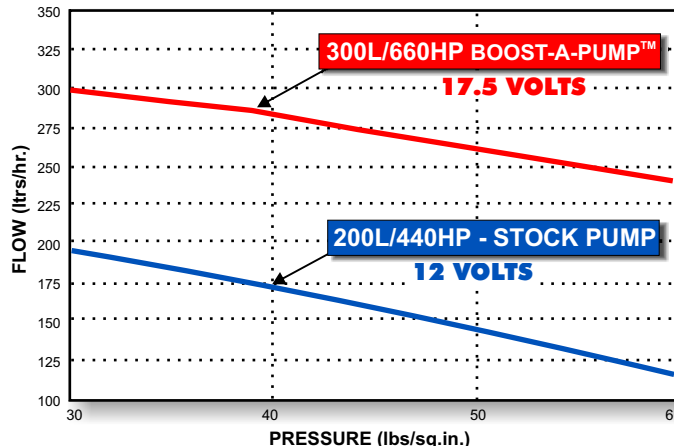
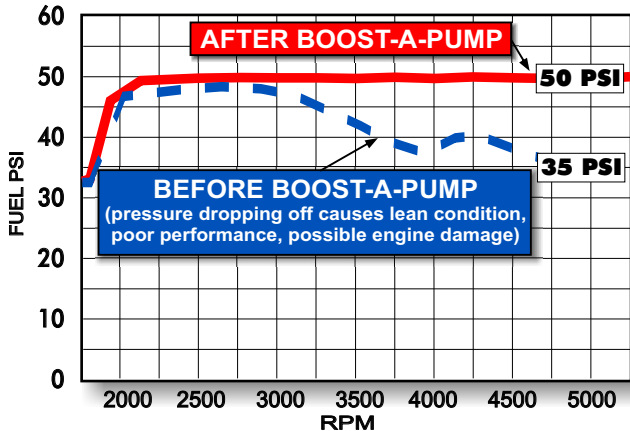


# FUEL PUMP TECH

## FUEL PUMP SIZING

Everyone knows that "You can't make horsepower without fuel." Pump sizing is relatively easy. If your engines output is to be increased 25%, then it's fuel pump output must be capable of supplying 25% more fuel. 40% more power - 40% more fuel. However, the 25-40% increase in HP will occur only at WOT (wide open throttle) and the upper rpm range. The BOOST-A-PUMP is the perfect solution and match as it increases the fuel supply ONLY at WOT. We supply a switch to activate the pump at "0" vacuum (naturally aspirated) or 3 psi (turbocharged or supercharged). At part throttle and cruise when the engine consumes relatively little fuel the BOOST-A-PUMP is not activated. Therein is the basic problem with larger "full time" in line or in tank pumps. They are "active" at all engine speeds and loads pumping all that unused fuel back to the tank - and heating it in the process. Remember that gas begins to boil at 95 degrees. That's why professional drag racers all use cool cans to cool and stabilize their fuel supply. This is an example of where larger and more i.e. bigger in tank pumps aren't better.

ACTUAL TEST ON FUEL PRESSURE BEFORE AND AFTER THE KENNE BELL BOOST-A-PUMP



"Even if the gauge pressure doesn't drop, the best fuel system insurance is the BOOST-A-PUMP." **Jim Bell, President**

### FUEL PRESSURE DROP OFF

Get a fuel gauge. You can't tell what your fuel system is doing without one. Fuel pressure "drop off" can be a serious and expensive problem. If a fuel pump is incapable of supplying an adequate volume at WOT, then the pressure will drop off at the higher rpm levels.

10 psi of fuel pressure will lean or richen an engine 8%. 5 psi is 4%. 20 psi is 16% etc. The BOOST-A-PUMP is your best guarantee against fuel pressure drop off. And since the BOOST-A-PUMP is also a voltage regulator, it automatically adjusts the pre-set voltage to the pump when the accessories lower the input voltage - or even if the alternator fails! In other words, it's also a voltage regulator.

