Break-In Procedure for Engines

The purpose of this document is to better familiarize you with all the steps that need to be taken to ensure that your engine is properly broken in. Proper break in is critical in ensuring your engine will achieve maximum performance as well as durability. Failure to follow these steps can cause engine damage and may void your warranty.

When a new engine is started for the very first time there are many things that are happening. Freshly machined surfaces are going to be running against other machined parts under load for the very first time. When this happens these surfaces will establish a wear pattern. This is the same wear pattern that you would see if you took the engine apart and looked at the areas where parts are sliding, rubbing and moving back and forth against each other.

Areas such as piston rings and skirts will be wearing against the freshly machined surface of the cylinder wall. As the engine heats up the various metal components in the engine such as aluminum pistons, cast iron or aluminum block and others will start to expand and the geometry of these parts will change. As the engine reaches operating temperature the geometry of most of these parts should normalize to some degree as the temperature is maintained.

Once the engine is at temperature these “wear” areas will go through microscopic “machining” operations. There are a couple of important areas where this process is vital.

When the cylinder bores are first machined and honed this creates a microscopic array of jagged torn metal when magnified. In order to create the best possible surface for the new rings to seat against we use a much finer stone in the end of the machining process to knock down these peaks of material. This creates a plateau finish for the rings. When the rings first run against this surface they further knock off any small microscopic peaks as they establish a pattern. We use a sophisticated surface profilometer to measure the surface finish of the finished bores to ensure they are within our tolerances.

The key to ensuring the rings “seat” is to make sure there is adequate cylinder pressure forcing them against the cylinder walls. The rings themselves have very little tension. What seals the combustion pressure from getting by the rings is the combustion pressure itself. The ring has a back angle on it that allows combustion pressure to work its way behind it and create a wedge of pressure forcing the ring out into the cylinder wall. This pressure or force is what is needed to make this final micro-machining process that we call “seating” the rings to happen.

When the engine is started its important that load be applied to it to start putting this pressure on the rings. At first this starts with light to medium load until you get the engine up to temperature. After the engine reaches operating temperature though at that point

it's important to switch over to a varied medium load. It's also important during this process to vary the rpm up and down while loading the engine as this allows the rings to see cycles of load and unload and to move around.

The job of the oil in all this process is to take those microscopic pieces of metal and carry them away from the rings. This ensures that the machined surfaces are wearing in properly and do not have an excess buildup of metal.

Oil Recommendations

The most common question asked is usually "what viscosity oil?" or "what brand oil?"

There is not really a "right" answer to this question, because there are a number of variables that come into play when it comes to choosing oil for your engine, engine type, application, climate, etc. So to say just one oil viscosity is right or wrong isn't accurate. Another variable that comes into play is shear viscosity; this is the viscosity that the oil shears too after use. Because the makeup of oils can be vastly different between brands and types it's not a safe bet to say that one 5w 30 oil is the same viscosity as another 5w 30. One type may be relatively shear stable over 1000s of miles, while another maybe quickly shear and be closer to a 5w 20.

Application and temperature greatly influence oil recommendations. A car that never see's track time might be completely fine with 5w 30 oil. The same car though in a road race application that is in Arizona in the summer might have a problem using that same 5w 30.

We recommend using only high grade oils in our engines. These are full synthetic oils designed for high performance engines. While the factory oils may be adequate in factory applications, they often fall short when placed in a high performance application.

Based on this we suggest using oils such as Job Gibbs Driven, Mobil 1, and other high end full synthetic oils. These premium oils are designed with full synthetic base stocks that are vastly superior to the blended oils that utilize a petroleum base stock that is refined. High end performance full synthetic oils are formulated for the applications they'll encounter. In most cases street/strip cars that never see sustained operation at higher RPM will be much more forgiving in regards to oils and viscosities. What determines the correct oil for the application and engine is based on the specifics of the engine and its application.

The following chart gives some general guidelines for oil recommendations. Remember, these are general guidelines, if you have a question or you feel like your application might require something specific to match, please email or call so that we can identify what makes the most sense for your application.

