



Engine Block preparation for the Do-it-yourselfer by the Technical Staff of the Standard Abrasives Motor Sports Division

Block Preparation

Engine block preparation is the cleaning and abrasive operations performed to an engine's cylinder block prior to the machining operations (boring, honing, align boring, balancing, etc.) that set the block's critical dimensions. For the purposes of this Guide, we're going to look at block preparation in a wider sense and include work on the crankshaft, the connecting rods and the pistons.

All of the block preparation techniques discussed in this Guide, surface conditioning, deburring and polishing, can be done by any do-it-yourselfer using the Block Prep Kit (p/n 260003) from the Standard Abrasives Motor Sports Division along with a die grinder and a few common hand tools.

The Block Prep Kit contains six types of abrasive products: Surface Conditioning Discs, Grinding Discs, Cartridge Rolls, Cross Buffs™, Flap Wheels and a 3-foot by 2-in., 320-grit Handy Roll. There are enough abrasives in the kit to perform basic deburring and polishing on a V8 cylinder block, crankshaft, connecting rods and pistons.



Everything the DIY needs to prep a V8 cylinder block is in this kit.



The Kit also includes all of these tools. Top is the holder for Discs. Middle is the mandrel for Cartridge Rolls. Bottom and left are the mandrel pieces for Flap Wheels and Cross-Buffs.™

Also included in the Standard Abrasives Block Prep Kit are holders and mandrels for all the abrasive products. These components are designed for mounting in a die grinder having a maximum speed of 18,000-20,000 rpm and a 1/4-in. diameter collet or "chuck".

An air-powered die grinder is desirable because of its relatively low cost and variable speed. It requires an air source and most air compressors powered by motors rated at 2.5 horsepower or more will work well. The air system should be equipped with an adjustable pressure regulator. The abrasive products' safe speed rating is 18,000-20,000 rpm. If an air grinder's maximum speed exceeds that, you must reduce it by using the regulator.



This is a typical die grinder with a right-angle head and a 1/4-in. chuck. A die-grinder with a straight head works acceptably. A right-angle head can make certain deburring operations less awkward.

While the never-exceed speed is 18,000-20,000 rpm, the majority of the abrasive products in the Block Prep Kit will have best durability when the grinder runs at 10,000-12,000 rpm. Measuring the die grinder's speed is difficult, however, most tools cite their maximum speed either in the unit's instructions or on a specification plate attached to the tool. Suppose maximum speed of your unit is 20,000 rpm, but you want to run it at 10,000. Operate the grinder at half throttle and listen to the noise it makes. Then, run it at full throttle and adjust the pressure regulator such that the noise is about the same as before. That will approximate 10,000 rpm.

The pressure regulator is important for another reason. It is easier to manipulate a die grinder with the throttle wide open than it is to control the grinder and modulate the throt-

tle at the same time.

You may be using an electric die grinder. That is acceptable as long as its maximum rpm is below the 18,000-20,000 rpm limit. Because electric grinders are often capable of exceeding that by a significant margin, an electrical device allowing the user to reduce the tool's speed is necessary. Additionally, speed regulation of an electric grinder will be necessary if you want to use the abrasives at 10,000-12,000 rpm.

Additional tools required are: a 5/64-in. hex key (Allen wrench), the die grinder's chuck wrenches, a medium-sized ball peen hammer, a medium-sized flat nose punch, a medium-sized cold chisel, taps to fit the bolt holes in your block and a roll of good-quality, duct or "racer's" tape.

None of the techniques used in a block preparation project are dangerous as long as proper safety procedures are followed, however, misuse of the tools or failure to observe a few safety rules may result in injury. Deburring and surface conditioning work throws lots of metal chips around, so the first thing you need to protect are your eyes. The minimum protection is shatterproof eye wear designed for industrial use. Better is a face shield made of shatterproof material.

Next, you need snug-fitting work gloves. We recommend the Mechanix Wear brand since they allow a good sense of touch while still offering protection. An alternative is a generic leather work glove of medium thickness. Avoid thin leather gloves or the very thick units intended for welding and do not use rubber gloves.

People sensitive to airborne dust may want a respirator mask such as the type used by paint and body shop workers. These inexpensive, white cloth masks are held to your face with an elastic string.

The noise some air grinders make is quite loud. If loud power tools are a discomfort, do your block preparation work wearing ear protection. Best are the muffs airport workers wear around jet engines. Acceptable are a set of ear plugs intended for industrial use.