Many racers use the BOOST-A-PUMP without an alternator to insure their pumps and stand alone computer systems are supplied a consistent voltage regardless of battery voltage.

### PUMP CURVES (STOCK vs. + 50% BOOST-A-PUMP)

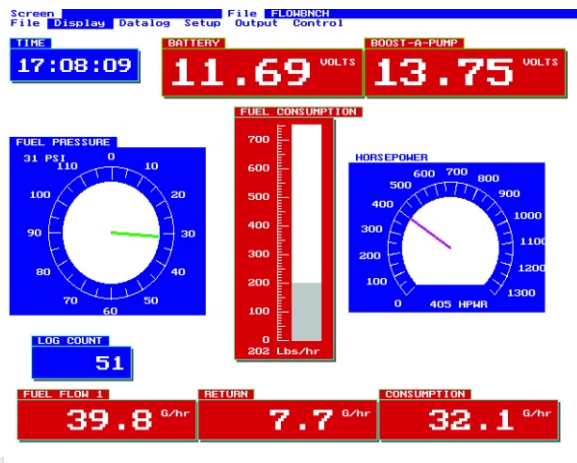
How many times have we heard "I've got plenty of pressure but I need more volume." Wrong analogy. If the desired pressure is there, don't increase or even worry about volume. Pressure is everything to the fuel injectors.

The two pump flow curves above illustrate the operating principle of the BOOST-A-PUMP. The ingenious device merely increases the flow (volume) of any pump up to 50% by raising the voltage supply to the pump from 12V to a maximum of 17.5V in .1V increments (lights, stereo etc.). A 10% voltage variance will affect pump output by 10%.

Study the graph and you'll notice that *as pressure increases, flow decreases - and as pressure decreases, flow increases*. To determine the flow and pressure of any pump, one must look at the pump's "curve." All pump manufacturers rate their pumps this way.

Again, the BOOST-A-PUMP merely spins the pump 1-50% faster allowing it to produce more fuel.

### KENNE BELL COMPUTERIZED FUEL FLOW BENCH



### COMMON FUEL CONVERSION FACTORS (FLOW AND PRESSURE)

TO GO FROM	MULTIPLY BY	TO GET
Litres	0.264	Gallons
Gallons	3.785	Litres
Litres of fuel	1.660	Pounds of fuel
Pounds of fuel	0.600	Litres of fuel
Gallons of fuel	6.300	Pounds of fuel
Grams per sec.	7.930	Gallons per hour
CC per min.	0.016	Gallons per hour
Inches HG	1.133	Inches water (H <sub>2</sub> O)
Pounds per sq. in.	2.310	Feet of water (H <sub>2</sub> O)
Pounds per sq. in.	2.030	Inches mercury (Hg)

### KENNE BELL FUEL SYSTEMS

Kenne Bell utilizes its own in-house fuel flow bench for the evaluation and design of fuel systems and components (pumps, regulators, bypass valves, lines, rails etc.). Unique products such as the Kenne Bell BOOST-A-PUMP™ would not have been possible without this sophisticated equipment. Single, in-line, dual pump flow and even fuel returned to the tank at any voltage or pressure is accurately measured. Boost and regulator pressure, vacuum, voltage, line size etc. may all be varied. All data is displayed on the computer monitor and stored for analysis.

# FUEL SYSTEM BASICS

## A Basic Overview of Fuel Systems

Kenne Bell has long been recognized as a leader in fuel system engineering and technology. It's perfectly understandable why so many others attempt to discourage the use of the BOOST-A-PUMP™. They have their own agenda and are promoting their pump upgrades, fuel rails, fuel lines, etc. No tests or tech info, but plenty of "good advice." The following should help you understand some fuel system basics. For our data and information, we rely on our highly sophisticated fuel flow bench to test not only pumps, but fuel lines, fittings, filters, fuel rails, injectors, etc. The BOOST-A-PUMP™, the most successful fuel system product ever, continues to be the NUMBER ONE choice for increasing fuel delivery. It has been used exclusively on Kenne Bell Supercharger Kits, including the dual pump ultra powerful Shelby GT500/Super Snake 725HP kits and one of the "Fastest Production Sport Cars in the World," the 806HP/242MPH Koenigsegg CCR and the Lingenfelter 950HP Corvettes. All pumps were tested on the Kenne Bell in house computerized fuel flow bench. Note: When viewing our pump flow data, it's important to keep the following hydraulic basics in mind.

