PFM Quick Start Training Guide

This training guide covers the basics of good brake rotor service and proper use of the Pro-Cut PFM Rotor Matching System.

Pro-Cut's PFM 9.2DRO on-car brake lathe

PRO-CUT has worked with engineers from the top vehicle manufacturers for over 20 years to help solve performance issues related to brake rotor service. The primary tools by which we've been able to achieve this higher level of performance are the PFM 9 Series and Warthog computerized on-car lathes. These lathes, or Rotor Matching Systems, use patented technology, and are considered without equal by many major auto manufacturers and large retailers for accuracy and ease of use.

Like any piece of precision equipment, they do require a certain level of skill and knowledge to achieve the superior results you should expect. With that in mind, let's discuss the basics of good brake rotor service, and proper use of the Pro-Cut PFM Rotor Matching System.

Pro-Cut's WARTHOG on-car brake lathe

What results are we looking for?

There are three goals we have when using a Pro-Cut Rotor Matching System:

A · Elimination of lateral run-out (LRO) as measured on the outer pad mating surface of the rotor to less than .002" (.001" or less on Nissan vehicles, and Pro-Cut's goal) — by this we mean matching the rotor to the vehicle's hub.

B · A flat (no thickness variation), smooth, clean surface finish with a roughness average (Ra) of between 30 and 60 micro inches. This will match the rotor to the brake pads and ensure full, even contact for best stopping power.

C · Leaving the rotor above the thickness spec. You can measure this with a micrometer or the new G2X cutting head (available upon request).

What would happen if we did not eliminate lateral run-out or have a flat, clean, and smooth surface finish?

A · Lateral run-out of greater than .002" (.001" on Nissan/ Infiniti vehicles) is, over time, the root cause of thickness variation (TV) which is the direct cause of brake pedal pulsation.

B · A rough surface finish will cause brake noise & potentially affect stopping distances.

C · It is possible to be fooled into thinking you have successfully completed a brake job if there is no pedal pulsation during the test drive. Pedal pulsation does not start to develop until you are 5,000 - 7,000 miles down the road.

SMART TIP

Thickness Variation is generally a result of excess lateral runout (wobble) causing the rotor to scuff the brake pads on the "high spot" once each revolution. Today's aggressive semi-metallic pad materials wear away the surface of the rotor at this high spot over time (usually 5,000-7,000 miles) until the TV is great enough to be felt in the brake pedal as pulsation.

TERMS

Now let's break out some of those terms.
Lateral Run-Out (LRO): The amount of "wobble" in the rotor or side-to-side movement as the brake rotor completes one revolution. In order to be measured correctly, the rotor needs to be evenly tightened to the hub and all mating surfaces must be clean and free of debris.

.002": This represents two thousandths of an inch. For comparative purposes, human hair ranges from between .0015 to .004 inches! Nissan & Infiniti vehicles now require that you eliminate lateral run-out to less than the thickness of a human hair as measured on the rotor face at the outside edge of the brake rotor — (less than .001").

Thickness Variation (TV): This is the amount by which the brake rotor's thickness varies if you were to measure it in several (usually 4–6) different locations around the rotor with a micrometer. Thickness Variation is generally a result of excess lateral run-out (wobble) causing the rotor to scuff the brake pads on the "high spot" once each revolution. Today's aggressive semimetallic pad materials wear away the surface of the rotor at this high spot over time (usually 5,000-7,000 miles) until the TV is great enough to be felt in the brake pedal as pulsation. Some of the new ceramic pads can even cause thickness variation by transferring friction material onto the rotor on each revolution. This occurrence of TV can also be eliminated using the Pro-Cut lathe.

TERMS *(continued)*

Roughness Average (Ra): The measurement for how smooth the surface finish is after machining. Measured by taking the average distance between the peaks and valleys on the rotor surface after machining, as expressed in micro-inches. Typically, a Pro-Cut lathe in good working order and with sharp cutting tips can machine a rotor to a Ra of between 40–60 micro inches with no extra sanding or cleaning.

Mating the Lathe to the Vehicle

Now that we've addressed what we're after, let's cover some of the finer points of the use of the lathe itself.

