LOW BOOST CAUSES & CURES

Introduction:

Boost is our business. Our superchargers are high precision air pumps that are incredibly consistent in performance. They don't vary so a "low" or "high" condition can never be attributed to the supercharger. When a low boost condition exists we can almost always rule out the supercharger itself as the problem. Look elsewhere for the problem. Instead, low boost is typically caused by non-stock cams, altered cam timing, headers, cat back exhaust, belt slippage, incorrect pulley size, inlet restrictions, kit modifications, increased engine displacement and/or efficiency, underdrive crank pulleys, defective gauges, leaky boost/vacuum links and fittings, weak tensioner, belt manufacturer (belts that stretch too much), etc.

Occasionally a customer will tell us "The car feels incredible, but the boost is low". That may tell us the supercharger kit is performing but the gauge is not. Test and replace the gauge or repair the line or fitting leaks FIRST. Don't psychoanalyze the kit itself.

The following list will help you to understand and analyze boost problems:

Defective Gauges:

First, compare your boost gauge with a gauge of known accuracy. We've seen boost gauges vary by as much as 2-3psi. The cure for this problem is to replace the gauge.

Vacuum/Boost Line Leaks:

Check ALL lines, fittings, and connectors that connect to the gauge, including line "T"s that are connected to the bypass valve, regulators, etc. An accurate boost reading requires all the air to reach the gauge so you need to diagnose a problem with a vacuum/boost line leak first. Any leak will "bleed off" boost and give a lower, inaccurate reading.

NOTE: Never assume an engine does not have a vacuum leak because the gauge reads "good", "high", or "plenty" of vacuum. The gauge is not reading leaks, but instead, only the nominal manifold vacuum of a big air pump. The cure for this problem is to replace the defective lines and fittings.

Pinched Vacuum/Boost Line:

Obviously a pinched or severed boost line will also not register boost accurately, or at all. The cure for this problem is to replace the pinched or severed line.

Wrong Connections:

The boost gauge line must be connected to the discharge (boost) manifold fitting. The cure for this problem is to re-route lines as per instructions.

Bypass Valve:

The bypass valve is "open" during vacuum and closes under boost. An open valve will bypass most but not all of the boost at WOT (wide open throttle). For example: An open bypass valve may register 1psi on a 6psi kit but 2psi on some 9-10psi kits. Check valve operation with a handheld vacuum/pressure pump (i.e. Mity Pump). Pressurize the line to the valve diaphragm to see if it closes completely. Use the vacuum mode to check vacuum opening. Most valves on Kenne Bell kits can be operated manually by moving the diaphragm arm up and down. The cure for this problem is to check for full travel (boost and vacuum) with the hand held pump and replace the bypass valve is its not operating properly.

WARNING: DO NOT operate the supercharger with the bypass valve closed all the time as this can lead to an non-repairable failure of the unit.

Bypass Valve Supply Line:

Any leaks in the supply line(s) or fittings that connect to the bypass valve can bleed off the air pressure and/or vacuum required to operate the valve properly. If the bypass valve opens and closes with the corresponding boost and vacuum inputs from the hand held pump, then the problem is a leak or incorrect routing of the vacuum/boost lines as this test eliminated the valve itself as the source of the problem. The cure for this problem is to replace any leaking fittings or lines and correctly route vacuum/boost lines to their intended locations.

Belt Slippage (Standard Kits):

Kenne Bell standard kits are engineered to perform slip free with the belt and pulley supplied in the kit. Belt slippage will occur at the

higher engine RPM levels where the supercharger requires more engine HP to rotate. First, check the supercharger pulley for signs of belt slippage (i.e. black powder or residue around the pulley). Glazed, smeared, or melted belt rubber on the supercharger pulley is another sign of slippage and the corresponding heat associated with slippage. A slipping belt/pulley will often make a screeching noise. Some noise or slip at the shifts is not a problem.

Check for:

1. Correct belt size

2. Weak tensioner

3. Oil on pulley or belt surface

4. Worn belt

5. Misalignment of pulleys

6. Recommended belt manufacturer (i.e. Gates or Dayco) *We do not recommend Goodyear belts.

7. Any modifications to the kit (pulley locations, spacers, belt routing, pulley size, etc.)

The cure for this problem is to replace and defective or worn components and ensure that the setup (belt routing, pulley locations, etc.) are all as Kenne Bell recommends.

