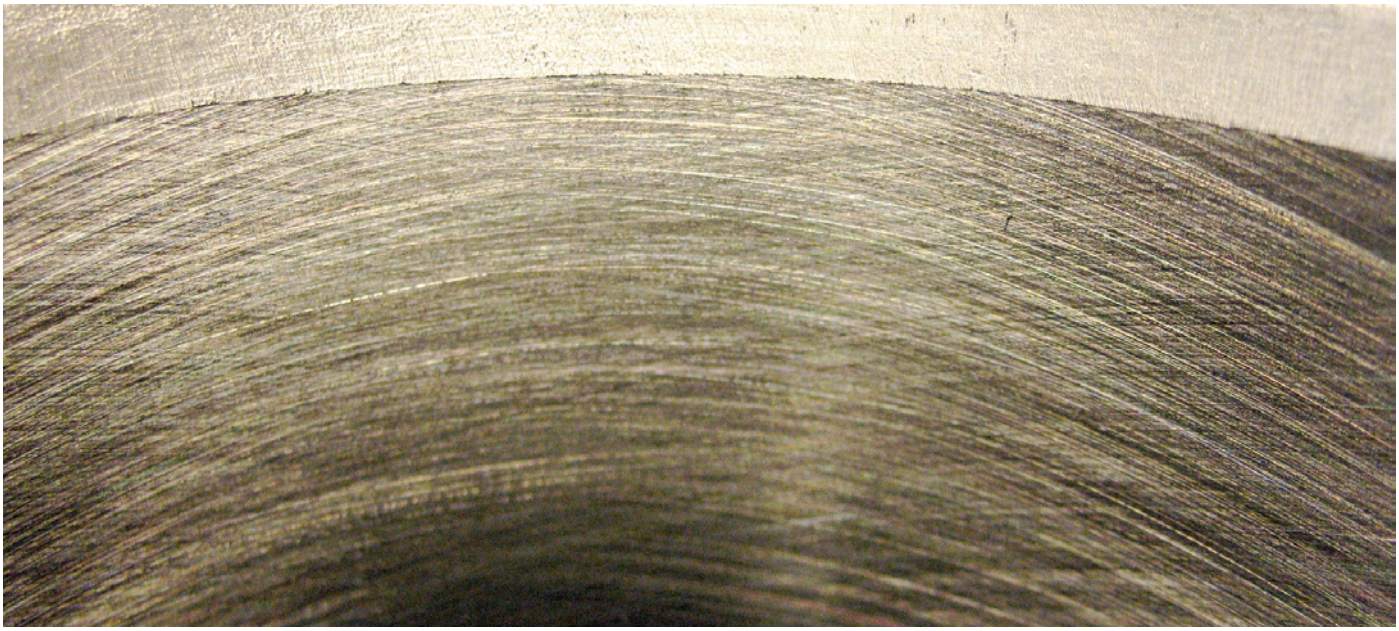
BY **KEITH JONES**



This is a shot of a used Nikasil coated cylinder in the un-run portion. If you look at the portions to the far right and left you can clearly see the very uniform crosshatch pattern.

