MR2 Turbo Fuel Pump Replacement Testing Report:

Brought to you by WolfKatz Engineering, MR Controls, and Chico Race Works

Here are the main conclusions from our testing:

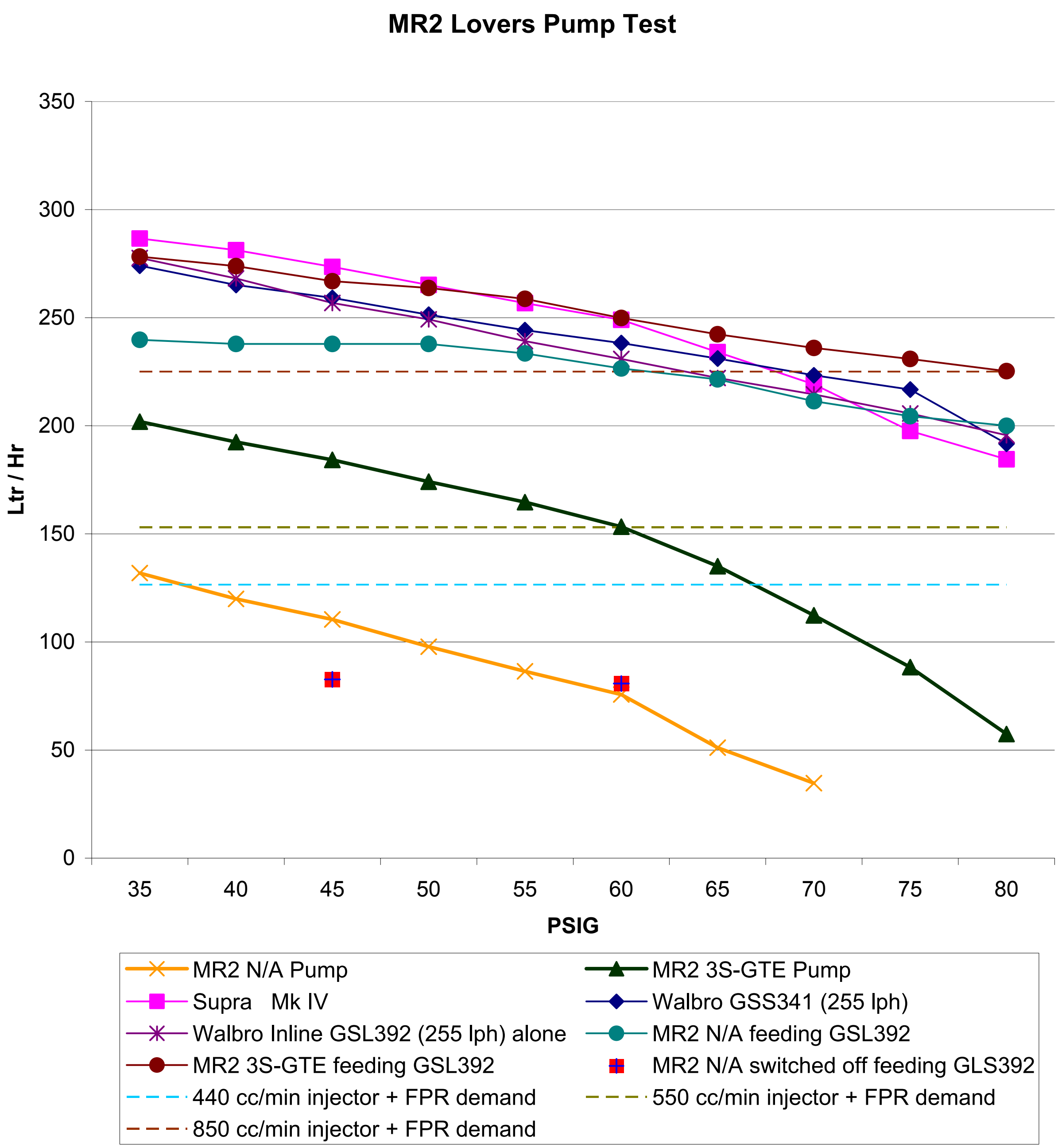
- The N/A pump is too small to support the 3S-GTE Engine at any boost levels above stock (10 psi). It is actually questionable to operate at 10 psi.
- When feeding an in-line pump like the Walbro GSL392, large amounts of horsepower can be made even with the N/A Pump as a “lift” pump.
- A failure of the N/A Pump or 3S-GTE pump in a “lift” mode (operating in conjunction with an in-line pump) will supply just enough fuel to your in-line pump **to blow your engine**. See recommended safety measures discussed below.
- The Supra Mk IV pump, Walbro in-tank GSS341 (255 lph), Walbro in-line GSL392 (255 lph) on its own with no lift pump, or the GSL392 with either an N/A or 3S-GTE stock pump as a lift pump are all **safe** for injector sizes up to 850 cc/min or 83 lbs/hr

Details:

Shown on the following page is a plot of the operating curves for various pumps that are often used as upgrade options in the 3S-GTE.

