# 800 To 950cc Big Bore Kit
# RACING PERFORMANCE HANDBOOK

Thank you for purchasing a CPC Racing Big Bore Kit. This kit will fit 2010 or newer 800 H.O. motors. Our custom high quality cast cylinders with billet heads and replaceable dome inserts are built to the highest standards in the snowmobile industry. Our twin 950cc engines can be tuned to over 195 horsepower with the correct pipe, compression and timing. As with any high quality engine, a little common sense and good maintenance will keep it running at peek performance for a long time.

## Assembly.

Power Valve cable adjustment is critical to the operation and performance of your engine. If the APV cables are out of adjustment you will experience lower power levels as well as a loss of RPM's. **Before engine assembly**, the stock power valves must be modified. Modified power valves are NOT included in the cost of this kit. You can exchange your power valves for modified ones but most mechanics will modify their own in order to save money. Using a die grinder and/or a belt sander, the power valves can be modified very easy. Before grinding on the valve you must clean the power valve and then reassemble the power valve into the new 950cc cylinder and then by using a black or colored marker or by using dye com bluing, mark the amount of valve that needs to be ground off. **Remove the valve and grind off excess material until you achieve a minimum of .100 (2.5mm) clearance from the edge of the cylinder to the power valve. Side load and rock the power valve from side to side, and at the same time measure and make sure that you have plenty of clearance. Reinstall the power valve assembly often to make sure that you grind in a smooth radius which matches the original angles**.

**It is the mechanic who is assembling the engine responsibility to make sure that the power valves fit correctly. If the power valve is not correctly modified, it can come in contact with the piston and damage the piston and cylinder. If you are not confident in making the modification, please send your power valves in to CPC and we will modify them correctly. Before assembling the engine, wash both cylinders with hot soapy water, then blow dry them with compressed air. Before proceeding with cylinder installation, temporarily install the power valves and tighten the bolts holding the power valves assembly to the cylinder. With the cable removed from the servo motor, pull the inter cable with your fingers and let the power valve snap back into the cylinder to assure the power valves are not sticking.**

**Before installing** the pistons and cylinders, you will need to remove the 4 rear cylinder studs out of the crankcase and replace them with longer CPC provided studs using a 4 mm Allen. Also you will need to remove all 8 exhaust studs from the stock cylinders and install them into the CPC 950cc cylinders. This is best accomplished by using 2 nuts and tightening them up against each other. Then using the bottom nut and a wrench, extract the stud out of the cylinder and install it into the new cylinder in reverse order.

Before you start assembling the engine, the hose that goes between the cylinder head and water pump must be shorted by ½ inch. Also the left hand chassis support and the left hand engine mounting plate behind the drive and driven clutches must be removed before installing the

cylinders. Both of these parts will be re-used and do not need to be modified. They are simply removed to make additional room for assembly.

The following instructions are provided to help you to avoid streaking and scuffing of nikasil plated cylinders. After installing new pistons onto the connecting rod and before sliding the piston into the cylinder we mandatorily recommend using STP Brand Oil Treatment to lubricate the **piston** and **rings** and **cylinders**. STP is used as an assembly lube to insure that the piston, rings and cylinder have adequate lubrication to avoid scuffing. It is important that the STP be applied in the piston ring land. STP is very sticky and will not run off like 2-Stroke oil. Also you must pour approximately 2 tablespoons full of 2- cycle synthetic oil into each crankcase cavity. (Underneath the piston, before installing cylinder.) The oil in the crankcase cavity will allow additional oiling during the first few minutes of startup which is the most critical time of break-in. **It is very important to use Arctic Cat part # 0636-069 high-temp silicon sealant on both sides of the stock base gasket. Only a small film (about .010 to .015 thick) of sealant is needed on the base gasket. Coating the base gasket will prevent antifreeze from entering the crankcase due to metal expansion caused by extremely cold and hot engine cycles.**

