

Can steel pistons in diesel applications be reused?

BY STEVE SCOTT

The simple answer is... potentially, but determining if the piston and pin are in reusable condition can be a challenge. Original Equipment Manufacturers (OEMs) publish various procedures for cleaning, inspecting, and possibly measuring these components. While some are very detailed, other OEMs can be pretty vague. The processes vary based on the design of the piston (one-piece steel vs. welded steel). The point of this article is not to attempt to address all the variables, but simply to point out some of the major areas of concern, and encourage those involved to fully understand the details of a particular engine they may be rebuilding before these components are reused. Not doing so can have catastrophic results.

One common detail in most of OEM publications regarding the reuse of steel pistons that tends to get overlooked is that the piston and pin must stay as a matched set, and the pin must be reinstalled in its original orientation. Mixing used pistons and pins, or simply reversing the direction of the pin in the piston, can cause the pin to no longer rotate and/or result in seizure. This will be covered in more detail further in this writing.

Compatibility: Before beginning the process of qualifying the piston and pin for reuse, make sure the information you have, and the parts you are working with, are compatible. Cancelled or superseded part numbers may not be interchangeable. It wouldn't be the first time a technician was unaware of an update, and installed a newer version ring set on a piston it was not designed for. Or, if one piston out of the set needs to be replaced, and an update in the piston design may require the entire set of pistons be replaced.

Cleaning: Biodegradable solvent solutions are the most commonly recommended, but in some instances glass bead blasting can be an option. Safeguards to protect the piston pin bores, the outer coatings and the ring lands must be in place prior to glass beading. The size of the glass bead and air pressure

(PSI) need to be carefully considered since they can alter piston dimensions. Too large of beads or too high air pressure can also hide small cracks or inclusions that would have kept the piston from being reusable. If not done correctly, glass beads can damage the piston beyond reusability.

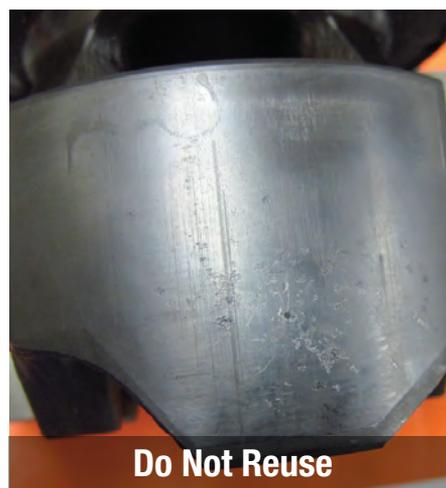
Visual Inspection: A quick visual inspection prior to cleaning can eliminate any obvious unusable parts, and help determine the next course of action. A second, more detailed visual inspection after cleaning can then focus on the conditions of the crown, bowl, skirt, pin bosses, retainer grooves, ring lands, and the general structure of the piston.

- Inspect the crown and bowl for any cracks, pits, erosion, scuffing, impact damage, and embedment (not likely in a steel piston, but it's possible). While cracks are not acceptable, "mild" surface pitting & impact in low stress areas may be.

- Inspect the bottom of the piston crown to confirm that the oil dam plate (if applicable) is intact and tight. If the plate is loose, the piston should not be reused.

- The piston skirt should be inspected for damage, scuffing, scratches, and wear to the coatings. If more than 50% of the coating is worn from the skirt, or if the coating is worn off at the outer edges of the skirt, then the piston should not be reused. Pistons should only be reused if there is minimal wear to the coating and minor scratches.

- Inspect the piston ring lands for wear, pitting and corrosion. The manufacturer may offer ring gages to help determine if the ring lands are within reusability limits, but these tools can be expensive. Depending on how often the process for reusing pistons for a particular engine model is needed, the expense of the tool could outweigh the cost savings of reusing the pistons. "Slight" scuffing between the rings may be acceptable as long as it is not "too wide". Again, the wording of reusability guides can be subjective.

