

MAINTENANCE OF EQUIPMENT



STEAM CLEANER (PRESSURE WASHER)

Your steam cleaner machine is really called a hot water-pressure washer. There is a difference although the public is unaware of this fact. Even the phone book will list it as a steam cleaner. Equipment is listed under 'steam cleaning equipment' and hot water pressure washing will be listed under 'steam cleaning-industrial' or 'steam cleaning service'. You should be familiar with your equipment and that's why we started with an explanation of the name.

Your hot water pressure washer has a number of components you should also be familiar with. First of all there is a gasoline powered engine about 20 hp that is at the heart of the machine. It has two cylinders. It's a four-stroke engine similar to a car. In a four-stroke engine you use gasoline unlike a two-stroke engine that uses an oil/gas mixture. The engine on your machine is extremely reliable if you change the oil and clean the air filter regularly. Regular maintenance on your machine is also important to insure that your warrantee stays in full force.

You should follow a regular schedule of inspection and service based upon operating hours. We recommend that you keep an accurate log book of maintenance services performed. Therefore, you will not have any problems if you need warrantee service. If you do need service and for some rare reason you don't get satisfaction from our approved vendor, call the franchisor. I'm sure if we call you will get a much different story or we might just have one less approved vendor. You must remember, any machine regardless of design or type will only perform in relation to the service it receives'. Same with employees. So remember, regular scheduled maintenance lowers operating costs.

This table serves as a guide and should be followed. We recommend regular service of your engine in the time intervals.

PERIODIC MAINTENANCE SCHEDULE FOR STEAM CLEANER

PERFORM AFTER EACH INDICATED PERIOD OF OPERATING HOURS

ITEM	8 HOURS	50 HOURS	100 HOURS	200 HOURS
Look over engine	X ¹			
Check oil level	X			

Service air cleaner		X		
Change oil		X		
Clean cooling fins		X		
Replace oil filter and change oil			X	
Check and clean spark plugs			X	
Check breaker points			X	
Change fuel filter				X
Replace points and condenser				X
Clean breather valve				X
Replace air cleaner				X
Check valve clearance				X
Compression check				X
Clean cylinder heads				X ²

X¹ Check for fuel and oil leaks. Listen for exhaust leaks.

X² If you only run unleaded gas you can wait 1000 hours.

pulleys because the water will make them slip and you will have no pressure to clean with. Also, stay away from electrical wires otherwise it might shock the ever living shit out of you. Trust me. It will definitely wake you up. If you plan on working on your machine for anything more than a simple oil change, do yourself a favor and disconnect the giant red cable on the battery.

Other stuff you should remember:

- Do not smoke within five feet of the machine
- Do not refuel the tanks while your machine is running
- Do not breath carbon monoxide from the exhaust when working in unventilated areas
- Do not leave oily rags next to the machine
- Remove excess grease from around the machine
- Do not work on things you don't know anything about (especially electrical)
- Make sure you buy the right spark plugs
- Do not put gas in the diesel tank or vice versa
- Do not touch both sides of the battery terminal at the same time
- Do not take off the shroud covering the belts
- Do not spill or splash hot oil from the engine on to yourself when changing the oil

That takes care of the engine part. The engine is set for a certain rpm and idle speed. The carburetor is set at exactly what it is supposed to be based on; the PSI of the pump, the number of gallons per minute, rpm of the generator, the load on the machine, the noise of the unit, etc. If you screw with the:

- Carburetor adjustment screws
- Governor low speed adjustment screw
- Main fuel adjustment
- Throttle stop screw
- Idle fuel screw

Your machine will:

- Run less efficiently
- Break sooner
- Run too rich
- Run too lean
- Cause premature failure
- Cause high pressure hose failure
- Etc., etc.

Who needs that. Don't tune up your own machine, especially the heart of your machine, the engine. You should only follow routine scheduled maintenance.

- **Components Of The Pressure Washer**

Your engine has a single crankshaft where all the power goes. In a car, this crankshaft goes to a transmission. On your machine there is a circular pulley pressed or wedged on to the crankshaft. The pulley has two grooves on it. A car has a pulley on the front of the engine block between the engine and the radiator also with grooves. One goes to an alternator and another goes to a water pump. The alternator makes electricity and keeps your car's battery charged. The water pump pumps water into your engine block from the radiator to keep your car from over heating. It does this by use of belts connected to these pulleys. It's relatively simple. If you look under the hood of you car, you'll see.

