CONTROLLING THE BEAST

Mark Weatherby recounts the development work that he and Igor Fedor undertook to improve the temperature control on their Seven 620R.

My interest in Caterhams goes back to the 1980s when I first saw a Series 2 Lotus 7 parked on the grass verge near my then girlfriend's house (yes, I married her!) Looking back, the chances are that it may have broken down, but at the time I just knew that I wanted one.

It wasn't until 1998 however that I was in a position to buy a Seven of my own, a new 1600 K-Series Supersport with a 6-speed box which I built myself. By 2004 however, I was craving more power and the Supersport was swapped for the then recently-introduced R400K which I also assembled from a kit. It was with the R400 that I got interested in trackdays.

Nine years on and I was getting itchy feet again, and thinking about replacing the R400 with something different. I toyed with the idea of a BAC Mono for a while, and even went as far as having an extended test drive and fully specifying a build. However I had a niggling worry that BAC, then a new entrant to the specialist small sports car scene, might quickly go the way that so many other similar companies have over the years, and that parts supply might become a problem. More importantly, I also felt that I would miss the Lotus Seven Club, or perhaps more correctly, the people within the Club who have provided great friendship and support.

The solution to my problem presented itself in November 2013 when Caterham announced the 620R. A quick test drive was sufficient to illicit my order and the car was built in the spring of 2014. As an added bonus, it was half the cost of a Mono! As an early customer (mine was one of the first seven built!) I was invited to see the car being assembled alongside the other early models. My car also features in the "How It's Made — Dream Cars" TV programme that was being filmed at the factory when it was being built (available to view on YouTube).

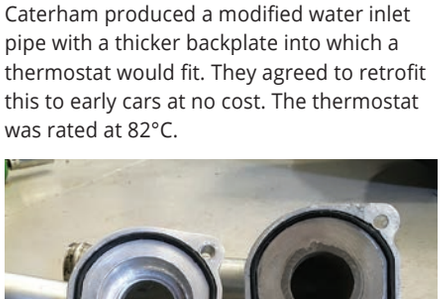
It wasn't long after I took delivery that I noticed that the 620R ran cool on the road, which was perhaps not surprising given that it has an intercooler, a radiator for the water, an oil cooler for the engine and a separate one for the Rotrex supercharger. The setup had been developed for the primary purpose of bashing around a track, but when used on the road during cooler times of the year, it needed some temperature control.

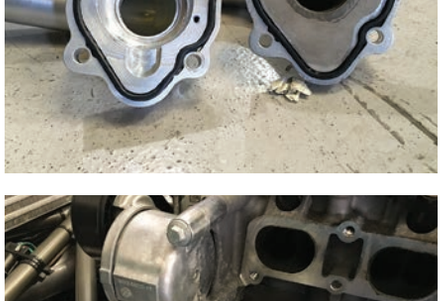
As an early owner, I was in regular dialogue with Caterham Cars about the ongoing development of the car. During that time, the exhaust system was upgraded to the current unit which includes the catalyst in the same housing as the silencer and thanks to my representations, all Duratec Caterham owners

Mark's 620R featured on TV's "How It's Made — Dream Cars"

can now benefit from nearside carbon rear wings that no longer have a cut-out for the long-gone, left-hand exhaust system. It was during these discussions that Caterham also agreed to look at adding a thermostat to the water circuit (it was designed without one) to keep water temperatures in the block higher.

The development of their solution took longer than anticipated, but in 2016 Caterham produced a modified water inlet pipe with a thicker backplate into which a thermostat would fit. They agreed to retrofit this to early cars at no cost. The thermostat was rated at 82°C.





Centre: Modified water inlet (left) next to original (right). Note the cut out machined into the new backplate.

Above: Partially-stripped engine bay, showing old inlet pipe still bolted to the block

Because access to this area is extremely limited, fitting the new inlet means removing the plenum and intercooler pipework. The adjacent photo shows the engine bay partially stripped by Caterham, with the old inlet pipe still bolted to the block. The only other water connection in this area in the standard Caterham arrangement is the black hose, which is the feed from the expansion bottle (and the heater return pipe if you have a heater).

The introduction of this modification improved matters to some extent, but in situations where the ambient air was below 10°C, I took to taping up the radiator a little to reduce heat loss, because the car still had a tendency to be overcooled. The car lived like that for several years.