Belt Slippage (Competition Kits):

Note: Number of belt ribs, belt wrap angle, pulley size, and supercharger size in liters is all about belt contact area. Whether it be belts or tires, more "contact patch" is always better.

Racing applications/competition kits that run higher boost levels than standard kit boost levels may require the following:

1. An upgrade from a 6-Rib to an 8-Rib belt system (more belt contact)

2. A larger supercharger pulley that will provide a larger belt contact patch

3. A larger companion crank pulley to accommodate the larger supercharger pulley

4. Larger or re-positioned idler pulleys to increased belt wrap on the supercharger pulley

5. A larger supercharger* with an accompanying larger diameter pulley for more belt wrap (*IF larger kits are available for the given application)

NOTE: At the same boost a 10% larger supercharger uses a 10% larger pulley with 10% additional belt wrap

The cure for this problem is to either increase belt to pulley contact through more wrap or more ribs through different belt angles, routing, pulley diameters (both supercharger and crank), or to increase supercharger size with a larger belt.

Aluminum Non-Kenne Bell Pulleys:

Kenne Bell superchargers are designed for billet steel friction drive pulleys. We do not recommend the use of ANY aluminum pulley because of the excessive wear and incompatibility with our steel friction drive components. Aluminum pulleys can slip and shear off the pulley bolt because of the soft nature of aluminum. Avoid them like the plague. The cure for this problem is to throw aluminum pulleys in the trash.

Note: Aluminum "Saw Slot" pulleys - A totally ridiculous product, never use these pulleys. They can, and in most cases do, shred a belt in one run. These pulleys also void any existing Kenne Bell warranty.

Incorrect Supercharger Pulley Size:

Obviously the wrong pulley will decrease boost. A 1/8" change in pulley diameter is approximately 1psi of boost so a 1/8" larger pulley will cause a 1psi boost loss. The cure for this problem is to install the correct pulley size.

Underdrive Crankshaft Pulley:

Kenne Bell kits are typically designed for the stock crankshaft pulley. Undersized (underdrive) pulleys will reduce boost. Boost is determined by dividing the crankshaft pulley size by the supercharger pulley. This "ratio" will determine the actual boos. The cure for this problem is to Install a new pulley, check with Kenne Bell first for recommendations on which crankshaft pulley would be best suited for your application.

Engine Size:

When a supercharger pumps more air than the engine, the supercharger builds up back pressure (boost). With all else the same a larger displacement engine will lower the effective boost of any supercharger. Therefore, to maintain the same boost with the same supercharger in a larger engine, the supercharger speed (CFM) must be increased or upgrade to a larger/more efficient supercharger (If available for your application).

Note: See Kenne Bell formula for determining boost based on engine and supercharger size.

The cure for this problem is to install a larger supercharger or smaller supercharger pulley if its available for your application.

Improving Engine Breathing:

Heads, cams, header, cat back exhaust, etc., that increase HP, may lower boost. As with a larger displacement engine, the supercharger speed or size may have to be increased to match the additional air flow/HP of an engine with improved breathing characteristics. The cure for this problem is to install a larger supercharger or a smaller supercharger pulley if its available for your application.

Air Filters:

As with any inlet component (inlet tube, mass air meter, throttle body, etc.) a clogged or insufficiently sized filter will reduce airflow to the supercharger and lower boost. Check the loss behind the filter, it should be 0"Hg, or test without the filter on. The cure for this problem is to replace or use a larger filter.

Mass Air Meter:

Meters restrict air flow and supercharger boost. Check loss in front and behind the meter with a calibrated vacuum gauge. The cure for this problem is to install a new larger mass air meter with a new calibration.

Throttle Body:

Throttle bodies can restrict airflow to the supercharger if its insufficiently sized. Check the loss in front and behind the throttle body. Ideal reading is 0"Hg indicating no loss through the throttle body. We have test data on most throttle bodies that customers use. Always verify that the throttle is opening fully. The opening of a drive by wire throttle body must be verified electronically with a scan tool. The cure for this problem is to install a larger throttle body but exercise extreme caution with "drive by wire" aftermarket throttle bodies. The suppliers are eager to sell you a throttle body and pawn off the real problem (a lack of tuning) on someone else. We recommend only stock (OEM) "drive by wire" throttle bodies as we DO NOT support the tuning nightmares aftermarket electronic throttle bodies create.

