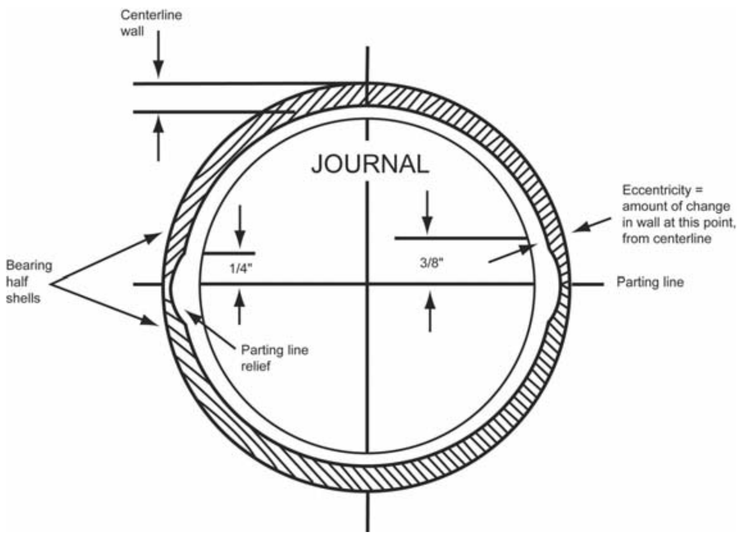
HOW MUCH CLEARANCE DO YOUR BEARINGS NEED?

How much clearance do I need for my rod, main or camshaft bearings? This is one of the most frequently asked questions we receive. Unfortunately there isn't one simple answer that suits every case. This is because engine application, lubricant selection, and operating conditions will dictate different clearance levels. This isn't to say we can't generalize on at least a starting point.

First, let's define how and where clearance should be measured. Half shell rod and main bearings do not have a uniform wall. The wall is thickest at 90 degrees from the split and drops off a prescribed amount toward each parting line, depending on the bearing's intended application. This drop-off is called "eccentricity." In addition, there is a relief at the parting lines. Eccentricity is used to tailor the bearing shell to its mating hardware and to provide for hardware deflections in operation. Eccentricity also helps to promote oil film formation by providing a wedge shape in the clearance space. The relief at each parting line insures that there will not be a step at the split line due to bearing cap shift or the mating of bearing shells that differ slightly in thickness within allowed tolerance limits.



For these reasons, bearing clearances are specified as "vertical clearance" and must be measured at 90 degrees to the split line. The best method of measurement is with a dial bore gage that measures the bearing inside iameter when the bearings are installed at the specified torque without the shaft in place. Measurements should be taken at front, center, and rear of each bearing position. Another common method of checking clearance is through the use of CLEVITE 77® Plastigage®.

For most applications .00075 to .0010" (three quarters to one thousandth of an inch) of clearance per inch of shaft diameter is a reasonable starting point. For example, a 2.000" shaft diameter would require .0015 to .0020" bearing clearance (.00075 X 2.000" = .0015" and .0010 X 2.000" = .0020"). Using this formula will provide a safe starting point for most applications. For High Performance engines it is recommended that .0005" be added to the maximum value determined by the above calculation. The recommendation for our 2.000" shaft would be .0025" of clearance.

Remember however, that the above are only recommended starting points. The engine and its application will tell us where to go from these starting points. For example, a passenger car engine assembled at .0010" per inch of shaft diameter might turn out to be noisy on start-up, especially if the engine has an aluminum block. Most passenger car engines are originally assembled by "select fitting" to achieve clearances that are less than what would result from random selection of mating parts. This is because the stack-up of manufacturing tolerances on the mating parts may exceed the acceptable level for control of noise and vibration. In addition, most new passenger car engines are now designed to use 5W-30 weight oils to reduce HP loss and conserve energy. These lighter weight oils are capable of flowing more freely through tighter clearances.

Let's pick some typical manufacturing tolerances and look at the potential clearance range that results. A tolerance range (from min. to max. sizes) of .0010" is typical for most crankshaft journals, as well as both rod and main bearing housing bores. If the engine uses bimetal bearings, the wall tolerance is .0003" per shell or .0006" in total. Adding these up, we get .0010" for the housing + .0010" for the shaft + .0006" for the bearings = .0026" total clearance variation possible due to mating part manufacturing tolerances. If our minimum assembled clearance is just .0005", this makes the maximum possible .0031" (.0005" min. + .0026 tolerance range = .0031" max.). For normal passenger car application, .0031" of bearing clearance would generally be too much. However, if we take the same engine, let's say a small V-8, and put it in a truck used to pull a camping trailer and use a heavier weight oil, the larger clearance would be more acceptable.

Clearance is also somewhat of a safety factor when imperfections in alignment and component geometry creep in. As surfaces are more perfectly machined and finished, sensitivity to oil film breakdown is reduced and tighter clearances can be tolerated. Tighter clearances are desirable because they cause the curvature of the shaft and bearing to be more closely matched. This results in a broader oil film that spreads the load over more of the bearing surface, thus reducing the pressure within the oil film and on the bearing surface. This will in turn improve bearing life and performance. Typically, a used bearing should exhibit signs of use over 2/3 to 3/4 of its ID surface in the most heavily loaded half (lower main and upper rod halves). Illustrations depicting these typical wear patterns are shown at the front of the CLEVITE 77® Bearing Catalog.

