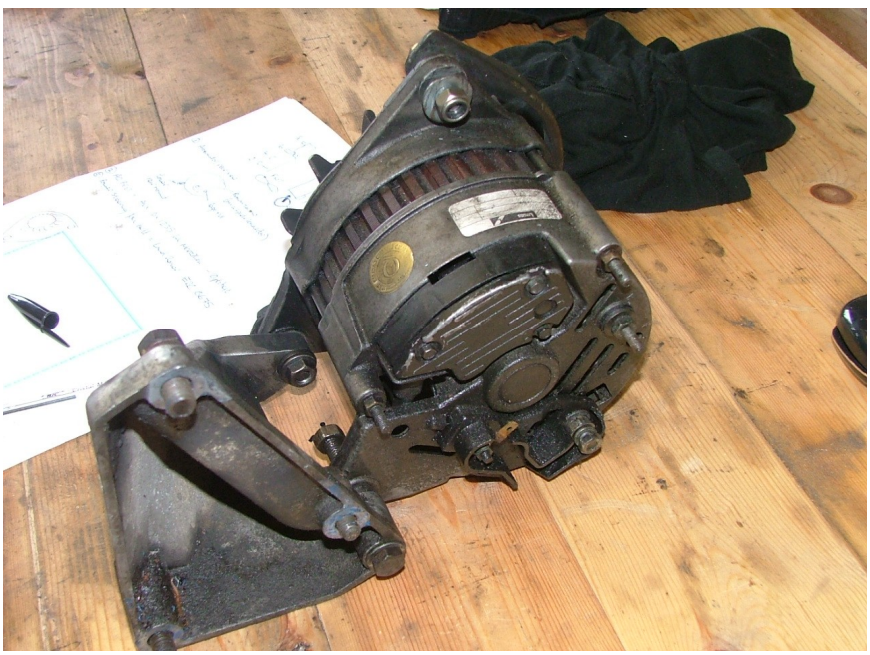
The weather continues to be awful. Yesterday was a complete wash out (and in the evening my wife and I went to see Prometheus – which wasn't nearly as good as I'd hoped but arguably wasn't a bad way to blow a couple of hours).

The weather today is no better, with storms forecast (quite high wind) and heavy rain all day. Unfortunately the forecast is talking of this kind of weather right through the weekend – which is a pain.

Anyway – I degreased the alternator and mount and the power steering pump (and bracket). I took a couple of pictures to see the orientation before I stripped them and cleaned them. The alternator complete with mounting bracket (and the front curved protector) is shown below

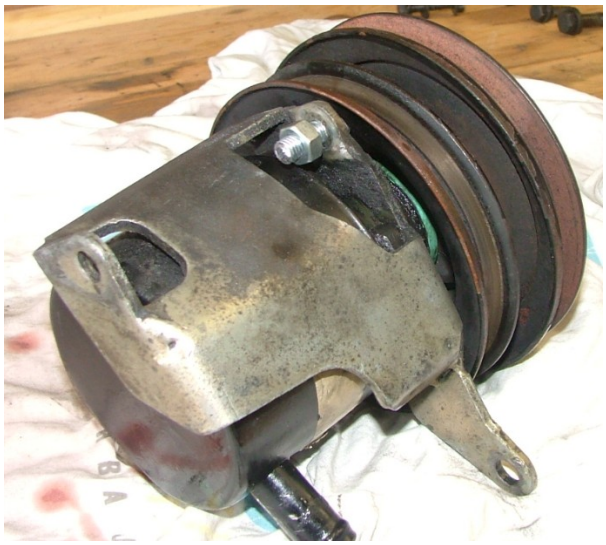


The rear view is shown next:-



The power steering pump is a little more involved as the bracket is separate from the pump – although it's worth saying that there are multiple ways this bracket can be fixed to the pump with the three 10mm bolts.

Also note that between the pulley and the pump flange that the pulley is bolted to, there is a spacer washer/plate (which is roughly 2" in diameter). The following three views will help show the orientation of the complete assembly (you can't see the spacer washer in these pics:-



The side view below shows the power steering pump sitting on its end.

Regarding the painting – I've decided to use a blue as my engine colour of choice. It looks much more in keeping with the age of the vehicle compared to satin black– but I'll see how the alternator and PAS come out with a coat or two.

8th May 2012

The weather continues to be awful – so last night and today, I degreased and cleaned the alternator, power steering pump and distributor (and all the brackets I'd removed from the engine). The end result does look good in blue as you can see from this (not very good) pic.

9th May 2012 – Saturday

A rare thing - a day without rain, and boy did I make the most of it. Started the day by gardening and then started on the engine in earnest while keeping an eye on the clouds. The long and short was that the day remained excellent, and I got the engine stripped completely and the heads are now in the garage. The following comments can be made

1. The exhaust down pipe on the passenger side was a mare. All three bolts were seized solid. They did come out, but they took damn near two hours to get out. On the driver's side, one of the bolts was threaded into a helicoil repair in the exhaust manifold – and that repair unscrewed as I was removing the bolt. So the exhaust log manifold bolts on both sides will probably all need some level of rework.

2. Although not draining the block of all coolant might have seemed like a good idea at the time of the initial strip down – it wasn't. This is something I should have remembered from my days working on American V8's – because by the time you split either head from the engine block, coolant in the upper part of the engine floods everywhere (and off course can and probably has ended up in the sump). So after cracking one head free (which was mercifully very easy) I removed a drain plug on the drivers side of the block (that plug is STILL removed and is noted in the checklist).

3. The exhaust log manifold bolts were all relatively loose (even though they were nearly all locked with the locking tags). Keep that in mind because I think it might be worth retightening them **after** a week or so running the vehicle before setting the locking tags.

Other than these points, the job went fairly easily. After removing the exhaust downpipes, I straightened the bolt locking tags on the log manifold bolts, and then undid all 8 bolts on each side. The manifolds can easily be removed from the engine (so long as the passenger side manifold is slid forward to clear the front of the engine before lifting out of the engine bay. I then removed the fixing bolts for both rocker assemblies (slowly and evenly removing all mounting bolts). I then removed each of the 16 rocker rods and placed them in their respective order using holes in a marked cardboard box. After that I removed the valley gasket (with its two metal plates at the front and back end).

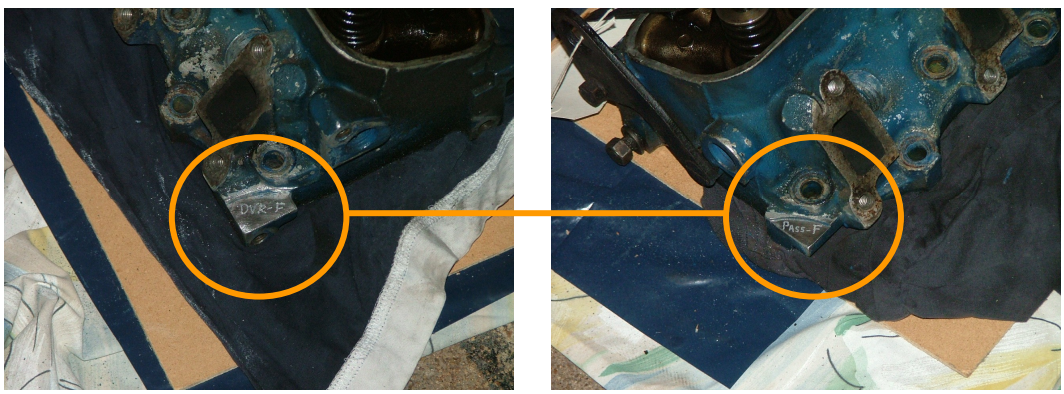
The last job was to slowly remove all 14 head bolts – using the same tightening sequence. Torque was high (think in terms of a very modest 80 ft/lbs – whereas for example Pontiac 400 cubic inch cast iron heads typically used 130-140 ft/lbs) but very manageable – and believe it or not, access to the bolts is good. It won't be hard to get the head bolts fully torqued up when refitting on both sides.

Note that the bolts form three rows, a row of five in the head and which are immersed in oil. A second row of five bolts sit below the spark plugs (outside of the oil) and a third row of four sit below those. The second row had some physically tight threads. My guess is that some dampness may have got into those threads, so pay attention when preparing the block.

A nice find was to uncover a steel head gasket which meant the surface of the block was more or less pristine. That massively cuts the work required to later refit compared to the slow arduous process of having to clear the remains of a composite gasket. I started work around 11.30am by the time I'd finished the garden and had both heads on the garage floor and the bench tidied by about 6pm – which wasn't bad at all.

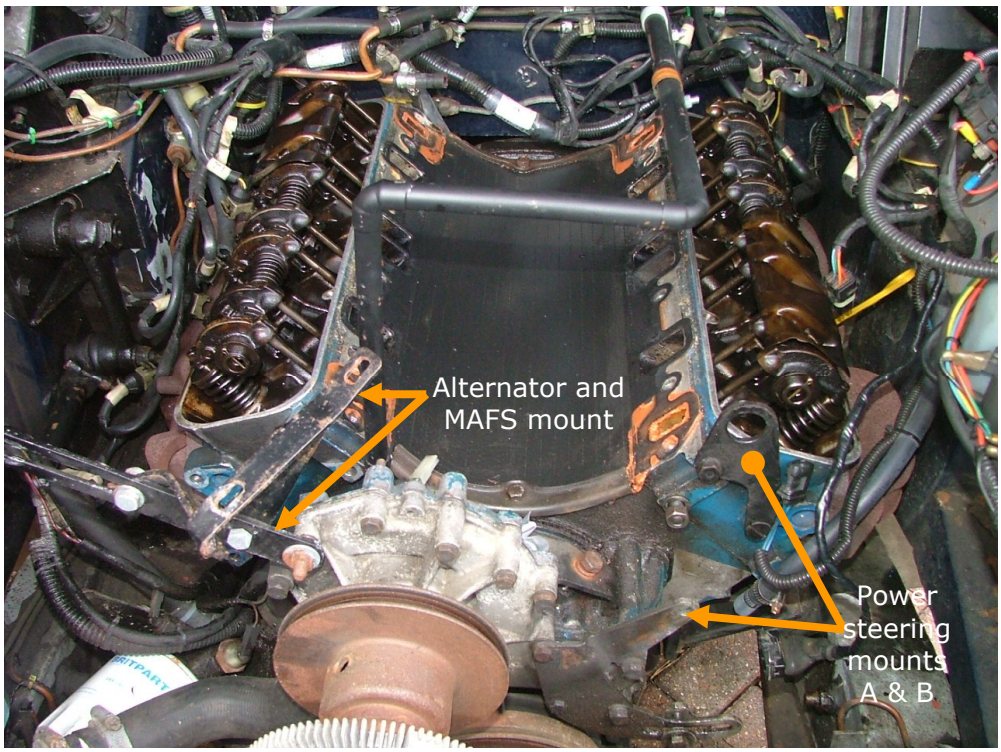
Some points to note.

1. Both heads are now engraved. The passenger side is marked PASS-F for the end at the front of the engine. Similarly, the driver side head is marked DVR-F for the end at the front of the engine. See below



2. The rockers are worthy of note because the splash plates are not abundantly obvious. Some care is required here, because although I've marked the splash plates (using PASS-FNT and DVR-FNT – both with arrows), the two plates could be separated from the rocker shafts.

   This picture shows the head configuration as when fitted to the block…



Note in this picture the layout of three brackets mounted onto the front of the engine.

There are two on the passenger side which are used to secure the power steering pump. Bracket A is mounted onto the head and bracket B is mounted on the front of the water pump. It is worth nothing that bracket A has a quite similar bracket mounted onto the rear of the driver side head. These two brackets have eyes and so may well be intended as hoist holes. On the drivers side of the engine lies the flat plate used to (a) secure the alternator, and (b) the mass air flow sensor.

Splash shield marked DVR-FNT ↓
The arrow points to the front of the engine

Splash shield marked PASS-FNT ↓
The arrow points to the front of the engine

12th June 2012

Easy day today spent doing the following

1. Degreased the intake ram pipes (trumpets), plenum and both rocker covers (inside and out)

2. After leaving all four to dry for 12 hours, I then painted them all with a special metal primer.

13th June 2012

I booked today off to take the heads over to Serdi – which was a real treat.

Reg (John's father) is still there and working and John Dormer is as I expected there as Director. His face does indeed look familiar even after all these years and even though dad and I only met him maybe four or five times perhaps 15 or 20 years ago while we were preparing the Pontiac big block full engine refurbishment and the earlier Chrysler small block head refurbishment (stage 1 and to run Nitrous). They did beautiful work for both of those engines and I remember dad really warmed to Reg. God I do miss dad as I work on these cars.

Anyway - it was oddly moving to go there and it really pleased me to see them doing (obviously) so well.

But, as I'd expect they are very busy. I've never seen so many large bore 8 and 12 cylinder engines in one place – Ferraris and Maseratis being the order of the day with a remarkable Peugeot 4 cylinder 1930's style monobloc engine awaiting work as well. It was fun to have my humble Rover V8 heads in amongst all this pedigree hardware, but as I say, due to the workload they were noticeably relieved when I mentioned I was in no hurry (given everything I have to do – and the fact I'm working in the evening only) and so we agreed a full month to turn the heads round – think in terms of getting them on or near 14th July 2012.

John's engineer Mathew will do most of the work – and in fact both gave each other a knowing look when I explained the problem. One of the bug bears they often have to deal with when it comes to Rover V8's is where machine shops in the past remove old guides by knocking them out of the head literally – which causes the guide passage in the soft aluminium to score and later leak oil. The proper (ie: Serdi) way to remove them is to first drill out about 80% of the guide, and then knock out the thin remaining shell. This is one potential explanation for the problem – but it's also early days yet and we won't know the cause of the problem until the heads are completely stripped down and assessed.

