



## Understanding Fuel Pressure

Monday, October 16, 2017

The Radium tech support department gets a lot of questions on all sorts of aspects related to fuel delivery. Many of the questions can be answered by understanding fuel pressure and how it impacts the output of the fuel pump(s).

### Fundamentals

Before discussing details of system pressure, it is important to understand some fundamentals:

1. Units: Bar vs. PSI. PSI (pounds per square inch) and Bar are two different ways to express pressure. To convert from Bar to pressure, just multiply by 14.5. To convert from PSI to Bar, just divide by 14.5.

**Bar x 14.5 = PSI**

**PSI / 14.5 = Bar**

### Constant Pressure vs. Rising Rate

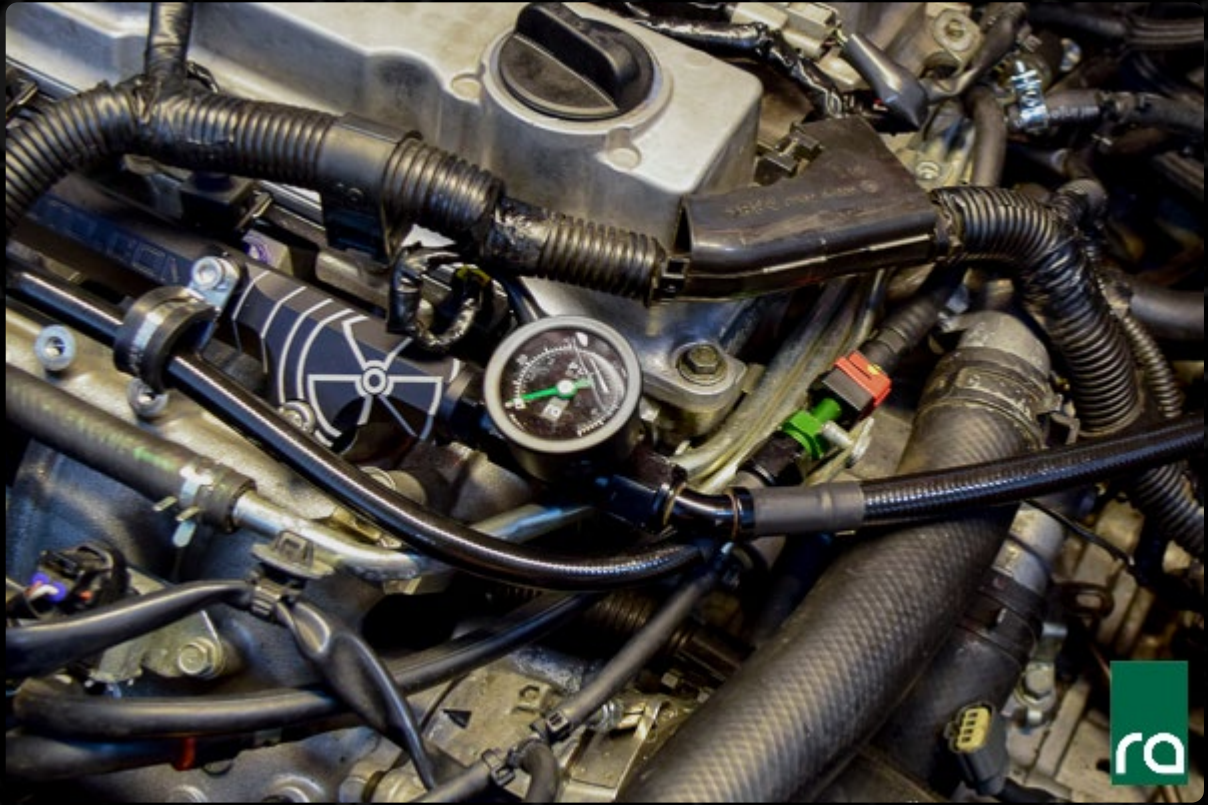
If the fuel pressure regulator (aftermarket or OEM) is connected with a vacuum hose to the intake manifold, then regulator is a 1:1 rising rate. This means that fuel pressure increases with boost and decreases with vacuum at a 1:1 ratio.

If the vehicle uses an integrated in-tank pump/regulator module, or there is no vacuum connection to the regulator, then it is most likely not pressure referenced. In this case, the fuel pressure is pre-set by the OEM and is held at that pressure regardless of what the engine is doing.

The focus of this article is on rising rate systems.

### What is my fuel pressure?

Fuel pressure is often measured at the fuel rail using a dial gauge or fuel pressure sensor. This is the best place to measure pressure when adjusting the fuel pressure regulator and calibrating the engine control because this is what pressure the fuel injectors are seeing.