**NOTE: When installing the pistons, make sure that the anti-rotation pins on the piston are opposite of the exhaust port. With the new lay-down engine design where the reed cage and exhaust port are on the same side of the engine; it is possible to be confused which side is the rear and which side is the front of the engine. If pistons are installed backwards, the ring end gap will snag on the exhaust port and damage the cylinder and piston!**

**NOTE: All cylinder bolts & nuts should be torqued to 35 to 45 ft/lbs. All head bolts should be torqued to 20 to 22 ft/lbs.**

**Power Valve cable adjustment:** Correct Power Valve cable adjustment is 1.437 +or - .039. This is accomplished after everything is assembled. Remove the cable end from the servo motor and with a pair of calipers measure the distance between the lead ball of the inter cable and the end of the outer cable.

After the engine is assembled, it is mandatory that you pre-mix a full tank of gas at a 100:1 mixture along with your oil injection and continue to do so as long as you use our engine kit unless your oil pump is set up to deliver more oil than a stock motor.

## 2. **Break-In**

How you break-in your new CPC engine will determine if your engine will be fast or slow. Proper break-in procedure also requires 30 minutes of break-in time at an idle in order to break the rings in and to avoid streaking of the nicasil cylinders. Do not rev the engine over 3000 RPM's during the first 30 minutes of idle time. In order to avoid overheating of the engine, you should run the engine three to five minutes at a time and then allow a ten minute cool down time. **After cycling it a few times, check your anti-freeze level.**

Make sure that oil injection lines are purged of any air bubbles before start-up. Also the use of high quality synthetic oils greatly increases the success of a proper break-in. Quality synthetic oils include Arctic Cat APV synthetic or Amsoil racing oil. After the 30 minutes of idle break-in time we suggest that you vary the running RPM's. Do not hold the throttle at a steady position

for more than 15 seconds at a time. Revving the engine up and down with short bursts of full throttle acceleration will improve break-in. If these instructions are not adhered to strictly, streaking and scuffing will appear immediately, causing poor performance and ruining the nikasil in the cylinder. We recommend that you have patience during the jetting and clutching tuning stages of your new CPC engines. Take a day or two of dialing the engine in before competition racing or long rides. Do not make any hard pulls up steep mountain or Dyno pulls at Wide Open Throttle (WOT) for more than 3 to 5 seconds for the 1st tank of fuel. Do not run WOT for more than 6 to 10 seconds on the 2nd tank of fuel and 12 to 15 seconds WOT for third tank of fuel. Do not make any hard pulls over 30 seconds long until after 4 full tanks of fuel or piston seizure will result!

3. **Compression** Before running any CPC Racing engine, the correct compression should be decided upon before you can choose the correct fuel. Compression and the quality of fuel are dependent upon one another. If you change compression, then the octane requirements also increase. The 950 cc CPC Racing engines can be ordered with a low compression, high compression versions, ultra high compassion or turbo inserts. The compression can be changed by simply changing the head insert. Each insert is marked next to the spark plug with identification. We offer turbo, low compression, high compression and ultra-high compression inserts.

At CPC we calculate compression by the volume of the head, **not** by taking compression tests with your compression gauge measured in pounds per square inch (psi). The reason for this is simple. If you take a given engine with a set head volume and you run a compression test on it, you will get different readings at different altitudes. For example, a given engine will vary in compression about 3.5 % per 1000 feet in altitude. At sea level you might register 140 psi. The same engine if tested at 4000 feet may measure approximately 120 psi using a compensation factor of 14% (3.5 times 4=14% then calculate 100%minus 14% = 86% times 140 psi = 120.4 psi). Also each compression gauge registers a different value. We have four different gauges in our shop and every one of them will register a different psi reading on the same engine from 5 to 20 psi. You can use a compression gauge as a comparison tool to make comparisons as well as a tool to trouble shoot and check for problems especially if you use the **same** gauge each time. At CPC we use a compression gauge to make comparisons. We also use mathematical formulas to determine compression ratios.

