ACL TECH TALK

COMPRESSION RING GAPS FOR HIGH PERFORMANCE ENGINES

Piston rings are usually pre-gapped to a formula related to the bore size of the engine. For normal road engines the ring gaps are 0.003" to 0.005" per inch of bore diameter plus 0.001". So for a 4" bore V8 engine the compression ring gaps could be as small as 0.013" to 0.021" Metric equivalents are shown in the table below. The table shows typical minimum compression ring gap recommendations imperial and metric units. The figures must be taken as a guide only for any performance application since there are many possibilities in terms of usage and the extent of modifications, fuel used and whether turbo or supercharged.

	Imperial (inch)	Metric (mm)	Imperial (inch)	Metric (mm)
Nominal bore size	3	76.2	4	101.6
Standard engine	.010	0.25	.012	0.30
Moderate output "street" performance engine	.016	0.40	.021	0.53
High output performance or marine engine	.018	0.45	.025	0.63

There are several reasons why piston ring gap specification may need to be changed for an engine being modified for higher output. Generally these engines require more gap in order to prevent the rings from butting.

Here are some factors, which can affect ring gap

1. As output increases the heat flow through the piston increases.

2. If the rings are placed high in the piston (i.e. a short or narrow ring land) they will be exposed to higher temperatures than if the top ring land is longer (wider). Also if the valve recess which makes some part of the top land shorter (e.g. the angled recesses on Cleveland V8 pistons) then portions of the top ring are effectively closer to the top and will get hotter.

3. If there is any detonation or pre-ignition the top rings in particular will get hotter and will need more gap. Second rings may also butt if detonation is allowed to occur.

4.The higher the top rings are located relative to the top of the block the poorer the heat transfer to the water jacket will be. In fact with very high top rings at top dead centre, the rings will be adjacent to the deck of the block, not part of the cylinder wall which has coolant behind it.

5.Operation on LPG may increase gap requirements due to higher temperatures resulting from the lack of quenching effect from vaporising petrol.

6.Continuous high-speed operation may require more gap than short bursts.

7.Forced induction engines may need more gap than naturally aspirated engines, depending on boost.

8.In marine applications where the coolant is the water the boat is floating on, the gaps may need to be increased since the cylinder bores will run a lot cooler than in a vehicle. (Also the piston to bore clearance needs to be increased for the same reason.

9.Engines running on oxygen enriched fuels such as nitrous injection also need special gap treatment.

10. Speedway engines are prone to radiator blocking due to mud and would need greater ring gaps to compensate for any over heating tendencies.

What happens when rings butt?
If rings do butt due to insufficient ring gap they will most likely seize against the bore and the increased friction will lead to lubrication breakdown, scuffing, bore damage and piston ring breakage. Blowby and oil consumption will increase and there will be a loss in performance.

Second compression rings
These should have the same gap as for top rings and if anything slightly more. Remember that the second rings main function is to assist in with oil control not contain cylinder pressure. The top ring already does that job nicely. Any excessive blowby getting past the top ring (due perhaps to bore distortion effects etc.) might under some conditions lead to pressure build up between the top and second compression rings and lead to ring lifting or flutter at high speed. So by making the second ring gaps any smaller than the top ring gaps will increase this tendency and may reduce power, not increase.

Conclusion.
In any case remember that the temperature reached by the top ring is much greater than the surrounding cylinder bore so any gap that is achieved at the time of assembly will be much less (about 50%) by the time the engine is at operating temperature.
Further, the volume of gases that can escape through the ring gap of the top compression rings will be limited by sonic velocity (velocity of sound in the gas at those conditions). Once sonic velocity is achieved through any nozzle or aperture the flow volume will be constant regardless of the pressure. A certain volume of gas will get through the gap but any increase in cylinder pressure will not create any increased blowby. In practice most blowby gases are due to bore distortion and leakage past the ring faces than through the gaps. Remember also that the gap area is related to the diameter of the bottom face of the groove of the piston and the size of the chamfer, not the full radial depth of the ring. The gap area of a typical top ring in a 4” bore would be about the equivalent of a 0.5 mm diameter drilled hole.

So while it may be fashionable to strive for very small ring gaps when building a performance engine, remember the downside may be butted rings and a seized engine.

ACL File back rings
File back rings are supplied for some of the ACL Performance piston range. These rings are made to allow specialist engine builders to choose their own gaps. These people do not necessary adjust these to very small gaps but with experience and care the gaps may be gapped a little smaller by progressively building engines and looking very closely for signs of ring butting. In some cases gaps as low as .010” have been obtained but it must be stressed that this is in the hands of experienced engine builders who are prepared to take the risk and who know and can control all of the engines operating parameters. Even then for most 4” bore engines it would be unusual to see gaps much less than .016”.