# LOWE Industries

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# Fuel Injection Instruction Book

The Fuel Injection Instruction book has been updated and now has 31 Chapters and 200 pages of full of information, graphs, diagrams and photos.

The LOWE Fuel Injection book is the most comprehensive and most technically up to date fuel injection book in the world. It covers information on all types of constant flow fuel injection for virtually every application.


It includes the following:

Prologue
Chapter 1 Introduction to basic fuel systems
Chapter 2 Fuel pumps
Chapter 3 Barrel valves
Chapter 4 Jets
Chapter 5 Nozzles
Chapter 6 Poppets
Chapter 7 Other valves
Chapter 8 Setting idle fuel volume
Chapter 9 Setting stage fuel volume
Chapter 10 Tuning – non supercharged
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Chapter 12 Fuel tanks and fuel
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Chapter 30 Glossary of terms
Chapter 31 Blower overdrive

**Topics**

Setting the butterflies on stack injection - Chapter 10
Setting the port nozzle check valve - Chapter 6
Setting the high speed check valve - Chapter 6
**First pass on new fuel system** – Chapter 20
Thread size chart – Chapter 19
Air density gauge - Chapter 25/27

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---------------- Below are some exerts from the book ---------------------

The LOWE Fuel systems instruction book covers the basic operation of the constant flow fuel injection in all race applications. Discussed are the details of the following components in the fuel system.

**Fuel pump**
**Barrel valve**
**Main jet**
**Nozzles**
**Poppets**
**High speed jets**
**Pump savers**
**Pump sizers**
**Pinch valves**
**Stage valves**

## Sample from the fuel system book....

Constant flow port injection fuel systems are basically simple. The camshaft driven fuel pump displaces a certain volume per revolution. The pump is sized to the displacement of the engine and the type of fuel used. Alcohol and nitro require larger pumps than gasoline because those fuels are consumed at a faster rate. The size and condition of the fuel pump is important, as the pump is the basis of the fuel delivery to the engine. The system only starts to get complicated as you add more features to your system...........

Constant Flow Port injection is meant to be efficient at four throttle positions.
Idle
Prelaunch (stage)
Transition (from prelauch or stage to wide open)
Wide open

**Fuel pump:** These are the "heart" of the fuel system. Pumps are sized for the application based on engine size, fuel type, blower size and even compression ratio. If your fuel pump is slightly too large we can "size" it down when we flow the system. (See pump sizers) If your fuel pump is too small the choices are to either speed the fuel pump up with an overdrive or replace it with a larger pump. We "size" your fuel pump to allow you to use main jets in the range of .100 to .125. This allows you to .....

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Maintenance of your fuel pump is important, after each race drain all the alcohol out of the system and oil the pump with a WD type oil or castor based oil, engine oil is not recommended. Blow the system out with air and spray with WD, Inox or Tri-flo and blow again.

## Pump condition and care.

***DO NOT LEAVE ALCOHOL IN YOUR SYSTEM.*** If you don't like working on your car then take up fishing. I don't care what anyone else says it is a recipe for disaster. If you leave alcohol in the system it will bite you some day- this is a guarantee. Get the alky out of the system and flush the system with WD-40, Inox or Tri-flo. The best stuff to use is Tri-flo. A lot of bicycle shops sell it as a chain lube. Try your local Supercycle shop. The fuel pump is the "brains" of the fuel system. If you are going fast you must know what your system is doing so you can repeat it if necessary. If your pump goes away how do you know where you are ? If your pump is weak now and you are going fast when you put a new pump on after the old pump completely fails where is your tune up? If you are not going fast now could this be the reason ??

