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Cam Degreeing Your Pontiac V-8: Do it Right!

Blueprinting Basics:

To a Certain Degree

Nitemare Performance Demonstrates How to Degree a Camshaft on a 462 Cubic-Inch Pontiac Crate Engine That You Could Win!

Swapping your camshaft can be a great way to improve your Pontiac's performance. Degreeing your cam during installation ensures you'll get every penny's worth of power out of your upgrade investment.

Story and Photos by Jason Scott

Whether you're building a new engine or just trying to improve the performance of your Poncho's existing powerplant, a new camshaft is usually one of the most cost-effective upgrades that you can make.

For a couple hundred bucks, you can replace your camshaft and lifters and, in the process, completely alter your engine's performance characteristics. It's not uncommon for a well-chosen camshaft to add 40 or more horsepower to an engine ... especially low-performance factory "economy" engines, or 1970s-era smog motors.

Unfortunately, even in today's age of Computer Numerically Controlled milling and grinding equip-

ment, camshafts are often machined ever so slightly incorrectly, so if you just slide the camshaft into the block, match up the dots on the timing gears, and call it "good," there's an excellent chance that you won't be getting all the power out of your Poncho's engine that it's capable of. The solution is easy, though: "degree" your camshaft during installation.

Some folks are understandably intimidated by the sound of "degreeing" a cam, but in reality, the process is pretty straight-forward, and Darrin Magro at Nitemare Performance, in North Haven, Connecticut offered to show us how it's done, while he degreed the cam in a 462-inch crate motor that is being raffled off this summer for charity.

What does it mean to "degree a camshaft?"

Without getting into too many details – because doing so could easily fill the rest of this issue or an entire book – the basic reason for degreeing a camshaft is to ensure that each valve "event" starts and ends precisely at the optimal "time" (as measured in crankshaft degrees) to achieve the performance characteristics that it was engineered to provide. The camshaft manufacturer specifies when these events should occur on the "cam card" for that particular camshaft. Alternatively, an experienced engine builder may choose to alter the specs by advancing or retarding the camshaft by a specific number of degrees, to alter engine performance in specific ways.

While a flat tappet cam like this one needs to be coated with assembly lube before you button things up, when degreeing, Nitemare Performance's Darrin Magro applies a coat of motor oil just to keep things lightly lubricated during the process, since thick lube can affect measurements. Bonus tip: Only coat one bank of lobes and journals at a time, as you insert the cam, to keep the mess to a minimum.

When the cam is fully inserted into the block, you should be able to rotate it by hand with only minimal effort. If it doesn't spin easily, you need to remove it and fix the issue before continuing … as was the case with the Nitemare Performance 462-inch raffle engine.

Magro determined that the front half of the #2 cam bearing was just a tad too tight, based on how freely the camshaft rotated as he inserted it. To confirm such a diagnosis, Magro recommends measuring the cam journals and I.D. of the cam bearings.

The #2 bearing wasn't mushroomed from the installation process, nor was there any sign of it being nicked during the cam installation process. But gently "kissing" it with a Scotchbrite pad with very little pressure removed just enough material to allow the cam to spin freely with some oil on the journal.

So, how do you degree a cam?

Degreeing a camshaft basically involves checking three basic things: camshaft end play; maximum intake/exhaust lift; and intake centerline. You can check more – like opening and closing events and duration – but if those three are within spec, then things are probably good enough for anything short of a professional race engine.

The process isn't exactly rocket surgery, though Nitemare Performance's Magro did point out that it requires a few specialized tools and a bit of basic math.

The basic gist is that you have to check camshaft end-play, install a degree wheel, find TDC for cylinder #1, then measure the intake lobe's centerline and compare it against the cam card. And if your cam happens to be off by a few degrees one way or the other, you get to make adjustments and repeat the process.

With that overview in mind, follow along in the accompanying photos and captions as Nitemare Performance's Darrin Magro degrees the cam in the 462-inch crate engine that they'll be raffling off to benefit charity this summer! ***PP***

With the cam fully inserted into the block, it's time for the lock plate. This is Nitemare Performance's Pro Oiling Cam Plate, which features not only the factory-style oil slot, but a circumferential oiling groove that greatly reduces friction and wear of the plate and nose of the cam, for improved performance and durability.