1. Tests were run at 60 psi. Pump flow increases as pressure decreases and decreases as pump pressure increases. Example: As compared to 60 psi, flow will be approx. 15% higher at 40 psi and 15% lower at 80 psi. So, yes, larger lower pressure injectors use less pump flow than higher pressure small injectors even though INJECTOR FLOWS ARE IDENTICAL.
2. Any increase in boost pressure must be deducted from the injector pressure rating as the manifold boost "resists" the flow/pressure of the injectors. The fuel pressure MUST be increased to compensate for higher boost. 10 psi higher boost and fuel pressure LOWERS pump flow 7%. Example: Our Shelby GT500 makes 801HP at 23 psi boost and 83 psi "rail" pressure to net 60 psi Delta or injector pressure. And it's exactly why boosted vehicles need HIGHER FLOW RATINGS than naturally aspirated engine pumps and why it's difficult to "rate" pumps. Be sure your tuner understands this. We refer to it as Delta pressure.
3. Air fuel ratio also affects pump flow. Example: Richening AF ratio 10% from 12.5 to 11.5 increases pump flow 10%.
4. A 10 psi reduction in fuel pressure affects AF ratio 8%.
5. AF ratio also effects pump duty cycle in non return systems.
6. Fuel supply lines are often upgraded unnecessarily without sound fuel flow analysis. At Kenne Bell, we flow test fuel pumps AND fuel lines. Example: There's only a 7 psi pressure drop from tank to rails at 700RWHP with an '03 Cobra. Who else has performed this test? The 7 psi isn't an issue if 1. the pressure is adequate or 2. the pressure is not dropping off.

A mere 3 psi drop at 600HP is certainly not an issue with a Cobra. And our '07 Shelby makes 801HP with the STOCK lines and pumps and the Dual BOOST-A-PUMP™ at 60 psi Delta (83 psi rail) and 96% duty cycle. At 40 psi Delta (63 rail) and larger injectors, the pump flow will increase a whopping 15% which will support another 15%HP or 801HP. Get the picture?  $801 \times 1.15 = 920\text{HP}$ . Rest assured, a larger fuel line or more/larger pumps WILL NOT MAKE MORE HP unless the engine is starved for fuel. The optional 20V BOOST-A-PUMP™ increases pump flow and HP (6-8% less duty cycle) up to 1000HP.

## FORD PUMPS

### DUAL PUMP FLOW SUMMARY (L/HR, 60 & 80 PSI) BOOST-A-PUMP™ vs NO BOOST-A-PUMP™

SHELBY GT 500, SUPER SNAKE, KR, FORD GT, 03 COBRA, LIGHTNING

DUAL PUMPS	FUEL SYSTEM	FLOW L/MIN				FPDM	MAX HP	BOOST-A-PUMP™	
		60 PSI		80 PSI				TYPE	PART NO
		NOBAP	BAP	NOBAP	BAP				
**05-'06 FORD GT	RL	482	684	424	600	2	800-1000	DUAL	KB89064
**07 UP SHELBY GT 500	RL	466	660	380	540	2	800-1000	DUAL	KB89064
**03-'04 COBRA (SHELBY PUMPS)	RL	466	660	380	540	2	750-925	DUAL	KB89064
**05 UP MUST GT	RL	466	660	380	540	2	800-1000	DUAL	KB89064
**99-'04 MUST	RL	466	660	380	540	2	800-1000	DUAL	KB89064
'03-'04 COBRA (STOCK PUMPS)	RL	290	430	238	378	1	700-750	SINGLE	KB89069
'99-'04 LIGHTNING (STOCK PUMPS)	R	254	362	190	316	1	575-625	SINGLE	KB89069
'99-'04 LIGHTNING (WALBRO 255)	R	384	548	316	454	1	740-800	SINGLE	KB89069

