

900 ULTRAMATIC MANUAL



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INTRODUCTION

Congratulations on your purchase of the Steam Way 900 UltraMatic. This model represents years of experience in the Portable Carpet and Upholstery Cleaning Machines. You can now appreciate the high degree of craftsmanship and reliability that have made the 900 the leader in this field.

This manual will provide the owner with a good basic understanding of the operation and basic maintenance of the unit. If you have any questions regarding the operation or maintenance of your machine, please consult your Steam Way distributor or the main plant - Portable Division.

NOTICE: Some data in this manual may become outdated due to improvements made to this model in the future. If there are any questions concerning this manual, consult Steam Way International of Denver.

Particularly important information is distinguished in this manual by the following notations:

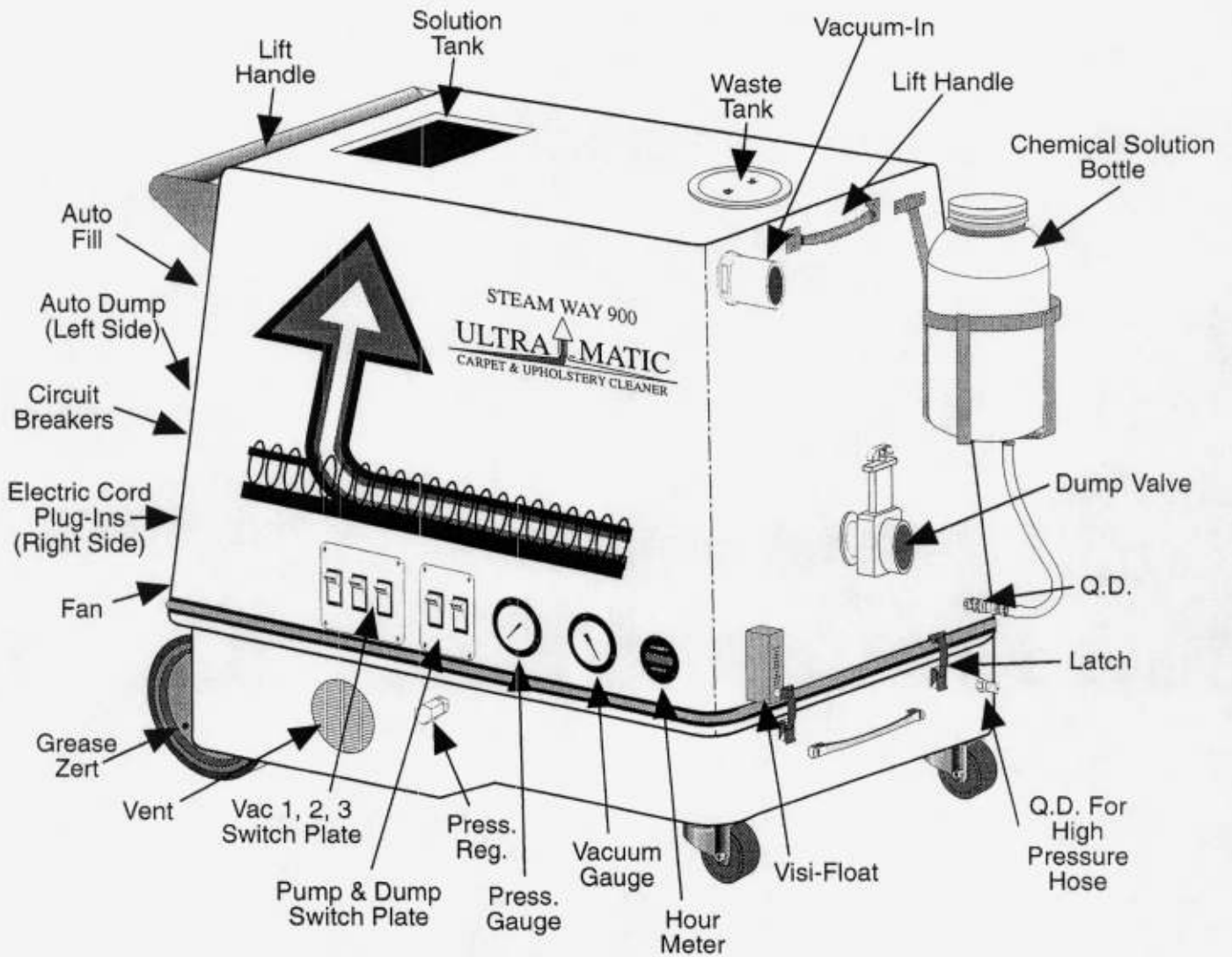
Note: A note provides key information to make procedures easier or clearer.

Caution: A caution indicates special procedures that must be followed to avoid damage to the machine.

WARNING: A warning indicates special procedures that must be followed to avoid injury to operation or person inspecting or repairing the unit.

NOTE: The serial number is located at the front bottom of the unit. When consulting the factory it is important to give the serial number of the unit.

STEAM WAY 900 ULTRAMATIC



PREPARATION OF MACHINE

CAUTION: During the months of November 1 to May 1, the machines are shipped with anti-freeze in all lines. It is important to flush the unit with clean water to avoid damage to the carpet.

