

From Jack Merkel Performance Engines.

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## Buick 231 Turbo V6 "Street/Strip" Technical Specifications

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The following is a guideline of recommendations for the Buick 3.8 liter turbo engine. I hope this write-up is helpful in making decisions when you rebuild or modify your turbo V6.

### **Oiling system:**

One of the most critical aspects of any engine, your oiling system requires some special attention when modifying or rebuilding your turbo engine.

### **Oil pump:**

We always recommend a rebuilt oil pump and thrust plate with a minimum of 60 PSI @ 3000 RPM. We like to see 20 PSI @ hot idle in gear, but even 10 PSI is acceptable. Remember, the oil pump must create enough pressure to push oil into the center of the main journal & then out to each respective rod bearing journal while centrifugal force is trying to push the oil back out from the center of each main journal. If your pump lacks adequate pressure and volume, your rod bearings may starve for oil! In the case of the V6, we recommend using one of the available rebuilding kits with the new thrust plate. Keep in mind that the oil pump is supplying oil to the engine as well as the turbo, so upgrading the pump is really mandatory on these engines.

In high performance street/strip motors, we suggest "blueprinting" the oil pump and timing Cover passages. Smoothing, deburring and enlarging passages will dramatically increase oil flow to your bearings in these engines. Specifically focus on the pump cover outlet (the rectangular slot) and the passage into the block (open to 1/2", 9/16" in race applications). Race applications will benefit from an external oil line running from the turbo oil supply fitting to the passenger side lifer oil galley in the rear of the block. The reasoning behind this external line is simple; you increase volume and pressure to the rear main and rod bearings because oil is now supplied from both ends of the oil galley rather than just from the front as is the case with the stock arrangement. Where the turbo feed fitting exits the block (front, passenger side) the block must first be drilled to 9/16" to the cam bearing then drilled 1" deep using a 19/32" bit, then threads tapped to 3/8" NPT to accommodate the new fitting and 3/8" external line.

In all out race engines, you should consider running an external oil pump, bypassing the front cover pump.

### **Oil Cooler:**

Since the turbo is cooled by the oil in these engines, it is important to be sure the oil cooler is clear and functioning correctly. These engines will generate considerable crankcase heat if the cooler is not functioning correctly, so it is important to keep your radiator/transmission cooler/oil cooler in top working condition. In fact, upgrading to a 4 core radiator is good insurance against damaging your engine/transmission from excessive heat.

We recommend using 30W racing oil or HD fleet type oil in these engines. Racing oils contain additional "anti-wear" chemistry and will help extend the life of your engine. We also suggest using a quality oil additive such as the products offered by Pro Blend or Pro Line.

### **Cylinder Heads/ Intake Manifolds:**

The turbo cylinder heads have some inherent shortcomings when it comes to performance. We recommend ported cylinder heads or upgrading to an aftermarket cylinder head such as the Champion "GN1". Our customers have reported faster spool-up with ported heads.

However, we realize that ported or new cylinder heads do not fit into everyone's budget. Below is a description of standard rebuild, bowl porting and fully ported cylinder heads:

#### **Performance rebuild:**

Intake and exhaust seats cut using 3 angle cutter. Bowl "hawg" used to open exhaust bowl throat. Valve springs replaced with Chevrolet "LT1" style springs. The stock valve springs in these engines are too soft (new seat pressure is 78lbs); the LT1 springs are better suited to the application without being too stiff (new seat pressure is 105lbs, but as little as 95lbs will suffice). New exhaust valves are installed, the exhaust guides are machined to accept valve seals and new "Viton" seals are installed. Exhaust valves are undercut to enhance low lift airflow; undercutting the stock intake valves is a waste of time.

#### **Bowls & Chambers:**

Intake bowls are ported, reshaped and blended into the port; particular attention is focused on reshaping, blending and smoothing the short side radius, the area of the port where most of your flow gains are obtained (intake bowl port and full port flow the same up to .550" lift). The exhaust ports require full port to deliver adequate flow for turbo applications. The combustion chamber is modified to remove any valve shrouding and finish polished. All other work is identical to performance rebuild described above.

