600/700 to 1000cc (Dragon Cat) Big Bore Kit
RACING PERFORMANCE HANDBOOK

This Big Bore kit fits 2003-2006 F6, F7, Fire Cat and M-Series snowmobiles using the "lay down" engine design. CPC Racing Engines are custom high quality cast cylinders with billet heads built to the highest standards of the snowmobile industry. Our twin engine 1000cc engines can be tuned to over 200 hp. As with any high quality engine, a little common sense and good maintenance will keep it running at peek performance for along time.

This handbook has been written as a generic guild . It contains valuable information that will help you tune your engine as well as save you money and time in avoiding potential problems. I would like to address some areas of importance. They are all important and do not appear in any special order.

1. **Assembly**

NOTE: 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 lower RPM's Make sure the power valves are installed correctly. Please read the section on Power Valves in this handbook. **If the Power valves are installed upside down, 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 to the engine, pre-assemble the power valve assembly and install into the cylinder. Then take a straight edge ruler and make sure you have a minimum of .080 to .100 clearance between the power valve and the straight line of the cylinder bore. If needed the mechanic can remove the power valves and grind on it with a die grinder to make sure there is enough clearance.**

Before assembling the engine, wash both cylinders with hot soapy water, then blow dry them with compressed air.

The following instructions are prepared 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 as an assembly lube to the piston, rings and cylinder. 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 ounces of 2- cycle 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 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 you install the Allen head socket bolts that hold the cylinder onto the crankcase, make sure that on the 95mm bore 1000cc Dragon Cat cylinders that you use the longer 125mm long bolts in the front of the cylinders and the 115mm shorter length bolts in the rear of the cylinders. If you do not follow these instructions, you will damage the crankcase by pulling the threads out of the front crankcase when torque is applied to the Allen head socket cylinder bolts. Allen head cylinder bolts should be torqued to 29 to 35 ft/lbs. The Allen head rear cylinder bolts are a close fit to the cylinder and can be sometimes hard to install. We have found that if you twist the bolts as you push them down into the cylinder at the same time that they will go in easer or by switching the bolts from hole to hole until all bolts go down. It is easer to install the two rear bolts in cylinder before sliding the cylinder onto the piston. All bolt lengths are the same on Dragon Cat 800cc motors.

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 export and damage the cylinder and piston!

NOTE: Before installing the head, be aware that there are two different length of head bolts on this kit. The stock long bolts are 50 mm long and the short bolts are 45mm long. It is important that the five short bolts that are provided with this kit are used in the recessed bolt hole locations in the head. If you use the longer bolts in the recessed bolt locations in the head, you will bottom the threads of the long head bolt in the cylinder and ruin the threads or worse yet break the bolt off in the cylinder. Only 2 NEW O-rings are provided with the kit. Remove 3 original 0-rings off three long bolts not used in kit and transfer them over to the 3 remaining short head bolts. If you forget you will leak coolant out of the head bolts.

NOTE: The routing of the power valve cables will need to change due to the fact that the cylinders are larger and you can no longer route the cables between the cylinder. Power valve cable routing will now be on top of the cylinders. Make sure when routing the cable that the cable is not kinked or that the cable does not have sharp bends. When installing this kit in a F-6 or F-7 snowmobile that you use the new external coil and servo motor relocation plates that are provided with the kit before the engine is installed or assembled.

NOTE: On Dragon Cat 1000cc engines, you must assemble the entire engine on your shop bench, including the head. It is impossible to get to the rear MAG center head bolt due to steering post clearance. The same is true when disassembling your engine, that is you must first pull the engine out before the head can come off.

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. You have an option on carburetor models in that you can disconnect the oil injection system but then you must use a 40:1 mixture after installing our engine kit.

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. Do not rev the engine over 2000 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.

Make sure that oil injection lines are purged of any air bubbles before start-up . Also the use of high quality synthetic oils greatly increase the success of a proper break-in . Quality synthetic oils include Arctic Cat APV synthetic, Redline 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 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 squish and compression should be decided upon before you can choose the correct fuel. Compression, squish and the quality of fuel are dependent upon one another. If you change compression, then the octane requirements also increase. All CPC Racing engines come in either a low compression or a high compression versions. The compression can be changed by simply changing the head insert. Each insert is marked with a **H** for high or a **L** for low or **P** for pump gas. We also manufacture an insert called ultra high compression (**UHC**) used strictly for racing on pure race fuel.