In order to draw some conclusions about what boost level/injectors each pump can support, we must first know an important detail about the FPR being used. In the worst case scenario we assume that the injectors are operating at 100% duty cycle and can calculate how much fuel is going out the injectors. However, it is **not** a safe assumption that the FPR is able to completely close (meaning no fuel flowing out the FPR). Thus there may always be some amount of fuel going through the FPR. In order to get a ballpark amount on this, we examined our previous testing. In the case where the stock 3S-GTE pump was used in the Gen II rail with 550 cc/min injectors, the pump was unable to keep up with the demand. For this test, the fuel pressure at the inlet of the rail dropped to 52 psi (even though the FPR was set for around 65 psi). Thus we can assume that the FPR was as closed as it is mechanically able (in an attempt to bring the pressure up). Using the pump curve above for the stock 3S-GTE pump, we see that the pump is flowing around 168 lph (liters per hour). Now, considering a pressure differential of 52 psi across the 550 cc/min injectors (which were held open) we see that there is 147 lph flowing out the four injectors. This means that there was 21 lph flowing out the Aeromotive FPR. We will *assume* this is the necessary flow out the Aeromotive FPR. It is important to realize that this introduces a large error into our calculations, thus these numbers are simply meant as a guide, ***not as an absolute guarantee!!!***

To determine the injector + FPR demand as shown on the plot, we simply took the injector flow rate, converted it to liters per hour and multiplied it by four (note this assumes 100% duty cycle). This was then added to the 21 lph that we have assumed is required to go out the FPR. Thus these lines are the fuel demand for the set injector size. As mentioned before, **this is not an exact number!!** The fuel system is very complex and there are many places that pressure and flow differences can be introduced. This is only meant to show the ball park demand for the different injector sizes.



Interesting points to notice:

1) Let's consider the worst case scenario for using the stock 3S-GTE pump with 550 cc/min injectors operating at 100% duty cycle. Note we **do not** recommend this; we are simply considering the worst case scenario for fuel demand. This would require 132 lph for the injectors plus 21 lph flow out the FPR for a total fuel demand of 153 lph. The 3S-GTE pump can support a total pressure of 60 psi, which is around 20 psi of boost. Thus the stock 3S-GTE is barely able to support normal boost levels (below 20 psi). When taking into account the possibilities of the pump flow being less than

that tested, the variation of voltage to the pump causing a variation in the flow, plus losses in the system (fuel filter, lines, etc.) it is not recommended to use the stock 3S-GTE pump with 550 cc/min injectors.

2) The question is often raised about safe boost levels for the stock N/A pump. If we assume 100% duty cycle (again, as a worst case; this is not recommended or even possible in some situations) and the stock 440 cc/min injectors with the assumed 21 lph flow out the FPR, we find that the N/A pump can not even support base pressure. If we assume 80% duty cycle the N/A pump can support a total pressure of 47 psi, which corresponds to around 7 psi of boost. Clearly there is little margin of safety if something happens (eg if your pump is older and unable to flow as much, if there is a voltage variation in the supply to the pump) and you can end up running lean even at low boost levels. Thus we recommend that the N/A pump **not** be used with the 3S-GTE.

3) Now consider the worst case scenario for 850 cc/min injectors operating at 100% duty cycle (not a good idea) at 20 psi of boost (assuming 40 psi base fuel pressure) for a total pressure of 60 psi. This would require 204 lph to feed the injectors plus 21 lph flow out the FPR making the fuel demand 225 lph. Any of the upgrade options can support this demand (although the N/A feeding the inline pump is right at the edge). Neither of the stock pumps are even close to supporting this demand. Taking into account the variabilities mentioned in 1), we don't recommend running higher levels of boost with 850's on the Walbro in-line being fed by the stock N/A pump.

4) If you decided to run an in-line pump in series with either of the stock pumps around, you run the risk of blowing your engine if either of the pumps were to fail. The points shown by the two large red boxes with black pluses above are what happens when the in-tank pump fails. This just enough fuel to run your engine lean under boost conditions and could blow your engine. Thus it would be wise to install some type of safety switch to kill your engine in the event that one of the pumps were to fail. An example of this would be to install two pressure switches both set at 30 psig. The first would be in-line between the tank pump and the in-line pump. The second would be after the in-line pump. An example of a pressure switch can be found here: http://www.omega.com/ppt/pptsc.asp?ref=PSW-190&Nav=preh02 . If you have to choose only one place to put a pressure switch, put it between the two pumps to protect the older of the two pumps. Wire the tach input signal that feeds your ignition (other options are available as well, you just want to immediately kill your engine if the fuel pressure drops) through the pressure switch(s) such that it is closed when the fuel pressure is below the 30 psig set point. When wired properly there can be no input signal supplied to the ignition and thus no spark at fuel pressures below 30 psig. Thus, if your pump(s) quit all of a sudden, you engine will just shut off.

The table of data used to create the above plot is show below.

	MR2 N/A Pump	MR2 3S-GTE pump	Supra MK IV	Walbro GSS341 (255 lph intank)	Walbro GSL392 (255 lph inline)	MR2 N/A feeding Walbro GSL392	MR2 3S-GTE feeding Walbro GSL392	MR2 N/A switched off feeding Walbro GSL392
35	131.88	201.89	286.6	274.06	277.6	239.75	278.23	
40	119.89	192.43	281.23	265.1	268.14	237.86	273.82	
45	110.43	184.23	273.46	259.13	256.78	237.86	266.88	82.65
50	97.81	174.13	265.1	251.37	249.21	237.86	263.72	
55	86.45	164.67	256.75	244.21	239.12	233.44	258.68	
60	75.72	153.31	248.98	238.24	230.92	226.5	249.84	80.76
65	51.11	135.02	234.06	231.07	222.08	221.45	242.27	
70	34.71	112.30	219.13	223.31	214.51	211.36	235.96	
75	131.88	88.33	197.63	216.74	205.68	204.42	230.92	
80	119.89	57.41	184.5	191.66	195.58	200	225.24	