#### **Fully ported:**

Intake ports are completely ported and reshaped, port opening matched to gasket. Intake ports are

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further enlarged in the pushrod area to increase port cross sectional area. Intake and exhaust valve guides are streamlined and valve bowl is reshaped, smoothed and blended. Exhaust ports smoothed and reshaped. Intake and exhaust seats cut using a 3 angle cutter, seat tops are radius cut. Exhaust guides machined to accept valve seals, Manley "severe duty" intake (1.775") and exhaust (1.5") valves installed as well as "LT1" style valve springs. Exhaust crossover is filled and blended. Combustion chamber is modified to remove any valve shrouding and finish polished. New "Viton" valve seals installed on both intake and exhaust. Intake and exhaust valves are undercut to enhance low lift airflow.

Two more considerations regarding cylinder heads; we recommend the use of either ARP professional series head bolts or ARP head studs (...do not use stock head bolts!) Also, we recommend having an "o-rings" machined into the cylinder head around each combustion chamber; this o-ring is used to keep the head gasket from shifting under extreme operating conditions.

We highly recommend port matching the intake manifold with ported cylinder heads; once the intake ports are opened to match the intake gasket, it becomes apparent how restrictive the intake manifold runners are if left as cast. You will better utilize the flow potential of your cylinder heads by port matching the intake manifold. Pay close attention to the floor of the intake manifold; once on the motor, it will be quite apparent where material needs to be removed! Porting the intake only applies to fully ported or Champion heads.

### **Valvetrain components:**

#### **Valves:**

In all instances, we recommend the use of stainless steel valves. The stock valve size is 1.71" on the intake and 1.5" exhaust diameter. If you are replacing the valves on stock heads, we recommend the Manley "severe duty" 1.71" intake and 1.5" exhaust valves. On ported heads we recommend upgrading to the 1.775" Manley "severe duty" intake valves. The Champion "GN1" heads use 1.9" intake and 1.6" exhaust valves.

#### **Rocker arms:**

The stock rocker arm assemblies are fine for most street/strip applications. The original rocker arms are reasonably strong and will work fine with most milder camshafts that utilize the "LT1" valve spring. There are plenty of cars running 10 second quarter miles with stock rocker arms, so I would invest my money in other parts before spending the big dollars for roller rocker arms. That said, the reduced friction will translate to a few extra horsepower and lower oil temperature, so if your car has all of the other "bells & whistles" and your budget will allow, you will see some gains running roller rocker arms on your motor even in mild street applications. Keep in mind that factory heads will require modifications to the rocker arm pedestals for roller rocker arms to fit!

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Larger camshafts (cams with more than .500" valve lift or more than 230 duration measured @ .050" valve lift), extreme boost levels (over 30lbs. of boost) and higher valve spring pressures (open spring pressures that exceed 275lbs) will necessitate upgrading to roller rocker arms. Also, some roller cam applications that fall below the above criteria none the less create high enough valvetrain loads to warrant upgrading to roller rocker arms...when purchasing a roller camshaft, consult with the cam manufacturer for their recommendation on rocker arms. When using Champion cylinder heads, we always recommend the use of roller rocker arms.

### **Pushrods:**

When using roller rocker arms, we recommend upgrading to chromoly pushrods. The Champion heads require different length pushrods (8.4") as do roller rocker arms on production cylinder heads. Retainers, keepers, springs:

We recommend the use of quality aftermarket chromoly retainers and hardened keepers when using stiffer valve springs than the "LT1" springs. Never use stamped keepers! Always use high quality machined keepers. As for valve springs, we follow the recommendations of the cam manufacturer, but for all of the street camshafts the Chevrolet "LT1" valve springs work fine. We have used stock retainers/keepers with these springs and on stock cylinder head rebuilds, but aftermarket retainers are good insurance (especially if you like to race a lot) and are required when using stiffer springs.