The plate bolts on with factory hardware or preferably hardened bolts with lock washers. Magro started with Nitemare's .121-inch thick plate, shown here, but switched to their "thin" .112-inch version to provide extra clearance for ...

...Nitemare Performance's nine-way adjustable billet double-row roller timing set, which features a bronze bushing to further minimize friction and wear. Depending on clearances in your specific engine, the upgraded timing set can often be used with a factory cam plate, but Nitemare recommends its HP or Pro Oiling Cam Plates for its optimized clearance and improved oiling capabilities.

Note how the camshaft protrudes from the cam gear slightly. This small lip helps keep the fuel pump eccentric centered on the cam, so it's of vital importance if you'll be running a mechanical fuel pump.

The Nitemare camshaft washer is secured to the cam with a factory cam bolt.

Again, with the gear set on the cam snout and engaged with the key, re-verify that the camshaft can be rotated by hand with minimal effort.

On the raffle engine, Magro installed one of Nitemare Performance's custom CNC-milled, hardened cam washers that replaces the factory washer and fuel pump eccentric. Since this engine lacks a fuel pump eccentric, it will require an electric fuel pump, which Magro recommends for any high-performance street engine to ensure maximum power and minimize the chance of fuel starvation or vapor lock.

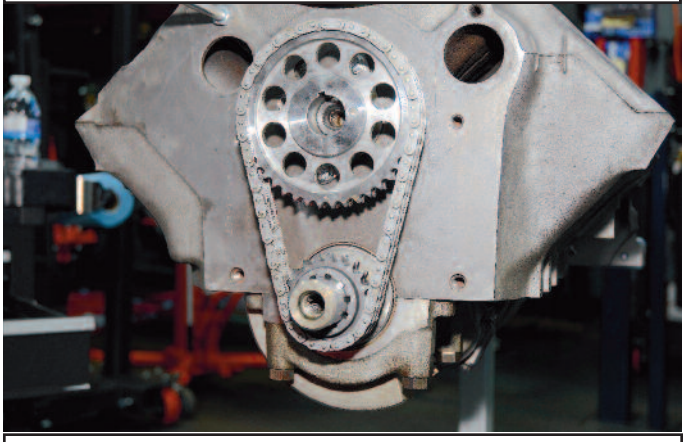
Until he's finished checking the camshaft's end-play, Magro only snugs the cam bolt, since it'll be coming back off soon.

With the cam gear installed temporarily, Magro verifies that cam end-play is acceptable. Ours measured .011-inch with dry thrust plate and cam gear and bushing surfaces, which is Magro's preferred measurement. The end play will tighten up by a few thousandths of an inch once the cam gear and bushing thrust surfaces are coated with oil.

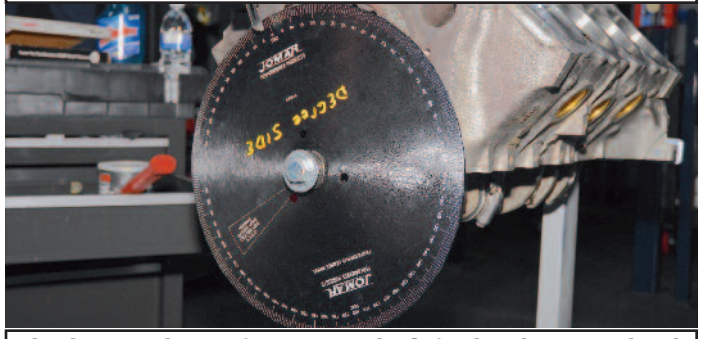
Now that the end-play is known, things come back apart for assembly lube. Here, Magro is applying lube to both surfaces of the Nitemare Pro Oiling Cam Plate.

The cam gear and bronze bushing also get a liberal coat of assembly lube.