Mechanix Wear gloves can be found anywhere racers buy parts and supplies. You should be able to find the rest of this safety equipment at a hardware store. Dedicated safety vendors, such as Lab safety Supply, are also good sources.

The first die grinder operation to learn is changing tools. Virtually all die grinders come with a set of wrenches used to loosen and tighten the chuck. Typically, one wrench holds the air grinder shaft and the second wrench turns the chuck's nut. You loosen the nut, insert the abrasive product's holder or mandrel, then tighten it, again. Finally, you will attach the abrasive to the holder or mandrel. In the process of your block preparation work, you will change the abrasive product several times. Always disconnect the air grinder from the air source and the electric grinder from the power source when making the change.

Once you start working, move the grinder as smoothly as possible. Grinding in one place will result in removal of too much material and uneven surfaces. Also, don't forget to set the speed of the grinder at 10,000-12,000 rpm.

If you are working with an aluminum cylinder block, use grades of abrasives suitable for aluminum and, regardless of the grade, use a more gentle touch than you would if you were working on cast iron. Because aluminum is softer than iron, it abrades faster. If you use the same grinder pressure you would with iron, before you know it; you will have shaved off too much material. Additionally, when working on aluminum under most conditions, the abrasive tool will "load-up" with caked on aluminum. Spraying the tool frequently with a light lubricant, such as WD-40, reduces this problem.

Block Cleaning and Surface Conditioning

If your project starts with a used cylinder block, you're probably going to have to clean it before any abrasive procedures begin. If a used block comes from an engine that was fairly clean inside, it may just need to be washed with solvent, then scrubbed with hot soap and water (Tide laundry detergent works well) and blown dry with compressed air. Shooting the solvent and hot, soapy water through some kind of pressure blaster makes the job easy.

If a high-mileage, used block is your starting point, it's probably coated with black, gooey, sludge making the solvent/hot-soapy-water method impractical. It is best to have a block that dirty "hot-tanked," a process that submerges the parts in a hot solvent or caustic solution. Typically, the block is left in this hellish brew



If you start with a used block, here is an example of a near-worst-case-scenario and a great illustration of why used blocks need to be hot tanked. Sludge? You got lots of it, here.

for an hour or so. If everything works right, it comes out of the tank devoid of sludge, dirt and paint. Hot tanking is a service offered by some auto parts stores, automotive machine shops and engine rebuilders. Use caution if you are working with an aluminum block. Some cleaning processes and solutions that are safe for iron blocks are not compatible with Aluminum. When in doubt, ask the facility doing the cleaning if the process they use is safe for aluminum parts.

The majority of DIY engine builds will probably be done with cast iron blocks. If that's the case with you, whatever cleaning process was used on your block, you will probably be confronted with a thin coating of rust on machined sealing or mounting surfaces, such as cylinder head decks, oil pan rails, timing chain cover mounting surface and accessory mounting pads. Even though the block has been cleaned, these surfaces should be conditioned to remove rust and any traces of old gaskets, paint, gasket sealer, and dirt left after hot-tanking. Aluminum blocks will have no rust, of course, but may have corrosion, gasket remnants or other residue left after the cleaning process.



These are GP Surface Conditioning Discs. Some engine builders call them "Gasket Blasters". The blue-gray units are Very Fine grade and the red-brown ones are Medium discs.

Using a putty knife or scraper to removing this stuff is not acceptable because neither will clean those surfaces completely. If your block is aluminum, putty knives or scrapers may even damage those surfaces. The first step in block preparation is to clean those surfaces with a Standard Abrasives General Purpose Surface Conditioning Disc. The Block Prep Kit contains two different types of them. The Medium grade discs are for iron blocks and the Very Fine grade discs are for aluminum blocks.

Disconnect the grinder, install the Standard Abrasives Quick Connect, 2-in. holder pad into the chuck and tighten the nut. The conditioning discs use Standard Abrasives' unique Soc-Att™ locking system, so installing the disc on the holder is as simple as a twist of your wrist.

One of the best features of Standard Abrasives Surface Conditioning Discs driven by a die grinder is their ease-of-use. Little or no downward pressure on the die grinder is necessary. The combination of the Surface Conditioning Discs' unique abrasive material and the high-speed rotary motion of the die grinder will do the work. If you apply any significant pres-

sure to the die grinder while using Surface Conditioning Discs, damage to the surface being abraded may occur.

If the work surface is aluminum, additional care with tool pressure and abrasive grade must be observed. Use only the Very Fine grade discs and make sure downward pressure on the tool is almost non-existent.