While they were looking at the valve faces they also pointed out that some of the exhaust valves in particular were quite recessed in their seats – which may well have been the problem the previous owner referred to in his emails. We noted that there were no seals on the valves – but that may be legit as some guides and valves are designed not to use seals. Anyway – the boys have the two heads now, and basically if they can't bring them up to a full working spec, no one can.

Before I took the heads to Serdi, I removed the bracket from the front of the passenger side head, and the similar (but not the same) bracket on the rear of the driver side head.

The rest of today was spent doing the following jobs.

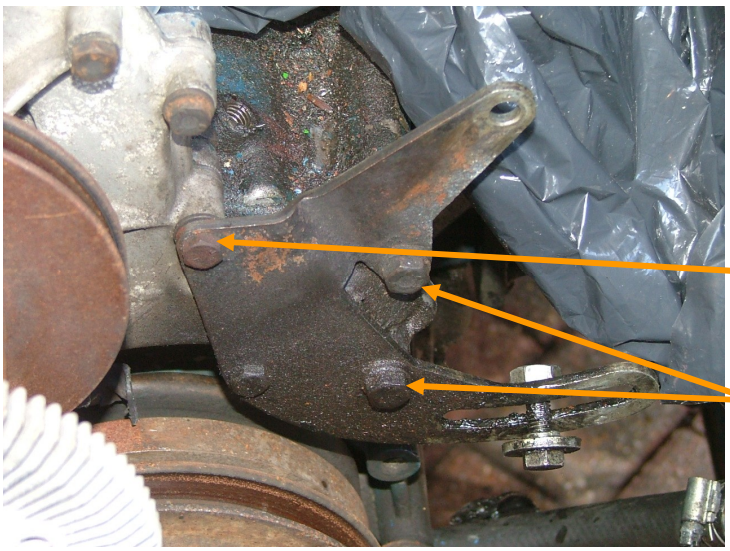
1. I painted the plenum, intake ram runners (trumpets) and both rockers blue. I think they will need two coats, because some of the primer red is still coming through. Even with 1 coat, they look good.

2. I also removed the water pump from the engine. I had two reasons for doing this. The first was that one of the power steering brackets needed to be removed (for cleaning and painting) but is mounted via four of the water pump bolts. As soon as you loosen those bolts, the water pump gasket (potentially) breaks. The second reason is that removing the pump with the heads off and everything cleared is relatively easy and given the part is subject to wear and tear, it is definitely worth replacing now.

While I was removing the water pump, I had to remove the (now unused) viscous coupling on the front of the water pump pulley – which actually required a puller when the pump was on the bench to remove. It is worth noting a rather nasty little dependency here.

Two of the bolts fixing the pump to the block can't be removed unless the water pump pulley is removed. The problem here is that you don't have enough room between the viscous coupling and the radiator to use a puller – and so eliminating that problem makes good sense. So, I am going to go back to the original spacer design for the water pump pulley.

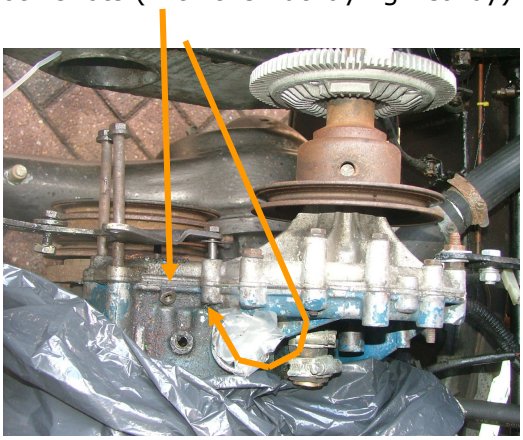
The pump was in ok condition, but is grubby and a little corroded, so it's no bad thing to replace it. Some pictures here show the bolt patterns (the bolts are all in a card holding the placements)



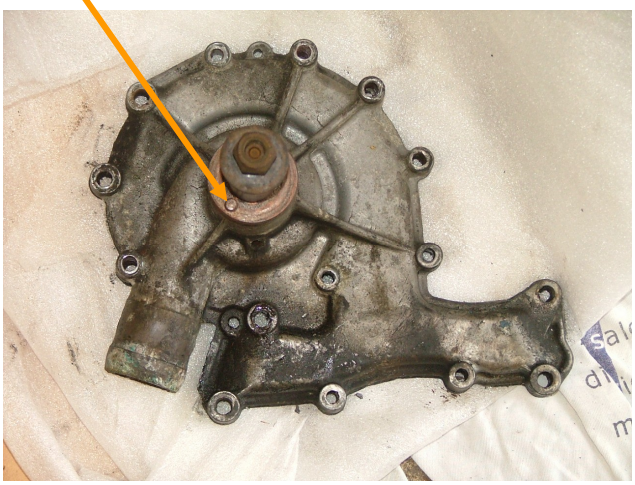
This pic shows the power steering bracket on the passenger side of the water pump. All four bolts fixing the bracket are water pump bolts. Note that this bolt into a nut at the back of the water pump.

These two bolts are long.

The two pic's below show the water pump bolt pattern from the top. Note the bolt and nut referred to above can be seen in both shots (with the nut laying nearby)



And finally with the pulley removed, the specifics of the water pump shaft can be seen (including the small key used to lock the pulley).



With the water pump out of the engine, the remaining power steering bracket along with the alternator/MAFS bracket and the distributor clamp were free for work. So I degreased and cleaned them all. I'll paint those brackets when I give the plenum, trumpets and rockers a second coat.

We're starting to narrow down on some core issues now – which could be listed as follows:

1. Improve the plumbing design for the heater matrix flow and return – cos I've never liked the way that looked or worked.

2. Clean the piston heads, and the deck surface

3. Clean the water pump receiving surface – and if possible tidy the paint in that area (that may be harder than you think because although I've degreased the area, its still grubby and greasy)

4. Clean and paint the intake manifold

5. Tidy some of the loom wiring now that the heads give you more clearance to get into the back of the engine

6. Re-plum the petrol feed pipes to better supply the intake manifold.

If you think about the work load above, assuming we go at a leisurely pace a month covering the head engineering is certainly workable.

17th June 2012

Not too many updates thus far, and given everything that's going on time has been quite short. Plus the weather has been gloriously awful. Mind you – the following jobs are now done.

1. The six studs in the exhaust log manifolds have all been removed, re heli-coiled (where necessary) and refitted with fresh M8 stud bolts and nuts.

2. The head mounting flanges have also all been cleaned.

3. The intake manifold has been completely cleaned (including all the mounting surfaces) and painted blue (which looks really good). Note that I didn't remove the injectors – suspecting that it might be better to leave those parts carefully undisturbed.

4. I've also now ordered components for the re-plumbing of the heater matrix feeds (flow and return). The following parts have now been ordered.

    a. 90 degree elbows in 19mm silicon x 3
    b. 20 Jubilee clips with range 25-35mm
    c. 2 x 1meter length of aluminium 19mm OD pipe
    d. 19mm to 16mm elbow reducers in silicon x 2
    e. 1 x ERC2319 (s hose used on the carb engine to connect manifold to water pump)
    f. 1 x ERC2278 (s hose used on the carb engine to connect water pump to the pipe under the manifold)

Basically I'm looking at a belt and braces approach to redesigning this hose layout. We won't actually be able to finalise the layout until *after* the heads are returned and fitted to the engine given you just can't set out the position of the pipe with respect to the intake manifold until after the heads are in place.

That said – there is nothing to stop us working on the re-plumbing of the fuel lines and also the linked tidy up of the loom

That's it for now

19th June 2012

The block deck (including the piston crowns) has now been prepared for the new heads.

This involved cleaning all carbon of which there was quite a lot – layered fairly evenly on all crowns. I used a slow hand power tool fitted with a brass cleaning wire brush tool and was very gentle on the block deck but did give it a thorough clean down especially round the water jacket sections. The brush does scratch

(not surprising given the block is aluminium) but not too badly and it will be ok once the gasket is sealed and fully torqued (especially as the head will be skimmed flat).

I used the usual Pontiac procedure which worked for both cast and forged pistons – so that after immediately after cleaning the deck and the piston crowns I smeared an inch or so of thick grease onto each of the cylinder walls at the top of the bores and then gently spun the engine over by hand using a half inch ratchet on the crank pulley. By the time the pistons have gone up and down two or three times most of the carbon lodged at the top of the rings has stuck in the grease and can be cleaned at the top of the bores.

The bores themselves are in excellent condition, with clearly visible honing and no discernable lip at the top.

Regarding the bolts – I've measured these as follows:-

Head Bolts

The heads use three different lengths, but all threads are 7/16th UNC (with 14 threads per inch). For my engine the Haynes manual doesn't state that the head bolts need to be changed (later 10 bolt engines do). I've ordered three taps at 7/16th UNC (14) to deal with thread clearing.

Intake Manifold Bolts

The intake manifold uses 3/8th UNC (with 16 threads per inch). Again – I've ordered 2 taps and because the bolts are a little corroded, I've order a full set of stainless replacements.

Water pump bolts

The water pump is a bit more interesting. Most of the bolts are 5/16th (with 18 threads per inch) but not all are. My guess is that the previous owner had some problems with these bolts and so either retapped or wrongly threaded those bolts – and interestingly as I was removing all of them, I had a definite bad feeling that I was going to have fun and games getting them back in.

I've ordered a set of three 5/16th 18 TPI taps which I can use to clear most of the bolts (be careful which ones) and will play the others by ear.

Regarding the water pump – the replacement pump arrived yesterday. I've now cleaned and painted the top surface of the pump housing on the block itself, and at the same time painted the new replacement pump. The old pump looks very sad by comparison, and the bearing does feel much looser so I think this was probably a wise move even if I end up with a struggle from the bolts.

I'm very pleased that I've got the block deck cleaned and prepared.

I've also reoiled the cam and lifters, and cleaned the valley area.

Also – the block is now sitting at TDC, with cylinder 1 ready to fire.

20th June 2012

Today – I looked at the loom and pipe work on the firewall – with an emphasis on the fuel lines.

The key problem with the fuel lines is the fact that both the solid pipes kick out at an angle of about 45 degrees towards the front of the car – which mean you are forced to use all sorts of horrible bends to get them aligned correctly for the injection input and output.

I simply cut the pipes flat so that the kick out was basically removed. I then fitted new hose and will either form a U bend in the hose or use some kind of copper U bend perhaps with the two sets of pipes in a fixed manifold. BTW I ordered a set of 8mm 90 degree bends just in case I want to go that route.

One thing I did find interesting is that the existing short straight section of hose pipe on the flow and return sides of the fuel lines were both lightly but noticeably cracked – as you can clearly see in this picture.

These are not old hoses and they are also DIN rated fuel injection hoses – so it was a little surprising. They have all now been renewed (and because of the new manifold, they will all be straight)

I also completely untied all the injection loom wiring, and the plumbing of the two 5/16th hoses supplying the under plenum heater panel. The two hoses were replaced with new hose, and retied. Similarly – the loom was refitted in more or less the same place, with new ties (which incidentally left the road speed sensor nicely pinned between the loom and a firewall bolt (and held there using two ties). It will need to be fine tuned when the heads and intake goes back – but the basic structure is pretty usable as it stands.

The painting on the front section for the water pump looks good.

What's next…

1. Check the lifters
2. Check the rockers
3. Check the state of the rods

After that we're looking at cleaning all the threads (ie: block threads for the head bolts, head threads for the intake manifold and the water pump threads) and then cleaning carefully all the bolts.

I'm considering closing one of the two rear pipes on the water pump (which is effectively a nuisance and unused opening). The only thing is I'm not sure (and won't be until I refit the intake) which one of the two should be closed. It might be worth leaving the water pump off until AFTER we get the intake plumbing finalised

I also discovered a problem today. When I was removing the intake manifold from the engine at one point it wouldn't budge. I used the handle of a hammer fitted into the thermostat housing to try to loosen it but unfortunately in my eagerness levered just a little too forcefully. The area of the housing that I'd previously ground back to accommodate the distributor cracked under the pressure – which meant the original housing is now useless. The problem with this housing is that the pipe part is kicked outwards towards the front of the car in order to avoid fouling the fuel rail. The housing from the carb engine actually looks superficially similar on first inspection but when mated to the intake manifold fouls the fuel rail.

I identified one replacement on eBay based on the casting number HRC1554, but unfortunately the seller was either dreadfully incompetent, or was a very bad liar – and ended up shipping the wrong part, and late which has since gone back for credit. Another part was selling on eBay for £20 (and included a gasket) but after I'd confirmed the purchase the company got in touch and said that they couldn't find the gasket and so offered either a full refund, or suggested I could just take the housing for the reduced price of £10 – which off course was ideal. Better still when the housing arrived, I realised that it was slightly different from mine in that it didn't contain a threaded boss for what on my engine was an unused temperature sensor. It's not often a difference works in your favour. Anyway – it arrived clean and after just a little work (and some surface flattening of the gasket surface) and a nice coat of paint looks perfect.

We're getting there…

21st June 2012

Serdi called today. The valves and guides were original rover, and the stems and guides all had a generous 2 thou clearance – hence the burning oil. One valve in particular is recessed – and the seat (and the valve) will be changed. The other valves (mainly exhaust) are worn on the lip of the valve – and so a complete new set of chrome surface valves have been fitted.