1. Always fill solution tank with water before running CAT pump.
2. Make sure all hoses and connections are in place and securely fastened.
 - A. High Pressure Hose
 1. Assure that the Q.D. locks in place on the machine and cleaning tool.
 - B. Vacuum Hose
 - C. Electric Cords
 1. Plug cords into two separate outlets (example: kitchen & livingroom)
 - D. Auto Fill and Auto Dump Hose
 - E. Chemical Line
 1. If not in use, close Visi-Float
 2. When in use, monitor chemical bottle to prevent run out.
 - a. Fill bottle when water reaches mold line at the bottom of bottle.

CAUTION: If Visi-Float is open or bottle runs out, air will enter the system, and pressure will drop and will not build pressure until air is out of the system.

3. Flush anti-freeze from unit with clean water.
 - A. Pressure Line
 - B. Chemical Line
 - C. Dump Line
4. Fill solution tank with water and/or chemicals which will be used during the cleaning process.
5. The machine is now ready for operation. Depress the "Pump" switch and the pump will start.
6. Set the pressure with the Pressure Regulator on the side of the machine.
 - A. Clockwise to increase pressure.
 - B. Counterclockwise to decrease pressure.

NOTE: Pressure must be set while the handle on the wand is depressed.

7. After pressure is set the Visi-Float is set in the same manner.
 - A. Depress the handle on the wand while the pump is on and set the Visi-Float to the proper metering amount.
 1. Between 2 and 3 is adequate.
8. Turn vacuum blowers on.

CAUTION: Always have Vacuum #1 on. Vacuum #1 controls the Auto Shut Off for all three vacuums. If Vacuum #1 is not on, the waste tank will over-fill causing possible damage to blowers.

9. Turn Auto Dump Pump on when waste tank is approximately half full of water.

MAINTENANCE OF MACHINE

Machine Cabinet:

Keeping the cabinet clean on the outside is just as important as the inside.
To clean outside of the cabinet, use any non-abrasive cleaner to prevent scratches on fiberglass.
Use hot clean water inside of cabinet to prevent odor build-up in waste tank and soap build-up in Visi-Float.

NOTE: A customer cares about the appearance of your equipment. Taking care of your machine shows you will take care of your customers carpet.

CAT Pump:

Change oil after first 50 hours of operation and every 300 hours after that.

1. Pump takes a little more than a half quart of oil.
2. Do not over or under fill.
3. Fill half way between red dot on view glass.

*NOTE: Once oil reaches bottom of view glass, level rises very fast.

CAUTION: Never run pump dry.

Dump Pump:

To flush out any dirt blockage, force water through lines and pump while pump is running.

Vacuum Blowers:

Periodically, spray a couple of shots of WD-40 down vacuum stand pipe located in waste tank. This helps prevent moisture build-up.

Back Wheels:

Grease hubs.

Dump-out Filter:

Remove after every use and clean filter.

CAUTION: Do not allow machine to freeze.

PERIODICAL INSPECTIONS

High Pressure Hoses:

Inspect hoses for damage or deterioration. Inspect connections for leakage. Repair, replace or tighten as needed.

Electrical cords/Wiring:

Inspect for cuts, bare wires, or loose connections.

Vacuum Hose:

Inspect for holes in vacuum hose. Damage to hose will cause loss of vacuum.

CAT Pump:

Assure proper oil level.

Visi-Float:

Inspect for soap build-up.

Dump-out Filter:

Inspect for lint build-up on filter.

Dump Pump:

Inspect for dirt blockage in lines.

TROUBLE SHOOTING GUIDE

PROBLEM	CAUSE	CURE
CAT Pump Pressure loss or no pressure build-up.	Air in system 1. Solution tank empty 2. Visi-float open and/or chemical bottle empty. 3. Holes in line	Remove air by forcing water through system while pump is on and handle on wand is depressed. Replace lines.
	Circuit breaker tripped on pump or machine.	Replace circuit breaker.
	Defective pump or regulator.	Replacement kits.
Auto Dump Pump Inoperative	Filter and/or lines clogged.	Remove brass filter and clean. Flush lines with hot clean water while pump is on.
	Deterioration of valves.	Replace valves.
Visi-Float not registering	Soap build-up in Visi-Float and lines	Flush with hot clean water
Loss of vacuum suction	Electronic shut-off system tripped.	Reset by turning vacuum switches off and on. Lower water level in waste tank.
	Lint screen restricted.	Clean
	Holes in or crushed vacuum hose.	Replace
	Circuit breaker tripped on machine.	Reset circuit breaker
Auto Shut-off inoperative	Bad blower.	Replace
	Vacuum #1 is not on	Turn Vacuum #1 on.
	Bottom or top bolt in waste tank on probe covered with lint and debris.	Remove lint and debris.
	Blue wires not connected	Reconnect
	Circuit board inoperative	Replace
	Shuts off too early: 1. Too much splash 2. High amount of foam 3. Leak in water Shut off probe	High water level - Dump tank Use defoamer Replace probe