R = Return style      RL = Returnless

• '03 Cobra w/stock pumps use "Single" BOOST-A-PUMP™ part# KB89069. OK to 750HP with 60-75 lb injectors.

• Ford GT, Ford GT FRP kit #M-9407 GT05 (Dual Shelby GT500 pumps), Shelby GT 500, KR, Super Snake use "Dual" BOOST-A-PUMP™ part# KB89064, KB89064-20. OK to 920HP (17.5V) and 1000HP (20V) with 72 lb.

**Kenne Bell BOOST-A-PUMP™'s are available in two voltages. Street 17.5V and Competition 20V. Consult us for recommendations and HP requirements.**

## SHELBY GT 500, SUPER SNAKE, KR, FORD GT

Our tests indicated fuel pressure dropping off at 550HP on the Shelby GT 500. Adding ONLY the Dual BOOST-A-PUMP™ allowed the car to make 801HP with 96% duty cycle and 11.2 AF ratio. Ford GT pumps (2-241L) are rated about the same capacity as the Shelby GT 500 pumps (2-233L). Not worth switching. Just add the Dual BOOST-A-PUMP™. There are no larger pumps available. The Dual BOOST-A-PUMP™ increases fuel pump flow 42-50%. No larger expensive fuel lines, fuel rails, fittings, return lines, wiring, tank mods etc. are required or recommended. Dual BOOST-A-PUMP™ is standard equipment for the Kenne Bell Shelby GT 500 and Shelby Super Snake Kits and is the preferred, most economical, least complex, most reliable and lowest cost method of increasing fuel delivery. And it is the ONLY system that prevents fuel psi “drop off” from low voltage.

## SHELBY GT 500, SUPER SNAKE, KR

The “Dual” BOOST-A-PUMP™ module is designed specifically for the new dual pump systems used on the ‘07 up Shelby GT 500, Super Snake, KR and the Ford GT. It raises the HP capacity from 550 to 800RWHP - with NO OTHER CHANGES - even with stock 52 lb high pressure injectors. Up to 975HP with larger 60, 72 lb injectors and 20V BOOST-A-PUMP™. It also works with Ford Racing #M-9407GT05 Dual Pump Kit for ‘05 up Mustang 4.6 GT (dual FPDm). Supports 800-975HP depending on injector size.

## ‘03-‘04 COBRA\*

‘03-‘04 Cobra stock dual pump system is good for 750RWHP with only the 17.5V BOOST-A-PUMP™ and 925 with the 20V with the stock single FPDm. For over 750RWHP, use the “Dual” BOOST-A-PUMP™ or use 2 of the Ford GT or Shelby pumps as in the D’Agostino Racing Kit (975HP with Dual BOOST-A-PUMP™. Note: The ‘03-‘04 Cobra uses a smaller 5/16” fuel line vs. the 1/4” for the ‘05 up Mustang/Shelby. Replacing it with 1/4” will raise fuel pressure 6 psi.

## ‘99-‘04 LIGHTNING (RETURN SYSTEM)\*

The stock Lightning 127L pumps are good to 600HP with the “Single” BOOST-A-PUMP™. Replacing the 127L pumps with Walbro GS5342 255L (actually 192L) will support +800HP with the “Single” BOOST-A-PUMP™. Note: We don’t recommend switching return and returnless style pumps. Use the basic pump design the system was designed for.

## ‘05 MUSTANG

Ford Racing #M-9407 GT05 Dual Pump Kit with Dual BOOST-A-PUMP™ up to 975HP with larger 60, 72 lb injectors. Same fuel feed line as Shelby and same HP potential.