Keep in mind that valve springs fatigue and lose tension over their lifetime. A spring can lose 10lbs. of tension after a few minutes of operation! Two factors will cause your valve springs to lose tension: excessive heat and being opened too close to coil bind. Most valve spring manufacturers recommend that their springs be used in applications where there is at least .060" difference between maximum valve lift and coil bind. The more you compress your valve springs, the shorter the life of the spring.

The stock springs are too soft. They start with 78lbs of seat pressure, but typically have only 50 - 60lbs of pressure after 100k miles. Now, consider the following: the stock exhaust valve is 1.5" in diameter, which, when you subtract out the stem diameter and leave off the outer edge of the valve that is beyond the valve seat and in the combustion chamber, that leaves a surface area roughly 2.5 - 2.75 square inches exposed to exhaust system before the turbo. Now, consider that, to build 20lbs of intake boost you could see 35+psi on the exhaust side of the turbo... $35\text{lbs} \times 2.75" = 96.25\text{lbs}$  of pressure exerted on each exhaust valve! The exhaust valve will not be blown open (intake boost pressure and cylinder pressure will counteract this force enough to prevent the valves from being blown open) , but at higher engine speeds this pressure will cause the valves to bounce or flutter on the seats! This is where you will lose horsepower with stock springs. It is apparent that the valves are bouncing with stock springs; the seats (especially the exhaust seats) are typically pounded on stock cylinder heads! Eventually the pounding causes your valves and valve seats not to seal sufficiently and you lose compression and power.

### **Timing Chain:**

We recommend double roller timing chains for all applications. There are several available but be careful to degree-in all camshafts as we have encountered timing sets that are off several degrees! When upgrading to the double roller chain, you do not use the factory chain tensioner. Also, replace the factory thrust button with the heavy duty replacement thrust button; this roller bearing "button" will reduce wear on your timing cover and the front of the block; it contains a stiffer spring to help prevent "cam walk".

### **Camshaft & lifters:**

When choosing a camshaft, a few items must be considered. It is easy to over cam one of these engines. Since this is a turbo engine, small gains in lift and duration are amplified, resulting in larger gains in power than would normally be experienced with the same camshaft in a naturally aspirated engine.

Be aware that many high performance camshafts are machined on a different "base circle" than the original factory camshaft. This "base circle" is the diameter of the cam lobe without the lift; the radius of the heel (non-lift) side times 2. To obtain more lift, many cam grinders will take more material off the heel of the cam to gain additional lift. When using a camshaft with a base circle different than the original base circle, some valve train adjustability is required to maintain correct lifter preload on hydraulic camshafts. Most of the milder performance camshafts (Comp. Cams 206/206 custom grind, Ruggles design 210/205) do not require an adjustable valvetrain to maintain sufficient lifter preload.

Some performance camshafts are ground with "fast ramps", they open and close the valves more quickly than is typical of factory camshafts. The good news is, this practice makes more horsepower. The bad news is, this practice can (under certain conditions) make for a noisy valvetrain.

Once you have made a choice regarding camshaft, there are a couple of things to consider before buying your lifters. Most aftermarket lifters tend to be a bit noisy with the fast-ramp cams. The stock GM lifters are reported to be quieter. It all has to do with oil metering. The oil metering orifice of the aftermarket lifter is much larger than the GM lifter, which is why they will "bleed down" more quickly at low engine speeds and can sound a bit noisy. However, the tighter oil control of the stock lifter can become a problem at higher RPM; the lifter can't bleed off oil fast enough so it "pumps up" or fills with oil. When this happens, the valves are held off the seat & you lose all of your power until the engine RPM falls low enough for the lifters to bleed off the excess oil and function properly again. Generally speaking, the stock GM lifters should work fine to 6000 RPM; if your camshaft will make its peak power below that RPM and the noise is a problem, use the GM lifters. If your peak power extends above 6000 RPM or the noise isn't an issue, use the aftermarket lifter. Also, be prepared to pay considerably more for the GM lifters than the aftermarket offerings!

We recommend the use of hydraulic roller camshafts in these engines. These camshafts offer superior wear to the flat tappet offerings. Also, these camshafts typically will increase performance by .2

seconds.