The squish must be checked before the engine is run. This test is performed by taking 1/8 inch solder in your hand and bending a arch in the wire at the same time pushing it down the right side of the spark plug hole in line (parallel) with the piston pin. The solder must reach the edge of the cylinder wall. Next pull the engine over three or four times while holding the solder at the spark plug location so the solder won't slip to the side. This test will require two people, one to hold the solder and the other to pull the engine over. Preform the same procedure on the same cylinder, but this time of the left side of the same piston. This allows you to recheck your measurement. The squish is measured by either using a veneer calipers or micrometer. Your measurement is the average of the two tests. Repeat the process and check the other cylinder. High compression inserts should have about .060 squish. Low compression inserts should have about .070 squish. The squish and compression can be adjusted slightly by the use of thicker or thinner base gaskets.

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 everyone 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 or barometer 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.

So let me get to the point;. You should use your gauge as a tool for comparison and not let the gauge reading over rule common sense and proven compression ratios. As compression ratios increase, so does the need for higher octane. Octane numerical ratings are a guild for how much anti-detonation abilities that the fuel possess. Higher octane fuel burns slower and resists detonation . Sense high octane fuel burns slower, it has a cooling effect which allows you to run higher compression and more ignition timing to produce more horsepower. If you increase your compression, you will also need to increase your octane. Engines that are run at low elevations need higher octane fuel than high elevation engines **<u>if</u>** they are run at the same compression ratio. This is due to the fact that the air is more dense 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. Engines that have less squish require higher octane fuel than engines with larger squish. Also larger bore engines require more squish than smaller bore engines. 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. Generally speaking, larger bore engines require higher octane fuel than smaller bore engines. The real question is how high of octane fuel is required for <u>your</u> CPC Racing engine? The answer is, it depends on elevation, timing, squish, engine bore size and compression. 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 85mm, and 95mm Bore CPC Racing Lay down Engines using a 2 degree timing key.

Elevation	**0' to 4,000'**	**4,000' to 7,000'**	**7,000' to 10,000'**
High Compression Head Insert	**105+ Min.Octane**	**94+ Min.Octane**	**92 + Min.Octane**
Low Compression Head Insert	**94 Min.Octane**	**92 + Min.Octane**	**91 + Min.Octane**

***** 100 Octane can be substituted by using 50 % 110 Octane Racing Fuel with 50% Premium 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 92 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. Be aware that many gas stations dispense low octane fuel out of it's pumps marked premium. It makes no sense to purchase an very expensive engine and ruin it by running junk fuel. If you can't afford the fuel, then you shouldn't be running our engines!

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, Redline 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 oil with the fuel at a 100:1 for additional protection and lubrication with each tank **even after break-in!**

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 a 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 155 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 150 + will experience shorter engine life! This means premature piston failure such as piston skirt collapse and anti-rotation pins falling out of pistons. Sense CPC Racing engines produce 40 to 60% more horsepower than stock engine, the bi-product of power is heat. Most heat exchanger's are inadequate to handle the increased heat that is produced by larger, more powerful engines. And worse yet, some customers want to remove heat exchanger's to make their snowmobiles lighter. The results are slow death to your engine. CPC requires every engine to have a water temp gauge to monitor water temperature. **Solution**: #1. Make sure that you have adequate quantity of heat exchanger. #2. Make sure that heat exchanger's are placed where the maximum amount of snow dust will hit them. If the rear exchanger's are too far forward in the tunnel, over heating will be present. Also the most effective heat exchanger is the one in the rear by the snow flap. Make sure it hangs down from the top of the tunnel above the snow flap. Increasing the volume and size of this heat exchanger will have the most effect on cooling. #3. 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. Managing water temperature is the most critical element next to proper jetting in a CPC Racing engine. Because we use such large bore's in our engines, there is a lot more thermal expansion and contraction in our engines. If you have too low of water temperature, then the cylinder contracts and the cylinder to piston clearances are reduced and can cause a cold seizure. If the water temperature is too high, then the piston will over heat and loose the heat treat properties (piston will be annealed) and the anti-rotation pins will loosen and fall out causing the ring to snag on the ports and destroy your engine. If snow conditions are marginal, you have three choices: **First,** ignore this section and ruin your engine or **second**, park your sled until snow conditions change for the better or **third** you can modify the stock cooling system by increasing capacity to prevent problems in marginal snow conditions. We have tested the 2004 Firecat's and the 2005 Proto-type M-6 and M7 sleds with our largest motor at high elevation spring snow conditions (simi-marginal snow) and the cooling systems were very adequate and we experienced absolutely no problems. 2003 model Firecat's do have marginal heat exchangers and coolant recovery bottles and small diameter hoses. We encourage all 2003 owners to rework their coolant system before installing our kits when used in marginal snow conditions. We installed water temperature probes in the engine by drilling and using a pipe tap to the crankcase next to the stock EFI water temperature sensor in the bottom half of the crankcase or install an in-line adapter between the water exit hose and the recovery tank. Remember on all lay down motors, the cooler water from the heat exchanger enters the engine at the head location and hot water exits out the bottom half of the engine. This is opposite of what Arctic Cat engines have used in the past. When we monitor water temperature, we are interested in how hot the water gets as it exits out the engine. Hopefully that explains why we place the probe in the bottom half of the crankcase.