# FREQUENTLY ASKED QUESTIONS

## DO I NEED BIGGER AFTERMARKET PUMPS?

No one wants to knowingly short change their engine on fuel. OEM style pumps, particularly with the BOOST-A-PUMP™, pump enough fuel for 99% of the applications, street or race. If one takes the time to look at the REAL test data on fuel pumps, it clearly indicates that the stock OEM pumps are over designed approx. 30%. Clearly enough fuel for a stock engine - or up to 30% more HP. Add this 30% to the 50% offered by the BOOST-A-PUMP™ and you have a whopping 80% additional fuel capacity vs. stock. That will support a LOT of HP i.e. +80%. Example: Shelby GT 500 450HP x 1.8 = 810HP fed by the stock pumps with a BOOST-A-PUMP™ (684L) and STOCK 52 lb injectors. Here are more examples:

## COMPARISON (OEM STYLE vs. “BIG” AFTERMARKET PUMPS)

APPLICATION	PUMP(S)	NO B A P	W/ B A P	SYSTEM TYPE
Dual	Shelby/Ford GT	482L	684L	R
Single	‘05 up Mustang/Focus	217L	325L	R
Single	Aeromotive #11101	324L		RS
Single	Aeromotive #11104	421L		RS

## Conclusions:

1. It would take two - not one - custom plumbed and wired big aftermarket pumps to even match the OEM/BOOST-A-PUMP™ combination which can support over 1000HP!
2. Then there’s the custom mounting bracketry, plumbing, larger wiring and fusing necessary to feed custom pumps which use more amperage.
3. And you can’t use RS (return style pumps) to replace R (returnless pumps). Oops!
4. Finally, the R and RS ECM’s use completely different strategies to operate the pump systems.

## ARE LARGER PUMPS A BETTER CHOICE THAN THE BOOST-A-PUMP™?

Absolutely not. If they were, Kenne Bell would use them on all our kits instead of the BOOST-A-PUMP™. The BOOST-A-PUMP™ simply increases the flow of any pump(s), single or dual, approx. 50% from 12 to 17.5V. And it raises the HP potential of the pumps the same 50%. The BOOST-A-PUMP™ is more reliable, easier and less costly to install - and guarantees consistent fuel flow that other pump systems cannot. Finally, the BOOST-A-PUMP™ is only “ON” or activated when your engine needs it. Quite often, even the big dual pump kits are not sufficient and require the BOOST-A-PUMP’s additional 50% fuel flow. Then there’s the competition 20V BOOST-A-PUMP™.

## SHOULD I UPGRADE MY SHELBY GT 500, SUPER SNAKE OR KR TO THE FORD GT PUMPS?

No. Output is almost identical (see above tests). Save your money. Note: SN97 pump is same flow as GT 500 but costs less.

	<u>STOCK</u>	<u>BAP</u>
2 - GT 500 pumps @ 233L =	466L	660L
2 - Ford GT pumps @ 241L =	482L	684L

Also, Ford GT pumps are physically smaller and use different fittings. Lots of hassle and cost for the tiny increase in flow.

