NRHS
V-TWIN PERFORMANCE
www.nrhsperformance.com

GENERAL INSTRUCTION SHEET

NRHS wants *every* customer's project to be a success. We provide what we believe to be the highest quality performance parts available. But to be successful, these parts *must* be installed correctly! Your factory service manual is an indispensable tool, however, high performance parts often require special attention in specific areas. We have listed these areas below. For all other procedures, please follow your factory service manual. If you have any questions, please call (303) 702-1600 and speak with a performance consultant. It's far better and cheaper to avoid a mistake than repair it!

1) Assemble your pistons and rings properly. First, it's *critical* that your rings are gapped properly. Square the ring in the bore and measure the gap with a feeler gauge. Adjust the gap with a ring gapping tool, or *very* carefully with a file (it helps to mount the file in a vise). Take off only a little at a time as you get close to the correct gap so that you don't overshoot and end up with a too-wide gap, this is a common mistake. Also make sure the gap is square, i.e. not "V"shaped or at an angle. Set the gap as follows:

- 3.498" to 3.563" bores: .018" top ring, .018" second ring
- 3.813" to 4.000" bores: .021" top ring, .021" second ring
- 4.125" to 4.250" bores: .023" top ring, .023" second ring
- Oil rings must have a gap of between .015" and .060"

Note that these gaps are for normally aspirated street motors on gasoline. If you need ring gap numbers for other applications, please call. Too tight of a gap will damage the cylinder wall or worse, so if in doubt, go a little bigger. Once the correct gap is achieved, *be sure to thoroughly deburr the filed area from all directions before installation onto the piston!* Burrs will cause the ring to hang up in the ring lands and burrs on the outside edge can actually score the cylinder wall. Nikasil cylinders are particularly sensitive to this! Finally, install the rings onto the pistons using a ring expander tool, taking care not to scratch the piston. It's *critical* that the correct ring (top or second) is placed in the correct ring land with the correct orientation! This is a common mistake that often results in excess oil consumption. The packaging will indicate the correct way to install the rings. If your rings are provided without packaging, the ring with the moly coating on the outside is the top ring and the uncoated ring is the second ring. If the ring is marked, the mark goes *up*. If the ring is unmarked, look for a bevel on the inside edge. That bevel goes up if it's a top ring, down if it's a second ring. If the ring has no mark and no bevel, it can be installed either way, but make sure it's in the correct ring land. If using a nik-a-sil cylinder, thoroughly lubricate the piston skirt, cylinder wall, *and the rings* before assembly. We recommend Red Line assembly lube, available from NRHS. The first few minutes of the Nikasil's life is critical and a lack of lubrication during this time will damage the plating. If using a cast iron lined cylinder, a thin coating of lubrication on the skirt and cylinder wall is all that's needed.

2) Check piston to piston clearance. With bolt-on engine kits (i.e. 1050/1250 XL/Buell kits, 98 inch Twin Cam kits, 85 inch Evolution Big Twin kits) this generally won't be a problem, although it doesn't hurt to give it a look. With big bore kits that require case boring and/or stroker kits, however, it is *extremely important* to check. Large bores and longer strokes reduce the distance between the piston skirts at the bottom of the "V". NRHS big bore engine kits have shorter piston skirts to compensate, however, we try to maximize the skirt length for better piston stability and engine life, and on a specific combination on a specific engine, you may have to slightly clearance the piston skirt. To check piston to piston clearance with the cases split, put the flywheel assembly into the left crankcase half, put the pistons on the rods, and slide the cylinders on, over the two cylinder studs. Rotate the engine slowly and observe the clearance between the pistons as the flywheel turns through the point where the pistons come closest to each other. Clearance the skirts as necessary for a minimum of .060" gap. To check piston to piston clearance after the crankcase has been assembled, install one cylinder and piston assembly only. Rotate the engine until that piston is at bottom dead center. Looking through the other cylinder's hole in the case, observe the piston skirt's protrusion into the path of the other piston. Use a straight edge against the wall of the open case hole to determine if the piston needs to be clearanced. A flush fit here will be adequate as both pistons are not at bottom dead center at the same time (but they get close). If clearancing is necessary, it helps to mark the excess piston skirt with a magic marker while the piston is still at BDC. Clearancing can be accomplished with a simple sanding roll on a die grinder. Be sure to thoroughly clean all chips from the piston before reassembly.