Now, when the cam gear goes back on, it has the chain draped over it and around the 9-way crank gear. Magro used one of Nitemare's .005-inch short chains, since the raffle engine's block had been line-honed. The shorter chain prevents slop that would otherwise result in erratic valve and ignition timing.

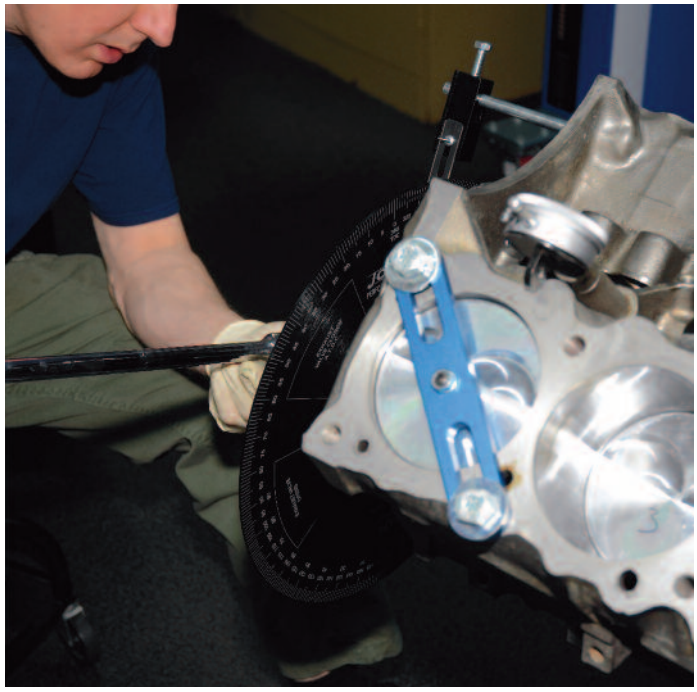


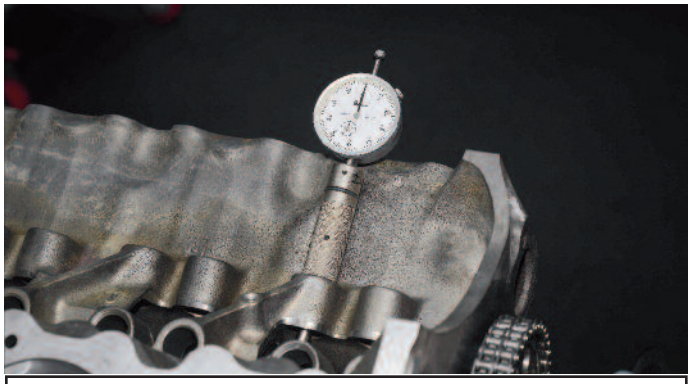
It may be hard to see in this photo, due to its size when printed in the magazine, but the dots on the crank and cam gear are properly aligned for our starting point of the degreeing process.



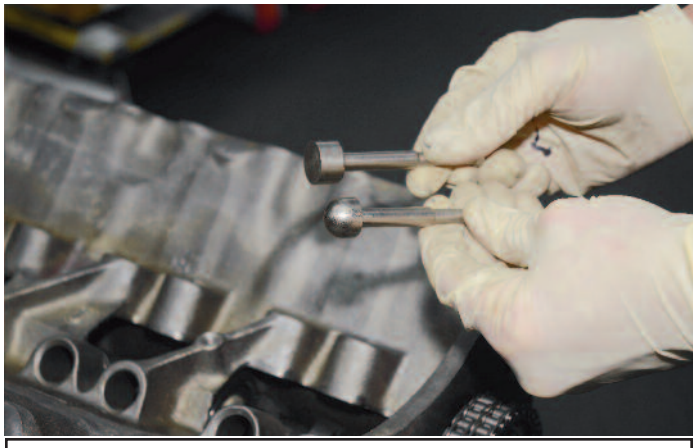
The key to degreeing a camshaft is the degree wheel. A large-diameter wheel like this one from Jomar Performance isn't strictly necessary, but it is more precise than a small-diameter wheel found in most degreeing kits. A Jomar adjustable degreeing pointer is bolted to the block at about the 11 o'clock position. Don't worry about the wheel's orientation when you first put it on ... you'll deal with that in the next step.