Note: There is a lot of good flow/loss/boost/HP information on our website under "Tech Tips" and "Mammoth Kits".

Supercharger:

There is only one way a Kenne Bell twin screw supercharger can be responsible for lack of boost. If it has ingested a foreign object (bolt, nut, rock, etc.) and is unable to rotate. If it rotates, without belt slippage, it will always produce the same boost.

Remove the belt and turn the pulley by hand. If the rotors turn, the supercharger is O.K. and is most likely not the source of your problem. The rotors DO NOT wear out or become less efficient regardless of age, mileage, or application. They never require re-coating or tuning. If the pulley turns freely and the rotors don't then the drive or pulley bolt may be broken.

Note: We have never sheared a 12mm pulley or drive bolt but an aluminum non-Kenne Bell pulley can slip and cause damage to the front seal ring, pulley bolt, and pulley itself. Then there is the "saw tooth" or "slotted" pulleys that look like a chain saw massacre survivor (they generally kill a belt in a single 1/4 mile run). These pulleys all void your warranty, throw it in the dumpster. The cure for this problem varies from case to case so the best course of action is to contact Kenne Bell for a recommendation and instructions on how to send your supercharger in to us for repairs.

Supercharger Drive:

A broken pulley bolt, drive, or rotor bolt disconnects the drive assembly from the supercharger. If the supercharger rotors do not rotate, there can be no boost. The cure for this problem is to contact Kenne bell for a recommendation and instructions on how to send your drive assembly in to us for repairs. If its something as simple as a pulley bolt and the threads in the drive shaft are not damaged customers are welcome to order just a bolt to install themselves.

The only possible way to damage a drive by continuously hitting the rev limiter, the use of a "saw tooth" pulley, or not getting off the throttle or putting the vehicle in neutral when exiting the burn out box.
Rags:

We've seen it all. A rag or shop towel in the inlet system will kill boost and power and if ingested into the supercharger could cause a

complete failure of the compressor. The cure for this problem is to remove the rag, better yet avoid the use of rags or towels in ports and intakes and instead use plastic glass protector or tape to cover openings to the motor.

Blow Holes:

Air leaks on the discharge side of the supercharger can bleed off sufficient boost air to actually reduce boost pressure. Look for missing fittings or plugs, open hoses, mis-routed lines, missing or leaking gaskets including head gaskets and manifold gaskets. The cure for this problem is to replace/fix all gaskets/leaks.

Elevation:

Yes, elevation will affect boost (approximately 0.5psi per 1000ft) but "elevation" differences do not register on a boost gauge. Only an absolute pressure gauge which measures both atmospheric pressure (14.7psi @ sea level) and boosted supercharger pressure can indicate an elevation change.

Boost Drop Off At High RPMs:

If the belt is not slipping and there is no leaks then the boost drop off is the result of inlet tract restrictions. The supercharger is being starved for air and is losing inlet pressure. Boost drop off will be most noticeable at higher RPM/engine air flow.

Note: With Eaton (roots type) superchargers, "boost drop off" is a more common problem at high RPM and boost even without excessive inlet respiration. The Eaton supercharger is simply less efficient than the twin screw type supercharger.

Exhaust Restriction:

Contrary to popular belief a restrictive (low flow, partially clogged, or clogged) exhaust system does not decrease boost. It actually increases boost. Since the engine's breathing capacity is reduced, the supercharger sees it as a "smaller" engine and is able to build up more boost. The cure for this problem is to try a larger supercharger pulley to slow down the supercharger and build less boost. Plugged cats are dangerous. They can cause a boost increase of 20psi or higher which can blow out engine gaskets and seals. The exhaust has to go somewhere and if the engine doesn't stall it can also break pistons and rods. So if you have a super sensitive and accurate boost gauge, you can tell if those headers, exhaust, or cats, really make more HP and lower boost. However, keep in mind that this is NOT always true. We have seen +25HP and NO boost drop and we have seen +25HP and a 2psi drop ("mixing" cams and/or cam timing). Another commonly used component that can result in unpredictable HP swings are headers. Not many people realize this or understand why it happens. Another test you can perform is to place a simple pressure gauge in the front of the exhaust component being tested and note the back pressure. We see 2-20psi depending on engine HP and the exhaust system being tested.