After installing the proper Surface Conditioning Disc, reconnect the grinder, put on your gloves and eye protection, then start conditioning the head decks the easy, Standard Abrasives way. Once the gasket surfaces are down to bare metal, disconnect the grinder and remove the conditioning disc set-up.



The key to good work with power-driven abrasive products is to control the grinder with both hands and let the rotating action of the abrasive do the work. Use only limited downward pressure, if any at all.

Install the Cartridge Roll mandrel into the die grinder chuck and install an 80-grit Cartridge Roll. Use that to clear the water holes in the cylinder head decks of rust, scale and casting flash. Doing this will improve coolant flow.

After you're done with the decks, reinstall the Surface Conditioning Disc and abrade the rest of the block's gasket surfaces, accessory pads and other machined surfaces.

Deburring the Block

You deburr a block for several reasons: 1) deburr the inside surfaces of the engine block to improve oil return. 2) deburr or radius other inside surfaces that are under high stress, such as sharp edges and casting flash around the main bearing webs, to make it more difficult for cracks to start 3) deburr the outside of the block or appearance purposes and to reduce the amount of nicks and cuts you get from handling the block.



Cartridge Rolls are the mainstay of many automotive abrasive operations. The Block Prep Kit has four different types: 40-grit, full-tapered; 80-grit, full-tapered, 40-grit, straight and 80-grit, straight.

You'll be deburring with the Block Prep Kits' Cartridge Rolls or its Grinding Discs and the Cartridge Rolls will be used most of the time. Deburring to improve oil return is done to two areas: 1) the oil return holes in the "valley" between the cylinder banks and 2) the surfaces of the cylinder bank walls that make up the sides of the valley.

Oil is delivered to most of the engine's moving parts under pressure but flows back to the oil pan over the engine block's internal surfaces by force of gravity. Iron blocks are sand castings and the rough finish left by that process impedes oil flow. This is seldom a problem for a production engine in normal passenger car duty, however, in street high-performance or racing engines, it can cause trouble. At high engine speeds oil can be pumped up into the top of the engine faster than it can drain back. This causes two problems: 1) a shortage of oil in the oil pan resulting in occasional inconsistencies in oil supply and 2) an excessive volume of oil in the top end of the engine resulting in oil leaks and oil ingestion into the intake tract. One way to reduce the severity of those problems is to remove casting flash inside of the oil return holes, then deburr the holes and the inside of the block valley.

If the oil return holes have a lot of casting flash restricting them you may need to knock large pieces out with the ball peen hammer and a flat-nosed punch or cold chisel. Once that's done or if there are

no large oil return restrictions, open up the Standard Abrasives Block Prep Kit and select either a 40-grit, straight Cartridge Roll or a 40-grit, full-tapered Cartridge Roll. The



It's best to use tapered Cartridge Rolls to clear the oil return holes because most of these holes will be fairly small. Some engines will have so much casting flash and crud in these holes that a cold chisel and a hammer may be necessary to remove heavy concentrations. Two hands on the grinder makes for better control.



After the oil hole work, depending on the surface, use tapered or straight cartridge rolls, to deburr and smooth valley areas.

type of roll you select will be dictated by the size of the oil return hole you are working on. If it's a large hole, the straight Cartridge Roll will work best. A small hole will be better "de-flashed" with a 40-grit, tapered roll. Typically, one starts from the top or "valley side" of the block but, don't forget to roll the block over and look at the other ends of the oil returns as they exit into the crankcase. In many cases these passages, as they dump into the roof of the crankcase around the main bearing webs, will need deburring work, too. Once the oil passages have been cleared with the 40-grit rolls, then go over everything again with 80-grit rolls to smooth the surfaces.

The next step is to turn the block back over and deburr the areas in the valley over which oil flows on its way to the oil return holes. Generally, this will be the cylinder block walls above the valve lifter bores and the surfaces surrounding the lifter bores. You may be able to deburr most of these surfaces using the 80-grit Cartridge Rolls but, some of the rougher areas will go faster and your abrasives supplies will last longer if you start with the 40-grit rolls then finish with the 80s. Also, there may be some large, flat or nearly-flat areas where the 100 grit Grinding Discs may work better. If you are working on an aluminum cylinder block, use only the 80-grit rolls and the 150-grit Grinding Discs with a soft touch.