## **Cylinder Block, Crankshaft, Connecting Rods & Pistons:**

The '85-'87 turbo block (casting number 25526109) is a pretty stout piece; capable of handling 750+ horsepower when properly prepared! Below, we will discuss these blocks, cranks, rod and piston considerations to give you a few ideas on how to best prepare your particular engine for your intended use.

### **Blocks:**

We recommend the use of main studs and billet main caps to replace number 2 and 3 stock main cap in all applications. The billet main caps have 3 times the strength of the stock main caps; they fit more snugly in the block registers, helping to prevent cap walk. We also use ARP main studs, these studs also contribute to reducing cap walk; they produce more clamping force than the original main cap bolts. Once installed, you will need to have the main saddles align bored. A very important note on line boring: the cylinder heads must be bolted to the block before line boring! The two center head bolts on the intake side of the motor will distort #2 and #3 (especially #3!) when torqued to spec. If you do not install the heads before line boring, you run the risk of having trouble with #3 main bearing once the engine is run hard. Also, if you intend to run 10 seconds or quicker, you'd better consider a main bearing stud girdle as these times are going to put you over 600 horsepower and start to compromise your block!

The turbo block itself is stronger than the pre-1985 3.8 turbo block, having thicker cylinder walls and additional webbing material in the main saddle area, but the big gains in stiffness were gained from the additional material in the lifter valley. Adding the studs and main caps in conjunction with this stiffer block provide a strong basis for any street or street/strip application.

We recommend the use of a torque plate when honing all blocks! A torque plate simulates the load of a cylinder head being torqued in place; this stress distorts the cylinders! In fact, the main caps should also be torqued in place before honing. We do not recommend boring these engines more than + .030".

We recommend drilling the number 2 and 3 main oil feed passages out to 3/8" to ensure adequate oil flow for numbers 2 through 5 rod bearings. Also, some blocks can experience excessive wear on the front cam flange surface. If this wear is deep (.020" or greater), the block can be repaired using a "cam spacer" from Mondello performance (part # CS-120). This cam spacer is .040" thick and will create a new wear surface for the cam to thrust against; the spacer must be fastened permanently to the front of the block using epoxy (Marine Tex or JB Weld work fine).

In very high horsepower application, cryogenic treatment is recommended. Also, we suggest using a block girdle when horsepower approaches 500 to the rear wheels.

### **Crankshaft:**

The nodular iron crankshaft used in the turbo engines is manufactured differently than the standard 3.8 crankshaft. The turbo crankshaft was manufactured with the main and rod bearings having a rolled fillet radius. This process makes the crankshaft stronger for several reasons. The rolled radius assures concentricity and uniformity in the radius which helps to distribute journal loads more evenly. The rolled radius reduces the likelihood of stress risers (microscopic surface cracks). All turbo engines (1978 - 1987, 1989) and all 4.1 liter engines (1981 - 1984) have their crankshafts manufactured in this manner. Standard 3.8 cranks have rolled fillets on the main bearings only and will fail if used in a turbo application.

We do not recommend cutting these crankshafts more than .010" in any high horsepower application. When you have your crankshaft cut, make sure it is cut on the "high" (tight) side; we recommend main bearing clearance of .0015" - .002" (.0015" preferred) and rod bearing clearance of .0018" - .0025" (.0018 preferred). If you use a 3/4 groove main bearing, clearances can be on the loose side, because oil bleed off will not affect oil flow to the rod bearings as it will with 1/2 groove main bearings.

In very high horsepower applications, cryogenic treatment is recommended.

### **Connecting rods:**

The connecting rods used in all Buick V6 engines are of a strong cap screw design. This type of connecting rod design has been used in racing and used by Ford in their NASCAR & drag racing engines. When introduced in 1975, these connecting rods proved to be 50% stronger than previous designs. In most applications, the stock connecting rods are more than sufficient.