On your machine, your engine also has belts connected to the pulley. One goes to the generator. The generator makes electricity and powers:

- The burner blower for heating water
- The spark to ignite the fuel to heat the water
- The vacuum on your truck
- The lights on your machine for night work
- The 110 volt outlet on your machine for your carpet extractor

The pump on the other hand pushes the water from the pump through the hose and then through a pin size hole at the end on the gun, which gives you incredible force from your sprayer.

- **Generator**

Your generator gives electricity off of 110 volts at a power of 30 amps. Thirty amps is a lot. About the same power as a motorhome generator or an 11 hp Honda generator. That's plenty for you to run:

- The vacuum
- Burner
- Lights and a
- Small T.V.

at the same time. Pretty good. Hmmmm. Doubt you'll have time to watch T.V. You will be too bust. But at least you know you could if you wanted to.

Make sure your belt on your generator is always tight. If it breaks, take in the old one to match the size at any auto parts store. Check the terminals on the generator every once in a while. Remove the ground wires and sand down the connection points. Working around water can cause the metal to rust and you won't get a good ground. Eventually this will cause premature failure of the generator.

Other stuff:

- Do not adjust belts or try to change them when the engine is running
- Do not touch the generator when the machine is in use
- Disconnect the battery when doing any routine maintenance on the generator
- Do not spray directly on to the generator while it is running
- Keep the generator dry

- **Pump**

Your machine has a General pump. General is the leader in the industry. It's a great pump. Your pump is powered by two parallel belts connected to your engine. You should make sure not to starve your pump from water. When the tank is empty turn off the engine. Starving a pump will burn it out in about thirty-five minutes. The manufacturer says five to ten minutes, but that's not life threatening. Your pump has a safety feature whereby when you are not spraying the water, it will automatically by pass into the tank provided there is enough water for the complete loop. Thank you. We also thought it was one of our great ideas. You should change the oil in the pump every month. Make sure your truck is on level ground and fill the pump to the red dot on the center of the eyeglass.

On your pump you will notice six large bolts. Inside of the holes are check valves with springs. After 300-500 hours you should change them. You can do this yourself. The valve kits are \$60.000. It's very easy:

- Unscrew bolts
- Remove old valve
- Replace valve
- Make sure to seat the valve evenly
- Screw the bolt back in by hand
- Make sure the O-ring on the bolt is snug
- Tighten with wrench pretty tight

- **Inspecting The Pump**

If you drain the oil and it's got bubbles in it or has turned white, then you have a blown seal and water is getting into the oil because:

- It overheated due to water starvation
- The casing cracked because of vibration
- You forgot to change the oil, dummy (\$600 mistake and one lost day's work)

Check to see if the belts are tight. If not tighten them. Look for water drips. A slow drip on the exit side of the pump could cost you as much as 150 PSI at the nozzle. A fast drip (two to three drops per second) could be a 250-300 PSI loss at the nozzle. A steady drip stream might be a 500 plus PSI loss. When you see water leaking, fix the leak ASAP. Be sure to use ample Teflon tape when re-tightening fittings. This will stop future leaks, prevent rust and make fittings easy to separate in the future.

A hole in a hose or leak on the inlet side of the pump causes air to get in. The pump will act as if it's starving for water. It might even pulsate. When the water level in your tank reaches a point below the leak in the hose, air will replace the water and you'll get zero pressure. That makes it very hard to wash anything.

Low pressure in the pump can be caused by a number of things such as:

- Faulty pressure gauge (Replace)
- Out of water (Fill up tank)
- Old or worn out tip at gun nozzle (Replace)
- Incorrect tip (Remove and replace)
- Belt slippage (Tighten belt)
- Hose leaks (Fix leaks)
- Faulty unloader (Replace)
- Mis-adjusted unloader (Re-adjust)
- Worn packing in pump (Take it to dealer)
- Inline filter clogged with dirt (Clean it)
- Obstruction in spray nozzle tip (Remove it)
- Chemical metering valve sucking air (Turn it off)
- Slow engine rpm (Check engine)

Fluctuating pressure is different than low pressure. You should:

- Worn piston packing (Call dealer)
- Pump sucking air (Fix hole)
- Blockage in valve (Remove, check valves and take out blockage)