The final block preparation task done in the valley is to Cross Buff the valve lifter bores. The Standard Abrasives Cross Buff™ is unique in the industry. It was designed exclusively for automotive use and is the perfect solution to a block preparation challenge: refinishing the valve lifter bores. Typically this is done with a clumsy brake cylinder hone which, if you can even find one these days, sometimes can do more damage to the lifter bore finish than good. Using one of the High-Strength, Very Fine grade Cross Buffs™ from the Block Prep Kit, lifter bore finishing becomes easy. Install the Combination Mandrel used for both Cross Buffs™ and Flap Wheels, add the hex-socket screw, tighten with a 5/64ths in. hex key, then screw the Cross Buff on that.



These are Cross-Buffs,™ a very specialized type of automotive abrasive product developed by Standard Abrasives Motor Sports Division.



In block preparation work, the main application of Cross-Buffs™ is the surface preparation of the valve lifter bores.



Both Cross-Buffs™ and Flap Wheels require the long, silver mandrel. When Cross-Buffs™ are used, the black set screw is attached to the mandrel and the Cross-Buff™ goes on the end of the screw.

Of the abrasives in the Block Prep Kit, Cross Buffs™ are most sensitive to grinder speed and should be run at 10,000 rpm for best results. Also, Cross Buffs™ must be used with a light lubricant, such as WD-40 or automatic transmission fluid. Dip the Cross Buff™ in the lube or spray it on. Place the Cross Buff™ at the top of the lifter bore then turn on the die grinder. All that is required is one or two passes through the lifter bore and its surface will be free of corrosion and properly conditioned. Though cylinder block cracking due to the stresses of high rpm operation is not common with street high-performance and many race engines, it does happen. If it does, it is more likely to occur in the structural areas of the crankcase around the main bearings.



Lightly round sharp edges on all the main caps, however, do not heavily radius these edges.

goes into the main cap or block surface. Those entry and exit holes may need to be slightly deburred or chamfered to remove flash or sharp edges that will impede oil flow.

It is not necessary to deburr all of the crankcase surfaces. You want to grind a small radius onto sharp edges and deburr places where casting imperfections are obvious places for cracks to start. You may even find casting imperfections in the sharp-edged part of the main webs that are actually tiny splits or gaps in the cast iron that surely could become cracks. Those problem areas need to be carefully deburred.

Don't forget to lightly deburr the sharp edges and corners of the main bearing caps. In the case of engines that have the oil pump bolted to the bottom of the block and the main oil feed running from the oil pump and into a main bearing cap or the block itself, inspect the areas where that main oil feed goes into the main cap or block surface. Those entry and exit holes may need to be slightly deburred or chamfered to remove flash or sharp edges that will impede oil flow.

For the most part, deburring or radiusing to eliminate stress risers can be done with 80-grit Cartridge Rolls but in some cases the 100-grit Grinding Discs may work well. If you are working on an aluminum block, use only the 80-grit rolls and the 150-grit Grinding Discs with a light touch.

Some of the surfaces inside the crankcase of most cylinder blocks can be anything but easy to access, but with a compact die grinder and the variety of abrasive products in the Standard Abrasives Block Prep Kit, you should have little trouble in working on the most difficult-to-reach spots.

Once the work inside the crankcase is complete, you should turn your block preparation efforts to the outside of the block. All casting flash should be removed and all sharp edges should be radiused. You'd think most of the work on the block's exterior will be for



Some engines, like Chevrolets, that mount the oil pump to the bottom of the block or to a main bearing cap, need to have the main oil feed line transition from the pump body to the block deburred to remove sharp edges that restrict oil flow.



This is what you call "heavy deburring". Major casting flash areas on the outside of the block should be attacked with a 40-grit, straight cartridge roll.

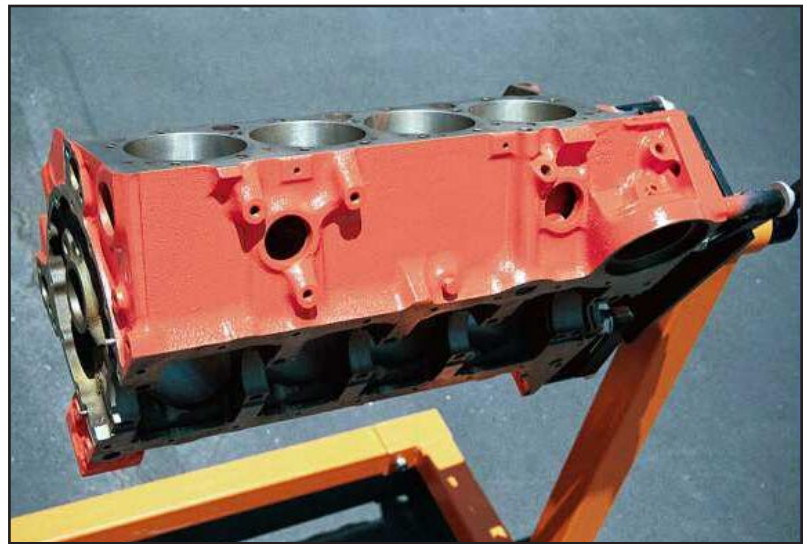
ascetic purposes—you want your engine to look as good as it runs. There is a safety reason, as well. Blocks with lots of sharp edges and casting flash can cut ones hands during the inevitable handling that will occur during an engine building project. A good block deburring job will greatly reduce the chances of cuts and nicks. A third reason to deburr the outside of the block is, like the main bearing webs inside the crankcase, there will be some areas of the block's exterior where deburring will eliminate stress risers and defray cracking.