As compression ratios increase, so does the need for higher octane. Octane numerical ratings are a guild for how many anti-detonation abilities that the fuels possess. Higher octane fuel burns slower and resists detonation. If you increase your compression, you will also need to increase your octane. Engines that are run at low elevations require a higher octane fuel than high elevation engines **even when** they are run at the same compression ratio. This is due to the fact that the air is denser at low elevation. Sense denser air is trapped in the engine; you have an increase in compression even though you didn't increase the compression ratio. And larger bore race engines need a little more advance on the ignition timing than smaller bore race engines. This is due to the fact that the flame front has a longer distance to travel on bigger bore engines. Engines that run more advance on ignition timing need higher octane fuel requirements. The real question is how high of octane fuel is required for your CPC Racing engine? The answer is, it depends on elevation, timing, and engine bore size and compression ratio. Sense each CPC Racing engine is built specifically for each customer needs, then engine octane requirements will vary from customer to customer.

## Octane Requirements on 92.58mm bore CPC Racing Lay down degree timing Engines using 2 to 4 degrees of additional timing.

| Elevation | 0' to 4,000' | 4,000' to 7,000' | 7,000' to 10,000' |
|---|---|---|---|
| High Compression Head Insert | 100+ Min.Octane | 95 + Min.Octane | 93 + Min.Octane |
| Low Compression Head Insert | 93 Min.Octane | 91 + Min.Octane | 91 + Min.Octane |

***** 100 Octane can be substituted by using 50 % 110 Octane Racing Fuel with 50% Premium 91 octane unleaded fuel.

For those of you who will be trail riding CPC Racing engines, we recommend that you use at least 1 gallons of race fuel with 9 gallons of premium unleaded for the above 93 Octane requirements. Aviation fuel (AV Gas) can be substituted for race fuel but still must be blended to achieve octane requirements that the specific engine requires.

4. **Oil Requirements** There are many good oils out in the market place. CPC recommends the use of quality synthetic oils. Oil brands such as Arctic Cat APV Synthetic or Amsoil are ideal and can be purchased at CPC. Synthetic oils provide a 2 to 3 % gain in horsepower and torque over petroleum lubrications. CPC recommends the 40:1 fuel/oil mixture on all engines which have the oil pump disconnected. If you are using the oil injection as a source of lubrication, then we recommend mixing 4 ounces of additional oil per tank.

5. **Cooling Information** The ideal running water temperature for most snowmobiles is between 125 and 140 degrees F measured as the water exits from the engine. Remember that on all lay-down motors, the water exits out the bottom of the engine. Water temperature can be measured by installing an aluminum coupler in the rubber hose between the hose that exits out the engine below the recoil starter and the bottom right hand heat exchanger inlet with the water probe screwed into the coupler. CPC has undergone an extensive study on the relationship of water temperature and horsepower output. **FACT #1**: Any CPC Racing performance engine than runs over 165 degrees F. will lose horsepower and will be hard to jet or tune. Further more it tells me that your cooling system is inadequate for the snow conditions of that day. Our findings indicate that engines that are run at water temperatures as high as 180 degrees will lose up to 15% horsepower! **FACT#2**: Any snowmobile engine that is consistently run at temperatures over 165 + will experience shorter engine life! This means premature piston failure. Sense CPC Racing engines produce more horsepower than stock engine, the bi-product

of power is heat. CPC encourages every one of our engines to have a water temp gauge to monitor water temperature. Using a water wetter agent such as Redline Water Wetter will also cool your engine down aproximately10 plus degrees. **FACT #3**: **If you ignore this section and fail to measure your water temperature, expect major problems!**

CPC engines should be run with a thermostat. Water temperature should reach at least 100 degrees F before running engine. Removing thermostat in heavy powder conditions can lower water temperature below 115 and cause a cold seizure due to engine cylinder not being allowed to expand so you have proper cylinder to piston tolerance.