Piston Ring Performance

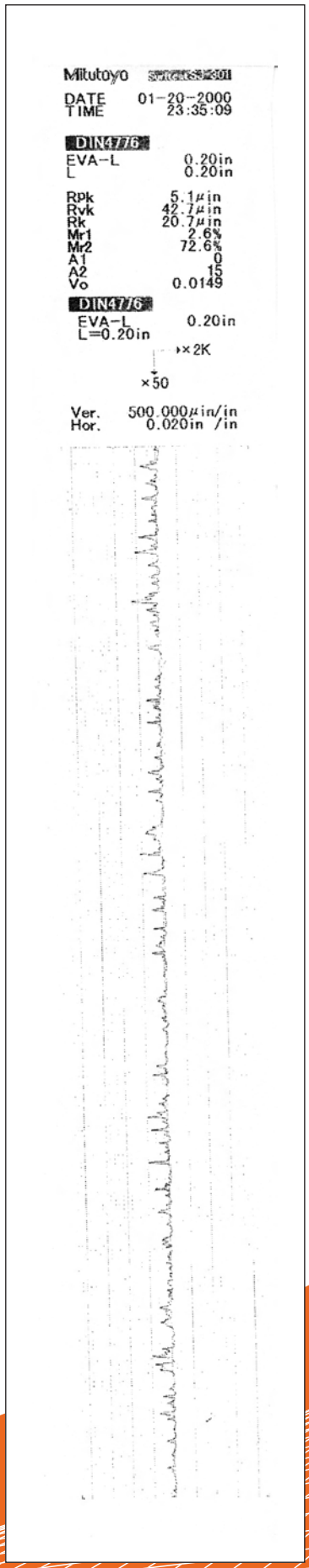
What I want to talk about in this article is the importance of a proper cross hatch angle and a good plateau finish in cylinder bores. I will also mention cylinder finish numbers.

The honed cylinder bore cross hatch angle determines ring rotation speed and its ability to promote proper oil migration up and down the cylinder wall. Most general application blocks use a 45° (included) angle which is measured as half of that from a horizontal surface. Some applications today are running angles as steep as 60° and some very high end race applications are as flat as 30°. Longer cylinder bores with longer strokes generally see a steeper angle as this helps to promote oil migration to the top of the cylinder- which, in turn provides proper lubrication. Shorter strokes sometimes go the other way with the angle. Most commonly seen in today's race engine is something in the 32-45 range depending on the specific application. Sometimes, too flat a cross hatch angle can cause the rings to chatter as they pass over it creating a loss of ring seal. Too steep of an angle can create excessive oil migration and cause the rings to align.

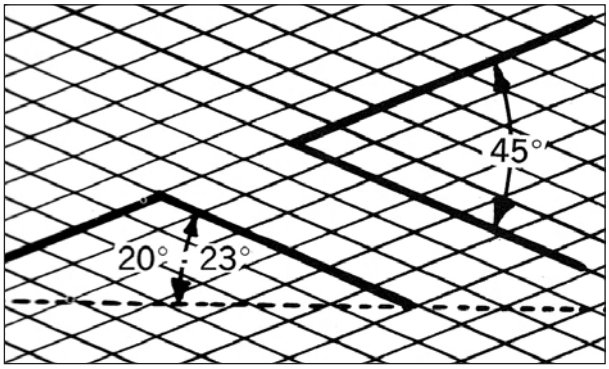
One of the most common problems I hear about today is what I like to refer to as crosshatch stacking - there may be a better technical term but this describes it pretty well. What I'm talking about is a crosshatch angle that changes significantly top to bottom. The angles should be consistent top to bottom in the cylinder bore.

Generally, unequal angles are created by a machine operator being inconsistent with the stroke speeds. Or also dwelling (not moving up or down) too long, trying to get the bore round and then not removing the circular cuts created by dwelling. The cylinder appears to have angles going every direction, many in a circular pattern. You'll also see a pattern stacked on top of a pattern and that pattern appears fuzzy - almost like it's out of focus. That type of a pattern almost always leads to an engine that smokes blue – as the rings ability is unable to properly remove the excess oil from the cylinder wall. During the highest engine vacuum periods that pattern can also promote excessive oil to go up the cylinder wall.