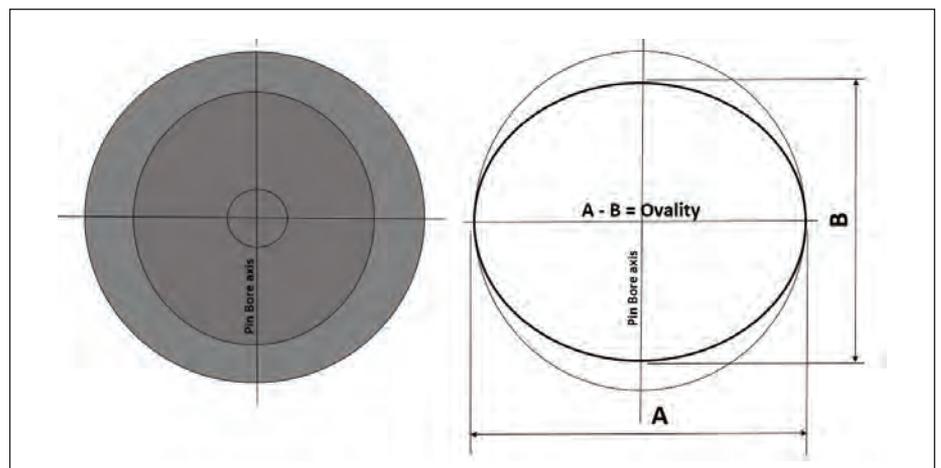
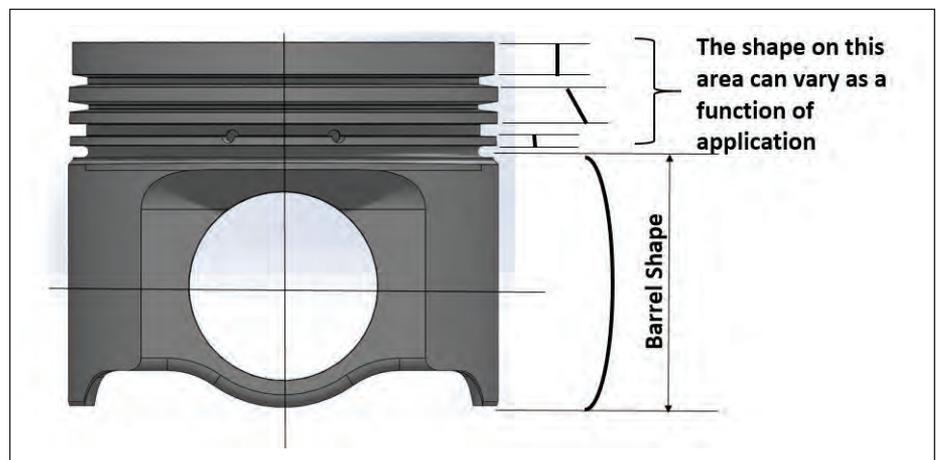




- The condition of piston pin bores is critical. Steel pistons may or may not have bushings. Do not reuse a piston that has tempering, polishing, abrasive wear (that is chained or linked together), or moderate scratches in the pin bore bushing. The coating on pistons without bushings must be intact, and with no visible signs of pitting or surface damage. Do not reuse a piston if the coatings have worn more than 50%. Lack of a coating can result in seizure, or stop the pin from rotating.

- Piston pins can often be reusable, but they can be difficult to qualify. The pin must be free from scratches, grooves, nicks, and cannot have material transfer or smearing on the surface. Discoloration is acceptable as long as the surface is smooth. The OEM reusability guides may list specifications for the surface finish, but the equipment to test the finish may not be readily available.