Locating Top Dead Center is critical when degreeing a camshaft. Magro first rotates the crank to bring the piston near the top of the cylinder, then installs a piston stop. Then he rotates the crankshaft clockwise until the piston contacts the stop and makes a note of the reading on the degree wheel. He then rotates the engine counter-clockwise until the piston contacts the stop again, and notes the reading on the degree wheel. He then adds the two numbers and divides by two, to find the point between both points of contact where TDC occurs, and he rotates the degree wheel itself (not the crank) so that the TDC value is at the pointer. Then he rotates the crank clockwise again until that number comes up again ... which should be when the piston touches the piston stop again. If so, the degree wheel is in-sync with the crank; if you remove the stop and rotate the crank to "0," the piston will be precisely at TDC. Be careful not to accidentally rotate the wheel on the crank now, or you'll have to go through these steps again.

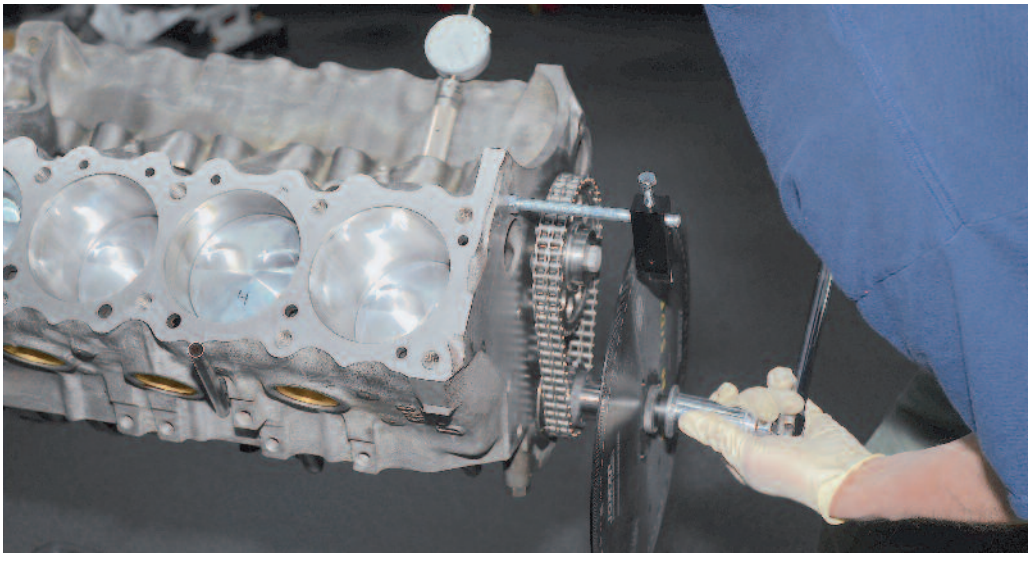