We recommend the use of ARP rod bolts in all applications. They are superior in strength to the original bolts...and offer cheap insurance against catastrophic failure! Please be aware that you must relieve the rod cap bolt holes; you need to take a 7/16" or 1/2" drill bit and slightly chamfer the bolt holes in order for the bolt's under head radius to clear. Sometimes a rounded file is necessary to de-burr the rod bolt holes in the rod caps. If you do not relieve the rod caps, the rod bolts will bind or not sit flush and they may not provide the proper clamping force....(please read that as a disaster waiting to happen!)

Once the bolts have been properly installed, we recommend that you consider having the connecting rods resized.

### **Balancing:**

We recommend all engines be balanced regardless of application...from stock to all out race motor, get it balanced! It has been our experience that balanced engines even idle smoother!

### **Pistons & rings:**

One area that cannot be compromised in these motors is the pistons. The pistons in these motors are exposed to extreme temperatures and pressures. Do not use non-turbo pistons in a turbo engine! The ring lands, pins and piston crowns are just some areas that are strengthened to handle the loads encountered in these engines. We recommend the use of a forged piston; we do not feel that a cast piston have adequate strength for most applications. Also, do not run more than 8:1 compression. We recommend piston to wall clearance of .0045" with TRW forged pistons. With other brands, follow manufacturer's recommendations.

Piston weight can become an issue in these engines. Basically, with heavy pistons, you're "leaving horsepower on the table". The light weight forged pistons (2618 aluminum) are highly recommended, as are thinner pistons.

Piston pins must be thick enough so as not to distort under high boost (if the pin distorts under high loads, they will loose press fit and walk out the side of the rods & into your cylinder walls!). We don't recommend thin wall, full floating pins for street applications; this arrangement is better left to all out competition engines. If you decide to use a full floating pin arrangement, you must have the connecting rods fitted with bronze bushings.

Piston rings should not be compromised. While standard moly filled rings will work, I question the choice as their life expectancy will be limited in severe use. We recommend the Federal Mogul "Plasma moly" rings, although there are several premium ring brands on the market that will work for these applications. These rings will better tolerate heat/cylinder pressures encountered in these engines and will have a longer service life than standard moly rings. We recommend a minimum ring end gap of .018" - .020" (top) and .020" - .022" (2nd). If you run extremely high boost, you might want to make these gaps .001" or .002" larger. Currently, Federal Mogul is suggesting the 2nd ring have a larger ring end gap than the top compression ring; for specifics on this concept, I suggest reading the Speed Pro "Performance Parts Catalog". Most aftermarket pistons use 1/16" compression rings; these rings offer sufficient ring seal with less drag.

### **Bearings:**

This is another area that can make or break this engine. Don't short change yourself; buy good quality bearings! Remember, this engine places a higher load on its bearings than most. Its making all of that power with 6 cylinders...not 8!

We recommend the Federal Mogul aluminum alloy main bearings for this engine. These bearings offer superior conformability. These bearings do not have the tin overplate (the shiny, light gray finish on bearings). They are bored to size...more accurate than previous stamped finish. You will find that the oil hole in the bearings is smaller than the feed holes in the block. We recommend enlarging the oil hole to 5/16" in all applications to promote higher oil volume to the main and rod bearings. These bearings



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should be deburred after enlarging the oil passages with a small round file and then cleaned with "Scotch Brite" and motor oil. These bearings also offer the benefit of a 3/4 oil groove; increasing oil flow to rod bearings by roughly 25%.

We suggest Federal Mogul rod bearings for this application, part number 6-3755APA. Please note that there are two different bearings available for the Buick V6: 3755AP and 3766APA. The difference between them is width, the 3755APA is wider and has more load carrying capacity than the 3755AP. These bearings should also be cleaned with "Scotch Brite" and clean motor oil before installation.

#### **Gaskets:**

We recommend the stock head gaskets for all but race only applications. These gaskets utilize a pre-flattened steel wire to help seal the combustion chamber and will be more than adequate for all but the most extreme applications.

We suggest using a cork oil pan gasket. These gaskets, when properly installed, will seal as well as any gasket available. The key to cork gaskets is to install them dry, as any oil or foreign material will create a wicking condition and promote leaking. Also, torque the bolts to 88 in. lbs.