Cams:

Improved engine efficiency (HP) means it flows more air. Highly efficient cams should, therefore, lower boost. Expect a 1psi drop from a large enough cam.

Cam Timing:

Factory settings are not always the same and can vary boost 1-3psi and power by as much as 45HP. Altered cam timing (retard and advance) on Ford modular motors can effect power from up to 100+HP, depending on whether stock manifolds or headers are being utilized.

Heads:

This has pretty much the same concept as exhaust and cams. If the air flows through the engine more freely, boost pressure may drop. The supercharger air flow must then be increased to build up the back pressure (boost) to its previous level.

Headers:

Again, headers that make HP will lower boost pressure.

Note: It is often necessary to use an accurate, higher resolution gauge as the boost (psi) reduction may be in tenths of a psi. At Kenne Bell we use highly accurate and expensive sensors that log 100 or more counts per second.

Engine Mechanical Compression Ratio:

Compression ratio affects boost because a lower compression has more cylinder volume for the supercharger to fill. So boost is lower with low compression and greater with higher compression ratios.

Engine Leakage:

An engine with reduced ring and valve sealing will, of course, develop less boost because some supercharger air "bleeds off".

Intercoolers:

All intercoolers have some restriction or pressure loss. Typically it's 0.1-2psi depending on air flow, boost, and water and air temperatures. Therefore, measuring boost "out" of the supercharger may be 2psi higher than the boost reading out of the intercooler or engine "in".

Clogged Intercooler Fins:

We've seen intercooler fins loaded with Teflon, silicone, rag threads, filter cotton, and even foam or other packing material. Anything that the supercharger "grinds" up can settle on the intercooler entry face and reduce boost. It's one reason why Kenne Bell never uses soft rotor coatings. They improve low RPM efficiency somewhat but is the "first to go" and get scuffed off the rotors at the higher boost/temp/RPM levels. Our hard anodized rotors with slightly more clearance seems to do much better on our 15 second high boost tests.

Catalytic Convertors:

We never see much, if any, HP loss in catalytic convertors. Sorry. One test revealed "0" loss at 775RWHP on my own '05 Mustang. Yep, the cats are still on it, but that's another story.

Air Density:

Cooler ambient temperatures result in a denser air charge into the supercharger and higher boost levels (1-2psi depending on temperature). Hot air = Lower boost.

Dyno Tuning:

As load decreases so does boost and A/F ratio (leaner). As load increases so does boost and A/F ratio (richer). Boost on the street will be slightly higher depending on gear and load just as A/F ratio is approximately 0.5 higher (richer) on the street because load is greater on the street than the dyno. Our tests further indicate that lower (higher numerical) rear end gear ratios also affect boost and load while robbing RWHP. Example: 3.73 gears lose 18HP vs. stock 3.30 gears. 4.10 gears consume even more HP, etc. 6th gear in a Shelby GT500 will generate the highest boost, load, and richest A/F ratio as compared to other gears.

This all might be considered "finite" tuning and negligible numbers to some but it must be dealt with for optimum performance, fuel economy, and emissions. Finally, as compared to closed hood - under front valance cool air kits, closed hood dyno runs with "hot air" underhood filters make less boost because the air is 30o-100o hotter which equates to less dense air.

Note: Any underhood filter, even when baffled or shielded and in the vicinity of "air holes", WILL mix with the hot underhood air.

Conclusion:

Always keep in mind that the easiest cure for a low boost issue is to install a larger supercharger or crank pulley. However, a pulley change, or a larger supercharger, may not be the best solution for your particular combination. Check with your supercharger company for recommendations as they know their product (efficiency, limits, etc.) best!

Perhaps the easiest method of adjusting boost is to simply "de-rate" our boost charts to compensate for all the above causes of low boost. Obviously this is not practical as we've seen up to -6psi in inlet restriction, -3psi in headers, -1psi in cat back exhaust, -1psi in cams, -2psi in cam timing, -1psi in engine leakage, etc. That’s -14psi total and if one considers all the other ways to lower boost how can we possibly furnish enough charts to accommodate every possible situation. There would be hundreds of them at best. At Kenne Bell we goto great lengths to supply our customers with accurate data on boost and HP. Not many companies do this. Yes, there are variables and we've experienced and encountered them all. We hope the above information answers your questions. If not, check out our website (www.KenneBell.net) or give us a call (909)941-6646 / (909)941-0985.