Engine	Application	Climate	Oil
Ford 2.3L & 3.5L Ecoboost	Street/Strip	Average	5w 30
	Road/Endurance Race	Average	5w 40
	Road/Endurance Race	Hot	5w 50
Ford 2V, 3V, 4V 4.6L	Street/Strip	Average	5w 20
	Road/Endurance Race	Average	5w 30
	Road/Endurance Race	Hot	5w 40
Ford GT500	Street/Strip	Average	5w 30
	Road/Endurance Race	Average	5w 40
	Road/Endurance Race	Hot	5w 50
Ford Coyote 5.0L	Street/Strip	Average	5w 20
	Road/Endurance Race	Average	5w 40
	Road/Endurance Race	Hot	5w 50
Ford Raptor 6.2L	Street/Strip	Average	5w 20
	Road/Endurance Race	Average	5w 40
	Road/Endurance Race	Hot	5w 40
GM LS1/LS6/LS2/LS3/LS7/LS9	Street/Strip	Average	5w 30
	Road/Endurance Race	Average	5w 30
	Road/Endurance Race	Hot	5w 40
GM LT1	Street/Strip	Average	5w 30
	Road/Endurance Race	Average	5w 30
	Road/Endurance Race	Hot	5w 40

The following steps discuss the process we recommend for breaking in one of our engines.

1. Fill the cooling system with a 50/50 mixture of new coolant and distilled water.

2. Fill the engine with appropriate weight break in oil to the appropriate level on the dipstick. (The break in is first done using break in oils, prior to the use of the final grade oils that will be used).

   Note: Livernois Motorsports recommends Joe Gibbs Break-In oil for this process. It is available in two viscosity's 15w 50 as well as 5w 30.

Warning- Failure to use the correct oil during initial break in of the engine can lead to improper break in of the engine and may cause both performance issues or engine damage. This will also void the warranty.

3. Check the routing of all belts, hoses, and wiring to make sure they are clear for startup. It is important to be thorough in making sure all connections are correct.

4. Check timing and hook up a wideband device so air/fuel can be monitored during startup. This is another critical step as the air/fuel ratio must be correct in order for the engine to run properly and be able to be broken in properly.

Warning- Failure to ensure the correct air/fuel ratio upon startup can cause engine damage. Too rich of a mixture can wash the oil from the cylinder walls and damage the rings.

5. Start the engine. If it doesn't start within 10 seconds of cranking, verify that everything is properly connected. All electronic connections must be made otherwise the engine will not start. If the engine does not start within 10 seconds do not crank on it for longer than that. Excessive cranking can lead to fuel washing the cylinders if the injectors are firing. This can cause ring damage. Excessive cranking can also cause the bearing lubricant to be wiped off and will allow metal to metal contact as there will be no oil pressure.

 Warning- Do not crank the engine for extended periods of time.

6. Have someone sitting in drivers seat at all times on engine startup. As the engine starts, bring rpm up to 2,000 rpm monitoring oil pressure, water temperature, and rpm. Having a second set of eyes is usually very helpful during initial startup as it helps to have two people monitoring everything.

 Warning- Stop the engine immediately if no oil pressure is observed.

Note: Remember that the cooling system on a fresh engine swap will have a lot of trapped air, which can lead to wild temperature gauge readings and possible water pump cavitation (water pump not moving coolant due to trapped air). To help avoid trapped air in the cooling system, try to fill the cooling system a few hours before you plan on starting the engine. Leave the radiator cap off during this time. This will tend to help purge a fair amount of trapped air before you start the engine.

7. Listen for any unusual noises, (knocking, tapping, scraping, etc.)

 Warning- Stop the engine immediately if any unusual noises are present.

8. Vary RPM from 1800-2400 for first couple minutes of run time. While the engine is running have someone check the cooling system and purge as necessary.

9. Stop the engine and visually check for fluid leaks. At this time, you should also check engine oil and coolant levels and add as necessary until the appropriate level is reached.

10. We now recommend checking timing and putting the vehicle on a chassis dyno or hooking up a wideband device so air/fuel can be monitored. Once air/fuel and timing is verified to be safe run the vehicle at medium load at cruising speeds to get it quickly up to temperature.

11. Allow the engine to reach full coolant operating temperature. At this point you can now switch to running medium/medium-heavy load. This can be accomplished by running the car in a higher gear (4th or higher) and at a RPM in the 2500-4000RPM range. Alternate between 35% to 70% throttle and make short bursts through the RPM range up to around 4500-5000RPM

    Note: Its important to keep in mind throughout this procedure the importance of getting load on the engine. As listed in greater detail in the beginning of these instructions you see how important it is to get load on the engine. The timeframe that this happens in is critical. Allowing the engine to startup and idle for 10 minutes is detrimental to the break in process and may cause performance issues down the road.

    This is a high performance engine that we want to ensure has the best possible chance to run at peak efficiency. This is why break in is so critical. From the time the engine first starts keep this in mind. Quickly assess that the engines fluid levels, fuel connections, air/fuel ratio and overall running condition are correct. At that point proceed directly to getting the vehicle where it can be run under load to get it up to temperature quickly so that higher load can be applied.