If your pump is noisy check for:

- Air in suction line (Check water supply and connections)
- Broken or weak inlet or discharge valve springs (Call dealer)
- Excessive matter in valves (Check and clean if necessary)
- Worn bearings (Check and replace. If necessary, call dealer)
- Vibrations from mounting (Tighten it. If unable, call dealer)

If you find the presence of water in the pump oil, it could be caused by:

- Blown pump head seals (Call dealer)
- High humidity in air (Change oil more often)
- Piston packing worn (Call dealer)

If water or oil drips from the bottom of the pump:

- Piston packing worn (Water - Call dealer)
- O-ring plunger retainer worn (Water – Remove and replace)
- Oil seal worn (Oil – Replace plug)
- Pump head seal shot (Oil – Call dealer)
- Crack in pump head (Water – Call dealer)

Pump lubrication should be done every three months or 500 hours, whichever comes first. Use SAE 40 weight oil or equivalent for Cat pumps. Use 20/30 weight non-detergent oil for General pumps. It should be hydraulic oil with anti-wear and rust inhibitor additives. The oil level should be checked by looking in the window on the side of the pump. Only fill oil half way to the red dot.

If you desire to do major repairs to your pump, follow these procedures:

REMOVING MANIFOLD HEAD (PUMP HEAD)

- 1) Drain out oil in the pump body
- 2) Remove eight bolts (the little bolts) from the side of the pump head
- 3) Separate the head from the crankcase (pump body) Note: It might be necessary to tap the pump head with a rubber mallet or piece of wood
- 4) Once the pump body and head are separated a little be careful to slide the pump head out slowly so the porcelain pistons are not damaged
- 5) The V-packing assemblies may come off with the head. At this point examine the plunges. The plunger surfaces should be smooth and free from scratches or scoring. If not, replace
- 6) Re-install the manifold head and torque to specifications per sequence described below:
 - A) Install all bolts finger tight
 - B) Start in the middle with a torque wrench at ten pounds
 - C) Use a crisscross pattern and tighten the four center bolts
 - D) Use the same crisscross pattern to tighten the four outer bolts

REPLACING PLUNGERS

- 1) Remove the stainless steel piston screw and plunger from the piston rod
- 2) If the slinger washer comes off with the plunger, be sure it is replaced before the new plunger is installed
- 3) Separate the piston screw from the plunger
- 4) Install a new O-ring and a Teflon backup ring on the piston screw. (A film of grease on the outside of the O-rings insures an easier and better installation)
- 5) Carefully press the piston screw into the plunger
- 6) Slide the new plunger over the piston guide
- 7) Torque the head to specifications listed below:
 - A) Install all bolts finger tight
 - B) Start in the middle with a torque wrench at ten pounds
 - C) Use a crisscross pattern and tighten the four center bolts
 - D) Use the same crisscross pattern to tighten the four outer bolts

REPLACING V-PACKING

- 1) Remove pump head
- 2) Insert the proper extractor collect (tool) through the main seal retainer
- 3) Tighten collect and remove retainers, v-packing and head rings
- 4) Place proper insertion tool in cylinder and install front head ring, v-packing and long life ring and press firmly onto the cylinder until they go in all the way
- 5) Next, insert the intermediate seal retainer, pressing it firmly into the cylinder until it won't go any further using the insertion tool
- 6) Install rear head ring, v-packing and main seal retainer into cylinder and press into cylinder
- 7) Repeat this process for all three cylinders
- 8) Coat each plunger with grease
- 9) Carefully remount manifold head (pumping head)
- 10) Torque pump head to specifications listed below:
 - A) Install all bolts finger tight
 - B) Start in the middle with a torque wrench at ten pounds
 - C) Use a crisscross pattern and tighten the four center bolts
 - D) Use the same crisscross pattern to tighten the four outer bolts

- **Coil Removal**

It may be necessary to remove the coil because of freeze breakage or to clean soot from it. This can be done easily, however, it can be a very messy job. Follow these steps:

- Disconnect the hose from the pump that leads to the inlet of the coil at the inlet side of the pump
- Disconnect electrical connection to the thermostat
- Remove the quick coupler from the discharge side of the coil
- Remove the burner assembly from the combustion chamber
- Remove all three 3/8 inch bolts from each side of the coil and tank assembly. (These bolts hold the tank to the chassis of the unit) *Earlier machine models have more bolts.
- Disconnect 1/2 inch pipe nipples from the inlet and discharge sides of the coil. (Some earlier model machines have an elbow, usually also a 1/2 inch pipe)
- Remove the top tank wrap exposing the coil and insulation. (Upright coil assemblies will be lifted in a skyward direction)
- Remove the coil. (It will be heavy. You may need a cherry picker, come-along and chain with a big bolt)
- Be sure to replace torn or broken insulation
- Put the coil on the lawn and blast it
- To re-install the coil, reverse these steps. Be careful when repacking the insulation

- **High Limit Hot Water Thermostat**

For reasons of safety, each unit is equipped with a surface sensitive hot water high limit control switch. In the event that the water temperature supercedes its preset operating degrees, the high limit control will turn the burner off until the water cools. Once your water returns to a safe operating temperature, it will automatically reset itself. The thermostat is located on all machines on the outside of the coil housing on the exit or departure side of the coils, thus measuring the water temperature as it is discharged from the unit to the pressure hose. If this thermostat unit fails, buy a new one. List price is between \$35.00-\$60.00 depending upon the manufacturer. Some are adjustable from 100° to 220° F. Those cost more. You need one set at a permanent 180° F, 185° F, 190° F or, 195° F. Our Founder likes 190° F but you may chose what you like best.

- **Diesel Filters**

Your machine has a burner that uses either:

- Diesel Fuel
- Kerosene
- Natural Gas

to heat the water. If you use diesel fuel or kerosene, make sure the fuel is clean. A clogged filter will cause blockage and it will turn off the burner due to lack of fuel flow. You should clean the crud out of your filter every other month.

- **Fuel Pressure Adjustment On Burner**

To adjust the fuel pressure in your burner (which we do not recommend), turn the adjusting screw counter-clockwise to decrease fuel flow. Clockwise to increase fuel flow.

Warning: Never exceed 150 lbs. of fuel pressure

If you do, you will create a giant flame out the top of your steam cleaner. You will also burn up the insulation around the coil. I've even caught the coil on fire. I turned off the heat but the fuel kept burning because it had soaked the insulation with diesel fuel. It also melted the paint off the coil shroud, burned up the transformer and worse yet, we ran out of water in the tank trying to put out the fire. So we drove down the street engulfed in flames and smoke, found a water spigot and hose at someone's house at one a.m. in the morning, turned on their hose and put out the fire. All the neighbors woke up. Someone called the fire department and of course two police cars showed up. All this because the water wasn't staying hot while we were cleaning sidewalks in the middle of the night and we thought we'd adjust the fuel pressure screw. This wouldn't have helped anyway because we had a water flow problem that was shutting off the water early before it reached the correct temperature.

Please don't touch that screw! – Call the dealer.

So you see you really can learn from our twenty years experience. That happened fifteen years ago, but we at headquarters will never forget it.

- **Fuel Control System**

Our units utilize a fuel solenoid valve located on the fuel pump to control the flow of fuel to the combustion chamber. This solenoid, which is normally closed, is activated by a flow switch when water is flowing through it. When you release the trigger on the shut-off gun, the flow of water through the flow switch

stops turning off the current to the fuel solenoid. This closes the solenoid, shutting off the supply of fuel to the combustion chamber.

By controlling the flow of fuel in this way, our machines are unique in that they create instantaneous burn-or-no-burn situations. This patented solenoid allows us to maintain safety by eliminating high and low water temperatures. Temperatures too low won't clean well and temperatures too high can cause an explosion, fire or melt down of the machine components. We've also nearly eliminated combustion smoke associated with our units by incorporating this shut-off gun. It also saves fuel and prolongs the life of the insulation. Not to mention that it doubles the time between regular de-scaling maintenance of the schedule 80 coils.

We recommend periodic inspection to insure that the fuel solenoid valve functions correctly. To do this, simply stand by the exhaust of the coils and pull the trigger on your gun. When it makes a low rumble sound you know everything is working great. With this patented solenoid in place on the machine we believe it to be a much safer piece of equipment.