Dimensional Specifications: The OEM reusability guide may list a few dimensional specification ranges for various areas of the piston, but those can also be confusing or misleading since they generally do not specify the exact locations to measure. For example, the outside diameter of the crown can be machined differently than the lands below it, and the lands between the



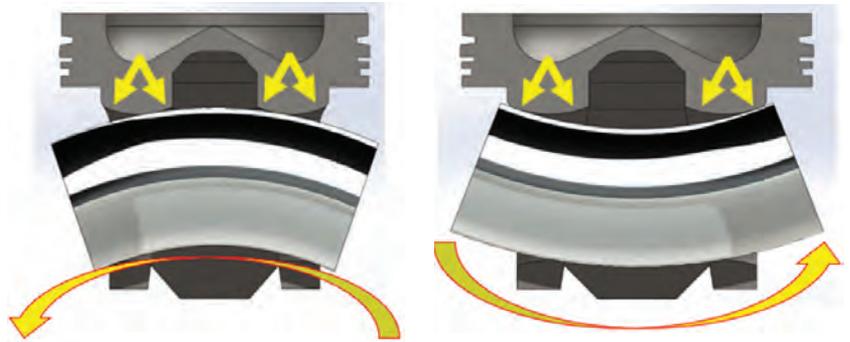
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rings may be machined at varying angles. Also, most newer piston skirts are barrel shaped and the piston may be elliptical. Measuring in the wrong location may disqualify a piston unnecessarily.

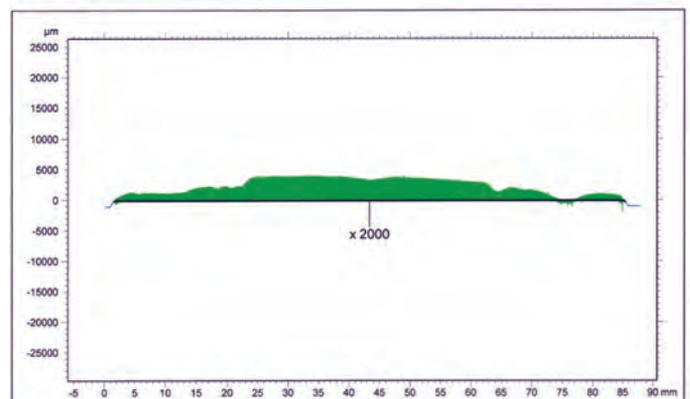