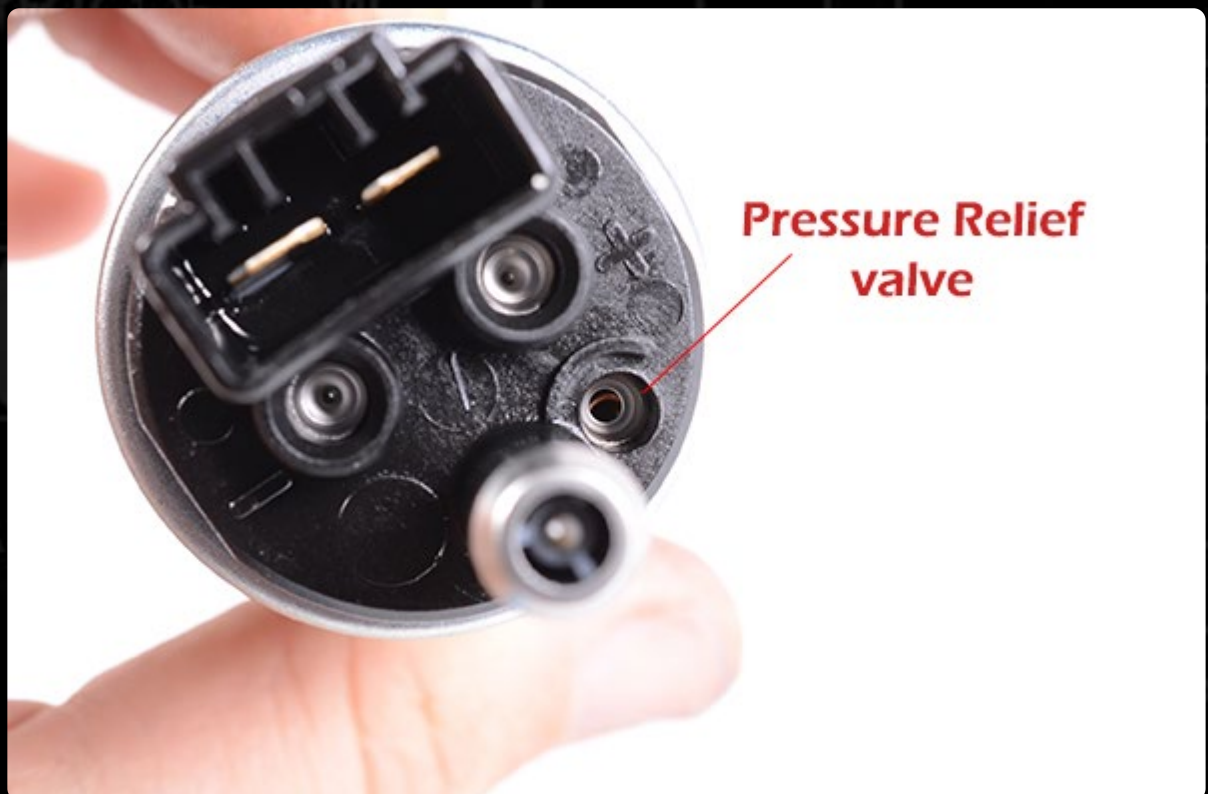


However, the fuel rail pressure is not necessarily what the pump is seeing. Due to inherent restrictions in hoses and fittings, the pump is actually experiencing a higher pressure. Unless it is explicitly measured, it is hard to know the exact value. Generally, 5 to 10 psi greater than fuel rail pressure is a good estimate. Knowing (or making a reasonable estimate) of pressure at the pump(s) is critical when troubleshooting a fuel delivery issue.

### Out of Flow or Out of Pressure??

When tuning a vehicle and fuel delivery becomes an issue, it is important to figure out exactly what the issue is, rather than just assuming "we are out of pump!".

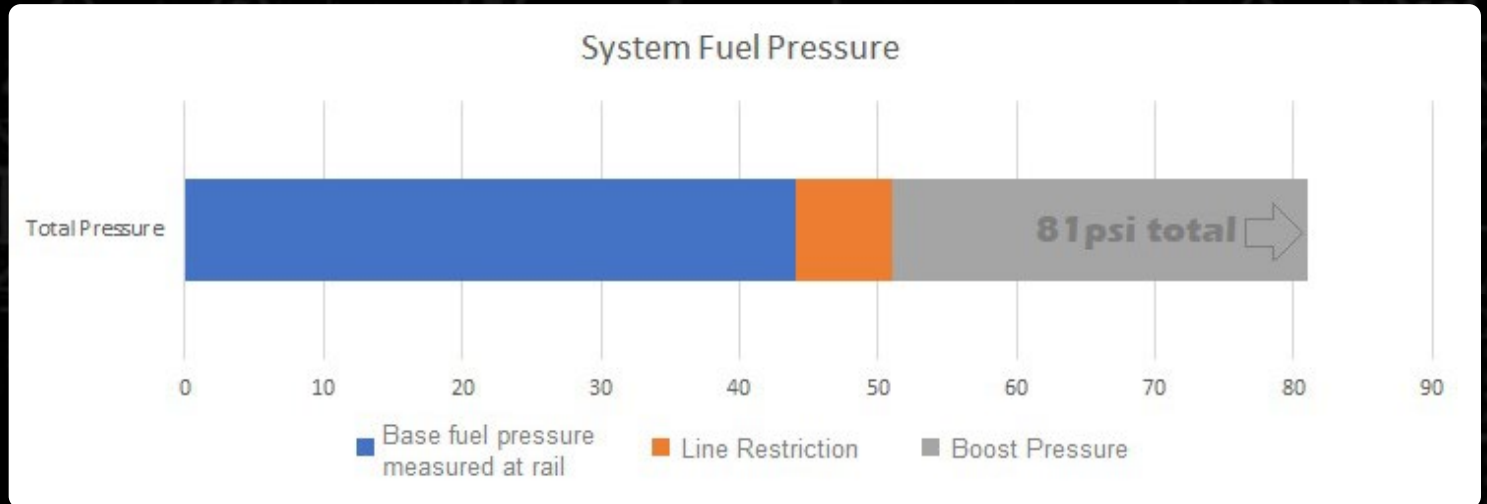
Modern fuel pumps, including all of the 39mm pumps that Radium uses in their products, include a built-in pressure relief valve. These valves are in place to protect the pumps from overpressure and damage.