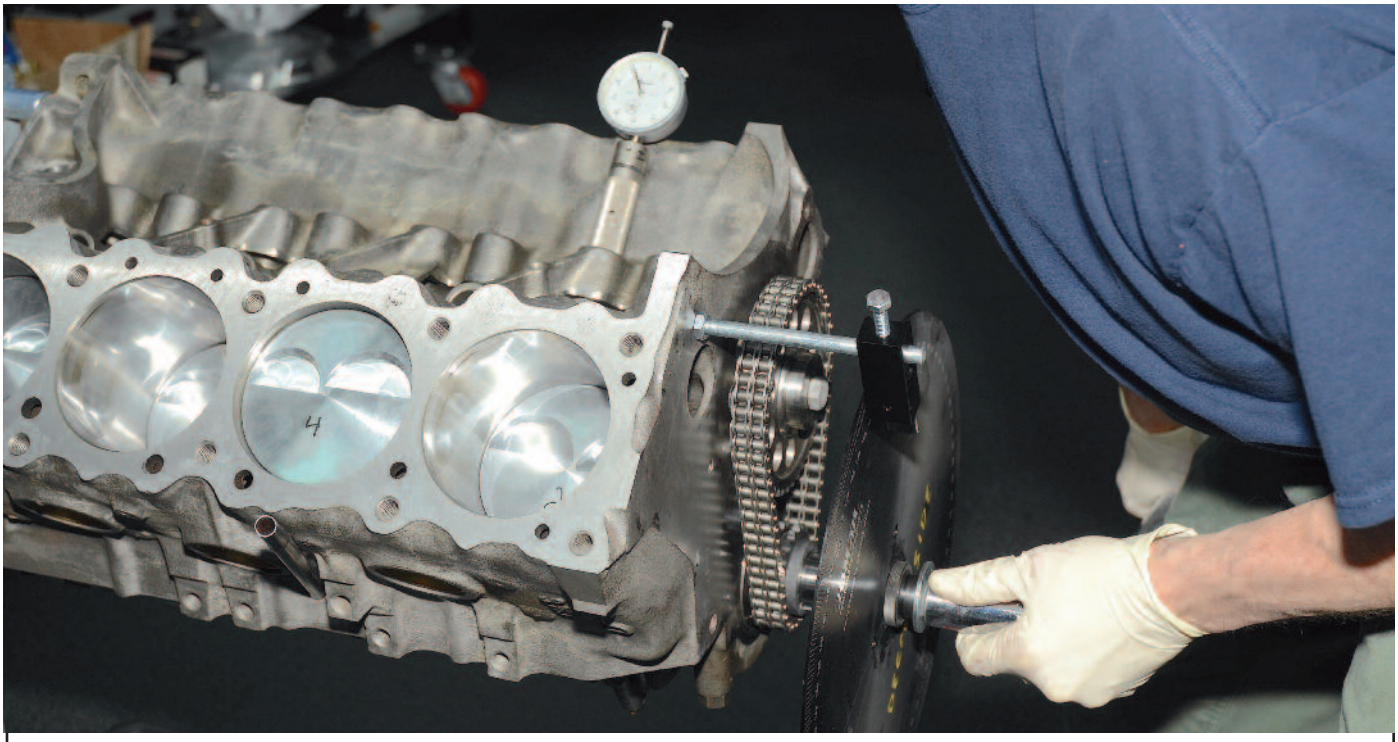
You'll need some sort of dial indicator to accurately detect cam lobe measurements. Magro uses a nifty adapter that slides into the lifter bore for the #1 intake lobe, but you can also use a magnetic base. You can also take measurements at the valve, if the heads are already installed ... you just have to account for rocker arm ratios then.



If you opt to get a lifter-bore adapter like Magro's, make sure you get the proper tip for whichever cam type you'll be measuring: flat for a flat-tapper cam, or rounded for a roller cam. Either can be used with both solid and hydraulic camshafts.

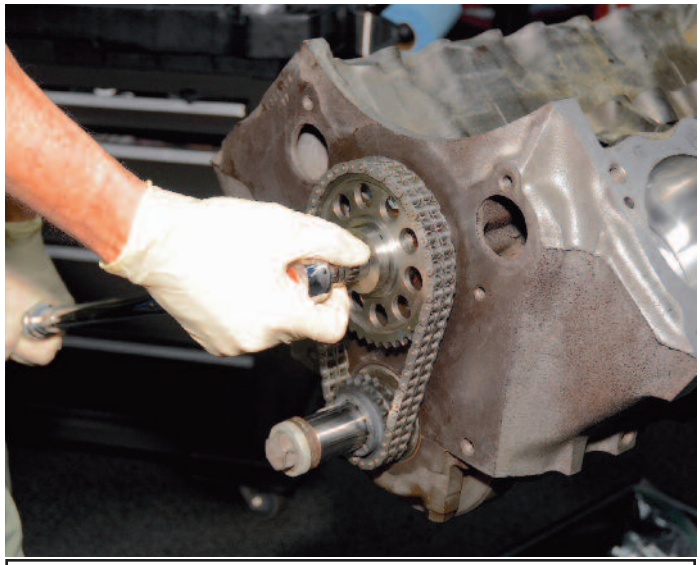


Magro checks duration and centerline during the same process. First, he rotates the crankshaft clockwise to find the point of minimum lobe lift on the dial indicator, then zeros the indicator at that point; that's the cam's base circle. Next, rotate the crank clockwise until the dial indicator reads .050-inch of opening lift and make a note of the reading on the degree wheel, to use when calculating duration.