**Barrel Valve:** If the fuel pump is the "heart" of the fuel system then the barrel valve must be the "brains" of the fuel system. The barrel valve is located between the fuel pump and the nozzles. The barrel valve sets the fuel volume to the engine at idle and at staging. On almost all barrel valves the idle volume is set with the hex cross link between the butterfly shaft and the barrel valve. Making this shaft shorter will make the idle "leaner" and making it longer will make it "richer". An easy way to measure this is with a leak checker with a .040 jet and a good regulator (see leak checker). Be sure to close or cap all other return ports in the barrel valve before testing as all you want the air to flow across is the slot or notch in the barrel valve spool. The leak checker must calibrate 80% leak with a .080 jet or orifice this is the 80 at 80 the racing industry standard method of comparing the idle position of the barrel valve slot. The race car tuner or crew chief will determine what the final adjustment here is. The best way to set the idle fuel mixture is with a pyrometer measuring the exhaust gases temperature (EGT).

Staging volume is a little more tricky and I have separate section on this . At wide open throttle(WOT) the barrel valve is not part of the fuel control system, except for the fact that some barrel valves have a lot of internal restrictions. As such if you have poppets before or after the barrel valve with a lot of restriction in the barrel valve it will effect the pressure in the system and as such effect the release of the poppets. The higher the fuel volume the more important this is. The fuel volume on normally aspirated fuel injection is very low compared to supercharged so this is much more important on supercharged engines than on non supercharged engines. Every fuel injection manufacturer has different barrel valves. Where the main jet is located in the system changes on each brand. On Lowe fuel systems the main jet is in the barrel valve. This also applies to Enderle and Waterman systems. The Hilborn system put the main jet in the idle check spring can.

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**Main jet:** The main jet is a removable drilled orifice he main jet sends some of the fuel back to the tank. The fuel pump supplies 100% of the fuel. If 70% of the fuel goes to the engine via nozzles then 30% goes back to the tank via the main jet. This allows the engine tuner to make one change and completely recurve the fuel delivery to the engine. This is different than carburetors where you have to change all the main jets to completely recurve the fuel system to allow for weather or other changes With fuel injection the nozzles only set the fuel pressure in the system. With fuel injection there is a relationship between the nozzles and the main jet. A balance should be maintained so the main jet size is between .100 and .125. If you go over or under this range the car will still operate but the changes in the main jet will not have the same size steps. This is usually not a problem in normally aspirated systems as the fuel volume in these systems is not as large as in supercharged systems. If the pump size is slightly large and the engine is "rich" with this range of main jets then you have a few options. Put on a smaller pump, put an under drive on the pump, or install a pump sizer. You should keep the main jet between .100 and .125. There are plenty of people racing that do not follow this guide line although I feel they would be a better tuner if they did. Get a calculator out and do the sums on jet size area do them all between .050 and .150 you will see the percentage difference in the steps every .001 under .100 and over .125 When you start to change sizes. you think you are making a change of a certain size but the actual change is a smaller or larger percentage than you think. Larger than a .125 and the return hoses have so much restriction in the flow the hose starts to act like a jet. I did a test on the flow bench to show a customer once and he had a .190 jet in his barrel valve. I ran the system with the .190 jet and then WITHOUT a jet. It ad the same flow numbers without the jet as it had with the jet in the barrel valve. The return hose was acting like a jet.

Look at the chart below to compare nozzle size changes in percentages.

-------------------------------------------------------------------------------

.125 main jet has .01227 sq in of area.
.124 main jet has .01208 sq in of area. This is a 1.55 % change.

-------------------------------------------------------------------------------

.100 main jet has .00785 sq in of area.
.101 main jet has .00801 sq in of area. This is a 2.04 % change.