6. **Timing Recommendations** Power gains can be picked up generally by advancing the timing. We do not recommend checking the timing until after the engine is broke in. Running the engine at high RPM before the engine is broke in will result in streaking the nikasil cylinders (see break in page 1). 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. Just as higher compression engines require higher octane, increasing your ignition timing also requires using higher octane fuel. The higher cylinder pressures caused by advancing the timing is similar to increasing compression, therefore the need of better quality fuel. Before doing so it is important to have your snowmobile jetted as close as possible. Timing can effect your jetting and effect the readings on your EGT gauges. As ignition timing increases, your EGT gauges will show **<u>lower</u>** 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 must read piston wash to determine proper jetting and comparing the piston wash to your EGT readings. 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. It is critical that you do not cruise at 1/4 to ½ throttle positions (5000 to 6000 rpm) for over 10 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 transportation and many miles of 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 caused by the timing curve which is pre-programed in the CDI box. 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 and not enough timing (especially at max RPM) will not allow the engine to reach full potential and produce max horsepower. The ideal thing would be for someone to custom program a CDI box ignition timing curve with low advance at part throttle and increased timing at high RPM. Since the factory has control of programing the CDI and does not allow after market companies to modify timing curves, the best we can do is install a advanced timing key to improve the high RPM's operation and caution owners to avoid long period of cruising at part throttle to avoid detonation.

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

CPC recommends that the EGT probe be placed at 7 inches from the exhaust side of the piston skirt to the center line on the probe (approximately 5 inches from the exhaust gasket). **A perfectly jetted engine will have a 3/8 to 1/2 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. Anything less than this and you can expect piston seizure. Failure to take time to jet your engine will be a costly mistake.

After you have about two hours of test time on your engine, then pull your spark plugs and by 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 tunning. 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 spark plug hole. On lay down style engines it is recommended that you remove the exhaust pipes. 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. You should then increase your main jets a couple of sizes and/or adjust the E-clip/needle jet settings on carbureted engines. On EFI engines you will need to increase the fuel pressure or adjust the fuel management system to increase fuel delivery. 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. An adjustment on the main jet and possibly the jet needle/needle jet circuit may need to be leaned. On EFI engines you may need to decrease fuel pressure or decrease the fuel adjustments on the fuel management system.

As a general rule we suggest the following temperature readings. These readings are only starting points. 1/4 throttle position to be at 900 to 1000 degrees F. ½ throttle position to be at 1000 to 1100 degrees F. 3/4 throttle position to be at 1100 degrees F. Full throttle position to be at 1200 to 1250 with 2 degrees of extra timing on the lay down engines. Using a 4 degree key at Wide Open Throttle (WOT) you will need to lower the temp approximately 100 degrees F. ie 1100 to 1150 F. Remember that on high compression engines that use a lot of advance timing, they create more heat due to the fact that the fuel is burned in the combustion chamber more efficiently. Also the heat is absorbed into the piston, rings, and cylinder rather than heat being sent out the exhaust port. This heat is energy, which is torque and horsepower. Therefore you will see lower EGT'S on your gauge even though your engine is jetted leaner. **The bottom line is that you need to compare EGT readings along with piston wash to determine the correct jetting (3/8 to1/2 inch piston wash).** See Photo Figure 1.