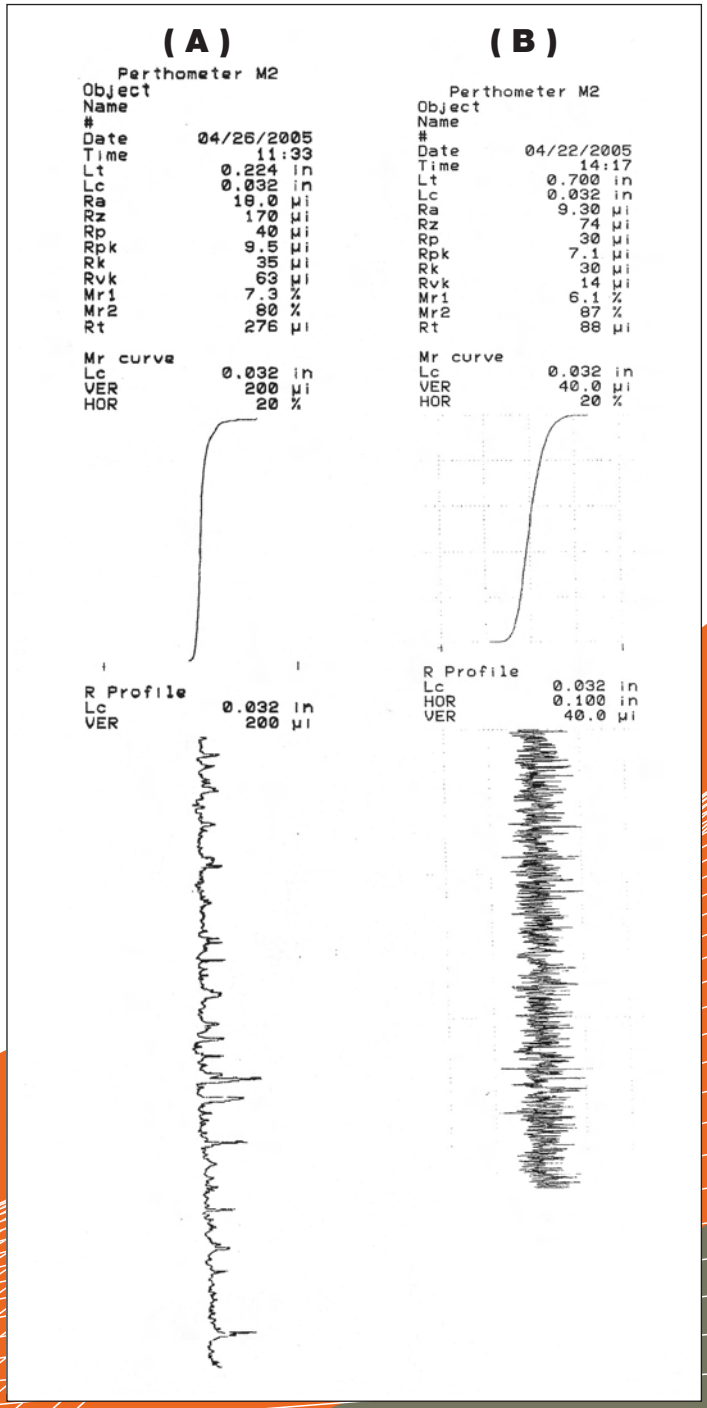
For example, I have a customer that was having that very issue and no matter what ring type or oil ring tension he used the problem could not seem to be cured. At the time this customer did the block, he was using an old manual, hydraulic



The surface profile pictured left shows a beautiful plateau — see all the flat surfaces and the deep valleys.



Cross hatch angle illustration.



These trace graphs are from a NASCAR block. Column B indicates the finish they had with diamonds and a brush. As you can see, there is no plateau and there was a horrible ring seal. The trace shown in column A, though it's too rough, has a great plateau and there were no more ring sealing issues. The finish produced in column A was achieved using a combination of diamond and then vitrified stones. Notice the difference in Rvk numbers between the two columns.

assist honing machine. We had many conversations about him needing to update that equipment, especially for his engine building level. Another engine with this problem ended at another customer's shop.