Note regarding the seats, I am assuming the seats are suitable for UL fuel based on what the previous owner told me. I'm pretty sure these heads all came with hardened seats anyway (as they were shipped to the US) but just in case, I've actually asked the previous owner about the discrepancy in the compression ratio marked on the block, and the ratio he told me about – and also about the unleaded issue

Separately I've asked Serdi to fit new springs, collets and seals.

Not much time today to work on the engine – but still got the following done.

1. Cleaned both rocker cover assembly's. They didn't need disassembling – but just a good clean, followed by a comprehensive soaking in light machine oil and then bagging. They are now in the clean area, with the oil splash plates in the right place, and the original paper labels. Note that the push rod and valve stem ends of each rocker were immaculate.

2. All 16 push rods have been cleaned, checked for straightness and both ends inspected to ensure the hardened surfaces are holding up ok (all 16 were fine)

3. I removed each lifter, and without exception all have the nice rotary wear pattern. However, it is worth saying that the front most lifter on cylinder 2 (drivers side bank) was showing a slight discolouration on its cam surface and also all the lifters to some extent are showing pitting and some scratching on the bright cam follower surface when inspected under magnification. The wear is quite light but I'm a little concerned about it – and think that I will replace the set. They cost something like about £75 (including VAT) but a smooth surface will wear the cam far less - so long as I can break them in correctly. I will pop over to real steel and get a set of standard lifters – and break in lube. Note that Real Steel also sell black high temp spray paint (ie: exhaust manifolds).

That's it for now

22nd June 2012

I got an email response from the previous owner last night. It is likely that he mixed up the compression ratio when he stated it on the selling blurb that it was 9.35:1, and that the 8.13:1 CR stamped on the block is in fact correct. He mentioned that he had another SD1 engine around when he was building the Landy, and that that particular engine was 9.35:1 CR. He also confirmed that he didn't swap heads between the two engines. So – my guess is we're definitely running a low compression 8.13:1 CR engine. That is also backed up by the amount of head/piston dome volume which reminds me a little of the old low compression Chrysler small block.

I'll await to see the head volume calculated by Serdi

Also regarding the valve seats the previous owner is 99% sure that the heads are running hardened valve seats – and in fact I called Serdi this morning regarding this issue, and the engineer told me that after cutting out the recessed seat, he can confirm that the heads are definitely fitted with hardened seats.

So it is low compression, and suited to unleaded fuel.

For a work horse like the landy, built for slow revving low end torque and which is capable of running the worst quality fuel it sounds basically ideal.

24th June 2012 - Sunday

Not too much to report today – as the weather was (again bad) and I had to install a cat flap (☺) so was otherwise occupied.

I got the following engine jobs done.

1. Head bolts all cleaned
2. Intake bolts all cleaned
3. Water pump bolts all cleaned
4. Spark plugs all cleaned
5. Exhaust manifolds (log to head) bolts all cleaned.
6. Original 82 degree thermostat refitted with new gasket into the thermostat housing fitted to the intake manifold. I sealed it with hylomar blue and both bolts tightened to 15 ft/Lbs torque. This was tightened to 20 ft/lbs the following day – because the Haynes manual is wrong on the torque (remember the intake hasn't been heated so the Hylomar will still be soft).

I also quickly realised that the taps I'd got (14 TPI 7/16th UNC) to clean the head bolts threads in the block were actually drill taps and were way too aggressive for the head. I didn't use them. I've ordered four new head bolts, and a complete set of intake bolts. I'll use the four head bolts as sacrifice bolts to do the cleaning of the block, and replace all the intake bolts.

Two other jobs I took care of was first to remove the fluid out of all 14 head bolts, on each side of the block. Although it takes time using paper towel the oil and water is now removed from all 28 holes. Second I cleaned and painted the lifting eye brackets from both heads (fitted to the rear of the drivers side head, and the front of the passenger side head), and also the two metal valley gasket clamps (front and rear). Again – the blue really does look very sweet.

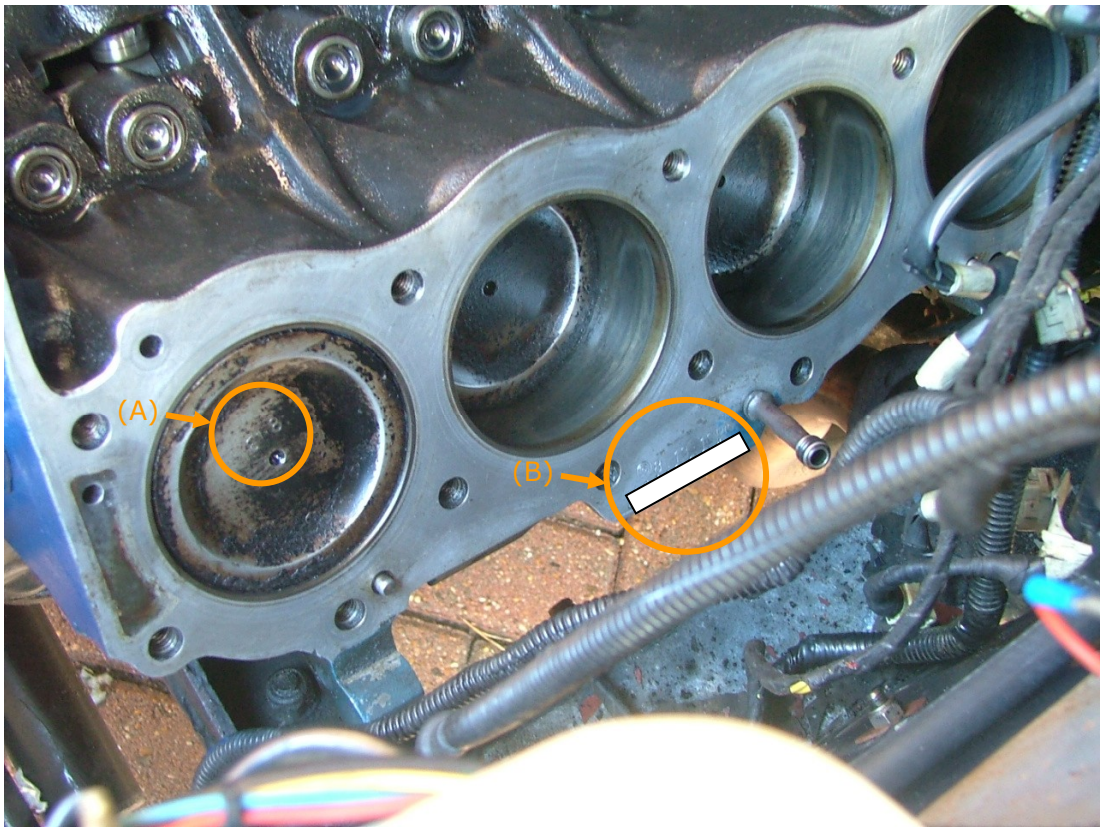
Regarding paint, we're now getting to the point where the only things remaining to paint are the two heads themselves.

Next jobs are…

1. We need to get break-in lube for the cam (BY103 from real steel).
2. We still need to clean the threads in the block deck (awaiting bolts) and in the heads (for the intake – again awaiting bolts).

Other than that – we're more or less done now until the heads arrive

One observation I made is that piston 1 is stamped 8.13:1 on the crown. So it looks like 8.13:1 is the compression ratio for sure.



Note the compression ratio markings stamped into the block (passenger side).

Mark (A) is stamped onto the crown of the piston in cylinder 1 and shows 8.13. Marking (B) shows the engine block number prefixed and just above is the stamp confirming the compression ratio for this engine "**8.13:1CR**"

Clearly this is a low compression engine, but with the way fuel might be heading (availability and cost), I could see that being an advantage in the future.

25th June 2012

Today I looked at an ancillary problem concerning the starter motor.

The Land Rover has always had an odd failure-to-engage problem with the starter – which is both noisy and obvious when it occurs as it grinds against the flywheel ring gear. The previous owner had mentioned this on the sales info – so it wasn't any kind of surprise.

With the exhaust log manifolds out, and the heads out – it's actually relatively easy to get at the starter (a lot easier than when the engine is built) so it seemed like a bit of a missed opportunity to ignore it. All the more so when you remember that the previous owner was kind enough to supply a recon replacement when the vehicle was purchased.

So I've just unbolted the old one, and swapped it with the recon unit. The wiring is relatively straightforward with the exception that the coils low current wire marked "IGN" used to be connected to the disconnected cable running up the loom positioned vertically in the centre of the firewall. That wire terminated where the old coil used to be but hasn't been used since the injection system was built – so it had been removed anyway.

One thing – as the engine is positioned at top dead centre and as the sump may be contaminated with coolant, I haven't yet tested the starter, and won't until more of the engine is built up – so I am taking a bit of a chance.

At the same time I've refitted the drain plug on the driver's side of the block (using Hylomar universal blue to seal)

26th June 2012

The small set of intake and head bolts arrived from Rimmer Bros – these completely replace the full set of intake manifold bolts (and washers) – and also replace four of the small head bolts (which means I can sacrifice up to four of the original small head bolts for thread cleaning).

I'll have a look at the issue of thread cleaning tomorrow weather permitting

Separately – I've also now drained all the sump oil, and replaced the oil filter (after filling the new one with half a cup of oil). I also took all the old used oil down to the local dump for proper disposal, and popped to the shops and purchased two 5 litre cans of the 20W/50 historic mineral oil.

I'm leaving the sump to drain over two nights and that's after pouring 2 litres of clean oil into the valley area (over the cam) to make sure that I drain out as much of the crud as I can before refitting the sump bolt and filling with fresh oil. I think it would be worth leaving the filling of the sump to when we have the heads and rocker assemblies fitted so that we can adequately lubricate them.

Remember we still need to apply cam lube on the new lifters and the cam lobes.

One other job I took care of today was to increase the torque of the two thermostat housing bolts from 15 up to 20 Ft/Lbs.

27th June 2012

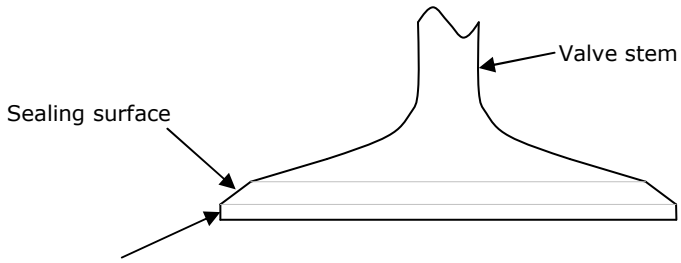
Got a phone call from Serdi today – the heads are ready. That's not bad at all given we'd agreed four weeks for delivery, and they'd actually delivered them in two. We sorted out the price and after now seeing the end result I am very pleased indeed. The following was done

1. The heads were hot tanked (all paint and deposits removed).

2. The old valve guides were all worn and original, and were consequently all tight in their interference fit bores in the head (which is good because it means they definitely hadn't been physically ripped out (ie: the wrong way) at any time in the past – a common fault and the cause of many a Rover burning oil due to scored guide bores allowing oil to drain. Mathew was forced to drill all 16 guides out of the head the proper way).

   Guide to valve stem wear was well over 2 thou on each guide. They were all replaced with the newer, later brass types and the upper section of each was prepared so that they could accommodate proper oil seals (which are now fitted).

3. The valves fitted in the engine were the original Rover parts and all were significantly worn. Surprisingly however it wasn't the stem-to-guide clearance that was the main problem – instead it was the area around the seat sealing surface…



This section should be something like 1mm deep - but on many of the exhaust valves it was simply missing. This is why a good number of the exhaust valves looked severely recessed into the heads on first inspection. Serdi and I suspected the seats at first…

The two heads are definitely fitted with hardened valve seats – and in fact Rover heads have been fitted with hardened seats ever since 1972 which makes sense given the engine was being sold in the US. However, a head using unleaded fuel needs hardened valve seats AND hardened valves – and after inspecting the values it is extremely unlikely that these heads were fitted with hardened valves (Land Rover used the cheaper valves for the UK market). The resulting valve wear accompanied with little or no seat wear supports the explanation that it was the combination of unleaded fuel and inappropriate valves that may have been responsible for the significant wear.

Regarding the wear – and just as a note, unleaded fuel and the linked valve seat wear problem is always confined to the exhaust valves, because they run at such high temperatures compared to the intake

Across all 16 seats only one needed to be replaced (with a hardened part). Also all the valves were replaced with a new set of best quality valves (chrome finish, tuftrided + wafer tip) – and which are off course hardened for unleaded fuel

4. All springs were replaced (the collets and locks are original)

5. The two heads were skimmed – one needed roughly 6 thou to be removed but the other needed 12 thou in order to flatten and correctly balance the compression ratio of both heads. Either way the compression will lift slightly from the very low 8.13:1.