-------------------------------------------------------------------------------

.060 main jet has .00283 sq in of area.
.061 main jet has .00292 sq in of area. This is a 3.18 % change.
A 3+ % change for a .001 jet change is too much for a main fuel system. It is OK for a secondary system like a high speed, pump sizer, enrichment or lean out valve. If the main jet is too large the idle return hoses will restrict the flow back to the tank and if the main jet is too small the changes are too large to make small steps in the tuning. I have always said that small main jets can cause tire shake because if you are very close to the correct fuel system for your combination and you make a .005 main jet change from .065 to .060 you are changing the fuel system. This is a 17.3 % change. Do you REALLY want to make a 17 percent change to your fuel system ? Even if you only change it .001 you are changing it 3.2 % and if you are "on the edge" this might step you over. Lean cars on good tracks shake. Lean cars on loose tracks might be able to spin the tires and get past the shake.

Enderle jets have a 7/16" threaded main jets with a slot for removing them. Note: I did not say screwdriver slot. The sides of a screwdriver have tapered sides and can (will) slip causing the screwdriver to burr the slot on the jet. Also the screwdriver large enough to snugly fit the slot will be so wide it will burr the threads so you usually grind one down or use a screwdriver that is too small. Buy one of our jet tools with flat sides and a grip surface to "grab" the slot ... or make your own but don't use a screwdriver. CAUTION ! If you are having a conversation with someone while you are putting the main jet in the barrel valve you might be distracted and put the original jet back in or put both jets in one on the top of the other --- now this will frustrate you. Slow down and take note of what you are doing . You won't believe how many people have made this mistake. I have. We recommend putting a bit of red tape on the shaft of the jet tool when the tool is fully in the barrel valve. If there is space between the barrel valve and the marker tape on the jet tool this will tell you that you have two jets in the barrel valve; one is on top of the other. Tuners will add check valves with a jet to alter the fuel flow curve to the engine. A note of caution applies as the jet is designed only to flow fuel FROM the "back" side of the jet not the slot side. If you install a jet in the system where the fuel can enter from the slot side the fuel flow can be different just based on the condition of the jet slot. Always ensure that the edges of the hole in the jet are neat and square without nicks or any type of chamfer. Changing the design of the jet will dramatically alter its flow characteristics and a .125 jet may flow like a .105. This will really upset the tune up. Almost all jets are based on "square edge" orifice calculations and any attempt to "redesign" the jet will make your "tune up" numbers impossible to correlate with whatever anyone else is doing.

**Nozzles:** The nozzles are removable drilled orifices that deliver the fuel to the engine. The fuel pump supplies 100% of the volume and if 30% goes back to the tank via the main jet then the other 70% goes to the engine via the nozzles. Nozzle sizing is based on what pressure you want the system to operate at an what size main jet you want to use and the fuel pump size. Simply saying that a 350 cubic inch engine uses a certain size nozzle makes a lot of presumptions. If those presumptions are true then the answer is true. If not then the answer is not true. How can anyone size your nozzle requirements unless he know how much fuel your pump flow. If you tell him that you have a certain size pump then the presumption would be that your pump is a very good pump or a average pump. There can be as much as 10% difference in flow at operating pressure from a average pump to a good pump. Both will work but must be jetted and nozzled correctly.

Now you have the basics covered with the pump, barrel valve, jets and nozzles. If you want to further customize your fuel curve it can be done with other devices such as high speed poppets and jets, pump sizer poppets and jets and stepped fuel systems.



**High speed valves or secondary valves:** In most applications as the engine reaches higher and higher rpm the volumetric efficiency of the cylinder heads and camshaft falls off. In other words per rpm the engine doesn't flow as much air. To make the most power you must keep the air-fuel ratio where the engine wants it. The high speed valve is set to open at a certain pressure when the system reaches this pressure the valve will open. Most supercharged systems will require a jet used in conjunction with this valve as supercharged engines require/produce higher volumes of fuel and need more fuel per rpm in the higher rpm ranges. Usually the screw type blowers are so efficient at high rpm that .......

**Pump Sizer:** If the high speed valve is open at low rpm (less than 5000 rpm) it is not a high speed valve it is considered a pump sizer.