- **Ignition Circuit**

Periodically you should inspect the wires, spring contacts and electrodes for their condition, security and proper spacing. To perform a transformer test, use a screwdriver (with no defects) with an insulated handle. Be sure to keep your fingers off the metal parts of the screwdriver. Lay the blade across one contact and within 1/2 inch of the other contact. The transformer should arc with a small lightening bolt over the 1/2 inch distance. Be careful not to touch this because it's 10,000 volts.

- **Burner Nozzles**

Keep the tip of the nozzle free from surface deposits. Use a clean solvent saturated rag. Be careful not to plug or enlarge the nozzle when cleaning. For maximum efficiency, replace the nozzle at tune up time every two to two and one-half years.

- **Air Adjustments**

Usually steam cleaners are factory adjusted for operation at seventy-five feet above sea level. If your unit operates at five hundred or more feet above sea level, you may need to make a one time correction because the higher above sea level you are, the thinner the air. This correction will improve efficiency, performance, economy and extend your machines service life. If you notice smoky or eye burning exhaust coming from your machine, it probably needs adjusting. But first, make sure you are burning clean fuel. Number One home heating fuel is best, but kerosene is ok. Diesel fuel can be used also.

An oily smoky fire indicates lack of air and the air band should be turned to allow the air to flow through the burner. A sharp eye burning fume indicates too

much air is flowing through the combustion chamber and unburned fuel is escaping so turn the air band the opposite way.

- **Cleaning Of Coils**

De-sooting the exterior is easy. Blast it on the lawn with whitewall cleaner. The inside is trickier. If the water you use is higher in alkalinity than is normal, lime deposits can build up restricting water flow. Similar to cholesterol build up in you veins. Of course, this build up of lime deposits increases with heat. If you use high quality chemical and in-line injection you won't get lime build up. We don't recommend this due to EPA laws. High quality chemicals with additives that might prevent lime build up are probably illegal discharges. So use some Koil Kleen Deliming Powder on steam cleaning jobs every once in a while. (See Deliming Powder instructions on every bottle of Koil Kleen.)

- **Winterizing Procedures**

Damage due to freezing is not covered under our current manufacturer's warranty. If the temperature goes below 32° F, you should siphon a small amount of anti-freeze (the environmentally safe stuff) into the system. Put a small amount of anti-freeze in the float tank in a 50/50 mixture with water. Unhook the nozzle and wait until colored water comes out the end of the gun. Put the gun into the float tank to loop the system. As soon as you see water, turn it off. Or you can put a little anti-freeze into the in-line chemical injection at 100% and turn on the machine for thirteen seconds for every fifty feet of hose.

- **Unloaders**

The unloader on your machine will last nine months to one year. At that time you should either replace it at a cost of \$75-100.00 or rebuild it with a \$35-45.00 rebuild kit. The reason these unloaders don't last very long is due to the type of work we do, pulling the trigger gun on and off all day.

When not working properly, your unloader can be aggravating to say the least. The most common problems include:

- Unloader stays in bypass mode and won't come up to pressure
- Unloader will not attain full pressure
- Unloader cycles under pressure
- Unloader bypasses at excessive pressure

If your unloader stays in bypass mode and won't come up to pressure, it may be because:

- There isn't sufficient flow (Increase flow)
- The outlet orifice and the nipple parts are too large in size (Change outlet parts to smaller sizes)

- The gun nozzle tip is too small (Change to a larger tip)
- Worn piston ring (Replace it)
- Compressed main spring (Install a shim just below the snap ring. Make sure the flat side faces upward)
- Broken main spring (Replace it)
- The snap ring slipped out of the groove (Replace the snap ring or re-install it with the flat side up)
- Failed bypass fitting O-ring (Replace that O-ring)
- Foreign debris internally (Clean and reassemble unloader)

These procedures will generally fix your pressure problem. Don't forget to check the water supply, in-line inlet filter and blockage or kinks in the inlet hose first.

If the unloader won't go to full pressure, there are a number of possible problems such as:

- Gun nozzle tip worn out (Replace tip)
- Insufficient water flow (Clear hose, increase flow)
- Failed sleeve O-ring(s) (Replace failed O-ring(s))
- Worn piston ring(s) (Replace one or more)
- Deformed valve body (Replace it)
- Sleeve not seated against the adjusting screw (Take it apart and push it against sleeve)

If the unloader cycles under pressure, this is an entirely different problem. First check the nozzle tip, outlet orifice and water flow. If that's not it, take it apart and look for debris or foreign objects. If this is the problem, clean it. If not, it's the piston ring(s). They are probably worn and should be replaced.