6. The chamber volume of the head after the rework was measured as: 34.25cc

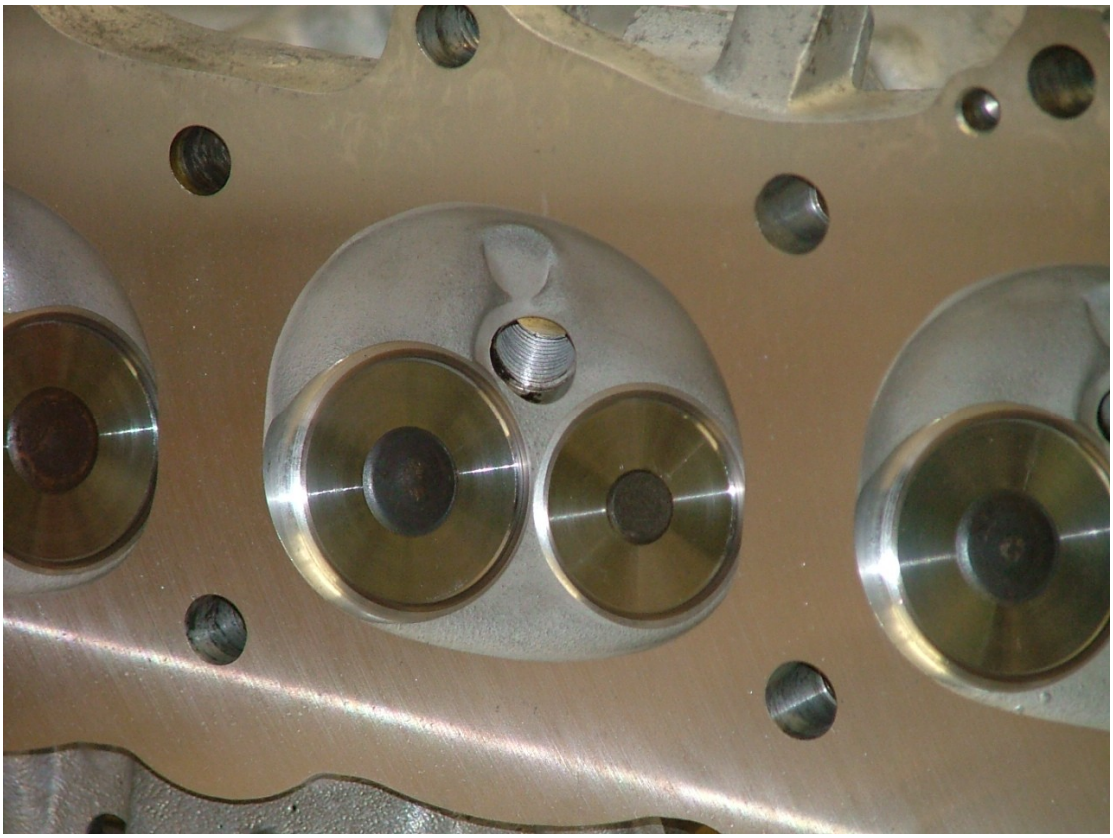
The heads are a thing of engineering beauty to behold.

These are the old heads as they came off the engine…

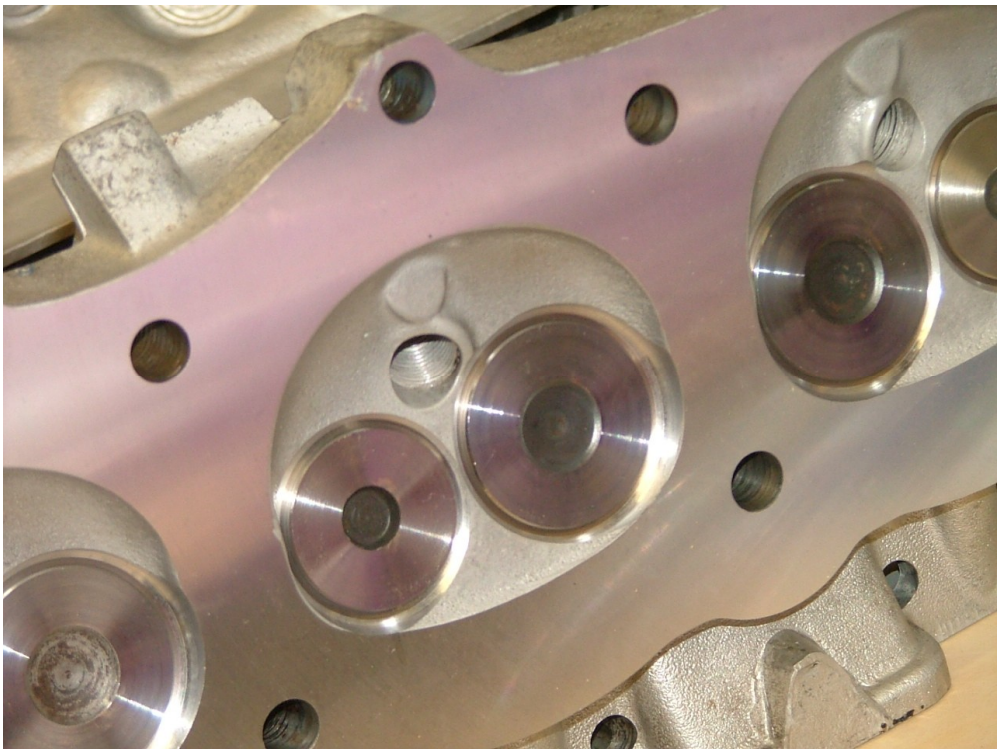
After Serdi's work here is the result (before I paint them)

The view looking at the skimmed surface

Close up of the combustion chamber – drivers side head first

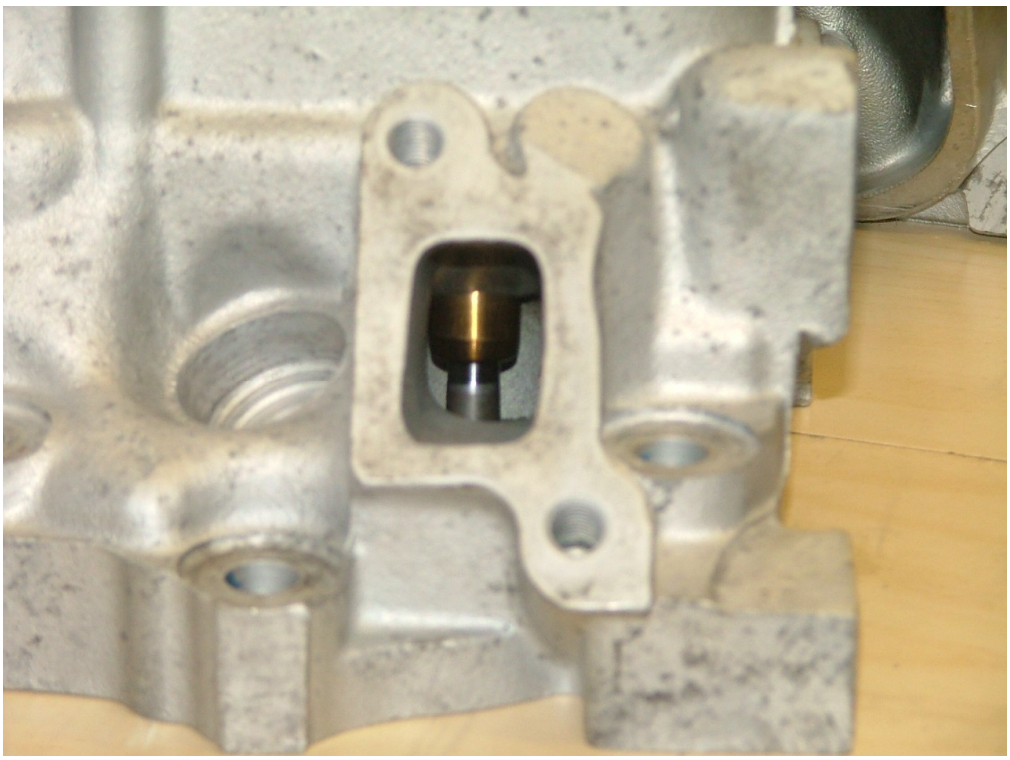


…Next the passenger side head (the colouring is a reflection of my red T shirt)

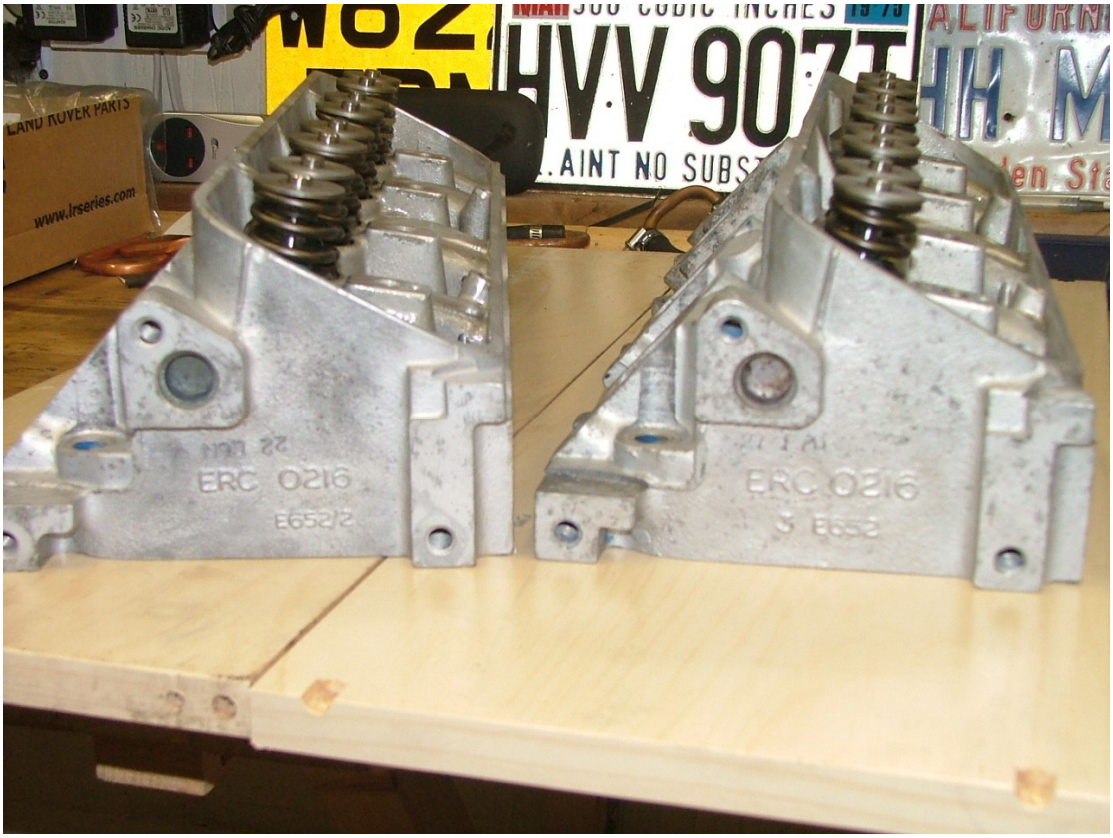


View showing the new oil seals and the tops of the valve stems. A straightedge can be placed along the tops of these valves, leaving no gap.

View of the valve through an open exhaust port.



View of the casting markings. It's worth noting that in fact both heads appear to be completely identical (and they have the same casting numbers with only minor differences in the smaller numbers nearby). If it wasn't for the fact I'd engraved them before sending them off for engineering I don't think I'd be able to tell which was which.



Additional work carried out today (other than collecting the heads)…

I picked up a container of BY102 break-in cam lube from Real Steel.

I also cleaned all the head bolt threads in the block. As planned, I sacrificed one of the short head bolts (because I'd purchased four new bolts from Rimmer Bros). I started by using a hacksaw to cut the bolt down its length – but it didn't take long to realise these are hardened bolts (they are definitely not the stretch type). Two hacksaw blades later, and with a slot less than 3 threads down, I had to stop.

I then had the bright idea of using the Dremel tool to cut four tap like channels down the lengths of the thread. In fact this turned out to be a much better way of tackling this problem. A big disadvantage to making a thread cleaning tool by taking a bolt and cutting a slot down the body with a hacksaw is that when the bolt is screwed home there is a tendency for the gap created by the hacksaw to close up. Off course the more you use the bolt, the looser it gets in the threads – and therefore the less effective it is at cleaning. Cutting a channel into the thread using the Dremmel leaves the inner part of the body of the bolt intact and so there is no gap to close. It is an altogether better tool – and in many ways is virtually as good as a proper cleaning tap.

I did exactly the same thing for one of the intake bolts – and then cleaned both the intake AND the exhaust port threads in the two heads.

Note that I checked that issue of the slight relief grinding notch to accommodate the intake injectors firing into the heads. It turns out that the intake ports are smaller than the ports on the heads – and the head ports accommodate the extra area of the injector reliefs comfortably. So – no drilling/grinding required.

I also checked the intake valley gasket (which last time was composite – but this time is steel) and again the port size matches the larger sizes on the heads very nicely. This shouldn't be a problem

I then painted the heads. They will need a second coat – which I'll sort out tomorrow.

Today/Tomorrow – aiming to prepare the heads (thread cleaning and painting).

Rebuild day – aiming for Friday 29th June

28th June 2012

Heads are now ready. The final paint was dry at 16:00hrs, but will be left overnight to harden for rough handling. This view shows the passenger side head exhaust ports and the intake side of the driver's side head.

And this view shows the passenger side head as seen from the intake ports

None of the head brackets are fitted and the threaded stud on the passenger side head will need to be cleaned - something we can do tomorrow once the paint is properly dry. Both heads had two very carefully applied coats of paint.

One other measurement I've now checked. The Haynes manual mentions that the top of the valve stem above the valve spring seat must not exceed 47.63mm. I've measured this and it is currently 46.33mm. It is worth repeating that on both heads the engineering is so precise that you can lay a straight edge along each of the 8 stem tops and find zero gap under any one valve. It's quite something compared to the "all over the place" valve stem height when the heads were removed caused by the seat / valve recession.

28th June 2012 - Continued

Let's consider the procedure we should aim to use tomorrow.