Diagram 4 - Lower Cabinet

Figure 4-1
3/8 Clear Braid Hose
3950610

Figure 4-2
Pressure Hose to Gauge
3934442

Figure 4-3
Blower Vacuum Hose
Tank to Blower #1
29-7740

Figure 4-4
Modified Vacuum Blower
19-7700

Figure 4-5
Blower Vacuum Hose
2-3
29-7731

Figure 4-6
Blower Vacuum Hose
1-2
29-7730

Figure 4-12
Circuit A, B
Wiring Harnesses
A) 19-1725
B) 19-1730

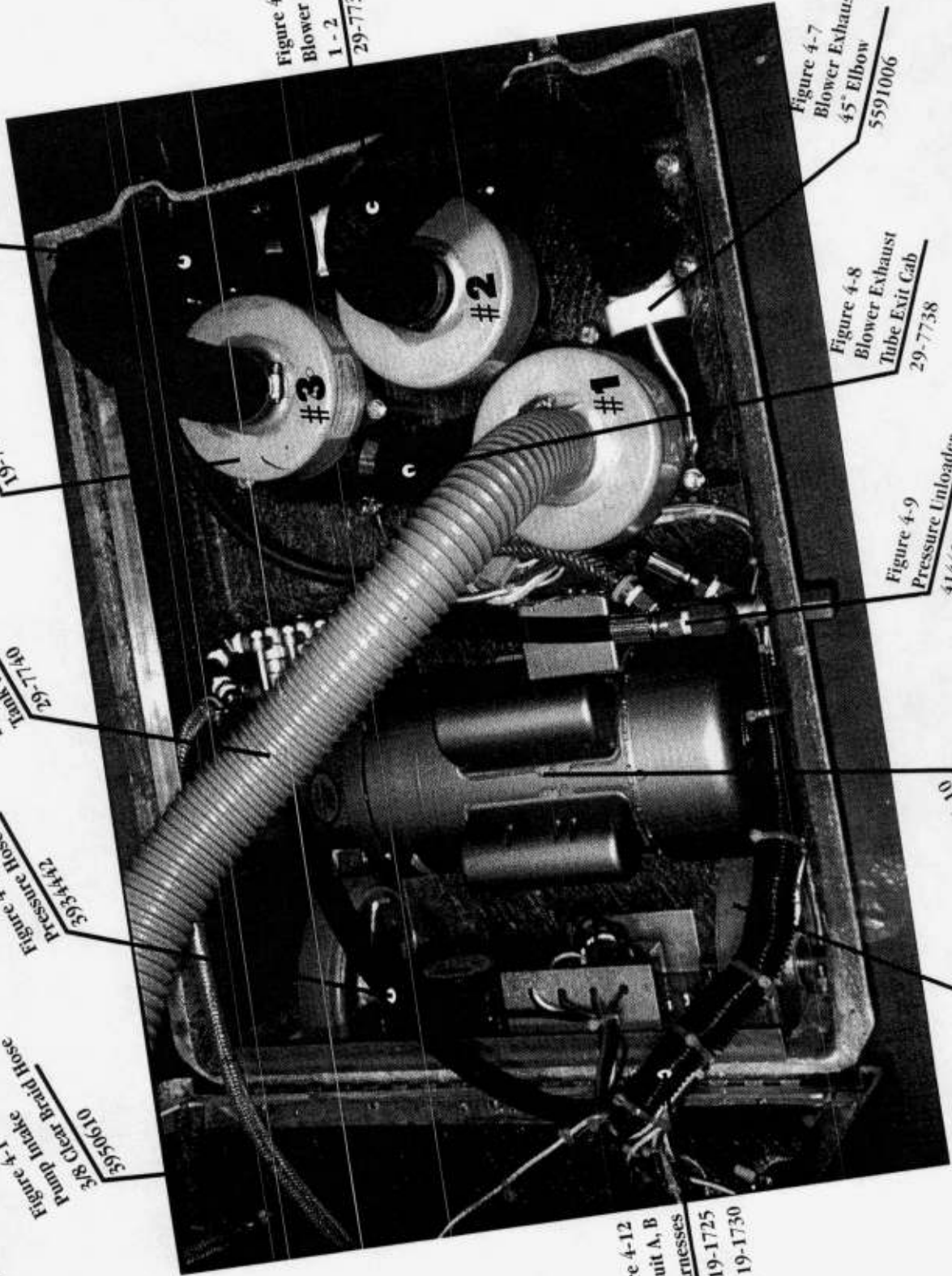


Figure 4-7
Blower Exhaust
45° Elbow
5591006

Figure 4-8
Blower Exhaust
Tube Exit Cab
29-7738

Figure 4-9
Pressure Unloader
4144205

4-10

Diagram 5 - Pump Assembly

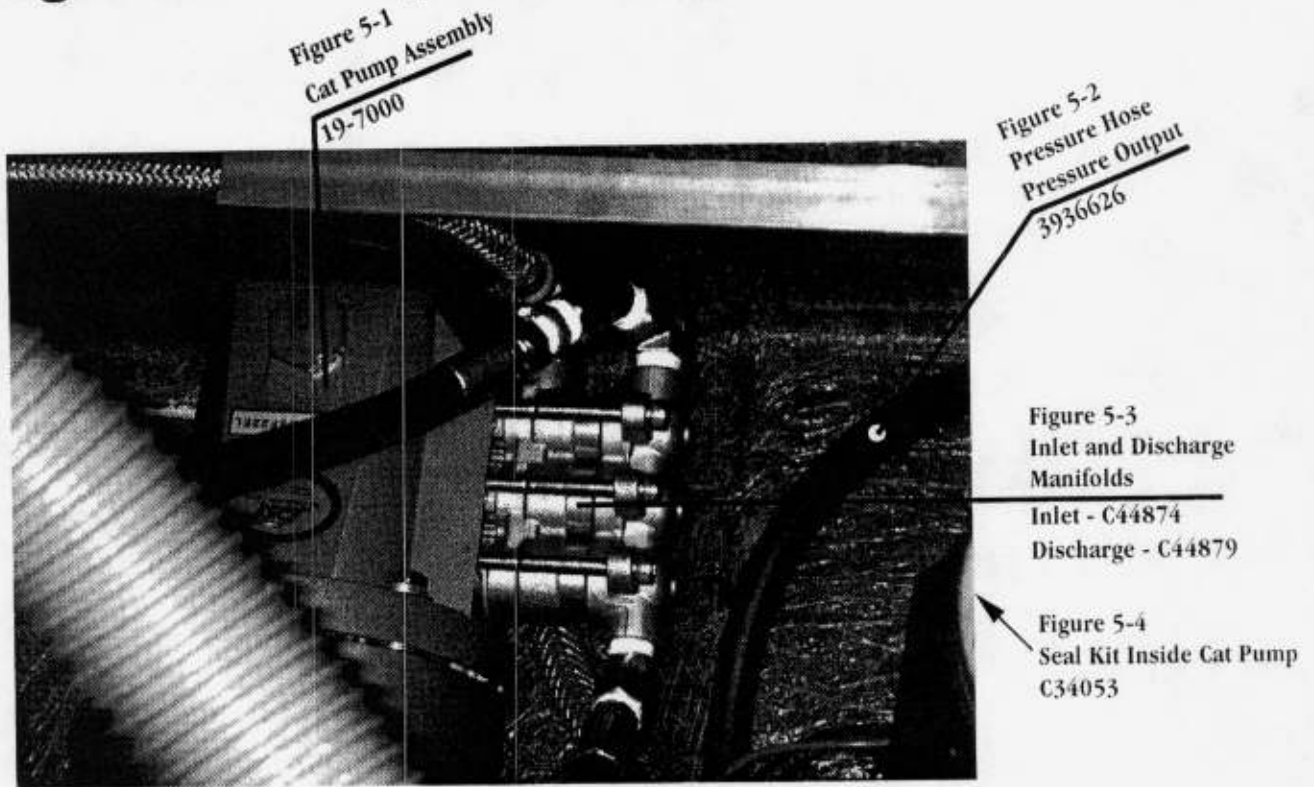


Diagram 6 - Control Panel

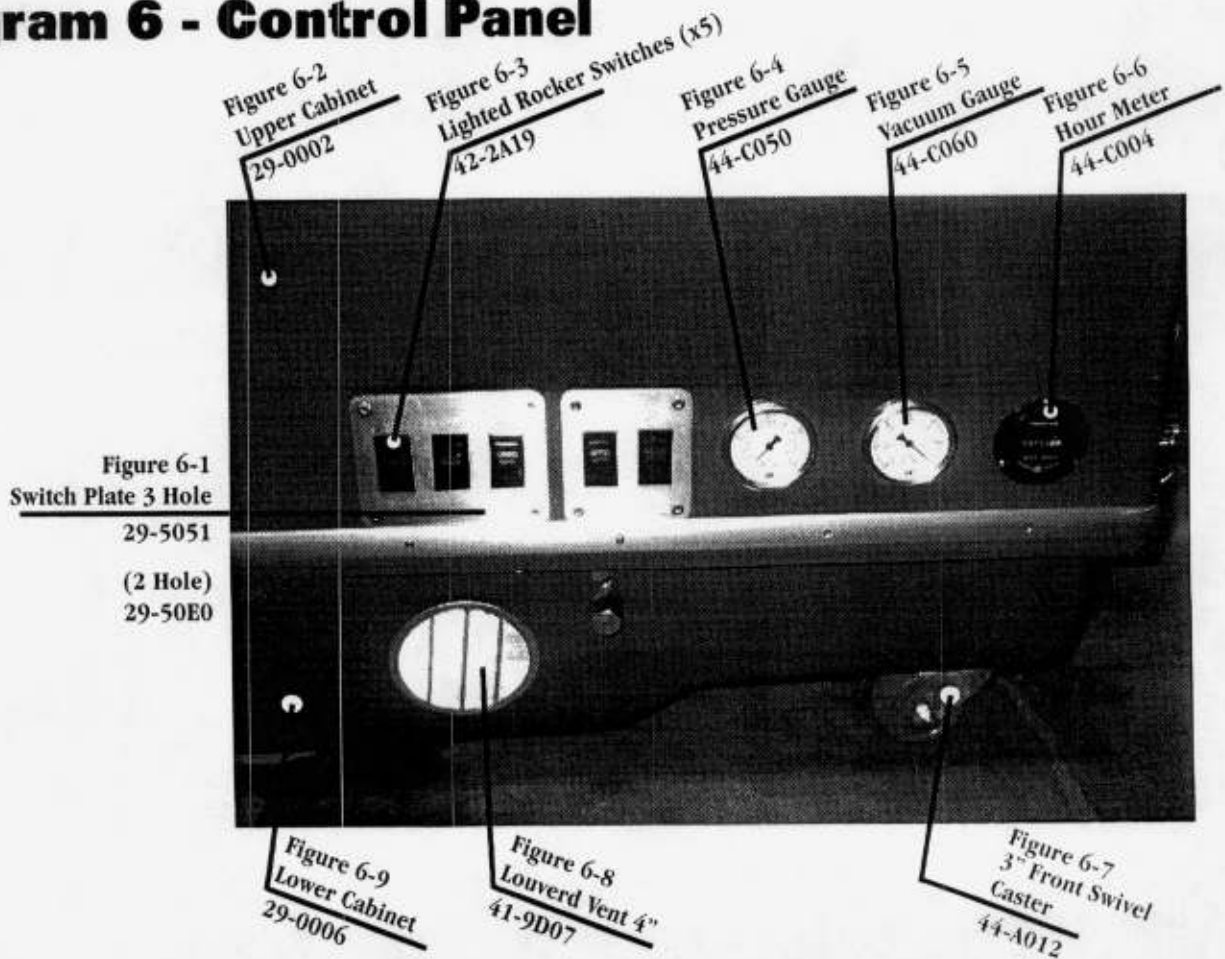
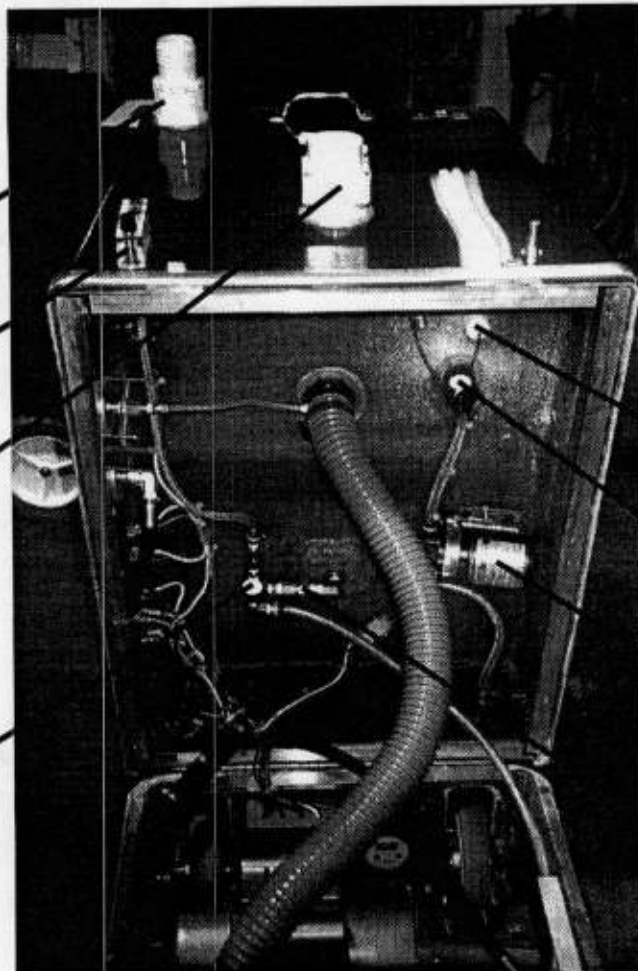