At this point, a short discussion about axles and other issues you may encounter with mating the lathe to the vehicle is important. In general, (probably 95% of the time), you will be able to set up the PFM lathe and, provided the transmission is in neutral, the lathe's continuous duty 1hp motor will turn the hub freely and the lathe will compensate normally.

SMART TIP

"When working on all wheel drive vehicle platforms: Turn the key to the 'accessory' mode, put the vehicle in neutral (for all vehicles), disengage the traction control, and leave the key in accessory mode until the job is complete."

However, since we are attaching a device to rotate the hub at a continuous 125rpm, there are a few vehicles that will either not turn at all due to excessive resistance, or may begin to turn and then lock due to a speed sensitive locking axle. These issues are almost always found on the rear axles of trucks, but may present in some all-wheel-drive vehicles as well.

In the case of excessive resistance you will usually be able to tell just by trying to turn the hub by hand. If you can't accomplish this, you may need to remove (drop) the rear driveshaft at the universal joint yoke at the differential. This only takes a couple of minutes, and will reduce the resistance and ensure the PFM will operate normally. In the case of all-wheel-drive-vehicles (SUVs and the like) that have electronic locking differentials, you will want to switch off the lock (sometimes this is called towing mode) to eliminate the resistance.

In the case of all-wheel-drive vehicles that do not have this optional switch, and at ambient temperatures below freezing, you may need to drive the vehicle first to warm up the gear oil in the viscous coupling to reduce resistance (Example: Subaru STI & WRX).

In the event that the vehicle has a locking, floating rear axle, you will need to remove the axle to eliminate the possibility that a lock-up will occur. An example of this type of vehicle would be some 3/4-ton GM trucks. Once the axle is removed, the hub will turn freely and the lathe will operate normally.

Mating the Lathe to the Vehicle *(continued)*

The additional time added to the job is minimal (in the order of 2–4 minutes). In the event that you do not remove this axle, lock-up may result, causing possible damage to the lathe.

Again, these steps, though important to remember, are not time-consuming. In almost all cases time savings realized by using the PFM far outweigh alternative methods due to the "trapped" rotor configuration of many of these rear braking systems.

PROPER LATHE SETUP

Once vehicle axle/drive system considerations are made, we can move on to proper lathe setup.

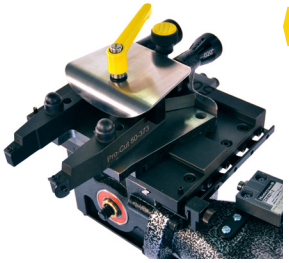
When setting up the Pro-Cut lathe it's important to make sure that all mating surfaces of the hub, rotor, and Pro-Cut adapter are very clean. Remember we are trying to achieve an LRO of less than .001" and a small flake of rust or dirt could change the outcome of our work.

SMART TIP

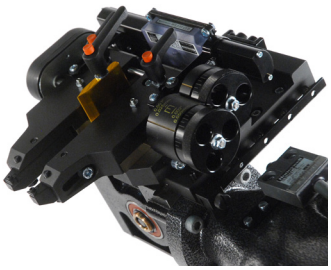
Since we are attaching a device to rotate the hub at a continuous 125rpm, there are a few vehicles that will either not turn at all due to excessive resistance, or may begin to turn and then lock due to a speed sensitive locking axle. These issues are almost always found on the rear axles of trucks, but may present in some allwheel-drive vehicles as well.

Once surfaces are clean and ready you may:

1. Remove any factory rotor retaining clips from the studs as the machine will not adjust properly if they were left in place.
2. Next mount the correct adapter and evenly tighten all nuts to no more than 20-25 ft. lb. Remember the important factor here is to achieve even clamping pressure.
3. When you attach the machine to the adapter both the face of the adapter and the face of the lathe flange should be flush against each other so there is no space between them. You'll know you have it right if the draw bar knob spins in freely by hand (like an oil filter). Snug the draw bar knob a bit extra by hand (over-tightening is not necessary!).
4. Center the cutting head over the rotor using one of the following methods:



Speed-Lock cutting head (Later PFM 9.2 models): Simply slide, center, lock, and set lock handles "in line" so silencer can easily slide over them.