1. Clean the paint from the threaded stud on the front of the passenger side head
2. Fit the two engine hoist plates on the front of the passenger side head and the rear of the driver side head.
3. Sweep the floor with the heads on the bench
4. Place both heads on the floor under cover.
5. Sweep the bench – and clear away all nonessential parts (all paint).

Start…

1. Refit the sump drain bolt and remove the two drain pans
2. Fill the sump with just three to four litres of new oil
    a. We don't want the oil pump to suck air
    b. We want to leave enough room to add oil to the engine later.
    c. The engine requires just over five litres – so 3 to 4 will be enough
3. Remove all 16 lifters. Leave them in order on the bench (for curiosities sake)
4. With the lifters out, apply break-in paste to the top half of the cam lobes, and then use the crankshaft pulley to rotate the engine and expose the under side. When finished rotate the engine to TDC, with number 1 firing.
5. Fit the new lifters, with a dab of paste on the base and after dunking in oil.
6. Fit the drivers side head – see haynes
7. Starting with the driver side - fit the head gasket with no sealant. Have the word TOP legible and readable.
    a. Make a note of which way the ridge is (upwards or downwards – because the valley gasket has the same design but isn't marked – although I suspect that the open hole (square cut) is the clue which round the gasket needs to go.
8. Have the number 1 bolt ready with thread locker.
9. Fit the head carefully on the dowels and secure with number 1 bolt hand tight.
10. Fit all 13 remaining bolts – using thread locker on them all.
11. Slowly work through the order of tightening hand tight first and then in increments of 10 ft/lbs for all 14. When you get to 40 ft/lbs, stop tightening bolts 11,12,13 and 14.

Repeat and fit the passenger side head. Next…

12. Fit the rods drivers side

13. Fit the rockers drivers side – check that the oil holes properly align before fitting the bolts and make sure the oil splash shield is fitted correctly
14. Do the bolts up very very slowly
15. Full torque is 28 ft/lbs (38Nm)

Repeat and fit the passenger side rockers. Next…

16. Fit the drivers side exhaust manifold.
17. Check the interaction between the manifold and the cabling – as this has been moved and so could represent a problem that must be cleared.
18. Check the gaskets (because they are apparently easy to reverse)
19. Remember to fit the steel C securing plates – but don't fold (we will do this in a week or so).
20. Full torque is 10 to 15 ft/lbs.

Repeat and fit the passenger side exhaust manifold. Next…

If you get to this point – you are now at the point where we can start exploring the plumbing issue for the heater matrix under the intake. Remember that the long pipe is NOT secured (both bolts are loose). Also use a plastic bag to protect the valley before exploring this solution.

BE VERY CAREFUL NOT TO DROP ANYTHING INTO THE VALLEY.

When you are satisfied the plumbing will work

HAVE YOU TIGHTENED THE TWO BOLTS HOLDING THE PIPE UNDER THE MANIFOLD?

If so fit the valley gasket and the intake as described in Haynes. Use thread lock on the bolts, and use silicon sealant (not Hylomar) on the water ports on the heads.

See page 48 of Haynes, and page 30 (engine section) of the land rover manual for the procedure. Gasket bolts (front and back) are torqued to 10 to 15 ft/lbs. Intake manifold bolts are torqued to 25-30 ft/lbs and need sealer on each thread.

With the valley gasket fitted in all its shiny glory, and the intake manifold fitted and fully tightened lay out the wiring loom for the injectors

Gap and fit the spark plugs (gap is 0.85mm, and torque is 21nM – using the small torque wrench).

21. Next step is the water pump – and fit it with the pulley off so you can get to the bolts. Turn to page 13 (above) to note the way the extra power steering bracket is positioned.

22. You can expect some fun with these bolts.
    a. The ¼ inch bolts are torqued to 7 to 10 ft/lbs.
    b. The 5/16th inch bolts are torqued to 16 to 20 ft/lbs.

23. Don't forget to fit the bracket for the alternator on the bolt at roughly 11o'clock

If you get the water pump finished – then the next step is fuel lines, alternator and power steering pumps – along with the two belts and the brackets (see pictures above).

24. Don't forget to replace the now cut hose on the power steering low pressure hose (note that you may need to buy some fluid as I'm not sure we have enough).
25. Fit the alternator, power steering pump, plumb fuel lines, loom.

After that its all the ancillary stuff such as

26. Fit the upper and lower radiator hose.
27. Fit the heater matrix hoses
28. Fit the under plenum hose
29. Fit the 2 oxygen sensor cables
30. Fit the plenum trumpets
31. Fit the plenum
32. Fit the PCV
33. Fit the vacume hoses (including brake servo)
34. Fit the throttle.
35. Fit the TPS sensor wiring.
36. Fit all 8 injectors
37. Fit the fuel temp sensor
38. Fit the coolant temp sensor
39. Fit the air intake and MAFS – and the cable and air filter
40. Drink beer
41. Get high

29th June 2012

Hard day – and all the more so given it started pouring down with rain for the morning. Even so I still managed to get the cam lubricated with break-in grease, and all the new hydraulic lifters fitted following a dunk in new oil and a dab of break-in grease on the base.

Later that day – the rain stopped and blue skies were the order of the day… well, at least until about 7pm, so in the end I did get a fair bit done.

In short…

1. Old lifters removed
2. Cam lobes lubed with cam break-in paste
3. New Lifter bases lubed with cam break-in paste, dunked in oil and fitted
4. Drivers side head fitted with new gasket – no sealant
    a. All head bolts tightened as per land rover manual (all taken up to 44 ft / lbs, and then 1 to 10 taken up to 70ft/Lbs)
5. Passenger side head fitted with new gasket as per drivers side.
6. All rods fitted – with the lifter end dipped in cam break in paste
7. Rocker arm assembles fitted.

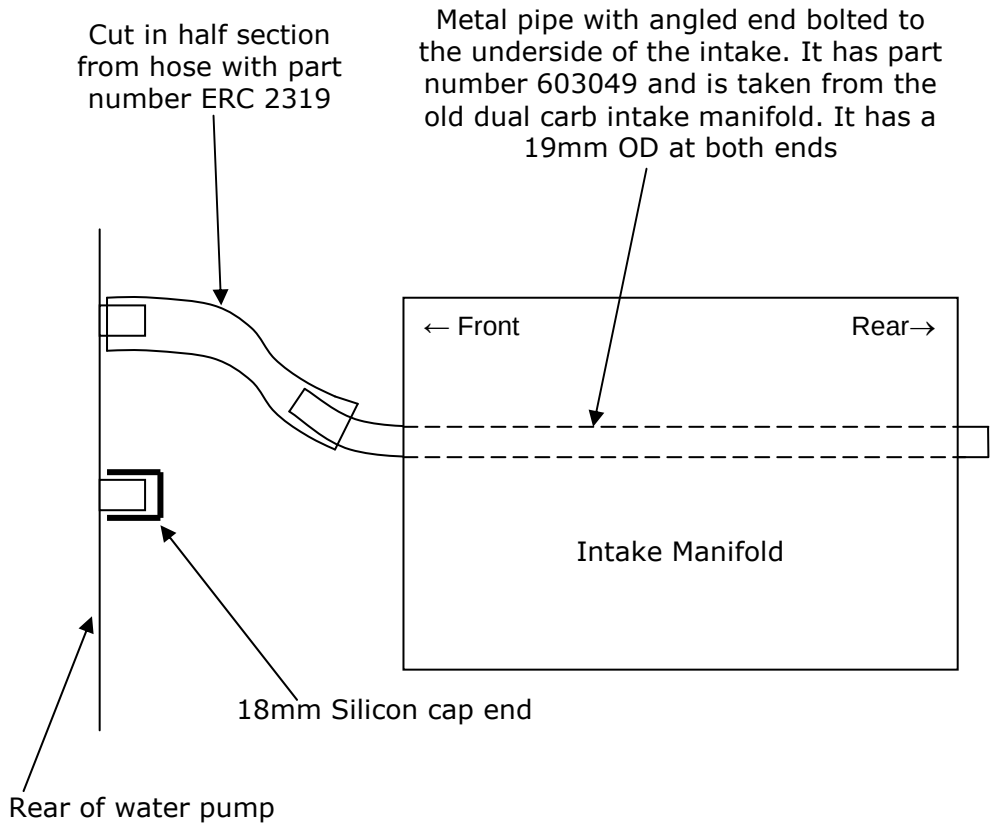
The rocker arm assemblies caught my attention. The Haynes book talks about a notch on the rocker shaft and for the drivers side said it should appear on the front, and upper most, but unfortunately on my drivers side shaft this notch is at the rear and has the wrong orientation. This worried me so I disassembled the shaft completely as a result – but as far as I can see the design of the shaft as they stand should be ok. The oiling path looks right, and the wear of the shaft looks well within spec (which you would not expect given the thousands of miles it has clocked up if the oiling was wrong). Anyway – I reassembled the driver's side shaft leaving it as was, and used new split pins on both ends.

8. Both rocker shafts very slowly tightened up and then torqued down to spec – as they came off the engine

With both rocker shafts fully tightened, I then slowly turned the crankshaft over multiple times. No problems were observed – and the engine is now on TDC number 1 cylinder firing (both valves closed).

Next step was to start looking at the water plumbing for the heater matrix.

Armed with the newly arrived S shaped rubber hoses from Rimmer Bros and the old 19mm metal pipe - the one with the bend that came from the carb manifold – and which is part number 603049, I found an elegant solution as shown below.



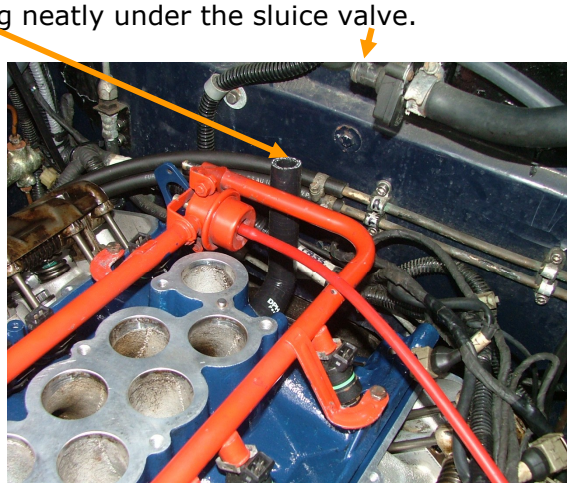
The 19mm steel pipe passes under the manifold but instead of hanging loose (the approach I took when the fuel injection was first fitted) this time it was bolted into position using the existing two threaded holes in the manifold. The pipe is positioned so that the bend is at the front of the manifold pointing towards the driver's side and with the straight end exiting on the underside of the intake manifold at its rear. The land rover hose (part ERC2319) was then cut in half and used to connect the driver's side port on the rear of the water pump to the front of the metal pipe. The other 2nd port on the rear of the pump body (passenger side) is now filled with epoxy metal and also capped with a neat 18mm ID silicon end stop.

Mock ups with the intake in position and the old valley gasket in position worked very well. On the back end of the manifold the straight exit pipe (19mm) is connected to a 19mm to 16mm right angle – which gets the pipe in the best position to connect via a 2nd right angle (16mm to 16mm in silicon) to the sluice valve of the heater matrix. That covers the return of the heater matrix

Regarding the heater flow pipe (a 19mm steel pipe at the front of the intake manifold under the thermostat cover) – this will be connected to a 19mm to 16mm right angle designed to bring the pipe out to the front drivers side of the distributor. From there it will be plumbed using a mixture of copper and then 16mm hose under the plenum to connect to the 16mm outlet on the heater matrix.

Looking at the S pipe during mock up (no jubilee clips) you can see how this new pipe works. Note the feed pipe will be connected by soft hose and is formed from the hose with part number ERC 2319 but cut more or less in half (its actually slightly longer than one half).

At the back of the manifold – the new 19mm to 16mm right angle can be clearly seen – and it is lying neatly under the sluice valve.



By the way – note the much better line of the fuel hoses behind the intake.

It is worth saying that the BIG difference between this solution and my last is that if the hoses on this coolant pipe fail – all the jubilee clips are accessible without having to remove the entire intake manifold. After that I went to get my wife and mum, and we stopped and got some fish and chips.

After that, I started the process of refitting the intake manifold.

1. I used silicon sealant to fill the notches when the heads meet the valley, and then fitted the two new rubber seals for the front and rear of the valley.
2. I then applied a bead of silicon around the four water ports on the head

3. I then carefully fitted the steel valley gasket (these are not stamped front or top – but they do have one rectangular cut out (matching the one rectangular bolt hole in the intake manifold – drivers side, second bolt from the front). I fitted the front and rear metal plates – not tight, but tight enough to compress the gasket so that the bolt holes all opened out properly.
4. I then applied a bead of silicon to the four water ports on the gasket, and also the four water ports (only two of which are open) on the intake manifold.
5. I then fitted the manifold – carefully levering the hose pipe onto the water pump port before dropping the manifold onto the head ports.
6. Note that I had already checked the two bolts securing the new 19mm pipe under the manifold. They are not torqued, but they are definitely tight.
7. I then fitted all the bolts – using the new stainless Rimmer Bros bolts and washers
8. I slowly torqued up going from hand, to 12, to 20 to a final torque of 30 ft/lbs. The only difficult bolts to access are the two rear bolts on the drivers side (and with care the rearmost bolt can be accessed by a torque wrench with no extension) – so the 2nd to last bolt is done by spanner, but believe me its tight.

PTO

After that I knocked off for the night, exhausted but pleased.