In spring 2020, Mark — a new 620R owner who lives on the Isle of Man — posted on BlatChat that his 620R was running cool. What followed was a thread that ran to over 300 posts and clocked up nearly 15,000 views, possibly the longest of any during 2020 other than those discussing Brexit and coronavirus! It became apparent that all 620 cars ran cool, but that mine was one of the better ones, while some were running significantly cooler for reasons unknown.

I initially fell into the "been there — done that" camp, and suggested that owners taped up the radiator a bit, but it was suggested that this was rather a bodge and that there should be a properly-engineered solution. With friend and fellow trackday enthusiast Igor Fedor, we decided to take up the challenge!

Unlike the normal Duratec plumbing in its Ford configuration, there is no dedicated bypass circuit on the factory 620. Caterham had originally designed the system so that water circulated freely through the block and radiator in a continuous, unrestricted

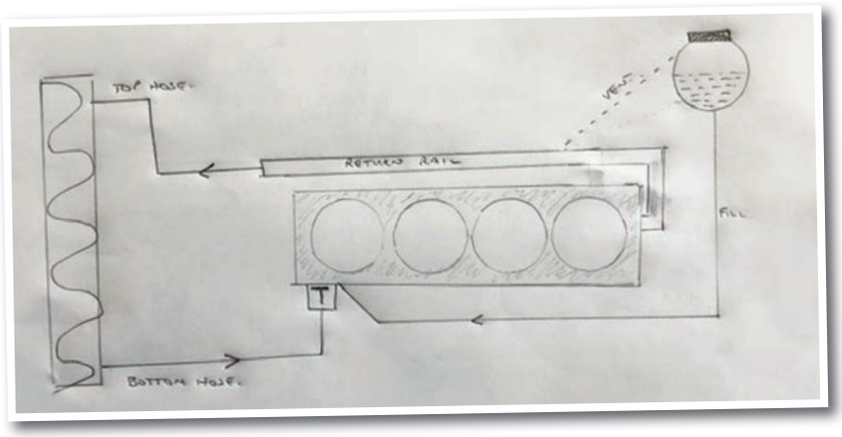


Diagram 1: Original 620R cooling circuit (no heater)

loop (left-side of diagram 1). To the right is another circuit comprising the air vent pipe and expansion bottle feed, which take care of venting the air and filling the system. The fill from the expansion bottle was plumbed onto the block spigot, the connection used for a bypass in a normal Ford set up.

When Caterham introduced the revised thermostat housing, it had the potential to shut off the primary coolant flow through the radiator completely until the thermostat opened. Opening would have to be via heat radiating back from the block, or via the only other circulation route i.e. via the air bleed vent and expansion bottle / fill pipe. Realistically, thermostat operation would be dependant on the limited flow that came via this latter route.

The air bleed pipe is a very small internal diameter, potentially giving sluggish thermostat response times. I think it was for that reason that a cut-out had been machined in the revised Caterham thermostat housing to allow free flow through the block, even when the thermostat was closed. The downside is that this cut out could flow cold water when it wasn't needed, resulting in lower running temperatures. We decided that a solution was needed to allow this cut out to be closed off completely.

With encouragement from other owners on BlatChat, Igor and I looked at introducing an arrangement similar to that which Ford had used when the engine was designed. The standard Duratec uses a double- ended thermostat — one end closes off the water supply from the radiator, the other closes off the spigot connection on the block which is fed from a bypass connection on the rear. As it moves to and fro, the thermostat balances the feeds from both sources. The standard Ford thermostat housing also has an unrestricted connection in the middle which is the constant feed from the expansion bottle.

The rear block bypass connection is relatively easy to resolve, so attention focussed on getting a third connection at the thermostat housing. An obvious solution was to fit the standard Ford thermostat housing as this is designed to fit the block and has one connection for the radiator feed and another for the expansion bottle, thus freeing up the connection for the bypass pipe. Unfortunately however, given all the intercooling plumbing that sits in the way, there was absolutely no way this would fit in the space currently available . A bespoke component was going to be needed.

Several mock-ups were made using wood and aluminium fittings to see if we could get a connection to the existing housing using proprietary fittings connected to a welded-on block fixed to the flange of the existing housing. However, it soon became clear that the off-the-shelf components were too big to fit in the available space and the angles weren't right. We'd need to have our own part fabricated.