If your unloader continually cycles in bypass mode, check for leakage in the down line chemical injection. If it's not that, it could be:

- Worn weep nozzle at the gun (Replace it)
- Stand pipe positioned downstream (Reposition to upstream from the unloader)
- Excessive pump inlet pressure (Install pressure regulator or restrict water intake flow)

If you notice your engine speeding up and under an unusually high load when you release the trigger, your unloader is going into bypass mode at too high a pressure. This can cause lots of problems such as, but not limited to, a hose blowout, O-ring blown in hose reel or damage to components. It could be caused by:

- Excessive tension on the main spring when unloaded (Remove shim to increase the springs clearance)
- Restricted bypass line (Fix immediately, clear any blockage)

- Inlet pressure too high (Reduce pressure or install an inlet pressure regulator, approximately \$30.00)
- Internal foreign debris (Clean it and reassemble)

If you choose to mess with your unloader, make sure you know what you are doing. Otherwise, let the dealer fix it or just replace the damn thing and get back to work ASAP. Make money. Don't be pennywise and pound foolish.

- **The Burner**

The most temperamental part of your machine is the burner. It is also the hardest to master. We recommend you let the dealer mess with it. But if you are the mechanical type, read the owner's manual twice before taking it apart.

If your burner won't light, first check to see if:

- The fuel tank is full
- You have good water flow
- Your switch is working
- The fuel solenoid is working
- The fuel filter isn't clogged

Check those first and first and fix the obvious. If that doesn't work, check again because these are the most common problems. When you are sure you have fixed all those problems, try these items as possible causes:

- Wrong type of fuel was put in the gas tank (Drain it and re-fill the tank with the correct gas)
- Water in the gas tank (Drain it and put in good gas)
- Misadjusted burner air bands (Re-adjust the bands for a cleaner burn)
- Little or no fuel pressure (Increase the fuel pressure or replace the fuel pump)
- Faulty burner transformer (Test for arc in transformer. If no arc, replace burner transformer)
- Short in wiring (Fix short)
- Burner motor thermal protector tripped (Reset it, if it doesn't work, then:
 - A) Check fuel pump shaft rotation for binding (Might cause motor to overheat)
 - B) Check voltage
 - C) Check connections
 - D) Check extensions
- Flex coupling slipping on the fuel pump shaft or on the burner motor shaft (Replace it promptly)

- Heavy sooting on the coil and burner can cause interruption of the air flow and shorting of the electrodes (Clean it up)
- Improper electrodes setting (Clean it first, then reset it)
- Fuel never reached combustion chamber. Check:
 - A) Fuel pump for flow
 - B) Solenoid flow switch
- Clogged burner nozzle (Clean it and try again)
- Flow switch malfunction (Remove, test for continuity and replace as needed)
- Fuel solenoid not working (replace it \$30.00)

If your burner lights but the motor won't run, it's probably because the overload protector tripped, so try to reset it first. If not, the problem could be more serious. So check all wiring, loose wires and the control switch (maybe it's defective). If this doesn't fix the problem, you'll need to spend some money because:

- Your fuel pump seized
- Your burner motor is defective or burned up

The only other possible thing I've ever seen go wrong was a burner fan which got loose and misaligned itself. You may be able to position it correctly and tighten the set screw if that didn't also break.

- **Hand Tools**

To prevent rust on your tools put a piece of:

- Charcoal
- Chalk
- Moth Ball

in your tool box to absorb moisture. Wax your tools with Carnuba or spray wax. A light coat will ward off corrosion and rust for quite some time. You can also put oil on a rag and wipe all your wrenches with it.

- **Generators**

Try to keep your generator dry and away from rain. Try covering your machine. Do not directly spray it with water. Water ruins generators. Do not let dirt or foreign material such as dust, sand, lint, abrasive particles get near the generator. As it spins, it will suck in such debris. This causes excessive wear on the bearings, gears, brushes, etc. These materials also clog ventilation holes and cause excessive heating.

The power required to start any electrical motor is substantially higher than the power (amperage-amps) it takes to continue the running of that motor.