I put the rockers on to keep the dirt off the rocker shafts. The end result…

Tomorrow

1. Spark plugs (gap them first)
2. Exhaust manifolds – and check the loom for clearance
3. Water pump – good luck with the strange collection of bolts
4. Refitting Ancillaries

If you can get all that done – you'll be doing well

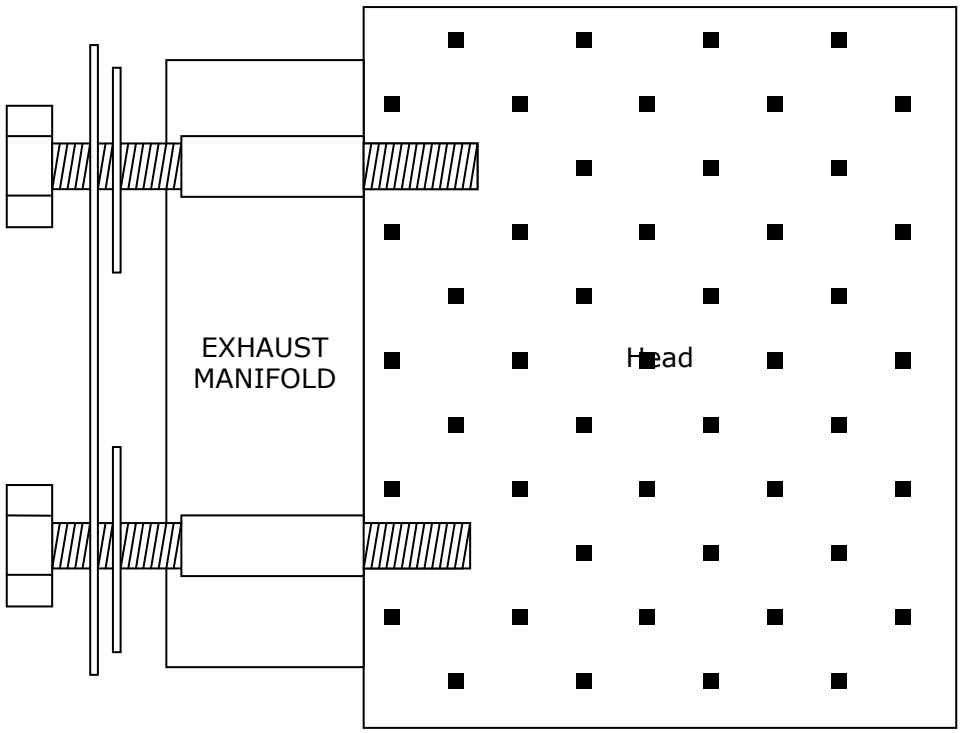
30th June 2012

A hard day this one – I ache in places I never knew that I had ☺

First I fitted both exhaust manifolds. I'm glad I didn't try to fit these onto the head before fitting the combined units onto the block. The extra weight would have caused some unintended consequences in terms of the evenness when torquing the bolts – and as it was (with just the heads) they were tricky enough to get located onto the block dowels while not tipping the steel gaskets off. So yes, that was a good move.

One thing to note about the exhausts is that I've fitted those C shaped bolt locks, but I haven't folded the locks over yet. I'll run the engine for a couple of hot/cold cycles before removing the MAFS pipe work to lock as many as I can down. Also

note when you fit them to ensure you insert the bolt through the C locking plate **before** fitting the washer. I did this the wrong way round initially on the drivers side manifold and then realised after all the bolts were tight that the lockers couldn't be folded over (the washer got in the way)..



As it was the exhaust manifolds are tricky to get on – but although a bit fiddly it's actually more about a little care, patience and small fingers. One important point to note is that that web site was right – it is very easy to put the port exhaust gaskets on the wrong way round. From the top they would look correct, but they wouldn't properly seal the ports. It might be useful to remember that when you look at the gasket, one of the two bolt holes on each gasket has the round penny size area surrounding it. That hole is always on the bottom when placed on the engine, and is rear most when fitted to the rear most two ports on the manifold and front most when fitted to the front two ports.

The really tricky part was getting the down pipes bolted up.

Unfortunately the fact that the studs in the manifold had been helicoiled where one or two of them are leaning slightly at an angle meant that the mounting plate on the down pipe was always liable to be a problem. I worried about this when I was preparing the manifolds but felt if they had gone in before (with the same angle) they should go in again. Alas – no way. The metal clamp on the down pipes wouldn't fit onto the studs at all on either side.

After a lot of head scratching I realised that the only way to fit these was to remove one or maybe two studs – position the clamp on the remaining stud or studs, and then screw in the removed stud(s). It is really hard under the car to do this because even with my small hands room is very limited. I unscrewed one stud on the drivers side manifold, and managed to get the clamp held on the two remaining studs, while later rethreading the third. The same approach required the removal of two studs on the passenger side. It took a great deal of time – with a lot of patient and slow movement in the confined space to get the clamps properly secured all using spanners (no ratchets). Note that the new stud bolts

with skirts were used on five of the studs, but I was forced to use an M8 plain nut on one of the passenger side studs. After that I made a much needed cuppa.

I then tided up the loom on both sides (which is now clear of the exhaust manifolds and pipes) and also laid and tied down to the injector lines. A number of the loom plugs are now fitted

- Both O^2 sensors
- All eight injectors
- The fuel temperature sender
- The coolant temperature sender

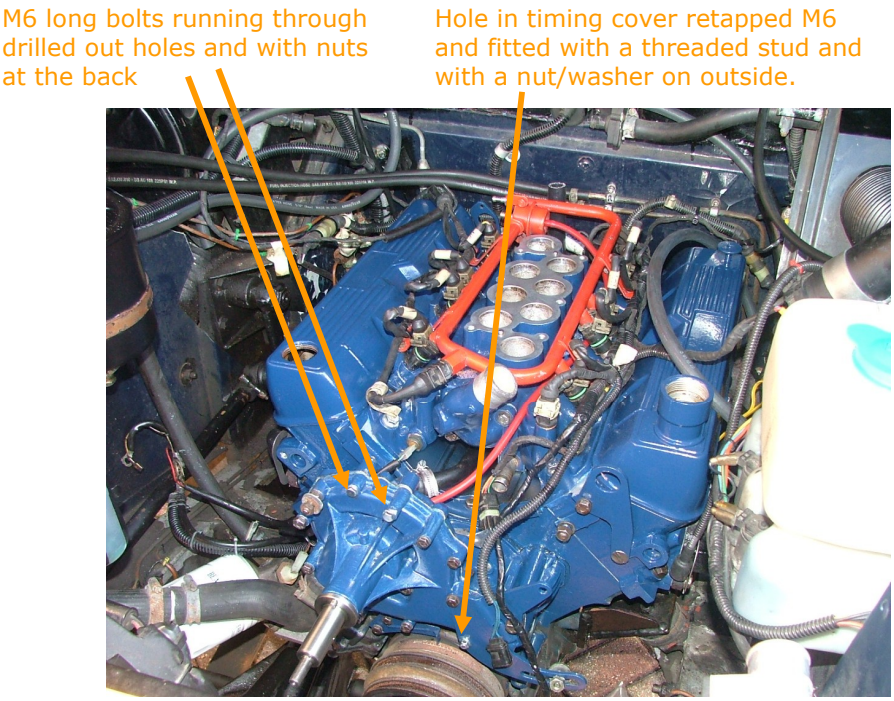
After that I decided to take the plunge and look at the water pump and just as I expected walked into bolt problems galore.

Basically we either need a new timing cover or we need to retap a number of these threaded holes. In the absence of that I've now retapped one bolt (as M6) and actually drilled through the threads for two of the higher (accessible) bolts using a 6mm bit so that they now employ rear nuts. I used M6 galvanized bolts and nuts.

The pump went on three times before I finally got the bolts to hold – and they basically feel ok. I'm a little doubtful, but think it will work. The gasket was not torn, and I used plenty of Hylomar blue which will help the sealing process. Thankfully it was a new pump – something that definitely helps.

If it fails – I'd seriously consider removing the entire timing cover and actually retapping for M8 bolts (or even studs) throughout. That won't be easy because you'd have to remove the crankshaft pulley, and that requires a deep socket, and is torqued to well over 200 ft/lbs – meaning you'll need to source a 1 and 5/16th deep socket and a very long breaker bar while securing the crank from turning over.

If you do ever have to do this, I'd buy hardened bolts – cos the galvanized standard bolts from your local DIY store shear quite easily even on low torque. Either that – or buy a new timing cover.



That's it for today – those three jobs (2 exhaust manifolds and the water pump took damn near the entire day). Tomorrow is a day for my wife and I.

What comes next…

1. Disconnect the ECU plug (so that the fuel pump doesn't activate at any unexpected time)

2. Fit the distributor.

    a. On Rover V8's the oil pump is driven by the rectangular key on the base of the distributor – which itself is driven by a worm gear on the cam. We will therefore need to fit the distributor to the block before we can establish if the engine will produce oil pressure. At the same time we should get the rough orientation of the rotor relative to the cap and leads sorted out now (we'll check the precise static timing later on). Ideally we need to match the lead pattern shown in Haynes book, while at the same time leaving the advance / retard canister so that it doesn't foul the thermostat housing. This will take some time to sort out unless you're very lucky ☺

3. With the distributor now physically fitted - top up the engine with oil (and make sure you start by carefully drizzling a half litre or so on each of the rocker shafts and tappets).

4. Refit the rocker covers loosely for now

5. Check that the ECU plug is physically disconnected (so that the fuel pump doesn't spin up).

6. Next turn over the engine on the starter and verify that we do get oil pressure (fingers crossed). This test will also fill the lifters and fully pressurise the rocker shafts. It will need 20 to 30 seconds before it pressurises.

Assuming all is ok continue - otherwise start trouble shooting.

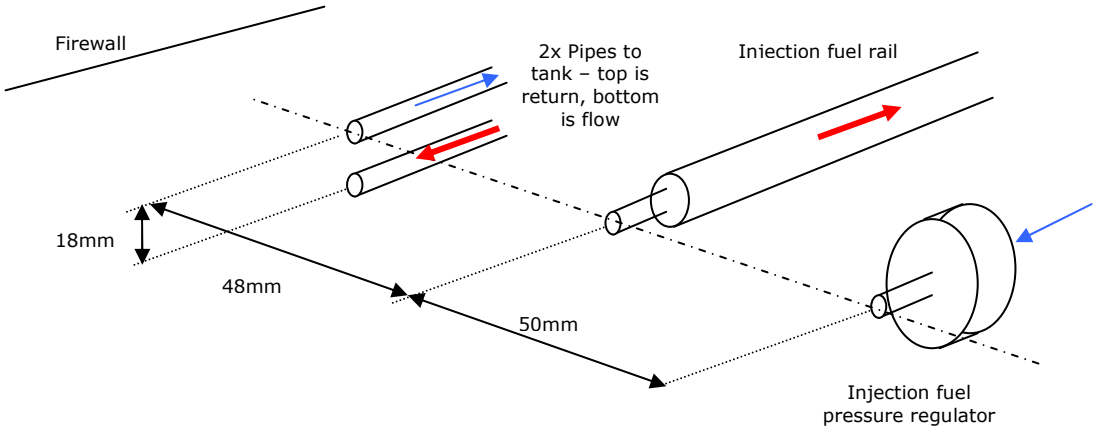
7. Set static timing now to 10-12 degrees BTDC
8. Gap and fit spark plugs next – torque using the small wrench.
9. Fuel line plumbing – using fabricated copper U bends.
10. Plumb the rear 16mm hose to the sluice valve
11. Plumb the 5/16th hose onto the intake manifold pipe (that feeds the under plenum heater).
12. Remove the problem hose on the power steering low pressure side (we will need this to connect to the base of the pump) and refit with a fresh piece of hose.
13. Fit the alternator
14. Fit the pulley on the front of the water pump
15. Fit the power steering pump
16. Fit both belts
17. Plenum trumpets (use Hylomar – and not silicon)
18. Fit all the vacuum hoses excluding PCV ie:-
    a. Brakes
    b. Distributor advance retard
    c. Fuel rail regulator
    d. Vac gauge on dash.
19. Plenum including the under plenum heating plate (two hoses – both fitted and ready).
20. PCV plumbing
21. Throttle

At that point you are very close to finishing with final checks.

2nd July 2012

After a break of a day, and with sore muscles and rubbish weather still present there wasn't a lot I could do. The one thing that I thought would be useful was to build the small fuel manifold – which I have now done. It is version 1, so doesn't look particularly pretty, but it is functional and robust and will help make those difficult fuel connections a little easier.