**Pump Saver:** You can set a poppet to a pressure much higher than the normal system pressure and create a safety valve for the system. In some systems where you have a very small main jet, and all the high speeds are located after the barrel valve and you have no pump sizer you run the risk of a very high pressure spike when you close the throttle after a run. When you close the barrel valve which is connected to the throttle shaft it closes off the fuel flow to the engine and everything the fuel pump is pumping is trying to go back to the tank.

**Other valves:** (Enrichment and lean out valves, pinch valves)
There are scores of different ways to tinker with the fuel system. I have seen launch lean outs and launch enrichers and second gear enrichers and lean outs as well as high gear ones. These are called stepped fuel systems because the fuel system steps from one size to the next depending on how many steps the tuner wants to make.

**Setting the idle volume:** The fuel pump supplies fuel to the barrel valve and the idle circuit. At idle rpm the engine needs very little fuel and therefore the barrel valve is nearly closed. The opening of the slot in the barrel valve lets the idle fuel get by to reach the nozzles. To allow adjustability in the system some fuel is always going back to the tank. The idle check valve spring sets the idle system pressure and on most barrel valves the short hex cross link between the barrel valve and the throttle plate adjusts the amount of slot that is open allowing the fuel through to the nozzles.

**Setting the staging volume:** On most fuel systems the idle fuel volume and the prelaunch fuel volume are tied together by the shape of the barrel valve spool slot. When you adjust the idle by turning the cross link to give it more fuel at idle. This will also give it more fuel at prelaunch- wide open is unaffected by this. At wide open the system is just a pump, jets and nozzles, the barrel valve is not controlling the fuel volume. By changing the idle check springs and changing the barrel valve leak you can get the idle that you want and .....

**Tuning**: **Normally aspirated alky:** Most non supercharged engines don't make enough cylinder temp to color the plugs so most tuning is done by observation and the time card. If the car goes faster it is making more power. On engines with enough compression and the correct heat range plug you ..........

**Tuning: Supercharged alky:** Different superchargers create different cylinder conditions and as such the tuning becomes much harder. Non helix blowers are usually tuned by reading the plugs looking for the magic 1100 degree Fahrenheit (where aluminum melts). Helix and screw blowers have a cooler blower exhaust charge therefore don't show the heat as much on the plugs. These are usually tuned by .....



**Fuel tanks**: Do not run the fuel back to the tank above the fuel pick up in the tank. A lot of fuel tuners today are installing a nipple in the fuel pump inlet to return the fuel to so they don't agitate the fuel in the tank.

**Note:** I do not recommend running a high pressure poppet line back to pump suction as it might not purge during the burn out and purge any air it may have during the run. If your poppet is before the barrel valve and set for over 50 psi run it back to the tank. If your poppet is after the barrel valve and set for over 30 psi run it back to the tank.

Fuel tank vents must deliver air to the tank to replace the fuel used by the engine. The more fuel the engine uses the larger the tank vent must be. I recommend a minimum 1/2" inlet on all non supercharged engines and 3/4" on all small supercharged engines or with a 6-71 or 8-71 blowers. Use a 1" tank vent on large engines with large blowers up to Top Alcohol type engines.

**Fuel:** You can use gasoline (petrol), methanol or nitro methane as a fuel source with gear pump driven constant flow port fuel injection. The small consumption rate for gasoline makes it a particularly difficult fuel to use with this type of fuel injection due to the small nozzles required. Though it is possible to use gasoline with this type of fuel injection the tune up window is much smaller than it is for alcohol (methanol). Because you will use 2.2 times the liquid volume with alcohol this acts as a natural cooling force to help prevent overheating of the race engine. The fuel volumes required for alcohol gives the tuner a broader tuning window. Nitro is different still. You can adjust the percentage of nitro to alcohol which will change the fuel volume required With nitro the more fuel you can put in the engine and burn the more power you will make. The injected nitro cars in the 1970's would run high 6.90 ET’s yet today the injected nitro cars run 5.3's ET’s and the cars all weigh over 700 pounds more today. Why ??