New cylinder head rear water outlet takes the existing temperature sensors for ECU and gauge (top and L) and provides a return outlet to the radiator (R) and a new outlet for the bypass hose (bottom)

Modified housing (left) with infilled cut-out, new expansion bottle feed and additional mounting point for thermostat alongside original part

Where I live in London, specialists that offer bespoke component manufacture are in pretty short supply, but I did manage to find a promising-looking specialist company south of Manchester on the edge of the Peak District. Igor lives relatively close and paid them a visit, during which it was agreed that they could modify some new Caterham housings sourced through Redline (Thanks Chris!) and make us a couple of new housings. These have the machined cut-out infilled so that the thermostat can fully cut off the flow from the radiator, and a new expansion bottle feed hole at the top of the housing. We took the opportunity to add another threaded hole so that the thermostat could be retained on both sides to prevent any risk of it flexing open against the water pressure. Igor offered his car as a guinea pig, and the fabricator fitted the component he had made and the other parts we had sourced. A trial road trip showed that all was working well, and Igor's car was also run at the Club trackday at Anglesey; although the modification had been designed to keep temperatures up, it was equally important that the engine didn't

overheat either. It was a pretty hot day at Anglesey and the car ran perfectly. Now was the time to modify mine!

The new bypass outlet comes from a new machined block. It takes the existing temperature sensors for the ECU and gauge and provides a return outlet to the radiator top hose and a new outlet for the bypass. Originally made by Cosworth, these are no longer available. I sourced an alternative from X Power Engines in Essex at a cost of about £100 as I wanted any alterations to be reversable. If I was doing it again, I would buy the angled bottom pipe from Ford (less than £20) and having removed the plug in the bottom of the existing housing, had it pressed in to the original casting. Once the new rear bypass was fitted to the block, a new bypass hose (standard Ford component 1-462-573) was run to the spigot above the thermostat housing.

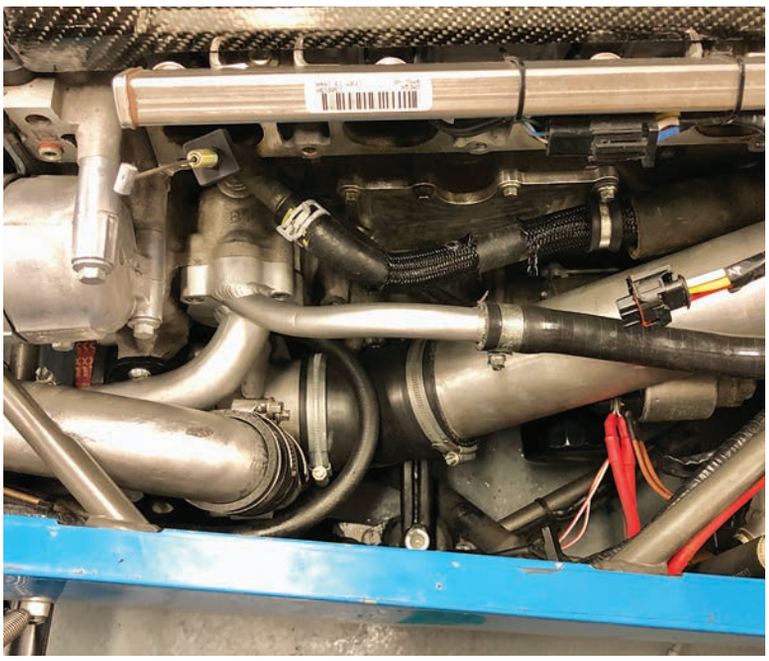
All the supercharger pipework was then reinstated. The position of the new expansion bottle feed pipe meant that some tweaking was necessary to the position of the throttle cable bracket to make sure that there was no chance of components rubbing.

With the revised flow, the thermostat remains fully closed upon start-up and water circulates through the block and back via the new bypass hose acting on the top of the thermostat. As temperatures in the bypass rise, the thermostat opens and bleeds in the colder water from the radiator and starts to close off the flow from the bypass, balancing the temperature in the block. Any air in the system is bled from the return pipe to the expansion bottle and the bottle feed keeps the system topped up, independently of whether the thermostat is open or closed.