G2X Cutting Head (50-1200) slide, center, lock and set lock handles. Simple operation and visibility of the control knobs as they are facing the technician. This cutting head will also measure the thickness of the rotor before, during and after the cut.

· **Start the machine** (turn on motor) and push the START button to compensate the machine for LRO. A properly working and set up PFM lathe should compensate in less than 60 seconds, and often less than 30 seconds. If for any reason the machine has not given you either 1 or 2 green lights (compensated) within 90 seconds, stop and recheck your setup.

MAKE SURE:

· The adapter fits correctly
· Lug nuts are tightened correctly and evenly
· The car is in neutral
· You didn't leave the factory retaining clip on over stud (behind adapter)
· Caliper on opposite side is removed and opposite side rotor is tightened evenly to the hub or removed.
· Rotate the adapter 180 degrees so that the locator pin on the adapter fits in the opposite hole in the face of the adjustment flange of the PFM.

MACHINING

Once the machine has compensated for LRO (1 or 2 green lights appear indicating this has been accomplished), you may begin the machining process. On current lathe models, you will see the lateral run-out displayed in thousandths and ten thousandths.

SMART TIP

Pro-Cut PFM lathes are considered single-pass machines. By that we mean that you don't need to make a rough cut and a finish cut, as was the case with older technology bench lathes.

Once the cutting head is centered over the rotor and the tool arms are separated enough to clear the rotor, wind the cutting head about halfway over the rotor surface and make a scratch cut first in the rear, then on the front. Keep in mind that if there are gouges in the rotor you will need to use the deepest gouge as your reference point. Also keep in mind that if there is a buildup of rust you will want to knock as much off as possible before proceeding with cut. Then zero out your adjustment knobs to set your reference point and back off each knob 2 hash marks or .005" per side. This will allow the cutting tips to clear the rotor as you wind the feed knob the rest of the way in to the inside of the rotor to begin the cut.

REMEMBER: DO NOT allow the cutting tips to come into contact with the hat of the rotor or any other fixed components of the vehicle — damage to the lathe (and your rotor) may result.

Pro-Cut PFM lathes are considered single-pass machines. By that we mean that you don't need to make a rough cut and a finish cut, as was the case with older technology bench lathes. All Pro-Cut lathes use a carbide neutral rake, positive relief, cutting tip that works best when used at a cutting depth of no less than .004" and no more than .020" per side. The sweet spot seems to be between .006" and .012" for best surface finish results on most vented rotors.

However, there are 3 exceptions to the depth rule: Solid thin rear rotors, larger dual wheel rear truck rotors, and drilled and/or slotted rotors should be cut with a maximum depth of .005" per side.

Because the lathe can remove a large amount of material, and is a one-pass machine, it's important to not be too shy with your cut so that you can be most efficient with your time. Remember, the depth of cut you select is determined by several factors including:

- The amount of lateral run-out
- Taper of the rotor
- Rust build-up
- Gouges in the rotor surface
- And most importantly, the rotor's minimum allowable thickness or "machine to" as set by the manufacturer.

SMART TIP

Pro-Cut cutting tips, when used properly, should yield 7–10 cuts per corner and cannot be flipped upside-down.

To make the cut, simply reset the adjustment knobs to zero (your scratch reference point) and turn the knob the number of additional lines required to obtain the depth of cut desired. Each line on a PFM 9.2 adjustment knob represents .0025". So 2 lines are .005" and 3 lines are .0075" and so on.

Pro-Cut cutting tips, when used properly, should yield 7–10 cuts per corner and cannot be flipped upside-down. The finished surface, by virtue of the "off-center" design of the Pro-Cut adapter threaded center hole, WILL NOT require the use of a non-directional finishing sanding.

This design allows the cutting tips to travel in an orbital motion as a small amount of radial run-out is intentionally induced to avoid the tendency that bench lathes have to cut a "record groove," or continuous pattern, into the rotor.

However, sanding with a 150-grit paper on a flat sanding block for up to 60 seconds per side after the cut is complete, but with the rotor still spinning, can reduce the surface Ra by up to 25%, or to between 30 and 45 micro inches.