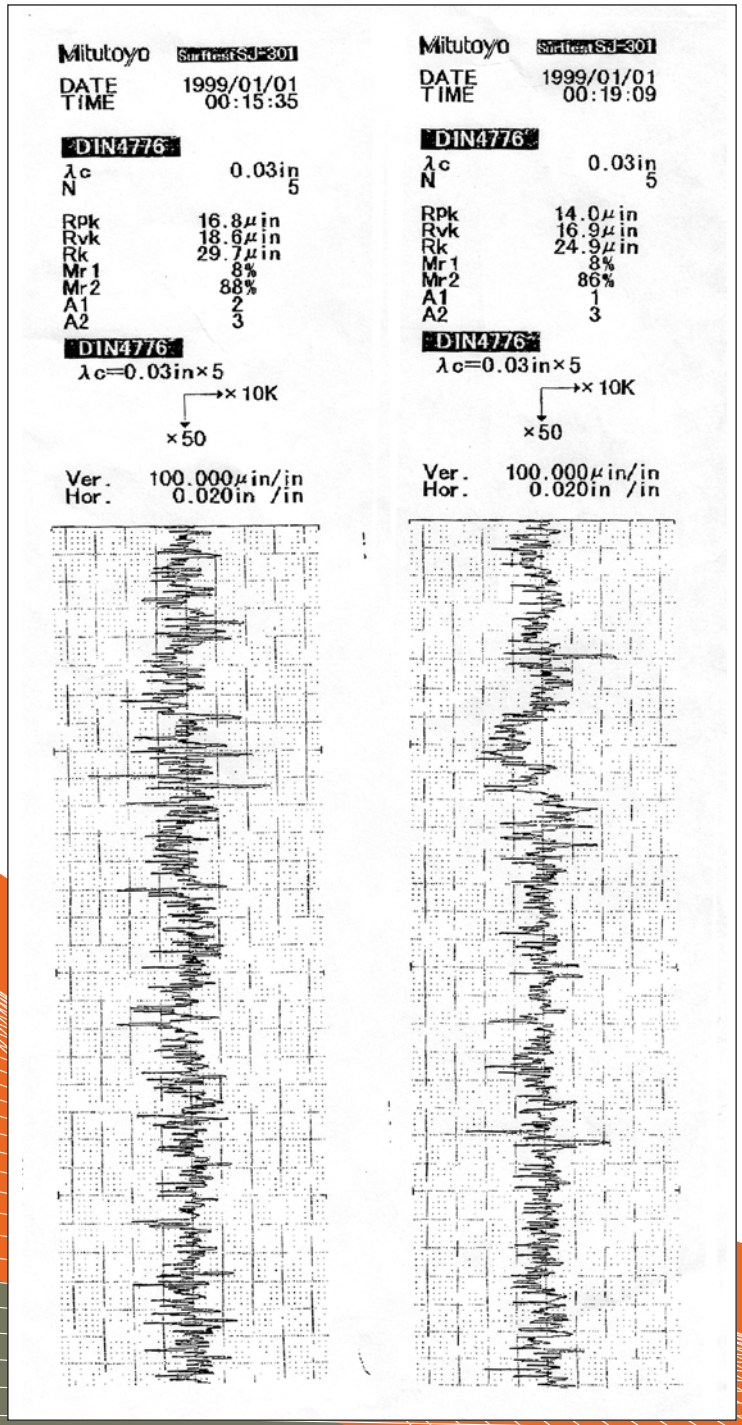
Upon teardown he sent me pictures of the cylinders and we all agreed that we had a cylinder that was exactly as described above. He then re-honed the bores with his recently purchased Sunnen CK-21 and put it back together with the exact same rings - as he stated they looked great and couldn't see anything wrong with them. After the re-assembly the problem was gone; the engine was as dry as a bone and up some on power. The point being a proper cylinder finish can make or break an engine project.

A proper plateau finish is also critical. You have to keep in mind that rings seal against the oil that is retained by the cylinder wall. How much sealing surface and oil retention does a pin point have? Not much! The plateau provides the proper bearing area for the ring to seal against.