12. Stop the engine and again visually check for fluid leaks and re-check engine oil and coolant levels. Add as necessary until the appropriate level is reached.

13. Continue to run and tune the vehicle on the dyno. You can now make max power pulls on the dyno.

14. “Sneak up” on the tune; make short pulls while monitoring air/fuel and timing.

15. We recommend changing the engine oil after the initial break in period. Check the oil for any signs of possible problems. If the oil smells like fuel, the tune may be too rich. (Damage can occur from running the engine too rich). If using the Joe Gibbs break in oil we recommend changing from the break in oil after 4-5 hours of run time or after the first 350-400 miles.

Customer Checklist

Oil Fill Check _____

Fuel Connections _____

Coolant/Water Connections _____

Electrical/Ignition Connections _____

Air/Fuel Check _____

Timing Check _____

Warnings

The following list of warnings are compiled together to make sure that the customer has as much information as possible to prevent any issues with our products. Failure to follow these instructions will void your warranty.

All of Livernois Motorsports engines are built to exact tolerances. We strive for perfection in every aspect of the engine build. We take considerable steps to ensure that cleanliness, precision and quality control are held only to the highest standards. These aspects are critical for engine life and performance. The shortblocks and engines we build are built in a climate controlled clean room environment. This is to ensure absolute cleanliness. This is why it's of utmost importance to ensure that whatever you add to a shortblock or complete engine that it's thoroughly clean. This applies to adding parts such as heads, oil pan, covers or any other parts to the engine as well as fluids such as oil or coolant. Failure to ensure cleanliness can lead to engine damage or failure. Never reuse parts that have come off an engine that failed.

These shortblocks and engines are built to tolerances of less than .0002 in many areas. When installing other components such as heads, camshafts, bolt ons, etc. it is critical to measure and ensure proper setup. Things like clearances such as piston to valve clearance must be checked. Valvetrain setup also requires that lash and preload be checked to ensure proper operation. Failure to check any of these could lead to engine damage or failure. Torque procedures also must be done per recommended specs for the fasteners being used.

The tune-up is another aspect that is of vital importance for engine performance, life and durability. This is an area where it is very important to do your research first and make sure you pick a tuner that has the ability to tune your engine properly. Failure to tune the engine properly can result in damage and failure and is not covered under warranty.

In conjunction with the tuning it is important to ensure that the conditions and criteria that the engine need to perform are meet. This means running the appropriate octane fuel along with recommend boost level for the fuel you are running. Livernois Motorsports recommends not running more than 11-12 lbs of boost on pump gas under any circumstances. While we acknowledge that under the watchful eye of an expert tuner you can achieve these boost levels without issue we have found that it is far too dangerous to do safely. The variability of pump fuel does not allow for high boost levels. While you may think that the fuel you are getting is 92 or 93 octane there is no guarantee. Pump fuel and especially the higher octane premium fuels can sit for long periods of time in the tanks underground. During that time the octane rating can be adversely affected as things like moisture and contamination can alter the fuel. This is part of the reason we do not recommend running high boost levels on pump fuel.

If throughout any portion of the process of the engine buildup or shortblock conversion all the way to the installation and tuning that there are questions or issues please contact Livernois Motorsports before proceeding.

Installation Notes & Warnings

1. Failure to follow break in procedure can result in engine damage or significantly increase wear on the engine and reduce performance.

2. Engines and shortblocks are packaged and lubricated to prevent corrosion and contamination. We don't recommend allowing engines or shortblocks to sit for extended periods of time without starting.

3. We recommend having an experienced professional install engines or finish shortblocks. Failure to properly install the engine or components can result in engine damage.

4. Exceeding the Horsepower and Torque specifications and/or recommended boost levels can result in engine damage. Ensure that the components in the engine will withstand the power you are aiming to make.

5. Do not use standard oils during the break in process. The break in process must occur with a break in oil. After completing the break in period do not continue driving the car/truck without changing the break in oil, failure to do so could lead to premature wear.

6. If your vehicle retains the stock tune, do not start the engine until a wideband can be used to monitor air/fuel and verify proper tune. Do not use the stock tune on a heavily modified engine with a power adder.

7. Excess fuel from improper tune can wash the cylinder rings and damage the engine. Excessive lean condition from improper tune can also damage rings and pistons and cause major engine damage.

8. Always check piston-to-valve clearance when installing aftermarket camshafts.

9. Remember that the tune is one of the most critical keys to engine life. If the tune is not correct the engine will not achieve peak performance and may be damaged.