Before running your CPC Racing engine, make sure you have at least 1.8 needle and seat in the carburetor. Anything smaller will lean out in wide open throttle (WOT) positions on long runs. We also encourage you to run two vents in your fuel tank to prevent a air lock which will starve your carb from fuel in custom chassis using not vented fuel caps. **Also make sure that your fuel pump is a high volume version. If you use standard fuel pumps, they may not be able to provide enough fuel to the carb and lean out air/fuel mixture causing piston seizure.**

CPC can not give specific recommendations on jetting because there are too many variables. Some of these include temperature, altitude, barometric pressure, octane, gearing, compression ratio, clutching and the brand and size of carburetor. When jetting, always start rich, then lean out as needed. Patience is the most important tool when jetting your CPC Racing engine. CPC offers a Handbook on Carburetors that goes through Mikuni and CPC "T" Flat slide carburetors tunning procedures for $19.95.

8. **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, but there is additional help. I have recently authored a book on clutching that has over 100 photo's and 100 + pages of information for $19.95.

When you are assembling your CPC engine and you install the drive clutch, do not tighten with a 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. Over tightening can cause premature clutch bolt breakage. The use of the impact can cause crankshaft deflection run out. Excessive crankshaft deflection will cause clutch bolt breakage as well as create extra friction. The end result is a slow engine.

9. **Power Valves**. CPC engines that use Arctic Power Valves (APV) must be adjusted and maintained properly for maximum performance. This section will cover both areas. The APV system adjusts the size of the exhaust ports to produce maximum horsepower and torque on the top end while providing excellent low end power and increased fuel economy on the low end of the RPM band. The system operates like this: at low RPM's the exhaust valves are held in the low position by the return spring. When the engine reaches higher RPM's, the CDI will send a signal to the servo motor instructing the motor to pull the exhaust valves open via a cable to a high position. 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 a 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 Make sure the power valves are installed correctly. **If the Power valve are installed upside down, or if the 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 to .100 clearance between the power valve and the straight line of the cylinder bore. If needed the mechanic can remove the power valves and grind on them with a die grinder to make sure there is enough clearance.**

To adjust or inspect proper cable adjustment, proceed

#1. Remove the two bolts securing the servo motor plastic cover.

#2. Using a small screwdriver, remove the cable retaining clip.

#3. Rotate the servo actuator counterclockwise to loosen the cable, then pull the cable housing out of the holder.

#4. Pull the cable up and out of the cable housing holder, then slide each cable drum to the left and out of the servo actuator.

#5. While holding the cable housing firmly, pull the cable out as far out as it will go, the release. Repeat this three to four times to insure that the valve is free and not hung-up.

#6. While holding the cable housing, lightly pull on one cable end to remove any slack. Measure the amount of exposed cable from the outer cable housing to the end of the cable. When measuring the cables, keep them as close to their installed position as possible. Proper cable adjustment on the 2003 to 2005 twin lay down engines should be about **34.5 mm plus or minus 1 mm** when measuring from the inside of the lead ball to the end of the outer cable housing. If the cables are not equal or are out of adjustment, then loosen the jam nut on the cable, then using the adjuster nuts in the center of the cable, lengthen or shorten the outer housing as needed, then tighten jam nuts. Generally we suggest that you start on the short side when adjusting.

10. **Troubleshooting the APV system**. The APV system has a self-cleaning and self-testing mode built in. Every time that the engine is started, the servo will cycle **once**, and this will wipe-off the carbon that has accumulated on the exhaust valves. The CDI unit also monitors the voltages at the servo during this cycle to assure they are within operational tolerances. If all the voltages are within tolerance, the system is ready for use. **If the voltages are not within tolerance, the servo will cycle up to two more times. If the voltages remain out of tolerance, the system will not operate.** Troubleshooting is simply accomplished by removing the plastic servo motor cover, then starting the engine and with the sled on a jack stand and after you have completed the idle break in, you can rev up the engine to see if the power valves open up at approx. 7200 RPM. As long as the engine is over 7200 RPM, the power valves should stay open. Proper adjustment is essential to producing maximum power! A final check should be made by starting the engine, then rev up the motor to 7200 to 7400 RPM's (after break-in) and hold the motor at this RPM for two seconds. **If the servo motor does not hold the valves open then shorten the cable by one half mm and try it again. Proper cable length for a 2005 model F-& or M-6 and M-7 is 34.5mm (1.350 inches). This measurement is taken from the inside of the lead ball to the outer cable housing, and is measured with calipers.** If the power valves do not open and stay open at 7200 + RPM, then you could loose up to 25+ horsepower! Contact your local Arctic Cat dealer for troubleshooting or for adjustment procedures.