## SHOULD I INSTALL LARGER FUEL LINES, FITTINGS, FUEL RAILS AND NON-STOCK STYLE PUMPS?

Ever notice how these recommendations are NEVER supported by actual test data? We've seen 764HP on the stock Cobra and 825HP on the '07 up Shelby - with stock lines and rails. For a better understanding of basic fuel flow dynamics, check out "Fuel Pump Figuring" at <http://www.kennebell.net/media/articles/FUELPUMP.pdf>. Pay particular attention to the friction losses (pressure drop) of fuel as it flows through a fuel line. It's all about pressure loss and flow and not about vendor agendas. It's important to understand that larger fuel lines ONLY reduce the pressure loss from the tank to the fuel rails and will do NOTHING to increase fuel flow if the pressure drop in the feed line is acceptable and is NOT CREATING EXCESSIVE PRESSURE LOSS. In other words, if the system has adequate fuel pressure, don't waste your money on fuel lines and rails. Does anyone know what the pressure loss is in a stock Shelby GT 500 fuel line? If you don't, how can you say it's too small? For example: The pressure loss at 500HP in an '03 Cobra is a mere 2 psi - and 7 psi at 700HP. So what. Just raise the Delta pump pressure 2 psi or 7 psi. You only need to upgrade fuel lines if there is not other way to get the 2 to 7 psi of pressure. If you're that close on pressure, you're too close to start with. There are many who don't understand fuel flow, lack the equipment to measure flow and pressure loss and/or "merely want to sell you larger fuel lines." It's your decision - and your money. You may want to read the fuel system tech and tech articles on our website before spending your money.

## WHY IS THERE SO MUCH CONFUSION AND CONFLICTING THEORIES ON FUEL PUMP FLOW, PRESSURE & HP?

Because few understand fuel system basics, which we have tried to cover in this test. Example: How much HP will the Shelby GT 500 pump system support? The answer will depend on:

1. If system is using a BOOST-A-PUMP™ (add 40-50% for BOOST-A-PUMP™).
2. What is the boost Delta pressure (deduct 8% for every 10 psi).
3. Injector size (see above). Larger injectors require less pressure.
4. Pump duty cycle.
5. Air fuel ratio (10%=10% pump flow).

## NITROUS?

Whoa. Stop here and keep this in mind. Where do these Nitrous systems get their fuel? From YOUR FUEL SYSTEM! Be sure there's enough for your supercharger kit AND the Nitrous. And forget "dry" systems with superchargers. Tuning should be left to an experienced shop.

## IS THE BOOST-A-PUMP™ A SAFE PROVEN CONCEPT?

We think so. Kenne Bell introduced the BOOST-A-PUMP™ in 1995. Today it is standard equipment on nearly all our supercharger kits. It is the most proven, reliable and efficient method of increasing fuel delivery. Also, it is safe and reasonably priced with virtually "0" failures. The BOOST-A-PUMP™ actually INCREASES pump life of any new returnless style pump. There has not been a single case of a Kenne Bell BOOST-A-PUMP™ damaging a fuel pump. And it is responsible for supplying enough fuel for a stock 500HP Shelby GT 500 to develop 825HP - with NO OTHER CHANGES to the stock fuel system. Still believe you need larger lines, rails and pumps?

## WHAT IS THE BOOST-A-PUMP™ PRINCIPLE OF OPERATION?

It's a simple, proven Kenne Bell concept that does not require larger pumps, fuel lines, rails and expensive plumbing. "Bigger" is not always better. Much like the stock Ford returnless systems, that uses voltage to LOWER pump output from 100%-0% duty cycle, the BOOST-A-PUMP™ merely RAISES voltage from 12V-17.5 and pump output up to 150%. Varying pump flow by voltage is precisely how the Ford "returnless" systems operate. The voltage is constantly adjusting up or down on the input side of the FPDM. The FPDM then "pulses" the pump to maintain the commanded pressure based on the Delta pressure on the fuel rail. When the pump voltage at 13V can no longer supply enough pressure, the BOOST-A-PUMP™ will increase the pump voltage (pressure and flow) up to 17.5V. The BOOST-A-PUMP™ merely "takes over where Ford left off" and increases and guarantees voltage accuracy.

## VOLTAGE FLUCTUATIONS

### EFFECT OF PUMP VOLTAGE ON FUEL DELIVERY

<u>VOLTS</u>	<u>233L SHELBY PUMP(S)</u>		<u>L / HR</u>
<u>PUMP VOLTAGE</u>	<u>1 PUMP</u>	<u>2 PUMPS</u>	<u>FLOW VARIATION</u>
11V	171	342	-26%
12V	202	404	-13%
13V	233	466	OEM RATING
17.5V BOOST-A-PUMP™	330	660*	+42%

\*660L/HR is the flow of both 233L pumps powered by the Dual BOOST-A-PUMP™. That's a LOT of fuel - and why larger pumps are not necessary.