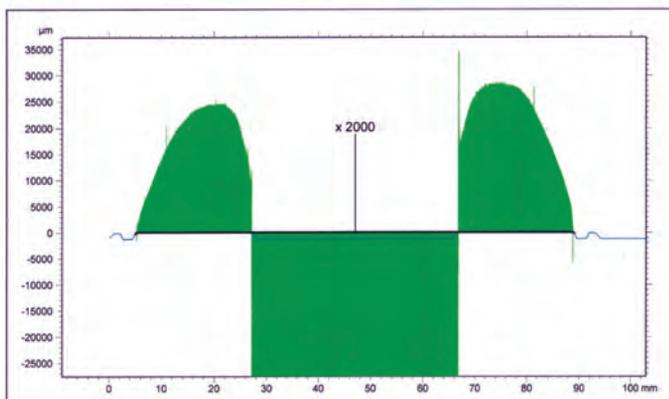
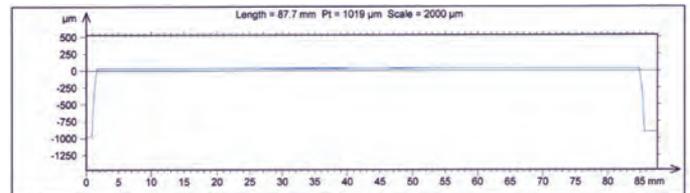
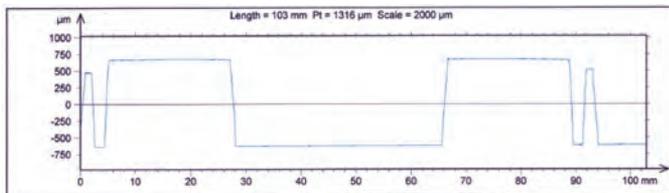
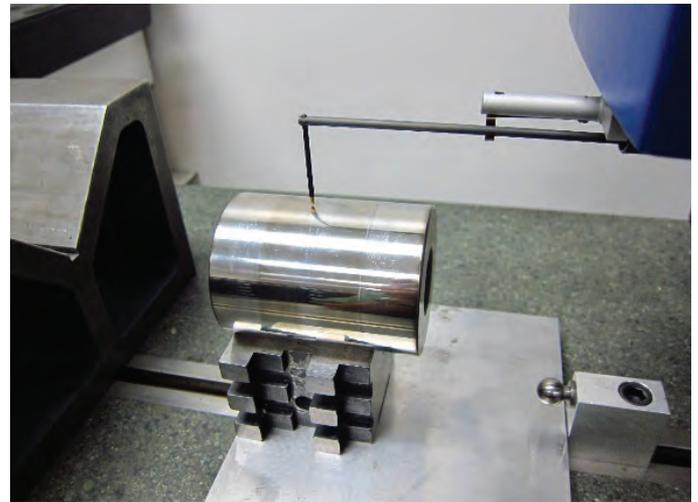
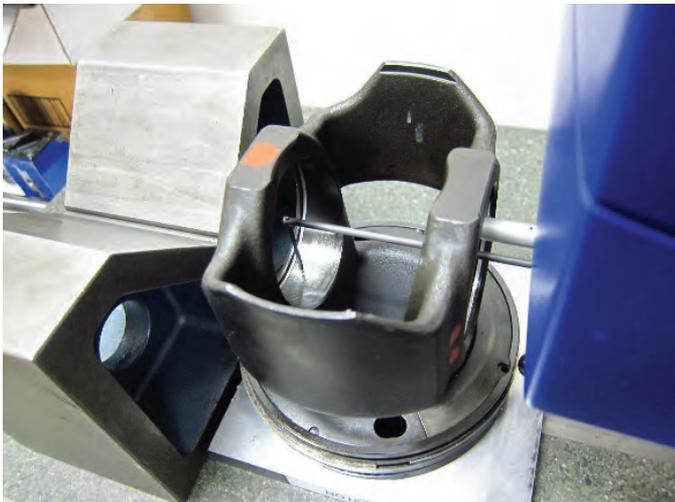
As mentioned above, if the piston and pin are to be reused, then the piston pin must remain in its original orientation with the piston it previously ran in. This is due to the wear patterns imprinted on the piston pin bore and pins from their previous service life. The demand placed on these components in today's high horsepower engines causes the pins to flex, wearing a profile into the piston and mating pin. The examples shown above right are over exaggerated to help illustrate the pin flexing condition.