## 6. **Timing Recommendations**

Power gains can be picked up generally by advancing the timing. We have experienced good power gains by increasing timing 2 to 4 degrees over stock ignition. Increasing the timing can be beneficial on large bore engines due to the fact that you have a large flame front on larger pistons. Increasing ignition timing builds additional heat into your engine. Heat is energy, and energy is horsepower. Additional timing can bring additional horsepower out of your engine; too much timing can add detonation, causing burn downs. Additional timing also means that you need to be using higher octane fuel. Timing can affect your jetting and affect the readings on your EGT gauges. As ignition timing increases, your EGT gauges will show **lower** readings. This is due to the fact that the fuel is now burning more completely within the combustion chamber. This heat is being transferred to the piston rather than out the exhaust port and into the pipe where it is measured by an exhaust probe. Even though your EGT gauges are showing a lower reading, the fact remains that the fuel mixture will be burning leaner because of additional heat produced by the advanced timing. You now can see that if you are on the ragged edge of jetting, and then advance your timing, the end result will normally end in detonation or piston seizure!

After timing has been advanced by installing an advanced timing key or by using an aftermarket fuel/timing box, it is critical that you do **NOT** cruise at 1/4 to ½ throttle positions (5200 to 6600 rpm) for over 20 seconds at these throttle settings as the timing curve is at its maximum advance. Long durations of cruising at high advance timing will cause detonation and or piston seizure. If you are going to use your CPC Racing engine for cruising, you must vary throttle positions from part throttle to full throttle and vise versa, up and down to avoid excessive durations of high advanced timing. When you install a 2 degree or a 4 degree key, you must remember that you advanced the timing from idle all the way to full max RPM's across the board including part throttle RPM areas. Too much timing can cause detonation. Too little of timing (especially at max RPM) will not allow the engine to reach full potential and produce max horsepower.

**Using a Power Commander fuel/timing module is our 1st recommendations because we have pre-programmed in safe amounts of timing at part throttle conditions. Do not use timing keys with the Power Commander/Timing module. 2 or 4 degree timing keys are recommended for standard Power Commander module, or Attitude brand box or Boondocker brand boxes not using built in timing.**

## 7. **Exhaust Gas Temperature (EGT'S) And Jetting**

CPC recommends EGT gauges on all CPC Racing engines. We recommend probe location on all single pipe exhaust systems be placed in the "Y" pipe at 100mm from the exhaust side of the piston skirt. (2

inches downstream from the cylinder to Y pipe surface). **A perfectly jetted engine will have a 3/8 inch wash on the piston.** Piston wash is the lack (No carbon) of carbon around the outside parameter of the piston. For trail use on CPC Racing engines it is highly recommended that you have about a 3/8 to 1/2 inch of piston wash. This gives you a small margin of safety to prevent piston seizure. **Jetting is your responsibility.**

After you have about two hours of test time on your engine, remove your power valves. Using a cylinder bore light; inspect the carbon deposits on top of the crown of each piston. This inspection is called reading the "Wash". As air/fuel mixture comes up the transfer ports, this mixture has a tendency to **wash** the carbon off the top of the piston if it is too rich. If the fuel mixture is too lean then the heat of the engine will bake carbon deposits on to the top of each piston. By reading the "wash" expert tuners can determine if the air/fuel mixture is too lean or too rich. Adjustments on jetting should be made according to what air/fuel mixture makes your engine run right and this is determined by reading the wash. If your EGT's readings say that your engine is running too lean, but the wash on your piston says it is too rich, then always use the reading of the wash to determine what the jetting should be. Remember that the EGT's are just a tool to monitor and aid you in your tuning. Don't be so paranoid about reading the EGT's that you fail to truly tune your engine. Reading the wash on the piston is best accomplished by lowering the piston down to bottom dead center, and with a cylinder bore light inspect the outer edge of the piston by looking down the power valve cavity. On simi dome pistons, there should be about 3/8 to 1/2 of an inch of wash (no carbon) on the top of the piston at the area of the piston in front of each transfer port (see Figure #1). If carbon is burnt to the edge of the piston in this area, then the jetting is on the lean side if you find that there is no carbon attached to the outer edge of the piston for over an inch, then the jetting is too rich.

