How to Size a Regulator Script

Selecting the correct regulator for an application requires intimate knowledge of what the application is. With the advent of high efficiency boilers and Tankless water heaters simply selecting a regulator by pipe size is usually not enough.

Common questions to ask are:

What is the application?

How far will the regulator be from it?

What is the turndown of the application?

What is the pressure going to the regulator from the source?

What does the pressure need to be cut to?

What is the capacity of the application?

First, to be able to properly size a regulator it is important to understand how a regulator works and how gas flows. All regulators simply open and close. The spring in the regulator controls the downstream pressure, the size of the orifice controls the rate of flow and the diaphragm senses downstream pressure. When an appliance turns on, the pressure between the appliance and the regulator drops. This drop in pressure also reduces the pressure on the diaphragm and the spring in the regulator pushes the valve open, allowing gas to flow. When the appliance shuts off, the pressure downstream of the regulator starts to climb. This pressure is multiplied by the area of the diaphragm (force = pressure x area) allowing a buildup of force strong enough to compress the spring, closing the valve and stopping the flow of gas.

All applications have working pressure ranges and with modern appliances the reaction time of the regulator becomes very important. The size of the orifice in the regulator and the distance of the regulator from the application determines the reaction time of the regulator. Gas flows like a line of dominoes tipping over. When an application shuts off, gas pressure builds up at the closed valve and, like dominoes, this pressure build up works its way back upstream to the regulator. So the longer the pipe the longer it takes for the pressure build up to reach the regulator. If the regulator isn't sized properly this will result in high lock up pressures because the seat will have to travel farther in the regulator to close off the orifice.
On start up the same domino effect occurs. The valve will open at the application and the pressure drop starts at that valve and works its way upstream to the regulator. When the pressure drop reaches the regulator, the regulator will open refilling the pipe. The size of the orifice in the regulator determines how quickly the gas will be supplied, refilling the pipe and feeding the application. If the orifice is too small the gas will refill the pipe too slowly and the pressure to the application will be supplied too slowly, resulting in flame out.

Knowing what the application is vital to selecting the correct regulator. More specifically, does the appliance ramp up from low fire to high fire or does it ignite on high fire? Units that only operate only on high fire require a larger regulator that will be able to supply the demand more quickly. Modulating systems are more forgiving, allowing more time for the regulator to react.

Sizing a regulator has been referred to as a dark science, because there are no hard, fast rules to go by. A predominant rule of thumb is to size a regulator so that the application is no more than 80% of the regulators capacity. Above 80% on a regulators capacity is known as the "droop range". Droop is when a regulator will sacrifice pressure to maintain flowrate, so a regulator should be selected where the application does not fall into tis range.

From what has been reviewed so far the capacity of the application is needed, but also needed is the working range, or turndown, of the application. Turndown of the application is just the high BTU rate and the low BTU rate. Dividing the high by the low will give the Turndown ratio. Regulators also have turndown ratios that are listed by the manufacturer. It is important that the turndown of the application is smaller than the turndown of the regulator.

The pressure supplied by the utility must also be identified. Normally this will be a single pressure, but depending the utility, pressure fluctuations may occur, so all possible inlet pressure must be known. Finally, what is the working pressure of the application? This will be stated as a pressure range.

There is now enough information to select a regulator. Pipe size was deliberately not included because more often than not the capacity of a regulator and the size of the pipe will not match.

It all comes down to inlet pressure, outlet pressure, capacity of the application and distance from the regulator to the application. Know the turndown of the application and the regulator, keep the capacity of the application less than 80% of the regulators capacity and select a regulator.