The exterior of a cast iron block will be done mostly with 40- and 80-grit, straight Cartridge Rolls and 100-grit Grinding Discs.. If you are working with an aluminum block, use only 80-grit rolls and the 150-grit Grinding Discs and a light touch.

Once the deburring and radiusing work on the outside of the block is complete, get out your taps and run them into each bolt hole on the block. It is especially important to do this to the cylinder head bolt holes. This removes any debris and repairs the threads in any holes that have been damaged. Either of those problems interferes with proper bolt tightening during the assembly process.



Our finished demo block shows the comprehensive deburring job one can do with the Standard Abrasives Block Prep Kit.



Once painted, the outside of the block looks professionally detailed. No sharp edges to cut your hands and no flash nor casting crud to make you look bad.

Crankshaft



Crankshafts, especially nodular iron units, have a multitude of sharp edges, flash and part lines that need to be removed.

Edges of counterweights are best removed with a straight cartridge roll. It is not necessary to heavily radius the counterweight edges, just remove the sharpness.



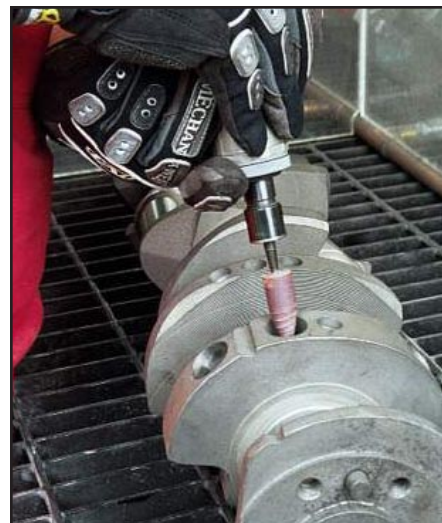
The crankshaft is the largest moving part in the engine and is the device that converts the reciprocating motion of the pistons into the rotary motion that moves the vehicle. Crankshafts are either cast of nodular iron or forged from high-strength steel. Regardless of the material, most crankshafts have sharp edges that need to be radiused and rough surfaces that need to be deburred.

Like the block the first step is to clean the crank. Run a wire-bristle brush through the crankshaft oil passages. Many "engine cleaning" kits have specific brushes for this purpose. A excellent and perhaps more easily-obtainable substitute is a 22-caliber pistol cleaning kit which usually contains both the brushes and a cleaning rod that comes in handy for this purpose. Next, you want to clean the crank's exterior. This can be done with a cold solvent washing or dipping or with a hot-tanking.

The crankshaft's sharp edges need to be radiused. It is not necessary to significantly grind down these edges. Just put a small radius on them using either the Standard Abrasives Block Prep Kit's 80-grit Cartridge Rolls or the 100-grit Grinding Discs. You may find some big holes in the counterweights and the edges of those holes need to be radiused using a tapered Cartridge Roll.



Part lines left by the mold (for a cast crank) or forging die (for a forged crank) should be deburred away. A Cartridge Roll is best for this.



Tapered Cartridge Rolls are best for counterweight holes. Use a straight roll and the diameter of the roll maybe too large to round the edges of the hole without chattering or destroying the Cartridge Roll.

For best results, the diameter of the roll must always be noticeably less than the hole and in many cases that means a tapered roll.



Duct tape greatly decreases the threat of a nicked journal if you catch a bearing journal with the tool.



Sharp edges just outside the bearing journals must be approached with care using a tapered Cartridge Roll. Do not heavily radius these edges. In some cases, such as this Chevrolet crank, you may be working near the crank's thrust bearing surface. Take care not to nick the thrust surface.