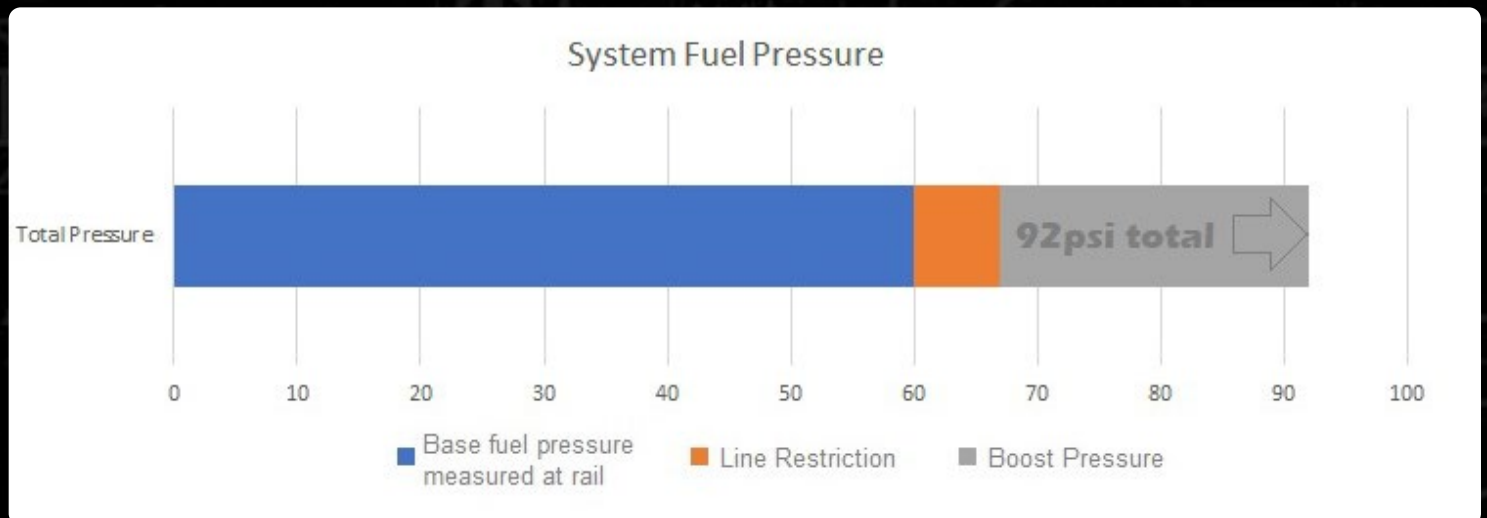


The pressure at which these valves open is documented on the [Fuel Pump Identification Page](#). Most open in the 87 psi range. When the valve opens, fuel sprays out, relieving the pump's internal pressure. When this happens, flow to the engine is reduced due to the flow lost through the pressure relief valve.

When a 1:1 pressure regulator is being used on a vehicle with forced induction, there is a chance that the maximum pressure might be reached. In the example below, base pressure at the fuel rail is 44psi, boost pressure is 30psi and 7psi is used to account for line restrictions. Adding these three numbers together yields 81psi at the fuel pump. This setup should be fine for use with standard pumps, as it is under the 87psi maximum relief pressure.



Looking at another case, the outcome can be very different. In this case a higher base fuel pressure has been used, 60psi, in order to compensate for slightly undersized injectors, or to get better injector atomization. When 25psi of boost pressure and 7psi of line restriction are added, the pressure at the pump is found to be 92psi. This value exceeds the common relief pressure of 87psi and will result in lost fuel flow when the pressure relief valve opens. This is often mistaken as the pump running out of flow.



The issue can be remedied by reducing the base fuel pressure to 50psi or less. With this adjustment, and retuning, the same fuel pump could possibly be used and the vehicle can be tuned successfully.

In applications where reducing fuel pressure is not an option, then searching for a fuel pump with a higher relief valve pressure setting could be an option. Radium Engineering offers the Walbro F90000274 pump with a relief valve setting of 112psi and can be used in high pressure applications.

There are other pumps on the market as well that can be used for high pressure (90+ psi combined pressure).