Diagram 7 - Upper Cabinet

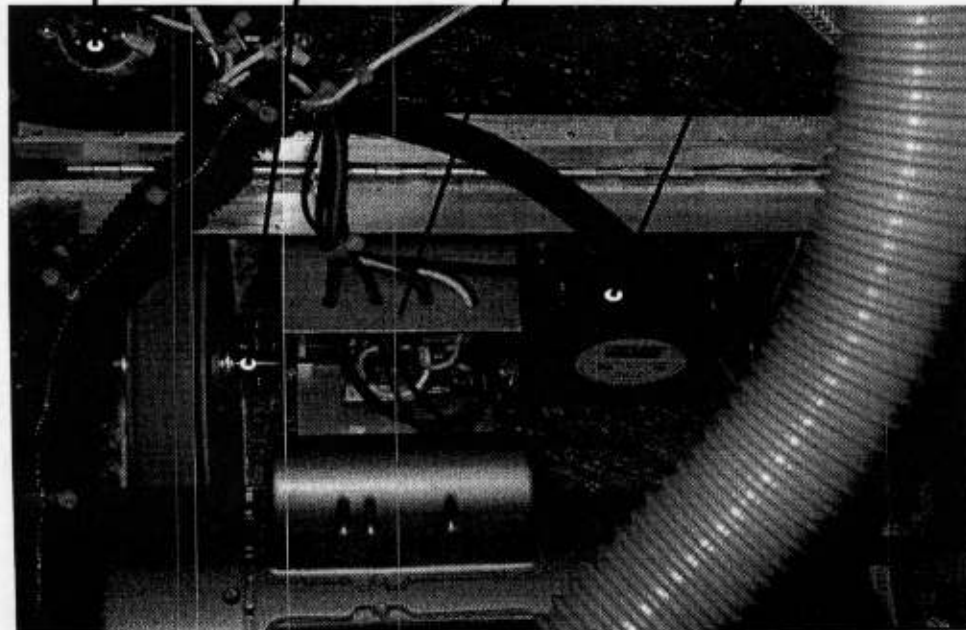
- Figure 7-1
2" Barb, DVC
5722006
- Solution Flow Meter Valve
Figure 7-2
4146105
- Figure 7-3
Dump Gate Valve
4142015
- Check Valve Assembly
Figure 7-4
19-5300



- Figure 7-5
Water Level Probe
19-1310
- Figure 7-6
Waste Tank Filter Assembly
19-1270
- Figure 7-7
Shurflo 60 PSI Dump Pump
41-0A19
- Figure 7-8
1/4 x 1/4 Check Valve
4146505

Diagram 8 - Electronics

- Figure 8-1
Male Inlet Plug
42-3A03
- Figure 8-2
Axel Bar Assembly
19-3005
- Figure 8-3
Water Level Vac Shut Off
19-2115
- Figure 8-4
Axel Fan
42-0B10





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Technical Bulletins

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WASTE WATER DISPOSAL

WHERE SHOULD MY WASTEWATER GO?