A one H.P. motor may take 30 amps to start but only 13 amps to run. Certain electric motors require much more amperage to start than do other motors. Split phase alternating current (AC) motors require more current (amps) to start them. There are many easy starting type motors such as washing machines or motors where the major load is not while starting but rather when the amperage is really needed during operation such as a drill press or hand tools. These types can sometimes draw five to seven times the amperage needed to start and you will notice when you drill something the motor may not go to full power when using a generator that does not have enough power. Try to avoid this situation.

Capacitor and repulsion-induction motors require from two to four times as much electricity to start as to run. The current to start (the spike) will vary from motor to motor. For example, an air compressor would require lots more amps than a motor that has no load connected to it when it starts. Because the heavy surge of current required for starting motors is only needed for one to two seconds, it will not damage the generator. However, it is safer to turn on the biggest amperage draw unit first, let it run and then turn on the other unit(s). I.e. turn on the vacuum first, then lights then burner on the steam cleaner in that order that is if you plan on running all of them at the same time. If you find you are having difficulty starting, turn everything off and start the difficult starting unit first.

Low voltage can damage both the generator and any motors connected to it. Running the generator at excessively high speeds results in too high a voltage that may also damage any devices connected with it. That might also cause the amperage winding to fail prematurely.

- **Brushes**

You should inspect the brushes for wear after about one thousand or so hours and every three to four hundred hours after that. They should be replaced when worn down to one-half inch. Whenever you replace bushes or remove them to do service work, be sure to remove one brush at a time and put the screws back into the brush holder to hold the lead wire terminals in place. If you don't you could have difficulty connecting all the wires to the correct positions.

- **Computator**

If your computator is in good condition, it will have a glossy finish and will be brownish bronze in color. If it gets greasy, rough or dirty, it may be cleaned with very fine sandpaper. Do not use emery cloth.

- **Bearings**

All ball bearings used in these generators are packed with grease before assembly. No further greasing is required. If they become rough or worn they should be replaced.

- **Locating Troubles**

If your generator does not work correctly, you should first check the conditions under which it has been operating and then make these electrical tests:

- Is the speed correct? (You can check the speed with a tachometer)
 - A) Adjust engine speed
 - B) Make sure the engine's governor is able to hold that constant speed
- Did you overload your generator? (If uncertain, check it with an amp meter and voltmeter)
- Is your generator getting sufficient ventilation? (If you are operating under extremely dusty conditions be sure all ventilation holes and slots are cleaned periodically)
- Are your brushes properly seated? (Remove the end cover with the generator in operation and examine the brushes to determine if there is any appreciable arcing and sparking. Start minor maintenance on brushes)
- No output voltage is obtained at the outlet receptacles or output wires (Disconnect all electrical loads and connect a voltmeter directly to the AC brushes. If no voltmeter is available, use any ordinary small 115 volt bulb. If normal voltage is obtained at the AC brushes but not at the output terminals, there must be an open circuit between these points. Caution: The center brush on your generator is grounded and neutral. Check from this brush to each of the other two brushes)
- Using an ohmmeter. (Check the field circuit for open circuits. To do this, remove the field coil leads from the brushes or the rectifier and check for continuity through the coils. If this doesn't work, examine the coil leads for possible opens and examine the spliced connectors connecting the coils together. Repair the opens. If the field coils are open internally, the defective coil must be replaced to fix the problem.
- If the problem is not located use the ohmmeter to check the field coils. (Disconnect the terminals. Check to see if the field coils are grounded at 1100 volts. If either coil is grounded, you should remove it and insulate it at the point of ground or it should be replaced.
- Other ideas. (Remove all lead terminals from the AC brush. If the generator operates properly with these wires disconnected, there is a short circuit in one of the condensers or the control box. Isolate and correct the short circuit. If the condenser is shorted, the wire can be taped and you can operate the

generator until a new condenser is obtained. The condenser is used to eliminate radio interference.

If all these tests do not lead to fixing of your generator, remove the armature and have it tested for opens, shorts and grounds on a growler. The same equipment and procedure used for testing DC generator armatures also applies to these armatures.