3) Check cylinder to cylinder clearance. Axtell cylinders are made as big as possible for maximum structural integrity. Although rare, look for contact between the cylinders in the center of the V. If you torque down the heads with contact here, you *will* break the spigots in the cylinders! Grind on the cylinders as needed to get a minimum of .030" of clearance between them.

4) Install your wrist pin circlips correctly. This is an easy mistake to make and it has catastrophic results. We recommend installing one circlip while the piston is still on the bench. *Do not* us a pair of pliers to do this, as you can all too easily distort or nick the circlip and risk a failure. Start the circlip in its slot with the opening at 90 degrees to the rod. Work around in a circle, gently pushing it into place with your fingers. Once the entire clip is inside the wrist pin hole, *make absolutely sure* it's completely and correctly sitting in its slot. Repeat the procedure for the other circlip after installing the wrist pin through the rod (we recommend rags stuffed into the crankcase hole to prevent a dropped circlip from entering the crankcase). Again, it cannot be overstated how important is to get the circlip properly in its slot without damaging it. Triple check this! If you damage a circlip, call us and get a replacement rather than risk it.

5) Check your squish. The squish band is the area or areas where the piston comes very close to the head at top dead center. Optimizing the squish band clearance improves chamber turbulence, which helps power as well as minimizing detonation. NRHS engine kits come with special gaskets that will give a good squish clearance on the majority of engines. However, you should *always* check your squish clearance and adjust as needed. To check squish, place small pieces of .060" solder across the piston dome in several places around the squish band. The solder can be held in place with a small dab of wheel bearing grease or by taping it to the dome, placing the tape in an area outside the squish band so the tape won't alter the measurement. Torque the head into place and roll the engine through TDC once. Remove the head and measure the thickness of each solder strip. The ideal squish clearance for a street motor is anywhere between .030" and .035". Also take note of the distribution of the clearance around the squish band. Squish clearance can be adjusted with different head and base gasket thicknesses (some builders opt to eliminate the base gasket altogether and use a sealer instead). If you have piston to head contact issues even with correct squish clearance, take a look at your wrist pin bushings. A

bushing that's too loose will allow the piston to rock side to side excessively and this will cause piston to head contact.
This is especially common after any type of a top end failure; even though the connecting rod may survive a top end failure without getting bent, it's very common for the wrist pin bushing to get elongated. This may be difficult to detect by feel, measure if you're unsure.