NOTE: It is possible to remove the power valve cable and servo motor from our CPC Racing cylinders on carbureted engines only. The power valves can be locked in the wide open position by removing the cables from the power valve retainer and installing a spacer between the power valve retainer and the power valve stopper. However by doing this you will experience a few negative side effects including but not limited to (A) loss of low end power (B) loss of throttle response at lower RPM's (C) loss of fuel economy (D) more difficulty in jetting the carburetors. On EFI model, you can not disconnect or by pass the servo motor, other wise the ECU will cause the system to go into a fail safe limp home mode, with a major power loss

11. **Troubleshooting EFI Models**. The APV system used on EFI models is very similar to that found on carbureted models. The self-cleaning and self-testing modes are much alike. The main difference between the two is the higher total electrical power required by the EFI and APV systems combined. Because of these more demanding power requirements, the EFI and APV system gets power from the stator lighting coil. The ECU constantly monitors the power output of the lighting coil, and if the lighting coil output get too high or too low, the ECU will activate the "limp-home" mode. The "limp-home" mode is an ECU operated engine RPM limiter. When activated, the "limp-home" mode will be seen as an immediate loss of engine horsepower.

For example, if the headlight and taillight are disabled, the ECU will sense a high voltage condition and activate the "limp-home"mode. Adding more than 4 amps of accessories will create a low voltage condition and activate the "limp-home" mode. Note: Running the snowmobile with the hood removed could damage your EFI system. *Another example would be installing a blanket warmer and a nitrous system that pulls more than 4 amps of power*.

On EFI engines, it is **<u>NOT</u>** possible to remove the power valve cables and servo motor because the EFI is powered by the ECU and the system will go into default ("limp-home" mode) if it is not working correctly or adjusted correctly. This default system is pre-programed into the programing of the ECU by Arctic Cat factory and there is nothing that CPC can do at this time to over ride it.

NOTE: Both carbureted and EFI model must have their power valves cleaned every 1000 miles. Power valve cable adjustment should be checked at the same time.

12. **Batteryless EFI System & 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. All EFI models regardless of elevation will require more fuel for the CPC Racing Engines to survive. There are a few things that you will need to know to assist you in making adjustments as well as understanding how the system works. First, lets take a minute to understand how the stock batteryless EFI system works.

The *stock* EFI system is run by an electrical control unit (ECU) which calculates input from five sensors:

1. Intake air temperature sensor
2. Water temperature sensor
3. Throttle position sensor
4. Ignition timing sensor
5. Barometric pressure sensor

All of these senors provide the ECU with information so the correct fuel mixture and ignition timing can be at optimum for correct operation on a *stock* engine.

The cool thing about EFI is that in theory, it automatically compensates for temperature and altitude and once it is dialed in, it should provide many miles of trouble free performance. The bad thing about EFI systems is that there are many electrical components than could fail. Also these electrical components are harder to tune air/fuel requirements at the different throttle positions because corporate Arctic Cat/Suzuki will not allow aftermarket companies to have software information to manipulate the factory ECU programing.

CPC has been working overtime in order to provide our customers a way to manipulate the stock EFI system in order to provide the necessary fuel the engine needs to survive with our engine performance kits. If the fuel system is too rich then you will experience poor performance. If the fuel system is too lean, then you will experience burn downs (piston seizure). There is a fine line between rich and lean fuel needs and riders/racers needs. For example; drag racers are looking for lean fuel mixtures to achieve maximum hp and trail riders are looking for safe jetting for hassle free pump gas trail riding. Since we walk the tight rope of trying to get the perfect fuel mixture for each owner of the CPC Racing engine packages; we decided that the best way to handle your fuel mixture needs was to let each owner be responsible for his calibration.

At this time there are a few ways to manipulate the stock EFI system. The method that we chose was to couple two components together to provide each racer/rider the ability to fine tune their engine.