- **Guns**

A quick visual inspection may take as little as ten seconds. You should do this weekly. Once you get in the habit, it will become second nature to you and will save you down time. You should check connections if the spray gun connections are leaking. You should:

- Fix the leak immediately with Teflon tape
- Fix the leak using Locktite 242 on threaded connections

If you have a leak, it means three things:

- Lost cleaning power
- Wasted water
- Wasted energy

You'll want to clean up the leak because it's aggravating working with a leak. It soaks you over a period of three hours of vehicle washing. It also is hard not to get water on the adjacent car with a leak

You should look over the gun housing to ensure that there are no cracks or other sharp edges on the gun's plastic housing trigger guard. It's not fun for one of your employees to get scratched or cut from the hard plastic. The gun should be safe to touch.

Feel-test the valve. Simply grab the spray gun like you were ready to wash a car and squeeze the trigger. Does the trigger pull easily? Is the valve opening and closing properly? Are seals leaking around the piston? All these problems can be fixed by buying a valve replacement kit. Some franchisees prefer to replace the entire gun because the cost is only about \$40.00 (\$39.95). Usually, by the time the valve is worn out the outside housing is also beat up.

If you want to do routine maintenance, you could clean the gun periodically and:

- Lubricate the stainless steel valve seat
- Open the housing and clean it
- Spray it with WD-40
- Rub oil on it
- Take apart the connections and re-Teflon tape them
- Make sure the housing is snug against the components

- Make sure the gun is free from scum and debris

So, you are asking what causes these units to fail. There are a couple of things such as:

- Scale build up inside the valve body
- Cars running over the gun
- Abuse, dropping the gun
- Letting the spring coil reel retract too quickly

Cleaning scale build up can be relatively simple:

- Disassemble valve body
- Soak parts in de-scaling solution
- Let solution dissolve scaling and lime build up
- Reassemble and operate

Watch for signs that tell you it is time to replace the spray gun such as:

- Broken guard housings
- Bent trigger pins
- Broken triggers
- Trigger guards broken
- Ball falls out or trigger pin falls out
- Housing worn through
- Melted plastic housing

To insure proper valve operation in your spray gun, you may want to install new valve kits periodically. Most gun designs offer 'cartridge' type valve kits. These, of course, are the easiest to install and replace. The ball, seat, spring and seals are contained in a single assembly. You remove the old and reassemble the new.

More care must be taken with valve kits containing individual parts so that pieces are not lost or incorrectly positioned. Follow instructions so you don't have to do it twice. Here are the instructions (very generic) which I recommend that you follow if your kit doesn't come with instructions from the manufacturer:

- 1) First insure that all water pressure is released from the gun
- 2) Remove the plastic, carbon graphite or composite housing
- 3) Secure the valve housing in a pair of vice grips or a vice
- 4) Remove the valve cap and pull out the spring, ball, seat, piston, O-ring and backup ring. (A hooked pick may be the easiest way to remove the O-ring and backup ring)
- 5) Replace the backup ring, O-ring and piston
- 6) Ensure the proper positioning of all parts before pressing the new seat in place

- 7) Place the new stainless steel ball on the seat
- 8) Position the new spring in place
- 9) Replace the O-ring on the valve cap
- 10) Apply thread sealant before reassembly into valve body
- 11) Button up unit. You are done.

- **How To Figure Out The Performance Of The Steam Cleaner After You Know Everything Is Working Efficiently**

$$\text{GPM} = \text{Nozzle \#} \sqrt{\text{PSI}/4000}$$

$$\text{Reaction Force (lbs.)} = \frac{\text{GPM} \sqrt{\text{PSI}}}{18.92}$$

$$\text{PSI} = (\text{GPM}/\text{Nozzle \#})^2 (4000)$$

$$\text{Nozzle \#} = \text{GPM} \sqrt{4000/\text{PSI}}$$

To help you understand, think of it this way. The closer you are the more power you get on the surface you are spraying. The size of the orifice on the tip of the gun and the PSI you are at determines the velocity. GPM or the weight of the force of water-kinetic energy determines power. If you have a fire hose at 100 PSI and 400 GPM, you will knock anyone on their ass. But if you have 100 PSI on the hose in your front yard at 10 GPM, you will piss them off and they'll want to knock you on your ass. The closer you are with a fire hose, the further and faster you'll knock them on their ass. With a garden hose, if they're close, the faster you'll piss them off and the sooner they'll catch you.

Heat also plays an important factor that adds cleaning power. Be careful. These machines clean great but can be dangerous to humans when you are too close to the skin. Take our advice. Don't cut or burn yourself. Spray away from yourself and others.