Most fuel injection systems use methanol as a fuel. Methanol will absorb water from the air so keep the lids on all the containers tight. Keep the fuel tank covered to stabilize the temperature of the fuel because as the fuel changes temperature the density changes which causes different flow rates into the engine. For example on one test I had a system on the bench and did three tests with the same hardware .........

Now, we all know that you want to reduce the fuel flow to the engine as the weather gets warmer (lean the engine) but you want to do it based on your calculations from your data. If the tank sits in the sun and gets "overheated" in relation to .........

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FYI
Specific gravity of methanol is .792
Specific gravity of water is 1.00

**Leak testers:** A leak tester or leak checker is a way of measuring the size of a hole or an orifice. The hole could be any shape and this device would measure the amount of air it would flow and this can be compared with a percentage of leak to any other hole. You measure the amount of flow the hole has, not just the size. Some holes of the same size will flow different amounts based on the inlet and outlet shape or the internal finish. By using a **high quality** regulator, and a .040 orifice as a standard restrictor you can make your own leak checker. See the diagram for the configuration of the device. Once you have a leak checker it can be used to analyze the condition of the piston rings. It can be used to compare nozzles and jets to ensure that the .095 nozzle or jet is larger than the .094 that is in the fuel system.... (they aren't always !) You can use them to set the barrel valve spool rotation position to measure how much fuel the engine is getting at idle and at prelaunch position. Once you have a leak checker you will find a lot of uses for the device. There are a lot of poor quality leak testers in use because of inexpensive general application regulators and or bad calibration. Most of the best leak checkers are "home made" as the builder understands what he wants. The people who just buy one don't really understand how important a high quality regulator is for accuracy needed. There is two ways to check the accuracy of a leak checker. One check the calibration (80% leak @ .080 orifice) this will read 20 psi (on a 100 psi gauge) with a .080 orifice on the end of the leak checker hose. Two is to zero the gauge on the leak checker (100 psi) and then move the knob on the regulator **ANY** movement of the knob **MUST** result in movement on the gauge needle. If the knob can be moved **any** amount then this is a "dead band" in the regulator indicating a cheap regulator which will result in inaccurate percentage readings even if it can be calibrated to (80@ 80). Ask yourself how much inaccuracy you are willing to live with. Do you check the clearances in the engine with a tape measure or a micrometer ? The people who make them for resale are trying to make a product at a price and as such don't usually use the highest quality components. Simply purchasing a name brand and expensive leak checker is no guarantee of accuracy, you purchasing a high quality regulator and gauges will give you this guarantee. The "brains" of a leak tester is the regulator and the gauge. Cheap gauges and regulator will not give you good, quality repeatable information. I prefer to use a 5" dial on a **instrument quality** 100 psi gauge. All leak testers have a jet or nozzle between the regulator and the gauge. The quality of the drill on the jet will determine the scale on the reading. This doesn't matter a lot unless you start comparing your information with someone else. The standard **calibration** is that you will flow 80% leak with a .080 jet in the end of the leak tester hose. This is usually achieved with a .040 nozzle inside the leak tester. I use one of our standard .040 main jets to achieve this. (An Enderle will do as well) this has a 7/16 unf thread and can therefore be replaced and adjusted to achieve the calibration of 80% leak with a .080 orifice. I have done some research and found high quality hardware so you can build your own leak checker that will provide you with very high quality information.

It is a good idea to "leak" your jets when you change them if you are making small changes because a lot of the time you will find a bigger (or smaller) jet will not flow more (or less) fuel. You think you are changing from a .105 to a .106 jet to lean the engine back just ........

**What blower overdrive should I use ?** Remember the more air you can put through the engine the more horsepower you will make. There is a limit to how much you can turn a non helix as at some point it will just start cavitation and stop pumping air. It will still take more horsepower from your engine ..........