Don't be concerned about the slight difference in flow between the Shelby 233L and a Ford GT 241L pump(s). Instead, worry more about VOLTAGE FLUCTUATIONS that can starve your engine of fuel by 26% and more. Note the huge flow variations that result from a 1-2V variation from the OEM "rated" 13.0V (see comparison) - up to -26% (342L vs 404L). The unique built in voltage stabilizer on the BOOST-A-PUMP™ eliminates dangerous voltage/fuel pressure and flow fluctuations. it will maintain correct voltage within .1% as low as 11 volts, a full 26% flow reduction. Normal voltage is 13.0 V. If your battery is low or the alternator dies, your fuel system has protection from a 26% "lean out."

### **DUAL BOOST-A-PUMP™ vs. TRIPLE PUMP KIT**

The "Triple Pump" kit works, but at the time of this writing is unproven, very expensive, complex, difficult to install, causes start up problems (fuel check valve is eliminated) and lacks low pump voltage/flow protection. "If it ain't broke, don't fix it."

For a better understanding of fuel systems, we highly recommend reading the following articles:

"Fuel Pump Figuring" at <http://www.kennebell.net/media/articles/FUELPUMP.pdf>

"Fuel Flow Forensics" at <http://www.kennebell.net/media/articles/FUELFLOWFORENSICS.pdf>

### **TESTIMONIALS (DUAL BOOST-A-PUMP™)**

ADAM MONTAGUE, ST MOTORSPORTS 825RWHP " World's fastest PD street legal 3v 4.6 Mustang w/no NOS." 9.50/142. Street Dual BAP w/ Ford #M907GT05 drop in dual pumps. Stock Fuel lines and rails 825RWHP, 60lb,92% duty cycle. Adams back to back tests with Competition Dual BAP-no other changes-lowered pumps duty cycle to a mere 62%! A whopping 32% reduction. That leaves lots of room to grow (+200HP) with other mods such as NOS, stroker kits, bigger cams, etc. Adam Quote:,"I couldn't believe the fuel flow this new competition system produces! The numbers don't lie. I could run in the 8's with this set up and NOS with no other changes. This is way more fuel than 99% of my customers will ever need!" Only \$449.00

1000HP fuel system. New Kenne Bell Competition 20V Dual BOOST-A-PUMP™ for Ford Dual Pumps Systems. '05 up Mustang, Shelby 500, Super Snake, KR, '03 Cobra, 2V 4.6 and Lightning. '07 Shelby up to 1000HP with stock pumps, fuel lines and rails. '05 up Mustang up to 1000HP with stock fuel lines and rails. Needs Ford FRP#M9407GT05 dual pump system (\$780 MSRP). Note: Shelby and late '05 Mustangs come with larger fuel lines than the '05 cars and don't need larger fuel lines, fittings, fuel rails, etc. The BOOST-A-PUMP™ is a far better approach than an expensive complex "3 pump system" with all the additional plumbing, fittings, rails, wiring and modules. And it uses less amperage. BOOST-A-PUMP™ works equally well with all injector types, stock, or aftermarket. Street BOOST-A-PUMP™ will support 800HP (52lb) or 100HP (72lb). This is the same basic BOOST-A-PUMP™ used on all those Kenne Bell Supercharged Shelby Gt500's, Super Snakes and high HP '05-'08 Mustangs - and the lower HP 50 State Legal Kenne Bell kits. The Dual BOOST-A-PUMP™ is now available in 2 versions - Street (17.5V) 800HP and Competition (1000HP (20V). How does the new competition BOOST-A-PUMP™ perform as compared to the street BOOST-A-PUMP™? Check out these back to back Dynojet tests and pump Dc's.