6) Install your cams correctly. High lift cams often require special attention in the gearcase and tappet area. Make absolutely sure the cam lobes swing clear of any obstructions in the gearcase with at least a .020" clearance. Mask the cam box and clearance material as needed. Sometimes it is necessary to chamfer the back side (closest to the crankcase) of the cam lobe itself, particularly to gain clearance for the pinion bearing race. If you have to do this, avoid encroaching on the lobe surface more than .100". Of equal importance is to make sure your tappets have adequate travel available *in both directions.* Install each cam and turn it such that the tappet is fully down. Make absolutely sure the tappet roller is still resting on the cam lobe and not hanging up on anything. This is a particularly common issue when using smaller than stock base circle cams in an XL, as the tappet's axle support will hang up on the cam bushing. Gain more clearance by slightly grinding on the bottom side of the tappet axle support. Also, with high lift cams you must check for adequate tappet anti-rotation pin clearance. The easiest way to do this is with a magnet. Turn the cam such that the tappet is at full lift and then stick a magnet onto the tappet from the top. Lift
the tappet up with the magnet until it stops against the tappet anti-rotation pin. You must have a minimum of .060" of clearance. To gain more clearance, the flat edge of the tappet must be extended down. A simpler method is to use a quality high performance tappet that already has a longer flat area, such as the JIMS performance tappets available from NRHS. Time your cams correctly. It's very simple to perform a spot-check of your cam timing, this is particularly valuable in cases where the alignment marks on the cams leave room for interpretation. With the cams installed but no pushrods in place, rotate the engine while watching the tappets on one cylinder. Position the engine approximately halfway between the point where the intake valve closes and the exhaust valve opens; this will ensure the lifters are on the base circle of the cams. Do not try to do this between the exhaust close and intake open event, that's the overlap period and there is no point where both valves are closed. Once the motor is positioned correctly, use a dial caliper positioned as a depth gauge and measure the distance between the top of the tappet block and the top of the tappet. Record these numbers. Now position that cylinder at TDC on overlap, i.e. where the exhaust is closing and the intake is opening, and repeat the measurements. For each tappet, subtract the overlap measurement from the base circle measurement and multiply the result by 1.625. You have just measured your TDC lift. Compare these measurements to the TDC lift specifications for your cams. They won't be exactly the same, but they should be pretty close. If there is a large discrepancy, open the gearcase back up and investigate the possibility that
your a tooth off in your cam installation. If your exhaust TDC lift is larger than the spec and your intake TDC lift is smaller than the spec, it indicates your cams are retarded, i.e. everything is happening later than designed. Likewise, if your exhaust TDC lift is smaller than the spec and your intake TDC lift is larger than the spec, it indicates your cams are advanced, i.e. everything is happening sooner than designed. Repeat the measurements for the other cylinder. If you are installing adjustable pushrods, be *sure* your adjustments are done with the tappets on the base circles of the cams. As with the above TDC lift measurements, you can only do one cylinder at a time because there is no point where all the valves are closed (unless you're working on a Blast). Position the motor about halfway in between the place where the intake valve closes and the exhaust valve opens. Do *not* try to do the adjustment between the exhaust close and intake open

point. Follow the directions that came with your pushrods or tappets. Solid tappets or travel limited tappets (e.g. Hydrosolid) use a different procedure from standard hydraulic tappets. Be sure to allow hydraulic tappets to bleed down before rotating the engine! If your bike's ignition timing is driven off the cams, *you absolutely MUST set your ignition timing properly again after*

changing your cams! Many people assume they can just mark their timing plate, swap the cams, and then put the timing plate back per the mark they made and it will still be timed correctly. We have installed hundreds of sets of cams and we have yet to see this work, because cams vary far too much from one set to another. And it doesn't take much to mess up the timing: a mere .065 of movement at the o.d. of the timing plate, which is the distance from a large hash mark to a small one on a plate with marks, is *a full five degrees* of ignition timing. Enough to make a big difference! If you're using an ignition module equipped with a static timing LED, use it to set your base timing per the instructions that came with the ignition. Then adjust the module, not the plate, for about 28 degrees of total advance with all of the advance in by 3000 rpm (23 degrees for a dual plugged motor). More than 90% of street motors on pump gas will make maximum power within a couple degrees of this setting. Final ignition timing setting is best determined on a dyno.

7) Check your valve to piston clearance. During overlap, the piston passes through top dead center while both valves are slightly open. If there is inadequate clearance between the piston and valves, contact will occur, which often causes valves and pushrods to get bent.