**How much boost should I have?** There are a lot of things that will affect the boost pressure. Blower size, blower efficiency, blower overdrive, are the ways most people think will change the boost and they are correct, but there are other ways as well Think of boost pressure as the air that is NOT getting in the engine. The supercharger pumps a ..........

**Computers ...... data loggers** On board data loggers (computers) will keep a record of EGT (exhaust gas temperature) while on the run and under load. This is a very good way of seeing the temperatures in the exhaust pipe. This is an indication of what is going on in the cylinder but not the final word as the spark plugs and bearing shells will tell you what is happening. Some data loggers will ...........

**How do you select the nozzle size for the engine ?** The nozzles are calculated to provide the fuel delivery by total area based on square inches of nozzle area. There are ratios that I have found work with various factors, such as .........

**How do I make more horsepower ?** This is very easy, just BURN more fuel. Now it gets hard, how do you burn more fuel. Just add more air and ...........

If you have the correct pile of parts to make an engine make power, such as cylinder heads, camshaft, and the block and crank is strong enough to hold it all together, plus a decent car to put it in; now all you need is the tune up. EVERYTHING relates to blower, fuel and clutch. If you pay attention to these parts you will make power.

**Should I stagger the sizes of the nozzles ?** Only to "square" up the fuel system for what the engine wants. Some blowers cause the fuel to .......

**What do port nozzles do & do I have to run them in my engine ?**
No you don't have to use them unless you need them and not all combinations need them. On roots type blowers I prefer to put as much fuel through the blower as possible. This cools and seals the blower. You get more boost faster by doing this. Port nozzles are .....

**When should your port nozzles open ?**On a supercharged car the starting line rpm is part of the tune up. Change the rpm and you effect the fuel system, blower rotor speed(boost), and clutch - everything that makes a supercharged car .......

**How do you set your port nozzle check valve pressure to open when you want to ?** You have to do a staging test. First determine what rpm you want to leave the starting line with. Now get the car ready to start, it will .........

**What spark plugs should be used ?** Superchargers create the environment inside the engine for making a lot of heat. The more heat that you make the colder the spark plug you need. When in doubt .........

**What ignition timing should I run ?** There are a lot of variables here. Compression ratio, combustion chamber size, dome configuration and more all contribute to the starting point for the ignition. The engine is .....

**What type of ignition should I use ?** There is a vast difference between what the ignition requirements are for an engine based on whether the fuel is gasoline, alcohol, or nitro. The first thing you have to look at is .........

**How do I set the idle rpm of the engine?** The idle rpm is set by the amount of fuel being delivered to the hat and the amount of air given to the engine by the hat. When you get your fuel system back the barrel valve leak is set at the desired starting point for fuel flow delivery. Stop right now ......

**How much fuel should my engine consume at wide open throttle?**
This is a crew chief or fuel tuners decision. EVERY engine fuel requirement is different based on dozens of possible variables in each engine combination. To make more horsepower it takes more fuel, the more .........

**What is a pump sizer?** The fuel pump is the "heart" of the fuel system and sometimes you need to have a fuel pump that is between the available sizes. There are a couple of options here. Firstly......

**Fuel pump extension:** We supply these in 2.5" and 5" lengths. The 5" is normally used in supercharged applications so the pump can be installed just outside the blower belt. The 2.5" is used in two applications. One is on a non supercharged engine to get the fuel pump out past a large harmonic balancer. The other is where you have an overdrive on the fuel pump which is 2.5" long and you still want to get the pump out past the blower belt so you need another 2.5" of length. Our fuel pump extensions are made with a support bearing on the internal drive shaft to remove the axial load from the fuel pump drive input thereby increasing fuel pump life. Due to the weight of the fuel pump, the hoses and the fuel in them and the vibration and tire "shake" that exists on drag race cars our fuel pump extensions are made from CNC machined billet aluminum. We have made the outer drive shaft housing .....