In the unfortunate event you do damage a crankshaft journal or thrust surface, the Block Prep Kit's Handy Roll will usually repair the problem.

There are parts of the crankshaft deburring process where you will have your abrasive tool very close to the bearing journals. You absolutely do not want to abrade those surfaces. To protect them, wrap each journal with several layers of good-quality duct tape. If you do nick a taped-over journal, stop deburring, remove the tape from that journal and put a fresh wrapping on it.

If you make a mistake by touching one of the journals and the abrasive cuts all the way through your layer of tape, immediately stop working and re-tape the journal, then continue the deburring process. After the deburring is complete, strip the tape off the nicked journal and use the 320-grit Handy Roll to deburr the nick. You will be able to tell then the nick is properly deburred by running your fingernail over the damaged area. When you can't feel anything, the nick has been deburred.

Once you've radiused all the crank's sharp edges, you may find the flat surfaces of some of the counterweights to be rough or scarred from the casting and/or machining process. The rough areas should be deburred using the 100-grit Grinding Disc or an 80-grit Cartridge Roll.

Lastly, run a tap through all the crankshaft's bolt holes to clear them of debris and repair any minor thread damage.

Connecting Rods

The rods are probably the most stressed moving parts in an engine. Most street-high performance engines and some race engines will use production, forged steel connecting rods. They will have sharp edges maybe even some casting flash and a noticeable parting line along the rod's "beam". The



At left is a rod after preparation using the Block Prep Kit. At right is the production rod. The greatest value in deburring block parts comes when you do the rods.



Begin the process with a 100-grit Grinding Disc. Remember to let the grinder's rotary motion do the work.

edges and the parting line are stress risers and it's important to radius all sharp edges on the rod and rod cap then deburr and polish the connecting rod beams.

The first step is to clean parts with either a solvent spray or by the hot-tank process. Next, understand there are three parts of each rod from which you want to keep abrasive products away: 1) the rod bolts, 2) the rod cap mounting faces and 3) the rod bearing mounts. Take care to keep the abrasive tool away from those areas.

Radius sharp edges on the rod and rod cap using the 80-grit Cartridge Rolls out of the Standard Abrasives Block Prep Kit. Generally you'll use a straight roll but some of the complex shapes on the rod caps might require a tapered roll.

Once the edges are radiused, it's time to polish the rod beams. Start with a 100-grit Grinding Disc and remove all traces of casting flash and the parting line left by the forging process.



The second stage of the rod work is done with the 80-grit Flap Wheel.

Once you've removed the heavy stuff with the Grinding Disc, select the Flap Wheel mandrel from the Block Prep Kit, install one of the 80-grit Flap Wheels and further polish the beam surface. It is extremely important during the Flap Wheel stage to move the abrasive such that the marks it leaves are parallel to the beam. The final step must not deburr or polish across the beam.



It is very important, to apply the Flap Wheel's rotary motion parallel to the rod beam. Applying it across the beam actually creates stress risers almost as bad as the ones you are trying to remove in the deburring process.



This is how the rod beam should look after the Flap Wheel work.

Pistons



Only use the Flap Wheel on pistons. The aluminum will abrade rapidly. Only light radiusing of the piston skirt edges is necessary.

The final step in a block preparation project is some minor abrasive work on the pistons. Like the other engine parts we've covered in this DIY Guide, if you are working with used pistons, they'll need to be cleaned.

Lightly radius the edges of the piston skirts and tops. This must be done with care because the edges will be very narrow and the material is aluminum which abrades much faster than iron or steel. Use either the 80-grit Cartridge Rolls or 80-grit Flap Wheels for this part of the job and remember—you need a very light touch with the abrasive. You only want to lightly radius the edges not grind them down substantially.

Closing Out the Job

Though many of the parts we've worked on in this block preparation Guide will next go to a machine shop for operations such as boring, honing, rod re-sizing and piston pin-fitting, you want to send the machine shop clean parts.

We suggest you rewash everything with hot soapy water, give them a water rinse then blow them dry with compressed air.

Typically, there will be enough abrasive products left in your Standard Abrasives Block Prep Kit such that, if you get the parts back from the machine shop and find you missed a sharp edge or a little casting flash somewhere, you can go back and remove it before the assembly process begins.

For information on more advanced block prep techniques typical of that used on all-out racing engines, Standard Abrasives markets a video tape titled "Race Block Prep" (p/n 269847) which covers DIY methods for preparing a block for extreme high output applications.