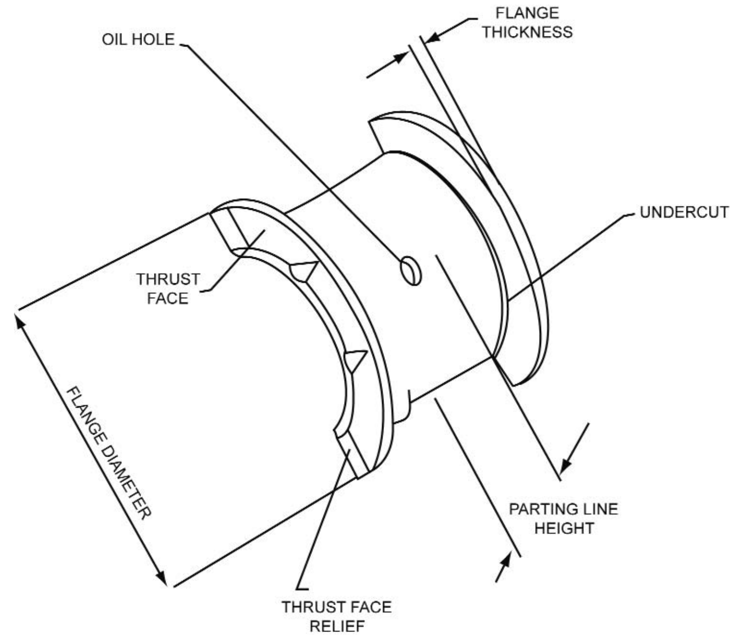
Clearance is just one of many variables that affect bearing performance. In addition, things like oil viscosity, which is determined by oil type and grade selection, engine operating temperature, oil pressure, engine RPM, oil hole drillings in both the block and crankshaft, bearing grooving, and other bearing design features all interrelate in the function of an engine's lubricating system.

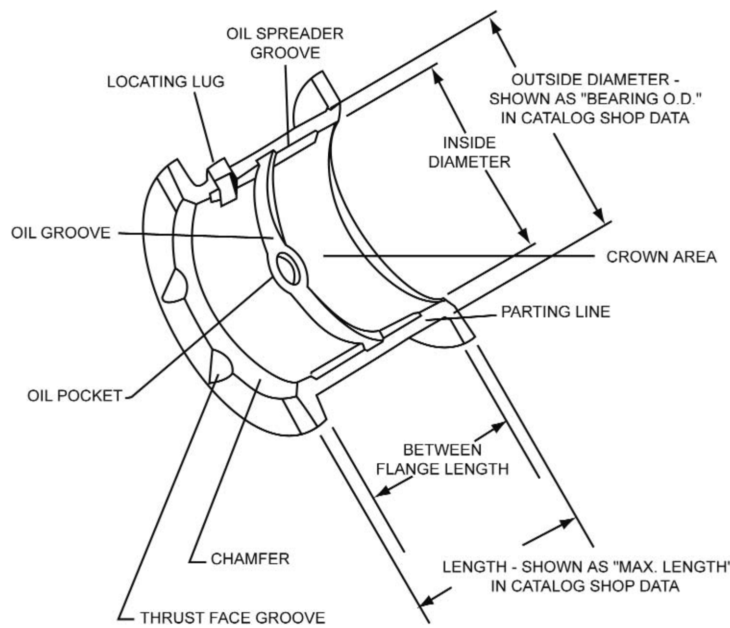
Lighter weight oils have less resistance to flow; consequently, their use will result in greater oil flow and possibly less oil pressure, especially at larger clearances. All oils thin out as they heat up; multi-grade oils, however, don't thin out as rapidly as straight grades. Original Equipment clearance specifications are necessarily tight due to the use of energy conserving lightweight oils, relatively high operating temperatures, and a concern for control of noise and vibration, especially in aluminum blocks.

High Performance engines on the other hand, typically employ greater bearing clearances for a number of reasons. Their higher operating speeds result in considerably higher oil temperatures and an accompanying loss in oil viscosity due to fluid film friction that increases with shaft speed. Increased clearance provides less sensitivity to shaft, block, and connecting rod deflections and the resulting misalignments that result from the higher levels of loading in these engines. Use of synthetic oils with their better flow properties can help to reduce fluid film friction.

Friction and horsepower loss are prime concerns in high performance engines for obvious reasons. As a result, the coating of various engine components with friction-reducing compounds has become common practice. CLEVITE 77® has announced the introduction of their line of TriArmor® coated bearings for selected High Performance applications. CLEVITE 77® wants to provide High Performance engine builders with CLEVITE 77® performance series bearings already coated with a friction reducing surface treatment. Use of these coated bearings may result in slightly less clearance than the uncoated CLEVITE 77® high performance parts for the same application. This will typically be in the range of .0005." This is because the coating, although expected to remain in place during service, is considered to be somewhat of a sacrificial layer. Some amount of the coating will be removed during break-in and operation, resulting in a slight increase in clearance. This is the reason no adjustment in bearing machining dimensions was made to allow for coating application.

So as you can surmise from reading the above notes, bearing clearance is not a subject that can be addressed without taking into account numerous variables including geometry of the parts, oil viscosity, oil temperature, engine load, shaft diameter, bearing coatings, and one's own ability to accurately measure and assess these variables.





CLEVITE 77® ENGINE BEARINGS

NASCAR PERFORMANCE

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