The first component is a CPC adjustable fuel pressure regulator. This device allows the tuner to simply remove the stock pressure regulator which is located in the fuel tank attached to the fuel pump assembly, and replace it with a CPC adjustable regulator. The CPC adjustable regulator will allow the tuner to either increase or decrease the fuel pressure. By adjusting the fuel pressure up or down, the tuner will be able to lean (decrease fuel) or enrich (add fuel) to the fuel mixture. The concept is simple: when the injectors open up to squirt fuel into the engine, fuel is either increased due to added pressure or decreased due to less pressure. It is important to understand that by using the CPC adjustable pressure regulator, fuel is added or decreased linear. That means that fuel is increased or decreased across the board from idle to wide open throttle. This device does **not** allow you to choose what throttle position you will add or subtract fuel. For example: Let assume that you need less fuel at 1/4 throttle and you need more fuel at 3/4 to full throttle using the stock programing in the factory ECU. In this example you have two choices, either to decrease fuel pressure slightly in order to improve 1/4 throttle position (which will cause and extra lean condition at 3/4 to full throttle) or vise versa, increase fuel pressure (which will cause the 1/4 throttle position to be extra rich and allow the 3/4 throttle to full throttle, the fuel it needs). In this scenario, the adjustable pressure regulator as a stand alone component would **not** be ideal. However lets assume that you need more fuel from an idle to full throttle, then the adjustable pressure regulator would be an ideal device to tune your engine.

NOTE: According to the factory repair manual, a Stock 600/700 lay down engine has stock fuel pressure at 42.8 to 47.3 psi. It is important to install a gauge on your engine with the stock pressure regulator to get your baseline fuel pressure before installing the CPC adjustable pressure regulator. You should write down and record this pressure before installing and manipulating fuel pressure so you can return back to stock settings if needed. **At high altitude we set fuel pressure at 45.5 lbs, at elevations of 0 to 3000 feet we set the fuel pressure at 50.0 lbs.**

The second component that we at CPC have been developing is an electronic device or “Chip” that piggy backs the stock factory EFI system and allows the tuner to over-ride the stock ECU programming and trick the factory ECU into thinking that the stock ECU is functioning normally, and at the same time allows the mechanic the ability to use the electrical device or “Chip” which is adjustable; to increase or decrease fuel at different throttle positions. The adjustability of the “Chip” allows the mechanic to electrically increase the pulse width or decrease the pulse width to tune the engine. Changing the pulse width is accomplished by manipulation of the amount of time (measures in milli-seconds) that the injectors stays open. The shorter the pulse widths, the leaner the fuel mixture, and vise versa, the longer the pulse width, the richer the fuel mixture.

The ideal situation is to have both a CPC adjustable pressure regulator and to have a “Chip” working in unison to accomplish the manipulation of the fuel requirements of the CPC racing engine needs. Using the CPC adjustable pressure regulator in combination with a “Chip” allows the “Chip” electronically more adjustability especially at lower elevations where more fuel is required. The extra adjustability is accomplished by allowing the pulse width to be turned down and the pressure to be turned up, thereby allowing more fuel to be delivered to the engine with a shorter pulse width.

Tips to note when installing the engine into the snowmobile.

1. On EFI models you will need to re-route throttle cable so it won’t melt on exhaust pipes. We suggest routing the cable between engine and the side PTO bulkhead removable support

plate.

2. The rear rivet that holds the rubber support on to the side PTO bulkhead removable support plate will need to be ground off or it will touch the head on all M snowmobiles.

3. All electrical wires will need to be protected with aluminum heat tape, that is not included in kit. Also all wires need to be routed below the fuel rail to prevent melting them.

4. On all Firecat model, you will need to relocate the servo motor and extend the external coil up to clear the head with supplied brackets.

5. The CDI or ECU will need to be moved to the left (Mag side) of the belly pan so it will not interfere with the routing of the exhaust pipes. Also the Air box will need to have an aluminum plate riveted on so the heat will not melt the air box from the heat of the pipes. (If the mag pipe is closer that 3/16 of an inch, you will need to fabricate a spacer to fit on to the air box to lift the mag pipe slightly so it does not touch the fuel rail.

6. It is helpful to remove the steering tie rod from the bottom of the steering post to aid engine removal and installation.

7. Because the exhaust pipes are so large, the routing of the pipe comes very close to the hood. It may be necessary to install some heat tape on the bottom of the hood to prevent melting. Also it may be necessary to remove on of the metal clips that holds the air screen on to the hood if it come in contact to the hood.