Pictorially this is the problem we had to solve…

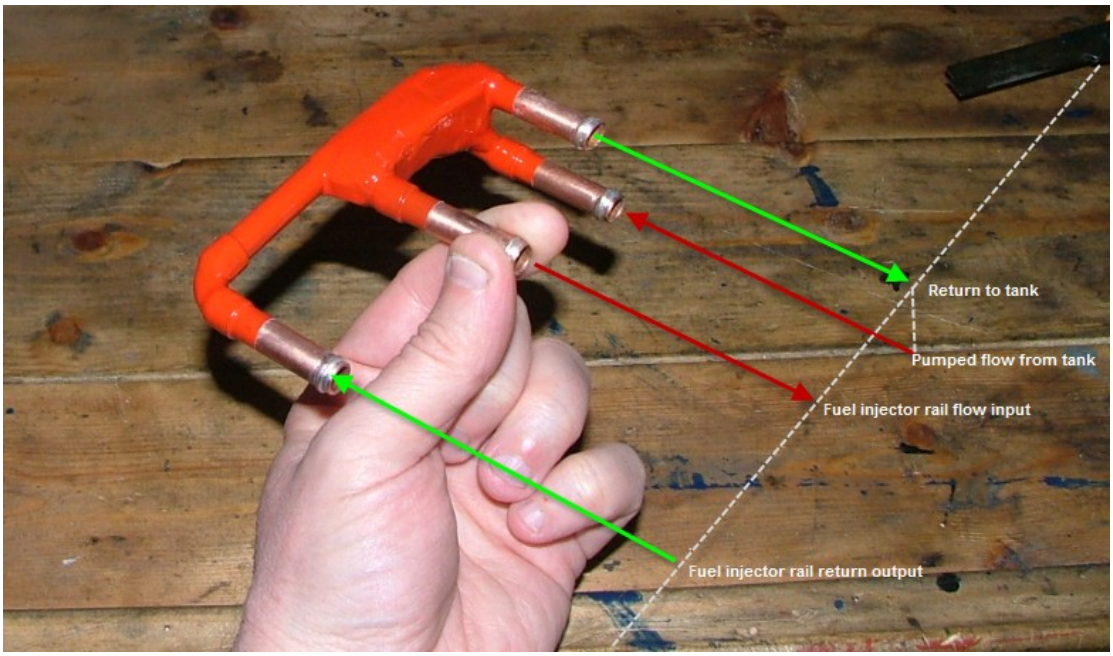


The two brass fuel lines fixed to the firewall and which supply and collect fuel to/from the tank are shown at the top. Both brass pipes have now been cut flat (to remove the old angled kick out) and they are mounted with a vertical separation of roughly 18mm. The return tank pipe, and the two connections at both ends of the fuel injection rail are horizontally on the same plane – and each of the three pipes is separated by 50mm.

The manifold as constructed (and as it would connect to the diagram above) looks like the following.

Effectively we needed a U bend to connect the tank return to the injection rail return, and a smaller but also bent U bend (offset by 18mm) to connect the tank flow to the injection rail flow line. It was constructed in 9mm copper using soldered preformed 9mm bends. The two U pipes are soldered together and then further secured by embedding in a small block of epoxy metal resin for strength – and each of the four union ends also were given soldered lips.
The resin does look a little rough simply because it was very difficult to smooth it out flat – even after filing and sanding. Regardless, the manifold is strong and I think will definitely make those fuel connections tidier and safer while also shortening both connection hoses. The assembly now has one coat of spray primer and two coats of red top coat (to match the fuel injector rail of the intake manifold).

The connections are shown below



4th July 2012

Yesterday was a complete wash out (really heavy rain) – and to be honest today wasn't a whole lot better, but I did get an hour and a half at lunch time after taking the neighbours dog for a walk. I wanted to do a couple of simple but very important (and slightly nerve wracking) things today namely:-

1. Fit the fuel manifold (that I built yesterday). The manifold is definitely tricky to fit simply because of the difficulty of getting four hoses on four nozzles all at the same time. Just a tiny bit of 3-in-1 oil on the receiving metal pipes helps (and be ready to cut the old hoses off before removing this in the future). Once fitted, the assembly works really nicely. It also clears the rocker, and because the hoses are short, it self supports. It is a vast improvement on the mess we had before. I fired up the fuel pump four times to test the system under pressure and it worked fine with no leakage. I pray there wasn't any crud in the pipe work regardless of my careful cleaning.

2. The next job was to fit the distributor in order to get a rough static timing and so that we would drive the oil pump when turning the engine over on the starter. This meant orientating the position of the rotor so that number 1 cylinder matched the cap plug layout shown in the Haynes manual (and not the layout employed by the previous owner and which had been rotated by one additional plug position). The additional complication was the need to mesh the base key of the distributor shaft with the oil pump drive shaft – which took a little jiggling to get meshed. Although the static timing can only be roughly estimated it does looks like the advance/retard canister won't foul either the water pump or the thermostat housing when the timing is at the right BTDC. We need to get the timing gun out in order to sort this any more precisely – and I think it would be wise to do this when more of the top half is built (so we don't walk into an unexpected clearance problem elsewhere.

With the distributor properly inserted and its key to drive the oil pump fully meshed I loosely fitted the base clamp (just hand tight) and then disconnected

the 14CUX ECU and connected the main 12v battery cable so we could use the starter motor. I topped up the engine with its outstanding 2 litres of oil and removed the driver side rocker so I could see all the valves. I set the small bathroom mirror so that from the ignition key I could see the rocker, and then span the engine over on the starter.

It worked like a charm – and I noted reassuringly that oil pressure very quickly came up to roughly 40PSI. I've spun it for maybe 20 seconds in total – so it could probably do with a bit more in order to pump up the lifters, but we have just passed a pretty big test.

The one comment I would make is just how different the new starter motor sounds. It doesn't even remotely sound like the old one – but thankfully it does work.

What's next?

1. Plumb the rear hose pipe (at the back of the intake manifold) to the heater matrix (do this before you fit the trumpets or plenum).
2. Fit the alternator and wire up
3. Cut off the old section of power steering hose (bottom hose) and replace
4. Fit the power steering pump
5. Fit both belts and tighten to make sure they grip correctly.
6. Trumpets
7. Vac hoses
    a. Brake servo
    b. Vac gauge (you'll need to remove a stub of copper pipe from the hose).
8. Plenum
9. Vac hoses
    a. Feed to the fuel regulator – which connects via red silicon to the port next to the idle speed stepper motor
    b. Feed to the distributor advance/retard canister – which connects via red silicon to the port just above the throttle blade.
    c. PCV pipe work complete
10. Throttle
11. Final wiring to the fuel injection loom
    a. Idle speed stepper motor
    b. Distributor wiring
    c. TPS sensor
12. Fit the plugs and leads

At that point you need to design the sweeping Hail Mary hose run for the heater matrix.

With that complete – you are more or less done.

1. Disable the inertia switch so that the fuel pump doesn't run.
2. Connect up the ECU
3. Hook up the timing gun
4. Turning the engine over on the starter attempt to set the static timing to about 6 degrees before TDC – and analyse any distributor fouling problems that occur at that time.

After that fill up the fluids and run her for the first time.

5th July 2012

Today was the first half way decent day for weeks and so I decided to try to get as much of this finished as I could. I didn't get it all done, but I did get a hell of a chunk complete.

I started by fitting the alternator. Nothing too much to note about that other than to say that the belt for the power steering has to be placed onto the crank pulley BEFORE the alternator belt. I also had to clean out the dowel hole in the water pump pulley, as for some reason the dowel pin in the pump itself was pressed forward in its hole until it hit the body of the pump and jammed the pulley.

I then fitted the power steering – and found it was perhaps a little easier than I expected bar two issues. The first was that the special bracket assembly (which I thought couldn't be rotated) was actually rotated off by 45 degrees (so I had to remove the pump – unbolt the pulley and move the bracket). The second issue was that the modified bolt I'd repaired on the bracket actually failed (the weld failed) which meant the head ended up spinning as the bolt was tightened. That was relatively easy to side step simply by pressing the back of the thinned bolt head with a screwdriver – but you need to be aware of the problem for the future. The old 16mm hose end wasn't too hard to remove once it had been cut with a Stanley knife – and refitting was then fairly straightforward. Both the alternator and the PAS have now had their belts tightened.

After that I cleaned the rocker cover gaskets, and refitted. I did have a little trouble with the screw in PCV filter on the drivers side (the threads had some paint on them and so the PCV filter was really tough to thread) so I unscrewed the drivers side cover and first cleared the threads with a wire brush and then cleared the small amount of debris that had fallen down onto the rocker. I then refitted both.

After that I fitted the ram housing (trumpets) sealing them with Hylomar and torqued down to 24 Nm as per spec. Following that I fitted the plenum (again sealed with Hylomar) and torqued down to 25 Nm. This time I have deliberately avoided using any silicon on the intake run – throughout.

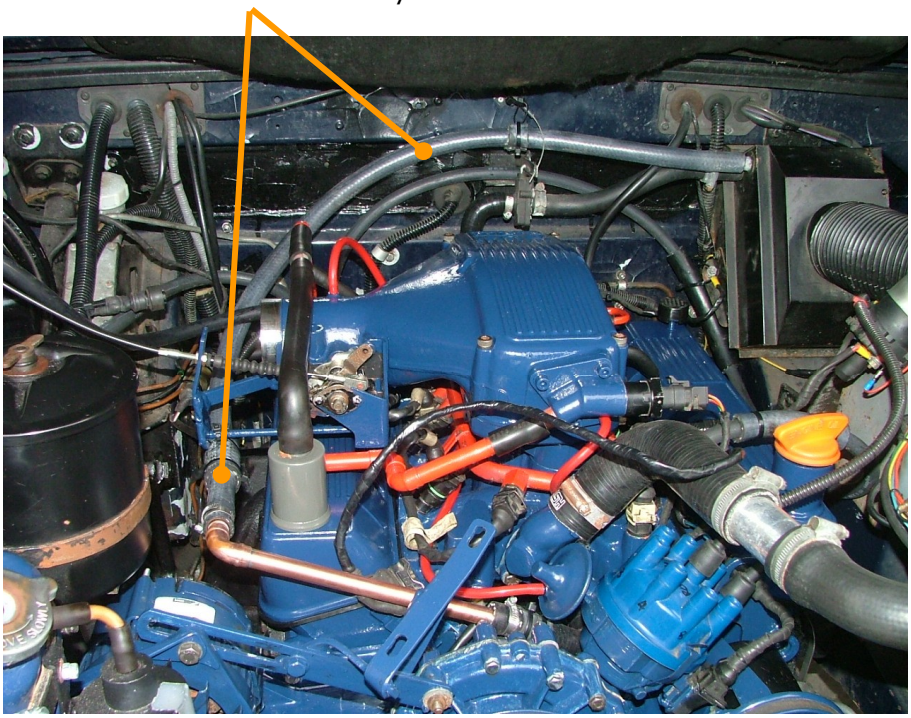
I then connected all the vacuum hoses including the PCV, the brake servo, the dash mounted vac gauge and both the small red silicon hoses (one for the fuel regulator and one for the advance retard canister).

Then I turned my attention to the hose connecting the front of the intake manifold to the heater matrix – the one I was calling the sweeping Hail Mary hose which turned out to be a great deal easier than I expected.

With the distributor fitted, and swinging through its range of motion, the right angle 19mm to 16mm silicon hose only needed about 3/4rs of an inch cut off the 19mm end to fit snugly without fouling the distributor. Pushing it so that the 16mm end was pointing towards the driver side meant that we had a nice line for a right angle connection to a hose mounted directly under the throttle cable (and which would clear the MAFS air intake pipe). The rest was a matter of supporting the hose running to the heater matrix itself in two places, and soldering a short copper pipe with a right angle end, and two straight through connectors for the hoses to screw onto.

In this picture you can see the copper pipe – and the angles that the pipe work makes when it connects to the receiving 16mm hose fixed under the throttle. Note that this pipe doesn't foul the MAFS air intake pipe.

This picture shows the route taken by the 16mm hose to feed the heater matrix



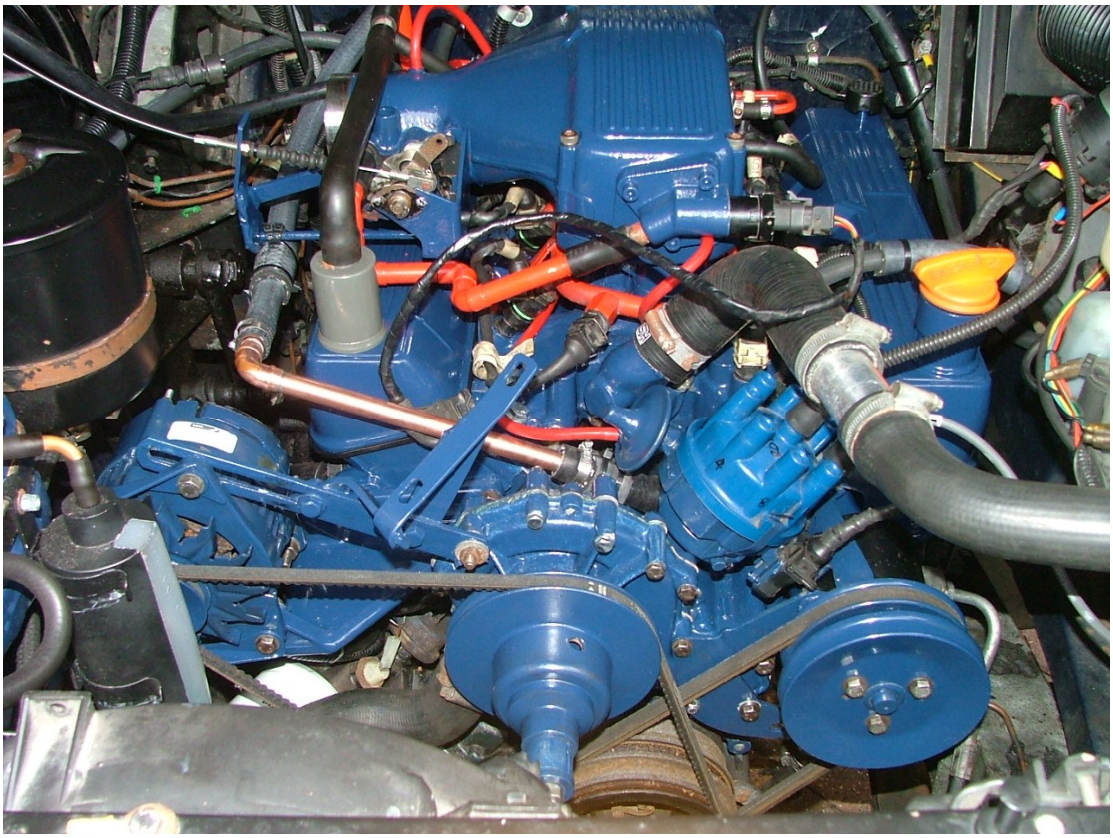
Note the tied support to the hose on the firewall. The hose itself wasn't in my stock (the only 16mm hose I have is the shinny black hose suited to very high pressure hydraulic oils – and which I use on the PAS). But after phoning Keith Gott, I spoke to a company called FRM in Aldershot. They have a web site at www.frmspares.co.uk and although they actually specialise in heavy commercial vehicles (dealing with things like props, huge UJ's and springs etc) they did indeed have 16mm ID coolant hose, and I got a good price and 3.5mtrs for the

price of 3mtrs. I also picked up 5 litres of automatic transmission fluid for about £18 – which is vastly better than Halfords prices and something I do need for the PAS. Speak to Gary if you ever call again – he is very helpful.