Talk about a touchy issue. For many years, magazines, convention agendas, and newsletters have been filled with articles and speeches about the proper handling and disposal of industrial wastewater produced during the carpet cleaning process. What can this author say that hasn't been said before? Well, the truth of the matter is that most articles about wastewater management simply come down to "war stories" of large fines being levied against some poor carpet cleaner and how if you'll buy a waste pumping system all of your problems will be solved. We wish it were that simple.

WHY DO WE DISPOSE OF WASTE WATER PROPERLY?

How big is the problem? According to Dr. Michael Berry, when he was with the U.S. Environmental Protection Agency, wastewater produced by carpet cleaners represents less than 1/2 of 1% of the total wastewater problem. However, carpet cleaners are visible and easy to identify, especially when they open up their dump valve on main street. However large or small our contributions are to the total problem, our wastewater must be handled and disposed of properly. Why, you ask? To quote Wilford Brimley of Quaker Oats commercial fame, "Because it's the right thing to do." The truth is that most companies will never be stopped or fined for illegal wastewater disposal. The motivation for change has to come from inside. We must want to take better care of the planet that we live on because it is the right thing to do.

So how do we dispose of our wastewater? Where should our wastewater go? Let's start with the absolute. Never, ever, ever, ever dispose of your wastewater directly into the storm sewer system. In most places, it's illegal. In all places, it is unnecessary and not wise. Now that we've gotten that out of the way, we can move on to the more complex issues. If we can't dump into the street and/or storm sewer, then where can we dump? Well, a proper understanding of that issue must first come from understanding what potential problems exist within the wastewater we are trying to dispose of.

Most cleaners simply think about what hazardous chemicals are contained in their wastewater. But there is more to it than that. In 1993, the city of Calgary, Alberta did an analysis of a professional cleaner's wastewater. You know what they were primarily concerned about? It wasn't any chemicals that were in the water—it was the fuzz, lint, and carpet fibers in the water. They were concerned that the large particle and fiber material would clog up the pumps of the sewage treatment system. They were making an excellent point. Fortunately, there are many easy ways for the professional cleaner to help solve this particular problem. Each professional cleaning company must take responsibility for doing some filtering of their wastewater. We're not talking about a \$20,000 trailer mounted filtration system that is available in the high pressure washing industry. We're talking about simple filter devices such as lint socks, filtration screens, and even old panty hose. Quite simply, wastewater should be filtered in the waste tank by the use of a lint sock or filtering screen. But it should also be filtered by running it through filtration screens within the vacuum recovery line. This is usually accomplished by the use of a clear viewing filter or a metal filter. If you do both of those things, you will have pretty much solved the large particle, lint, fuzz, and carpet fiber problem.

DO OUR CLEANING CHEMICALS PRODUCE HAZARDOUS WASTE?

Now, let's focus on the chemical content of the wastewater itself. Are there hazardous chemicals in carpet cleaning wastewater? For our purposes, the wastewater that results from the cleaning process can be classified two ways. Industrial wastewater contains levels of no hazardous ingredients at part per million levels above government standards. Hazardous wastewater contains measurable hazardous ingredients that are measured at standards higher than government regulation allows. We can only determine what the cleaner used to clean the carpet with. In our industry, most preconditioners and carpet rinsing detergents do not contain any hazardous ingredients. Therefore, as long as no hazardous chemicals pre-existed in the carpet that was cleaned,

then the resulting wastewater is not hazardous. This discussion excludes the issue of butyl solvents. Some preconditioners contain butyl solvents such as Butyl Cellusolve. Butyl Cellusolve is considered to be a hazardous ingredient. However, it is also a commonly used solvent in many products. If it is contained in a carpet cleaning preconditioner in a quantity of 10% or less, its parts per million after use in a 100 gallon waste tank, classifies it as industrial waste rather than hazardous waste. However, the conscientious professional cleaner should be aware that many inexpensive carpet cleaning chemicals contain higher levels of butyl solvents; that's how they make them cheap. Also, when evaluating the resulting wastewater from a carpet cleaning chemical, it is important to keep in mind that just because a particular chemical has an ingredient listed as hazardous on its Material Safety Data Sheet, does not automatically mean the resulting wastewater would be classified as hazardous. Once the chemical is mixed and diluted in use application, and ends up as a minute percentage in a one hundred gallon waste tank, its parts per million classifies it as industrial waste. In general, carpet cleaning chemical usage results in industrial rather than hazardous wastewater. We will discuss proper disposal principles for industrial wastewater in a few moments.

However, there are a few chemicals that some carpet cleaners can or have used that might result in hazardous wastewater. Generally, these are chemicals used in spotting application. Rust removers that contain percentages of hydrofluoric or phosphoric acid greater than two percent could result in hazardous wastewater if they were used in large enough quantities. However, since the cleaner has usually used alkaline cleaning agents, these agents counteract and balance the acid ingredients resulting in industrial wastewater with a safe pH in the 7 - 9 range. One general rule that can apply here is to test the pH of your wastewater. In most places, for them to be classified as industrial wastewater, the pH should fall between 5 and 9. Take note if you are using highly alkaline cleaning agents (pH of 12 or higher); you may need to pH balance your resulting wastewater. Another category of spotting agents that we must consider are non-volatile solvent spotters. These usually contain amyl acetate and can be identified by their "banana oil" fragrance. As long as most of these chemicals are used in quantities of 8 ounces or less per 1000 square feet of carpet cleaned, they pose no danger to making the resulting cleaning wastewater hazardous. However, it is still good practice to use them in a post-spotting application and rinse them with volatile solvent spotters.