The smoother the surface we can achieve the less potential for “growl” or other unwanted brake noises.

Once the Ra is reduced to an optimal level, we need to clean the pad mating surface of the rotor thoroughly. For years most folks have been using both chlorinated and more recently non-chlorinated solvent based brake cleaner. Solvents are great for getting grease out, but what we want to do is get metallic dust off the rotor and out of any of those minute “valleys” on the rotor surface. The best method for cleaning machined cast iron is good old soap and water (warm water is best). A tablespoon of dish washing detergent in a 32 oz. pump spray bottle works very well. Some companies are now making special soaps that are perfume and dye free to minimize residue even further. The soap works as a surfactant and lifts the material out of the valleys and off the rotor. Use plenty, and when you’re done clean thoroughly with a clean cloth or white paper towels (not a shop rag — even clean ones can harbor residue from past use) until it wipes totally clean.

You have just completed two critical tasks:

· Matched the rotor to the hub by taking into account the imperfect nature of the hub and the stacked tolerances from the hub and other components — thereby eliminating a potential pulsation comeback.

· Given the braking surface a new, clean, flat finish that is ready to be mated to the friction material.

SMART TIP

Once the Ra is reduced to an optimal level, we need to clean the pad mating surface thoroughly. The best method for cleaning is soap and water (warm water is best).

At this point you must be absolutely certain that you DO NOT jeopardize the fine job you have just completed! To complete the job correctly the following MUST be done properly:

First: If for any reason you must remove the rotor after completing the matching process with the PFM lathe, you must match mark the rotor to the hub with a crayon or the like and replace the rotor in that same position. Failure to do this will result in a complete undoing of the LRO correction of the job. For this reason it is always preferable to use the PFM last after all other suspension/hub/axle work is compete and the wheels are ready to go back on the vehicle.

Second: The lug nuts for the wheels must be set to manufacturer’s torque specifications. DO NOT use an impact gun without the proper TorqStik (sold by Pro-Cut) or use a hand torque wrench. Uneven torque will cause the rotor to deflect and will actually induce LRO and undo the nearly perfect brake job the PFM, and now you, performed. Do it once, do it right!

***- GW** 9/1/2009*

FAQ

Here are answers to the most common questions about the PFM lathe.

Q: We have a drive-on rack that we would like to use for brake work. Is that possible with the Pro-Cut lathe?

ANSWER Absolutely. Depending on the type of rack and the width of the vehicle you're working on, you may need the 50-390 adjustable height trolley to get around the rack. For narrow vehicles a 50-049 double-thick nose cone extension may be needed. See Product Catalog for details.

Q: Brake rotors on dual wheel trucks can be a real pain to get off; can the Pro-Cut lathe be used on these trucks?

ANSWER Definitely! There are adapters available for dual-wheel Dodge, Ford, GM, Isuzu, International and others. There are a few things to be aware of (especially for machining rear rotors): Depending on the brand of truck, you'll need either the 50-935, or the 50-944 dual-wheel adapter to find the correct bolt pattern. If you want to attach a lathe to the rear you'll also need a set of hexagonal "stand-offs" (various part #s) and a reach extension plate (50-1492 or 50-1492) due to the offset of the rotor and the size of the hub. If your shop frequently works on dual wheeled vehicles, we suggest our Warthog A10 lathe as is it a larger platform.

Consult your local Rep, Product Catalog, or call Pro-Cut @ 800-543-6618 for details on your specific application.

Q: Sometimes our shop gets so busy that we have to work off of the floor too — is there a way to use the Pro-Cut at lower heights like when the vehicle is on jack stands?

ANSWER Yes there is! The optional 50-360 Low-Boy trolley was designed to work in the 18"– 26" range so you can use a Pro-Cut lathe with any lift, or even no lift!

Q: Our shop occasionally gets some performance cars in with slotted/cross drilled rotors. Can we use the Pro-cut on these?

ANSWER Sure. Here are the tricks:

1. Be sure the cutting head is perfectly centered over the rotor so that the cutting tips are directly opposite of one another as they touch the cutting surface.

2. Take light cuts of no more than .0025"–.003" per side.