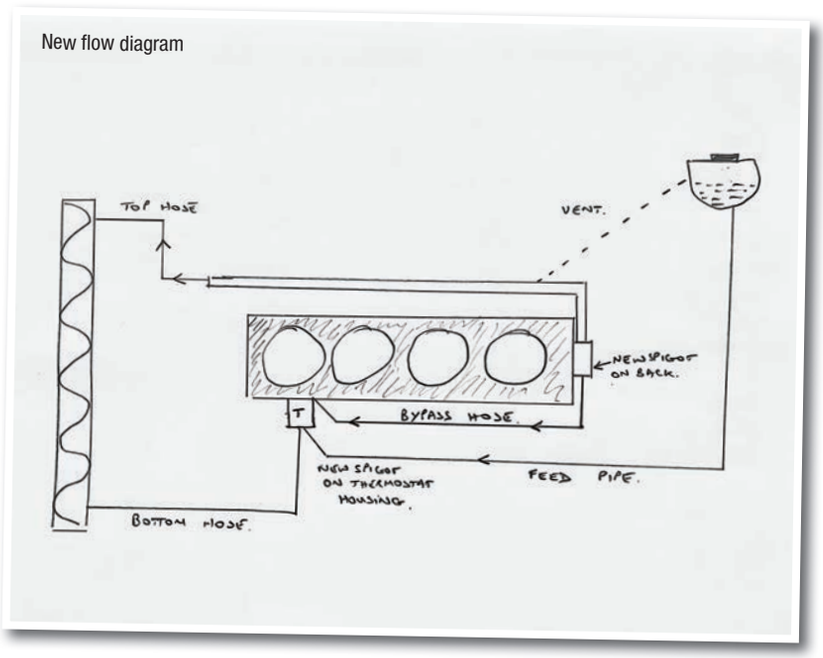
Thanks to the modifications, there is now a constant flow of coolant through the header tank due to the fact that this flow is now independent of the position of the hot side of the stat. As a result, the de-airing is more reliable. The thermostat is now exposed to the mix of hot bypass flow and cold rad flow. As a result, it can react much faster and regulate the water temperature more accurately. Because my car has an unlocked ECU, I was able to do some data collection on the results. Firstly, I just started it from cold and let it idle. It took five minutes to get to temperature, then sat at a constant 91°C.

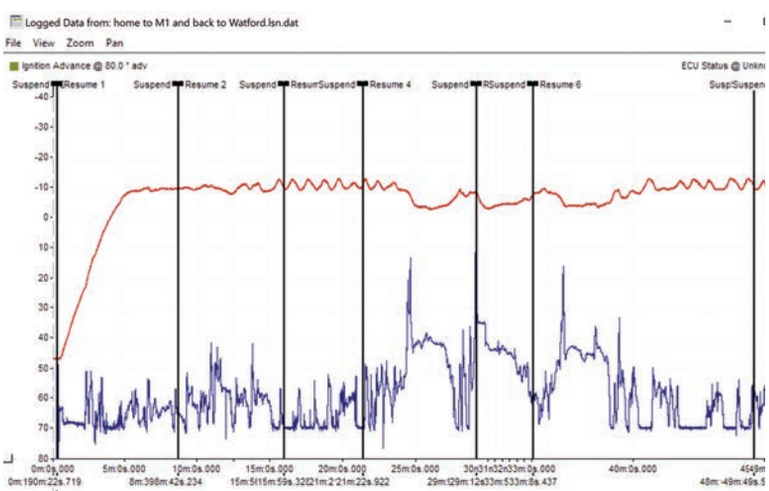
I then took it for a run through slow North London traffic up the motorway. Once again, the car warmed up within five minutes and held a pretty constant temperature of between 80°C and 90°C, including through some periods of harsh acceleration. The logging shows that the temperature initially drops by about 5°C under heavy load as the increased flow from the pump draws cold water from the rad, but the thermostat quickly arrests this and the temperature stabilises again. Prior to the mod, the temperature would have dropped to 70°C and stayed there unless the rad was blanked. The car has since done quite a bit of road mileage and a couple more trackdays and all is well. One of the side effects of keeping the temperatures up is that the fan kicks in more quickly than before. It is factory set to come on at 92°C, but given that I have an unlocked ECU, I might nudge it up a little to increase the cycle time.

Igor and I did this development for interest and experience; we are glad it proved worthwhile and hope that by sharing our knowledge, others may choose to do the same. We got a lot of support from other Club members during the development, and we have shared our findings with PGM Motorsport (Andy Jupp) and Simon Lambert of Caterham Cars. Caterham have responded by saying that they are looking at introducing something along the same lines, which was reiterated during the recent webinar with Club members. In the meantime, Andy has taken things a stage further and can now offer a conversion for anyone with a 620 who is interested. **LF**



Replacement thermostat housing fitted with expansion bottle feed relocated to new spigot, ready for intercooler pipes and throttle assembly to be refitted





Logging throttle position (blue) and temperature (red) shows that the temperature is kept under control during both low and high-speed running