NRHS Hurricane pistons are made with large valve pockets to give extra valve to piston clearance. In the majority of street applications, with common valve sizes and using cams with a modest amount of overlap, you will probably not have an issue. In applications with special large diameter valves and/or cams with a lot of overlap, extra clearancing of the valve pockets will likely be required. The key camshaft specification that indicates the likelihood of a clearance issue is the TDC lift figure. Larger TDC lift figures are closely associated with extra overlap. Large TDC lift figures also cause an issue with valve to valve clearance. However, if NRHS prepared your heads and you notified us of which cams you are using, we have already set up your valve to valve clearance. To check valve to piston clearance, place a measurement media such as clay or solder in the valve pockets. Position the piston just past TDC on the power stroke, safely before the exhaust valve opening which occurs later in this stroke. Torque the head into place (with the gasket) and install the valve train. After the tappets have bled down, rotate the engine forward until the exhaust valve fully opens and then fully closes and the intake valve fully opens and then closes. Remove the head and measure the media. There are *two* dimensions of interest. First is the vertical clearance. The intake valve must have a minimum vertical clearance of .060" between the bottom of the valve and the floor of the valve pocket. For the exhaust valve, this dimension must be a minimum of .090". The reason for the difference is that the piston chases the exhaust valve closed, but the intake valve chases the piston down. So a little valve float compromises the clearance to the exhaust valve, but not the intake valve. Vertical clearance adjustments generally require a fly cutter. NRHS can handle this service for you. The second critical dimension is the "eyebrow" clearance, which is the difference between the o.d. of the valve and the i.d. of the pocket. This must be a minimum of .050". This clearance can generally be adjusted with a small sanding roll and a die grinder. It's a good idea to mark the material to be removed before grinding. Whenever you clearance a valve pocket, either vertically or eyebrow, pay attention not to weaken it any more than necessary. Of particular importance is the amount of material between the bottom of the pocket and the top ring land. If this area gets too thin, a little bit of detonation will break that area of the piston.

8) Torque your heads properly. NRHS normally provides Cometic MLS head gaskets. Torque your heads with oiled head bolts and in the correct sequence per the service manual. However, torque them in the following steps: 9 ft-lbs, 14 ft-lbs, 22 ft-lbs, 35 ft-lbs, 42 ft-lbs. Then repeat the 42 ft-lbs sequence. Use only high quality clicker style torque wrench of known accuracy. Note that Cometic MLS gaskets do not use separate viton o-rings around the dowels the way many gaskets do. If you use viton o-rings with Cometic MLS gaskets, you virtually guarantee yourself a leak.

9) Clearance your rocker boxes. NRHS often equips heads with heavy duty valve springs that are larger in diameter than the stock valve springs. With a stock rocker box, the spring & retainer will make contact with the rocker box. This can have far more damaging results than just a little additional valvetrain noise, because it will generally force the valve to land sideways on the valve seat, resulting in valve seat recession and resultant leakage. Use a die grinder on the rocker box inside wall to gain at least .020" of clearance for each spring. Center the rocker boxes such that you have equal clearance to each spring before you tighten the bolts. Also, with high lift cams, the rocker arms may try to contact the rocker box tops, which can cause excessive noise as well as leaks. Clay can be useful in determining whether or not you have this issue. Clearance the rocker box top with a die grinder as needed.

10) Always turn your engine over by hand until you're sure everything is right. During all of these procedures, and even after assembly is complete, turn your engine over by hand *only*. Your starter motor is unforgiving and if you have mechanical interference, it will bend and/or break parts. Do not touch that starter button unless you know for sure the engine will turn over without any mechanical interference. This is a common mistake and it can be costly.

11) Break in and heat cycles. Okay it is time to start the bike. But we do not want to overheat the rings and cause microwelding. So we need to do some heat cycles. Once the engine starts run it only for about 1 minute, then shut it down and let it cool completely. If you have a stand type fan place it so it blows air across the cylinders. Now run the bike for 2 minutes and cool completely again. Then repeat for 3 and 4 minutes as well, each time cooling completely between runs. Now take the bike out for about a 20 mile ride and cool completely again. Your heat cycles are now complete. Now for the next 400-500 miles keep your rpms below 3200. Once you have reached that feel free to wick it up!!!

12) Tune your bike. You have just successfully installed the highest quality performance parts available for your Harley Davidson or Buell. But unless you tune the package properly, you've wasted your money! Proper air/fuel and timing are critical, do not assume these are "close enough". In fact, if they are far enough out of whack, you *will damage your engine!* Don't make the mistake of spending thousands on your engine only to leave 10hp or more on the table because you didn't spend $200 on a dyno tune.

OUR POLICY

At NRHS, we know that despite the greatest of care, sometimes people make mistakes when assembling an engine. If you make a mistake and accidentally damage NRHS supplied parts, please contact us. We will repair or replace the damaged parts at a substantial discount. Our philosophy is that we do not need to make money on the same project twice, and it's far more important to have satisfied customers with successful projects.