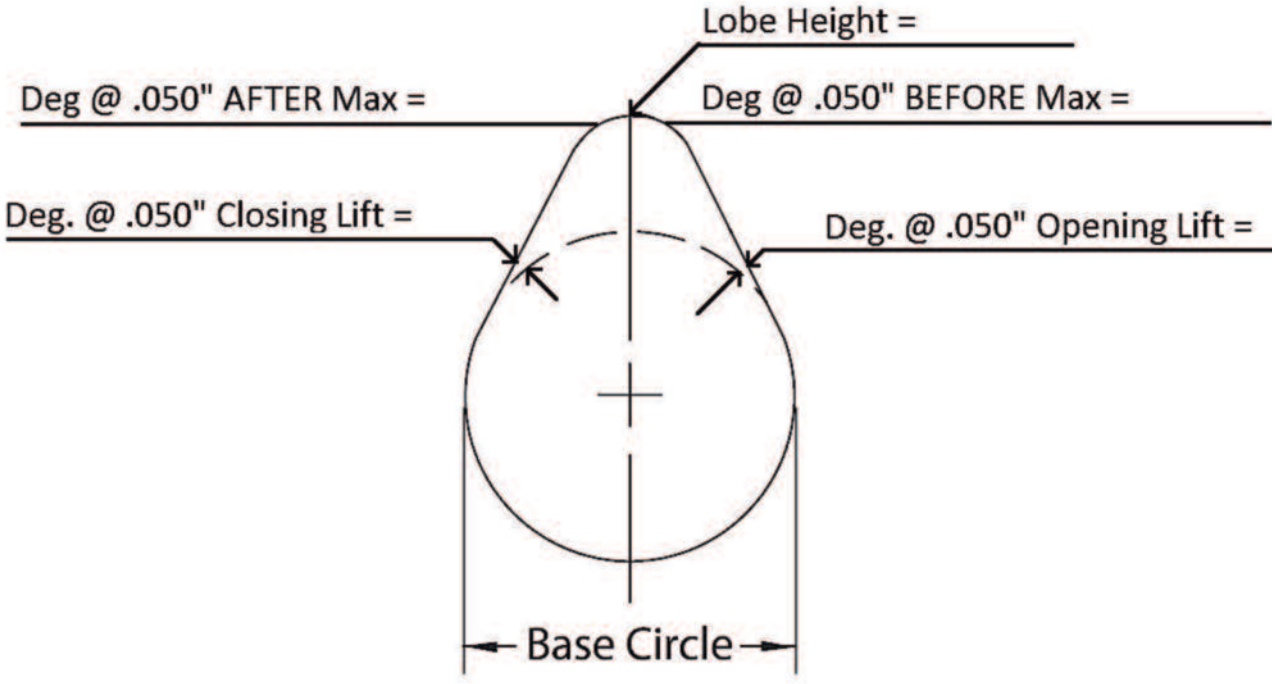


Resume rotating the crank clockwise and watch the dial indicator to note point of maximum lobe lift and the height of that measurement. Compare the height to the cam card. Now, rotate the engine counter-clockwise to a point that is .075-inch less than maximum, then clockwise to .050-inch lift less than max lift and note the point on the degree wheel. Continue rotating the crank clockwise through max lift until the indicator is again .050-inch less than max lift and note the degrees. Add the two numbers taken .050-inch below max lift and divide by two to determine your intake's centerline and compare it to the cam card. Now, continue rotating the crank clockwise until you're at .050-inch above the base circle – the closing lift – and note that point. Add the opening lift plus the closing lift plus 180 degrees to get your lobe duration, and compare to the cam card. In the case of the raffle engine, the duration was on-spec, but Magro's centerline calculation was 104 degrees, while the cam card specified 106 degrees, so the cam was actually retarded by 2 degrees, which would have decreased power a bit at low RPM. This is why Nitemare Performance degrees the cams of its crate engines: to make sure they get installed correctly.