In general, it's a good practice that spotting agents only be used after basic cleaning procedures would not remove a spot or stain. A good general rule to keep yourself safe is to only use spotting chemicals bought from reputable chemical manufacturers that specialize in fabric cleaning.

SO WHAT ARE OUR DISPOSAL OPTIONS?

So now that we have determined that a large majority of the time our wastewater is not hazardous, what are our options for disposing of it? We have already eliminated dumping it onto the streets. A good general rule of practice is to always dispose of the wastewater into the sewage treatment system only after the large particle solids and carpet fibers have been filtered out. There are several ways of getting the wastewater into the sewage treatment system. The first, easiest, and least cumbersome and expensive way is to find drain access to the sewage treatment system. This may be through a garage drain, toilet, bathtub, shower, sink, or janitorial closet sink. Transporting the wastewater to these drains on-site is best accomplished by the use of a waste pumping system. Several different types of waste pumping systems exist. Some mount directly in the waste tank and some are attached to clear view or metal filter boxes. A second way to dispose of wastewater into the sewage treatment system is simply by using the waste tank collection system of your equipment to hold the wastewater so that you can transport them to a site where direct drain access to the sewage treatment system can be used. In this case, the filtered wastewater can directly be dumped into the drain. Obviously, in these cases, the larger the waste tank, the more efficiently you can do this. Some cleaners have taken their wastewater to dump at car washes. Most car washes filter and recycle their water. If not, then they do feed them into the sewage treatment system. Whatever the case, never dump at a car wash without first making arrangements with the car wash owner/operator. Also, make sure you filter the lint, large particles, and carpet fibers before you dump the water. These materials will clog up the drains and the recycling pumps at the car wash.

There are exceptions to this "dump your wastewater in the sewage treatment system" rule. An important item to remember is that when you dispose of industrial wastewater, you are literally under the jurisdiction of at least three government agencies. The local agency is usually a city or county wastewater management force. The state agency is usually a state environmental protection agency or industrial wastewater agency. The federal group is usually the United States Environmental Protection Agency. Hopefully, these groups are working together, but that is not always the case. Generally, local ordinances are more specific and stricter. It is usually a local or state agency that may contact you. We will discuss how to work with these agencies later. The best way to find out if you can legally put your filtered wastewater into the sewage treatment system is to ask your local wastewater management agency. What kinds of exception will you find? Plenty. For instance, in El Paso County, Colorado, it is illegal to dump into the storm drain. However, it is not illegal (in fact, it's recommended) to dispose of industrial wastewater onto grass and shrub covered land. A customer of ours in Alaska has really ran into difficulty. His city does not have a sewage treatment system (everyone uses septic tanks). It is illegal to dump into the storm drains or onto the land. So what is he supposed to do? Transport the wastewater to a disposal site in Utah? He has to build a treatment system in his back yard. This is a case of bureaucracy being unable to find a reasonable solution. On the issue of septic tanks, generally, your wastewater should only be disposed of into septic tanks and septic systems when you make sure the enzyme balance within that septic system has not been damaged. If it has, then you must restore that balance.

What about dumping your wastewater onto land? This should not necessarily be a "cut and dry" issue. Unfortunately, with many bureaucrats, it is. Obviously, a better solution is the sewage treatment system, but sometimes that is impossible, impractical, or too expensive. I don't think any well-meaning environmentalist or wastewater management enforcement executive really wants to put a conscientious professional cleaner at an extreme competitive disadvantage. What is the make up of the non-hazardous chemical ingredients within industrial wastewater? Basically, our cleaning chemicals contain anionic or nonionic surfactants and alkaline builders. None of these are harmful to plants. Most are very biodegradable. In fact, many of the ingredients contained in our cleaning chemicals are also contained in fertilizers. There has been a lot of publicity surrounding phosphates that are contained in many carpet cleaning detergents. Phosphates themselves are not hazardous. They are actually a fertilizer. In too high a percentage in the water supply they can cause too much plant and algae growth. Theoretically, this growth of plants and algae could become too intense. This would harm water wildlife because the plant and algae growth would use up too much of the oxygen, not leaving enough for the wildlife. In addition, a lake could become more of a swamp because of too much algae and plant growth in the water. Therefore, these ingredients can be harmful to fish or other water life when too much phosphate is in the water supply. Only in Oregon are phosphates in industrial cleaning detergents prohibited. If you continue to use cleaning detergents that contain phosphates, never dispose of your waste water within two miles of a stream or other water flow. There is something else you should consider about waste water disposal: Picture your goldfish trying to breathe in your bath water after you've just shampooed your hair. The detergents inhibit the natural function of the gills, which could cause an oxygen shortage to the fish. That's why our wastewater must never be directly or even in close proximity, be dumped into the water supply. Some enforcement agencies use a "two mile" rule. In some places, you may dispose of industrial wastewater to the ground as long as you are over two miles from a stream, river, or lake. Our industrial wastewater is probably not harmful to wildlife. However, many agencies feel that "probably" is not good enough. They may be right. However, many city and county sewage treatment systems are archaic in nature and/or overloaded. They would prefer that wastewater not be disposed of into the sewage treatment system. Many rural areas don't have sewage treatment systems. Many agencies feel that there are no ill effects of dumping industrial wastewater onto the ground. This is a complex issue. Whenever possible, your industrial wastewater should be disposed of in a sewage treatment system.