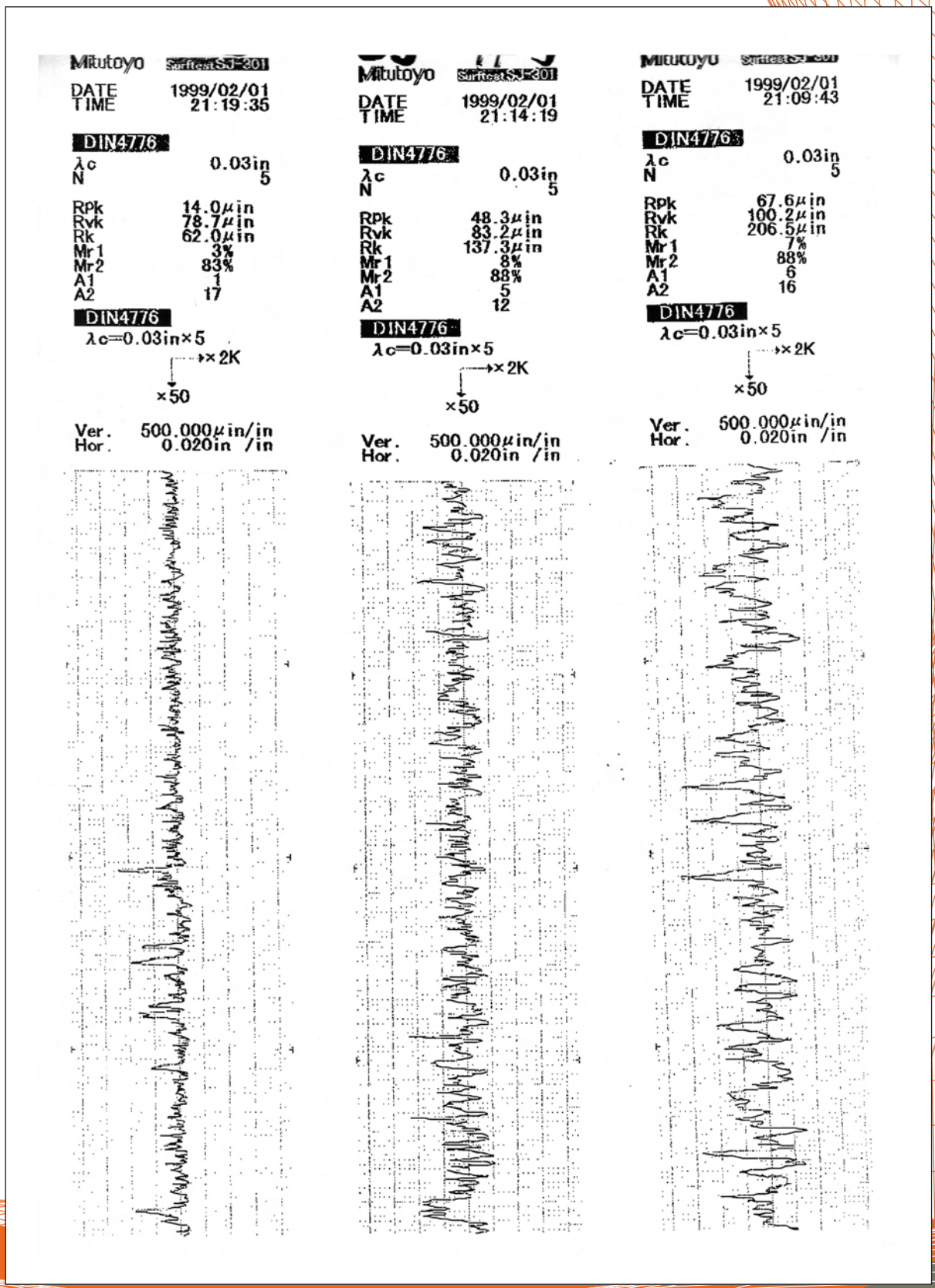
Think about it like a bearing on a crankshaft – enough oil allows the bearing to stay off the crank surface in turn doing its job properly. Not enough, then you have metal-to-metal contact and we know how that turns out. Improper lubrication to the ring package results in premature wear of the ring(s) and bores and it creates poor ring seal. Rings by nature plateau a cylinder through normal motion - we often refer to this as seating-in the rings. In a conventional type passenger car block with Brinnel hardness of 160-170, seating-in happens fairly quickly all on its own and provides the machinist a pretty wide range of forgiving finishes that can be gotten away with. The modern race block or sleeve can have hardness numbers ranging from 210 to over 300 Brinnel and though the ring will eventually wear that surface in to a plateau, it could take thousands of miles or hundreds of hours to do so and no one wants to wait for that. This leads to excessive blow-by oil control issues etc.