To better illustrate these wear patterns, the graphs below are from a used piston and pin. After reaching their initial service life, we took precautions to assure the pin remained in its original orientation to the piston. Using a surface profiler



to trace the actual wear surfaces of both piston pin bores and each end of the piston pin, we were able to create the following charts. Note, the specialized measuring equipment used for this article is very sensitive, which gives the graphs presented an exaggerated appearance.

By matching up the profiles shown below, and inverting/flipping the profile of the pin, we can see the high and low

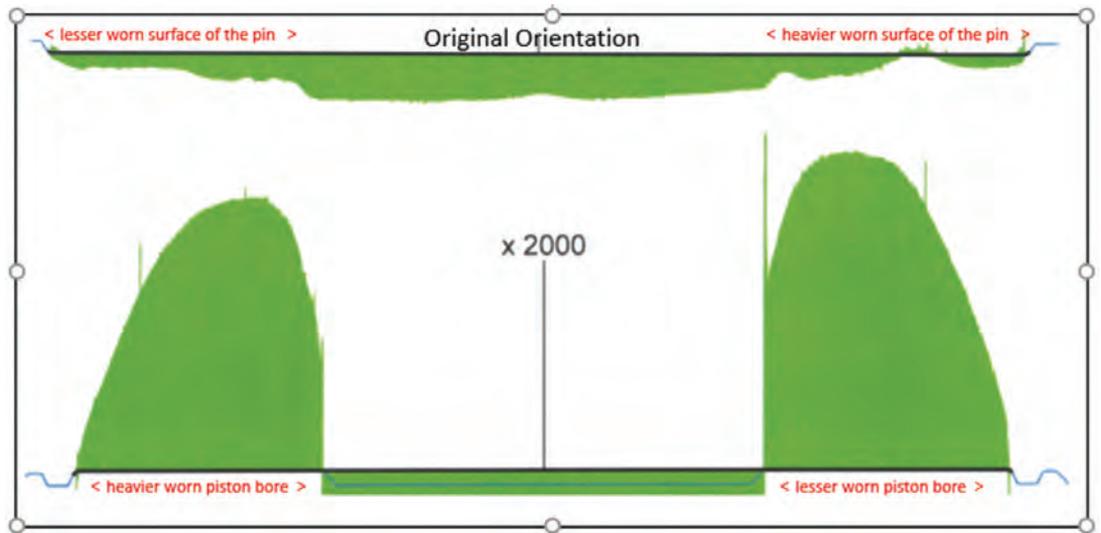


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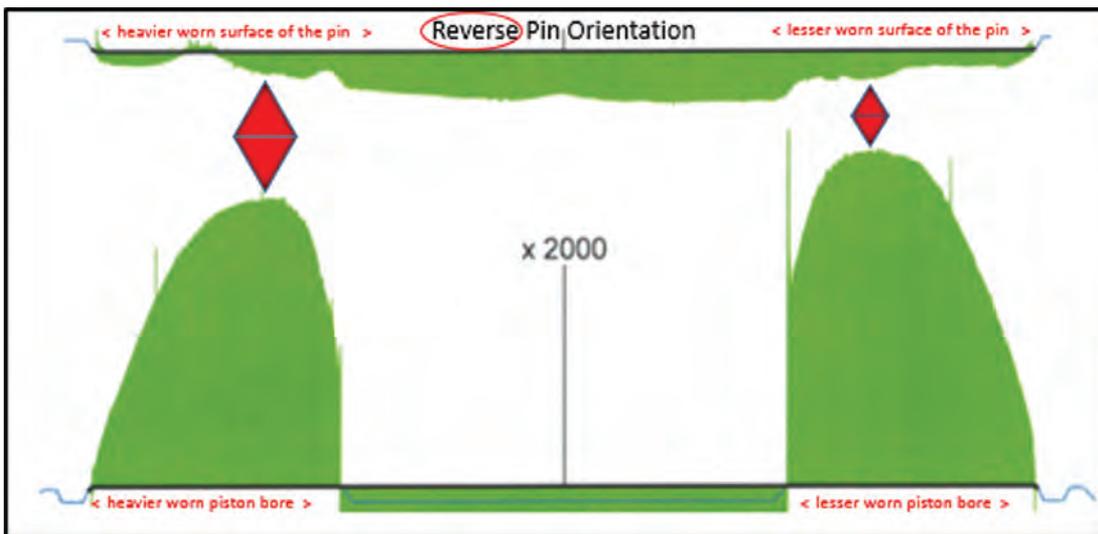
spots on the mating surfaces. Any twist in the connecting rod, variations in the connecting rod bushings, rod journal of the crankshaft, rotation of the pin, and/or lateral movement of the pin in the piston pin bores can affect the wear patterns found on these surfaces. As these components wear, then peaks, valleys, and arched wear patterns are created. Note that the right side piston bore is slightly higher than the left side, and the wear pattern in the pin reflects these traits.

To illustrate the effect caused by reversing the pin orientation, the graph



below shows how the wear patterns would compare when the pin is reversed. Note that on the left below, the heavier worn pin bore of the piston is now on the same side as the heavier worn area of the pin. This increases the clearance between the pin and piston. On the right below, the lesser worn pin bore of the piston is on the

same side with the lesser worn area of the pin, resulting in tighter clearances. The load factors between these contact points have been completely altered by simply reversing the used pin in a used piston. The condition of the protective coating has also been compromised by the new alignment of the peaks and valleys of the worn surfaces.



Steve Scott joined the service department at IPD in 1982, working with parts, service and sales for a variety of equipment, diesel, and natural gas engines. Since 2004, he has been the director of product development and technical support for IPD. For more information, email sscott@ipdparts.com.

Repeating this test on other used pistons and pins would result in differing results, possibly better or worse because there is no method to control these unique wear patterns.

Can steel pistons be reused? Reusability guides are subjective at best, cleaning processes can further damage parts, careful control of the

piston/pin orientation must start at teardown, and ultimately the technician's experience, and available resources will be needed to make the final determination. ■