**Fuel pump drive magneto drives:** Although the magneto drive is not part of the fuel system I thought I would mention these here as they use the hex drive from the camshaft like the fuel pump does. We make these in 8.2" offset to allow the installation of the magneto on the front of the engine giving more room on the top of the engine for large superchargers or fuel injection. The FPMD (Fuel Pump Magneto Drive) is available with 2.5" extension to set the FPMD back inside the blower belt or with a 5.0" extension to set the FPMD outside the blower belt allowing you to rotate the FPMD to clear other hardware (fuel tanks, cross members, ECT). Since the FPMD is driven from the front of the camshaft and all engines turn the same direction they will fit any engine that has a camshaft drive fuel pump. You will need a Chevrolet rotation Supermag for this application. One option is to have a mechanical tach drive on the FPMD, another is to have a quick disconnect fuel pump flange installed on the FPMD.

**Filters:** Drag racing is a relatively clean racing and very few people use filters. Clean the tank, clean the lines and strain the fuel and you will have no problems. Some people have used filters on the pump discharge side. Most people .......

**Shut off valves.** All sanctioning race bodies will require a fuel shut-off valve. Some are simple 1/4 turn valves that just interrupt the flow to the barrel valve. NEVER install a shut off valve on .......

**Hoses:** Old, hard, used hoses have caused many problems in race car fuel injection systems. The fuel line hoses should be replaced every 12 months. The hose can "flake" off on the inside and small pieces of rubber can get lodged in the injector nozzle. The inlet hose can......

**Fittings**
Check flared steel and stainless lines for cracks at the intersection of the flare and the tube.

**Stainless or rubber nozzle lines?**
The options are stainless steel tube or rubber lines. Each has an up side and a down side.

**Stainless tube up side:** Won't rot - Looks good

**Stainless tube down side:**
*Can crack at the flare causing loss of system pressure and fuel delivery causing blower backfire.
*Difficult to relocate if you want to move the nozzle location.

**Rubber hose up side:**
*Easy to tune the engine by changing the nozzle locations.
*Won't crack the flare if you shake the tires hard.

**Rubber hose down side:**
*Will dry rot and cause flaking of the inside of the hose. Will need to be replaced regularly.

We make both kinds of lines right here at LOWE Fuel Systems.

**Nozzle holders:** The nozzle holders in the hat are vented or aerated. This allows the engine to draw air in through the nozzle holder past the nozzle and cause the fuel coming out of the nozzle to be broken up into very tiny droplets. This makes a very ......

...... Nozzle holders are not the only cause of "look rich - run lean" systems. Often incorrect prelaunch volume will cause this as well.

**Are there any other little "tricks" ?**

We used to keep a log of how long it took to .......

**Caps and plugs:** Get enough caps and plugs so when you have your fuel system apart you can put a cap on every fitting and a plug in the end of every hose. This will ensure that you will seriously reduce the possibility of getting debris in the fuel system. This debris might cause a clogged nozzle and a clogged nozzle will bring no joy. If you get a .....

**What should I do on the first pass with the new flowed fuel system ?**

## Formula's for checking your nozzle areas.

Pi radii squared will give you the size of the nozzle in square inches. Example: A .050 nozzle has a .050 inch diameter hole where the fuel goes through. .050 hole has a radii of .025 so pi (3.141593)x.025 x .025=0.00196 square inches. Do this for every nozzle in the system and add up the total nozzle square inches and this is your total nozzle area. Be very careful in doing this as it is very easy to make a mistake and get yourself lost. When you finish double check your calculations. I wrote a computer program for doing this very quickly and very accurately. Give me a call and I will punch them into the computer and give you the numbers. If you have been tinkering with the port nozzles and you think your nozzle area is getting away from you this is some thing that you need to stay on top of.

There will be a relationship between total nozzle area and the pump size and the jet size.
**Fuel system tools available from Lowe Fuel Systems.**