To correct for the intake centerline variance, Magro had to remove the degree wheel and the timing set, install the 9-way crank gear with the 2-degrees advanced keyway on the key, then reinstall everything and repeat the entire process, at which point the cam specs matched those on the cam card.



Once you've gotten your cam as close as you'll get it to the cam card specs, make sure you torque the cam bolt to spec, and you're done. Congratulations! You've successfully degreed your camshaft!



This illustration may help you keep track of the numbers and do your calculations. Before installing the cam, you can use a micrometer to measure the lobe height then subtract the base circle to determine the lobe lift. Measure the degrees at .050" opening and closing, add them plus 180 to get duration. Add measure degrees at .050" before and after max lift, then add them and divide by two to get lobe centerline.

Do I need to check both the intake and exhaust lobes?

While it's always good to check your exhaust lobe, too, realistically, if it's wrong, your only recourse is to get a new camshaft, since you can't adjust the exhaust lobe independent of the intake lobe. Any change you make to one will affect the other.

It's also worth noting that, technically, it could be worthwhile to check all the lobes of your cam, to ensure that they've each been ground properly. But unless you're a professional racer, that's really overkill, though many engine builders will quickly measure each lobe with a micrometer, to ensure that each has the proper amount of lift.

Off With Their Heads! (Or Not.)

While many engine builders, like those at Nitemare Performance, degree a camshaft during an engine build, before the heads are on, you can degree a cam with the heads on, if you choose. The process is similar, though a few steps and calculation adjustments need to be taken into account, if you degree with the heads on and measure lift at the valve. Specifically, when measuring the lift at .050-inch lift, you'll need to multiply that by your rocker arm ratio – normally 1.5:1, for most factory Pontiac rockers, though Ram Air IVs used 1.65:1 rockers from the factory. For 1.5:1 rockers, that means you'd use 0.075-inch lift (.050 x 1.5 = .075); for 1.65:1 rockers, watch for .0825-inch lift. It's worth noting, too, that rocker arm ratios are rarely precisely what they're supposed to be: factory 1.5:1 rockers often measure only 1.48:1 … or sometimes 1.52:1, for example. Aftermarket rockers – even expensive ones – are no different. If in doubt, measure the lift you get at the valve and divide it by the lobe lift stated on your cam card.

Sources

Nitemare Performance
www.nitemareperformance.com
Cam installation & degreeing process; Adjustable Billet Timing Set; Pro Oiling Cam Plate

Comp Cams
www.compcams.com
Nitemare-spec hydraulic, flat-tappet camshaft

Jomar Performance
www.jomarperformance.com
Degree wheel and pointer

About Nitemare Performance

Nitemare Performance, located in North Haven, Connecticut, specializes in the restoration and race-preparation of vintage Pontiacs. In addition, Nitemare manufactures a full line of precision-engineered performance parts for Pontiac engines.

Win This Engine!

One hundred tickets are being sold at $100 each, with all proceeds from the raffle going to The Tomorrow Fund and Alex's Lemonade Stand Foundation charities to benefit children afflicted with cancer. Each $100 ticket gets you a 1-in-100 chance of winning this very engine. The engine build-up will be covered here in the pages of *Poncho Perfection*, and the drawing for the raffle will take place on September 23 at the Pontiac Registry's "Pontiacs With A Purpose" event in Warwick, Rhode Island.

To purchase a ticket, make out a check or money order to Pontiac Registry Fund and send it along with a self-addressed, stamped envelope to:

Nitemare Performance
11 Belmont Rd
North Haven, CT 06473

Don't forget to include your full name, daytime phone number, and email address for notification purposes.

For more info about the raffle, visit nitemareperformance.com; event info: pontiacregistry.com.