After that I finished off most of the connections, and filled the radiator with fluid (everything held up ok – but off course the real test will be what happens under pressure).

I then collected my wife and so later that night did a static test of timing with my wifes help. To be honest it was virtually impossible to do because the speed of the engine on the starter is relatively slow, but I think it is more or less in the right place – at least sufficient to get her running. I hope so – cos I did notice that the battery is sounding a little flat.

The end result looks as follows:-



6th July 2012

Heavy rain forecast for today – in fact there are warnings of exceptionally heavy rain ("one months rain falling in a day" – is the headline) consequentially linked to serious flooding. Now off course all of these forecasts come from the Met office so who the hell knows how bad they will actually be. Anyway as soon as I got showered, I got cracking – and only just got everything done before it started to drizzle.

I gapped all 8 plugs 0.85mm. I then fitted them and torqued them to 21Nm as per spec. I then fitted the leads which were interestingly just a little shorter on the run to the even bank allowing now for the changed position of the distributor.

They are in, but they are also a little tight.

After that I fitted the air intake and MAFS – bolting that to the bracket (which to my surprise fitted perfectly for both bolts (even after that entire assembly had been moved about after the removal of both the alternator and water pump). I then hooked up the MAFS cable.

I refitted the front wheels, and removed the vehicle of the stands and push rolled her in front of the garage. The wheel bolts are all tight

I then paused – to make some notes (above) and think through anything I may have missed. After an hour I popped down and began the final preparation to start.

I first filled up the power steering fluid and then enabled the fuel inertia cut off switch. I checked the oil level (full), and hooked up the timing light. I turned the ignition key to run, not to start but to (a) check for ECU fault codes, and (b) prime the fuel pump. I got error code 17 which made me smile given I immediately recalled that I'd had to disconnect the TPS while I was working on the heater hose yesterday. After reconnecting – I reset the ECU to obtain a 02 code. All ready to go…

Lastly I checked the coolant and then turned the key to start.

It fired first time and at about normal idle speed – even with the low cranking speed (the battery is definitely quite flat)

I quickly stepped round to check the timing, and to my utter astonishment found it was roughly right ie: 9 to 12 degrees before TDC, and the advance / retard canister is more or less mid way between the thermostat housing cover, and the back of the water pump. You couldn't really have it in a better place – and the wiring layout of the distributor cap now matches Haynes.

Over the next 10 minutes I ran her up to full temp (until the fans kicked in), all the time keeping an eye on the hoses, and while rocking the steering to bleed the PAS – the fluid of which foamed heavily to start (its worth saying that the bearings on the PAS pump were definitely moaning for the first minute or two but after that, they settled down. Keep an eye on this just in case the belt needs a little loosening). As far as I can tell she's running well and I can't hear anything bad like valve train noise or the like. Applying light throttle, again she sounds about right.

The only one problem I found was that the brass cap on the radiator started leaking just a little coolant fluid when the engine was at full temp (82 degrees).

I then shut her down, depressurised the coolant system and properly sealed the brass bolt on the radiator (using Hylomar) after cleaning the bolt, the washer and the radiator. I then topped up the coolant reservoir tank to its proper amount.

Separately I checked and topped up the PAS fluid and sealed that lid down tight and then checked the engine oil (which was down by about half a litre) and topped it up to bring her full.

I then checked the ECU for error codes (none) and then refitted the passenger side seat.

The next step is to take her for a test run and see how she behaves. If we're going to get as much rain as they are threatening – doing that sooner rather than later might be a wise move.

Problems…

Later on – after a run everything is running well – but there is a substantial leak of coolant somewhere under the intake manifold.

After a lot of playing around and tightening various hose clips at the front I wasn't curing the problem. In an effort to try to narrow it down, I snugly fitted one of the cut tail ends of a curved hose to the blanked off port on the water pump and filled the hose with paper towel. I also wrapped paper towel round the thermostat housing, and I also added a good size pad of paper under the rear most hose connection.

After a blast down the local roads I found that the rear most hose pad of paper was absolutely soaked through, but the other two were bone dry. I checked the under plenum heater (both pipes) and again as far as I can see they are both bone dry.

I can't be 100% sure, but I do now suspect the rear heater hose is the cause of the leak. A truly worst case scenario is that the intake manifold is somehow leaking on the back water jacket ports which is a bit worrying. We'll work on the assumption of it being down to the hose first as that is the most likely cause and see what happens. I'll wait for the system to cool right down, drain it – and then disconnect and remove that hose and refit. It's a bit awkward, but far from impossible.

One hour later…

With a break in the clouds and now that the engine was cooler I roped the bonnet to the light bar rail (to get it as far open as I could) and siphoned off the radiator (which netted roughly 4 litres) and then removed the hose assembly at the back of the intake. It actually wasn't too hard.

If I'm honest I couldn't see anything wrong – and the hose was ok on a suck test (I know it's crude but it's quite effective).

In the end I used wire wool (the silver stuff) to clean the end of the metal pipe and then refitted the hose assembly using one jubilee clip (instead of two) and in such a way that it was clamped very close to the lip of the pipe. It is now tight – and I've placed a paper pad underneath (remember there is still a small amount of coolant still under the intake – which will probably get absorbed by that paper pad). Additionally - I tightened the clip on the other end of the pipe.

Let's see how we get on with this, and take a judgement after that.

7th July 2012 - Saturday

More heavy rain occurring sporadically through the morning – but even so I got cracking from 8, and cleared the garage completely – and then got a test drive in. Just before I ran the engine up (it was pouring by then) I'd checked the paper pad under the rear hose, and confirmed that it looked dry.

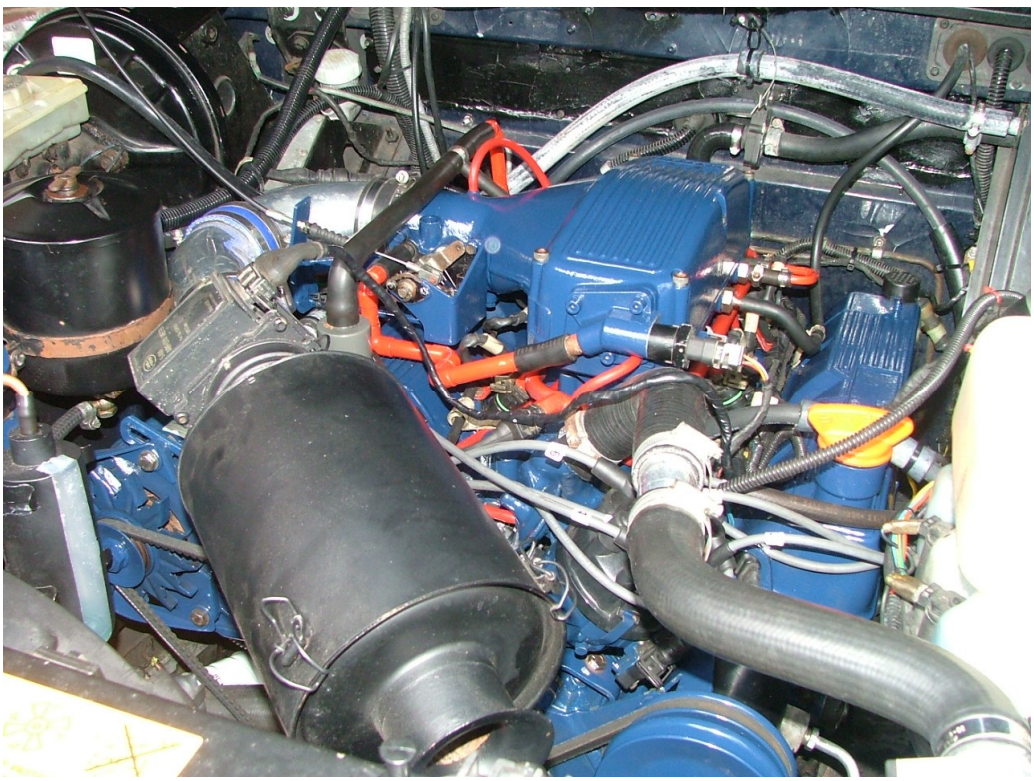
After a good blast I stuck the nose of the landy into the garage (which fits very well – albeit you do have to drop the bench) and checked out the intake to have the joy of realising that it was pretty much bone dry. The pad of paper at the back had some coolant – but it was cold and not very damp – which means it was almost certainly the residue from yesterday. Later tests confirmed that diagnosis.

One thing I did spot was that the curved hose on the rear of the water pump port was not fitted quite square onto the water pump port and so the jubilee clip was a kind of half on half off the hose. It was also leaking a very small amount. I loosened the clip, and forced the hose into the pump and then retightened. As far as I can see the entire area is now clear.

And that's after taking the landy down the local roads only to get stuck in a large traffic jam which took 30 mins of slow driving to clear before I could take a filter lane to double back home. Checking the area under the intake – it was completely clear.

The only one thing I'm not happy with is the blanking of the 2nd rear port of the pump. I have a feeling that's going to bite me if I rely on the epoxy filler – and if it does fail the loss of coolant would leave me stranded. I've just spotted a blanking plug in silicon (steel braid reinforced) and have bought two from eBay. I couldn't get them for a 19mm pipe (the only options were 18 and 20mm) but remember these ports are tapered and I think 18mm will work just fine. I've ordered two.

Final pic – complete with MAFS and air filter box – and showing a running engine



Little beauty

10th July 2012

A set of four silicon 18mm end caps arrived this morning.

The 2nd port on the water pump is now clamped and shut off. Even if the epoxy failed – the silicon end stop clamped with a jubilee clip will now prevent any leaks from that port

Important Checklist

1. Consider running the vehicle for a week or so, before retightening the log exhaust manifold bolts and then setting the locking tags. Or tighten the manifolds on the bench, and then lock

2. ~~Spark plugs need to be gapped. (Use 0.85mm and torqued to 21nM).~~

3. ~~Coolant pipe under inlet manifold is not secured (the two bolts are loose)~~

4. ~~Completely replace the oil and the oil filter. Stick to the 20W/50 oil from Halfords which still seems to be the desired oil for an engine of this age.~~

    a. ~~Note as of 26th June the old oil has now been drained and the old oil filter removed and replaced with a new partially filled new filter.~~

    b. ~~The sump is now going through two nights of full drain down.~~

    c. ~~As of 26th June new oil has been purchased – and I've stuck to the 20W/50 from Halfords.~~

5. ~~**Don't turn the engine over on the starter UNTIL AFTER you replace the oil and oil filter – given the sump oil is almost certainly contaminated with some amount of coolant.**~~

6. ~~Leave the water pump off the front timing cover until after the plumbing is sorted out for the heater matrix – on the off chance that we could close one of those two entry holes on the rear of the water pump mounting flange.~~

7. ~~Be careful when tightening the head bolts as the Haynes method is not the correct method. Refer to page 29 in the V8i Engine section of the land rover work shop manual (grey cover). There is a known problem with 14 bolt heads where the lower set of four bolts when tightened to same torque as the other 10 bolts effectively cause the upper surface of the head to lift away from the block deck by a small amount. The head is basically pulled down artificially by the lower four bolts leaving a gap on the other side. The net result is that although you usually don't spot a problem, blow by passes into the valley beneath the valley gasket causing a build up of contaminants (and a large reduction in the quality of the oil). Current advice is to torque the row under the rocker cover and the centre row of bolts (in other words bolts 1 though 10) to a full torque of 66.3 ft/lb (or 90Nm), whereas the lower four bolts should be torqued to the reduced amount of 44.25Ft/Lb (ie: 60Nm). Keep in mind the order of tightening is 1 through 10 first, followed by the lower four (bolts 11,12,13,14)~~

8. ~~Engine block threads need to be cleaned either using a tap or a cut bolt~~

~~9. The head threads for the exhaust and intake manifolds need to be cleaned either using a tap or a cut bolt~~

~~10. Log exhaust manifold threads and bolts need work.~~

~~11. Log exhaust needs spray painting with high temperature paint~~

~~12. Engine hoist brackets (bolted to the front of the passenger side head, and the rear of the drivers side head) needs painting~~

~~13. Valley gasket mount plates (front and rear) need painting.~~

~~14. Engine block threads need to have all fluids removed from the holes (oil and coolant). This needs to be done for all 14 holes per side.~~

~~15. Check the state of the lifters and cam lobes.~~

~~16. Consider replacing the starter motor (for the new part we have)~~

~~17. Coolant drain plug on drivers side of the block must be refitted~~

Started 5th May 2012 and ran to 10th July 2012
66 days working evenings and weekends only with a period of two weeks awaiting the engineering of the heads to be completed