Another thing is the color of the cylinder - it should be bright and shiny never dark or dull i.e. burnished. Cylinders that have been burnished during the honing process have very inconsistent results - sometimes they are ok but generally they have issues. The peaks of the cylinder have been rolled not

This is a compacted graphite DRCE pro stock block honed with 600 grit diamond. Customer thought he had ring issues but the problem again is no plateau. That material is very gummy and will load up a set of stones in just a few strokes and as you can see we have lots of torn material. It would take many hours of run time for the rings to wear down that far, especially with the very thin low drag rings we use in these types of applications today. Current sizes are .0274" .0274" & .078 or .7 .7 2.0mm ring packs. They thought they had a great finish, but it's not even close. We loaned them one of our profilometers to check and you see the results. These are just a few of the services we offer our customers. The rings, cylinders and pistons all have to work together — if any one of them is wrong, they all look bad.



This is a Darton sleeve from a 410 outlaw sprint car block. The top profile is a Sunnen C30-J45 stone. The middle is four strokes after that with a C30-J55 and the bottom is 8 stokes with a C30-J85. As you see, the profile keeps getting smoother and begins to show a plateau.



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cut away and create all kinds of ring sealing issues including long seat up time (if ever) loss of oil control excessive blow etc.

When we talk about cylinder finish people always tell me the stones they used. Though that is important information, it doesn't tell me much about the finish. I can use one stone and get 5 different finishes depending on feed, speed, load honing oil, etc. The stones are just a tool — what is the result of the use of that tool? The surface should be measured with a surface roughness tester. That tool, in my opinion, is a critical instrument and no shop should be without. One wouldn't grind a crankshaft without a proper micrometer to measure the journals with, would they? Without proper inspection tools we are just guessing and trust me those guesses are usually nowhere near what they thought they had. For instance while working with a very well known Pro Stock engine builder we were able to pick up on average, over 10 HP by not only obtaining the proper finish we wanted, but getting it the same in all 8 cylinders. Consistency can be a major issue with today's very hard blocks and sleeves.

In today's performance engine we are looking at numbers beyond just the Ra which most like to reference. Though an important number, you want to look a bit deeper into the numbers that make up the Ra. They are the Rpk, Rk and Rvk, or simply said the top, middle and bottom of the cylinder wall surface. For most general applications we like to see an Rpk in the 8-12 micro-inch range, Rk 25-35 micro-inch and Rvk 40-50 micro inch. This will provide a cylinder with great longevity, good oil retention and a decent plateau. In applications a bit more specific like Pro Stock or NASCAR engines that have a very limited life cycle, and we want it to be its best right away, we're looking at numbers more along the lines of an Rpk of 3-5 micro-inch, Rk 12-18 micro-inch and Rvk 20-25 micro inch. Those figures are very low drag surface and they don't hold up as long as the previously mentioned finish. I hesitate to give stone number recommendations here as they can be very misleading. We invite the customer or machinist to call us and discuss what they are working on, what they expect from it, and what type of honing equipment they are working with. The best way, we have found, is one-on-one communication with the customer… though time consuming, we feel it's just too important to guess.■

Keith Jones has been in the automotive industry more than 32 years with the last twelve of them working for total Seal in their Technical Department. He has traveled to numerous race tracks around the world absorbing hands on experience of hundreds of race engines. For more information, please contact Keith at Total Seal Inc., Phoenix, AZ. Call 623-587-7400 or email keithj@totalseal.com.