Figure 1. Full radius dome pistons. Left, too rich; center, perfect; right, too lean.

As a general rule we suggest the following EGT temperature readings. These readings are only starting points. 1/4 throttle position to be at 700 to 900 degrees F. ½ throttle position it is hard to tell because of ignition timing. 3/4 throttle position should be tuned to be at 1000 degrees F. Full throttle position should be tuned at 1100 to 1150 with **2 degrees** of ignition timing. When using a **4 degree** key or Power Commander Ignition box at Wide Open Throttle (WOT) you will need to adjust jetting to 1050 to 1125 F. at Wide Open Throttle (WOT). Big Bore engines need a lot of advance ignition timing. Therefore you will see lower EGT'S on your gauge as you increase ignition timing.

**If you are tuning with an AFR gauge, then the wide open AFR setting should be about 11.6 to no more than 11.8.**

8. **Engine maintenance.** CPC suggests that the pistons be replaced every 1200 to 1500 miles on a properly jetted engine.

9. **Clutching**. Clutching, gearing and jetting are the big three tuning areas to focus on when prepping a CPC Racing Engine. There isn't enough space here to go over all theories on clutching. Call CPC for a custom clutch kit to fit your needs. When you are assembling your CPC engine and you install the drive clutch, **do not** tighten with an air impact wrench. The clutch bolt should not be over torqued. Correct torque is 50 to 55 ft. lbs of torque. Over tightening can cause deformation of clutch taper and make it extremely difficult to remove the clutch. The use of the impact can also cause crankshaft deflection run out.

10. **Power Valves**. CPC engines that use Arctic Power Valves (APV) must be adjusted and maintained properly for maximum performance. This system requires periodic cleaning and cable adjustment. Cleaning is recommended every 1000 miles or every 50 hours of use. Cleaning is accomplished by using an aerosol carb cleaner and a plastic or wooden scraper to remove any carbon on the valve or the valve cavity. The use of high quality synthetic oil will minimize cleaning due to lower carbon build-up.

Cable adjustment is critical to the operation and performance of your engine. If the APV cables are out of adjustment you will experience lower power levels as well as lower RPM's. Correct power valve cable adjustment is 1.437 + or – .039. **If the Power valves were not cut correctly for your particular cylinder the piston may come in contact with the exhaust valve and damage to the piston and cylinder will result! This will not be covered under warranty! It is the mechanic who is assembling the engine responsibility to make sure that the power valves fit correctly. Before assembling the cylinder onto the engine, take a straight edge ruler and make sure you have a minimum of .080 (2.0mm) to .100 (2.5mm) clearance between the power valve and the straight line of the cylinder bore.**

11. **EFI Fuel Management System**. All EFI model snowmobiles with a CPC performance engine kit will require some method of manipulating the EFI system to add more fuel. **CPC 1st recommendation is to use a Power Commander box with built in CPC ignition timing module and proprietary CPC fuel map.**

## 12. Clutching

The CPC 950 big bore kit can be run with different pipes. Add or subtract weight in the cam arms to achiever proper RPM's based on which exhaust pipe that you use.
Correct running RPM's on a stock Arctic Cat pipe is 8200 RPM.
Correct running RPM's on a SLP single pipe is 8250 RPM.
Correct running RPM's on a Jaws single pipe is 8250 to 8350 RPM.
Correct running RPM's on a CPC single pipe is 8200 to 8250 RPM. Ported motors run at 8250 to 8300.

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