Other alternatives that sometimes are given are simply not realistic. Carpet cleaners cannot afford to transport their industrial wastewater to a hazardous disposal site. Most cities don't even have one. They can't afford to pay someone to take it away—that can cost up to \$3,000.00 for a fifty-five gallon drum of soapy water. That's absurd! How can any agency fairly enforce waste disposal laws that prohibit dumping into the sewage treatment system to companies that only use portable equipment? Laws and regulations are only useful if they can be fairly enforced against every company. Environmentalists and agencies must work together with cleaning companies to develop reasonable solutions to this challenge. As stated earlier, no well-meaning environmentalist or agency wants to force a cleaning company which makes such positive health contributions to the indoor environment, out of business, by passing unreasonable rules and regulations.

HOW TO DEAL WITH A REGULATORY AGENCY?

That brings us to our discussion of what to do when you deal with a regulatory agency. First and foremost, be honest. The best defense is a good offense! When you show and demonstrate that you are genuinely concerned about being in compliance with regulations, they are much more likely to work with you. When you show and demonstrate that your company is environmentally conscious, then reasonable solutions seem to be found. Second, have your Material Safety Data Sheets ready for the chemicals you use to clean carpets. Explain to the agency what each chemical is and how it is used. Third, don't be afraid to let them test your wastewater. In fact, request it. Fourth, if you have been accused of a "wrongdoing", don't panic. Be courteous and helpful. If you are dealing with a totally unreasonable individual, (a bureaucrat who wants to save the world in two months or thinks all business people are trying to destroy the world with pollution) always ask for a meeting with his/her supervisor. Usually, more experienced regulatory people are better able to reach reasonable solutions. If you have to, go all the way to the mayor, county commissioner, or governor's office. Remember that government is for the people. Demonstrate a true willingness to reach solutions that are reasonable to everyone's needs. Fifth, have a posted waste water disposal policy for your company at your office, garage, and on each van, so that you and your employees know the proper procedures for the disposal of industrial wastewater. After reading this essay, if you get caught for illegal dumping of wastewater into the streets of your town, as they say, "Don't come crying to me." Finally, sell the fact that you, like they, are in the cleaning business. It's your job to clean up indoor environments. It's their job to clean up outdoor environments. You need to work together.

PRE-EXISTING CONDITIONS

A few important thoughts before we close. We all must deal with an important issue. That is what we can do about "pre-existing" conditions. "Pre-existing" conditions in this case are chemical residues that are left in the carpet by installers, pesticide applicators, or even by the homeowner, that may be picked up during the cleaning process, thus perhaps making the wastewater hazardous. Truthfully, the chance of any residue being enough to make one hundred gallons of wastewater hazardous are slim, but it could happen. What should we do? First of all, pesticides are becoming organic and safer. Second, installation people are now using cleaning solvents that are environmentally friendly. Thus, the main people who must take responsibility for what chemicals are put on their carpet are the carpet consumers.

WHAT IF OUR WASTE WATER IS HAZARDOUS?

Occasionally, the cleaning process can result in the production of hazardous wastewater. A professional cleaner must learn how to identify these situations and take appropriate actions. If the people who have hired you to do the work are not willing to pay to have the appropriate authorities and experts dispose of the hazardous wastes properly, then you must walk away from the job.

WHAT ABOUT OTHER CARPET CLEANING METHODS?

Finally, we need to take a close look at what kind of wastes other carpet cleaning methods produce. Obviously, in hot water extraction "steam" cleaning, water is the main carrying agent and ends up "holding" most of the soiling. Does that make so-called "dry" cleaning solution methods better for the outdoor environment? Not necessarily. The wastes produced by these dry cleaning methods may or may not always be disposed of into the sewage treatment system, but almost exactly the same sets of rules and regulations apply. In the case of dry extraction absorbent compounds, the resulting wastes, if disposed of in a trash can, will still end up in a sanitary landfill, where they will never be treated by anything. If they contain hazardous materials, then they have been illegally and improperly disposed of.

First, we must examine the ingredients of these cleaning solutions. Dry powder cleaning chemicals, usually consist of a carrier that is cellulose or urethane based. These carriers are saturated with anionic or nonionic detergents. The cleaner who is using dry powders is responsible for determining whether the resulting wastes are hazardous or not. Bonnet cleaning solutions include the use of water both in the mixing of the chemical as well as in the cleaning of the bonnet pads. Usually, bonnet cleaning solutions contain similar ingredients to preconditioning agents. Often times though, they have a higher solvent level. Since bonnet cleaning solutions are not extracted from the carpet, the only consideration is whether washing out the bonnet pad might produce hazardous waste. Normally, this will simply be industrial waste also. Dry foam shampoos are anionic and/or nonionic detergents. They are mixed with water before application. Dry foam application machines produce waste that must be properly disposed of. With the use of dry powder, bonnet cleaning solutions, and dry foam shampoos, sometimes preconditioners can be used in extreme soiling circumstances. The use of carpet shampoo involves anionic surfactants that are mixed with water. Shampoos are usually vacuumed out or wet extracted out resulting in cleaning wastes.

Second, with any cleaning method, the determination and classification of the wastes, as well as their proper disposal, must be made by the cleaner.

PRINCIPLES OF WASTE WATER DISPOSAL

In closing, let us summarize what we have learned:

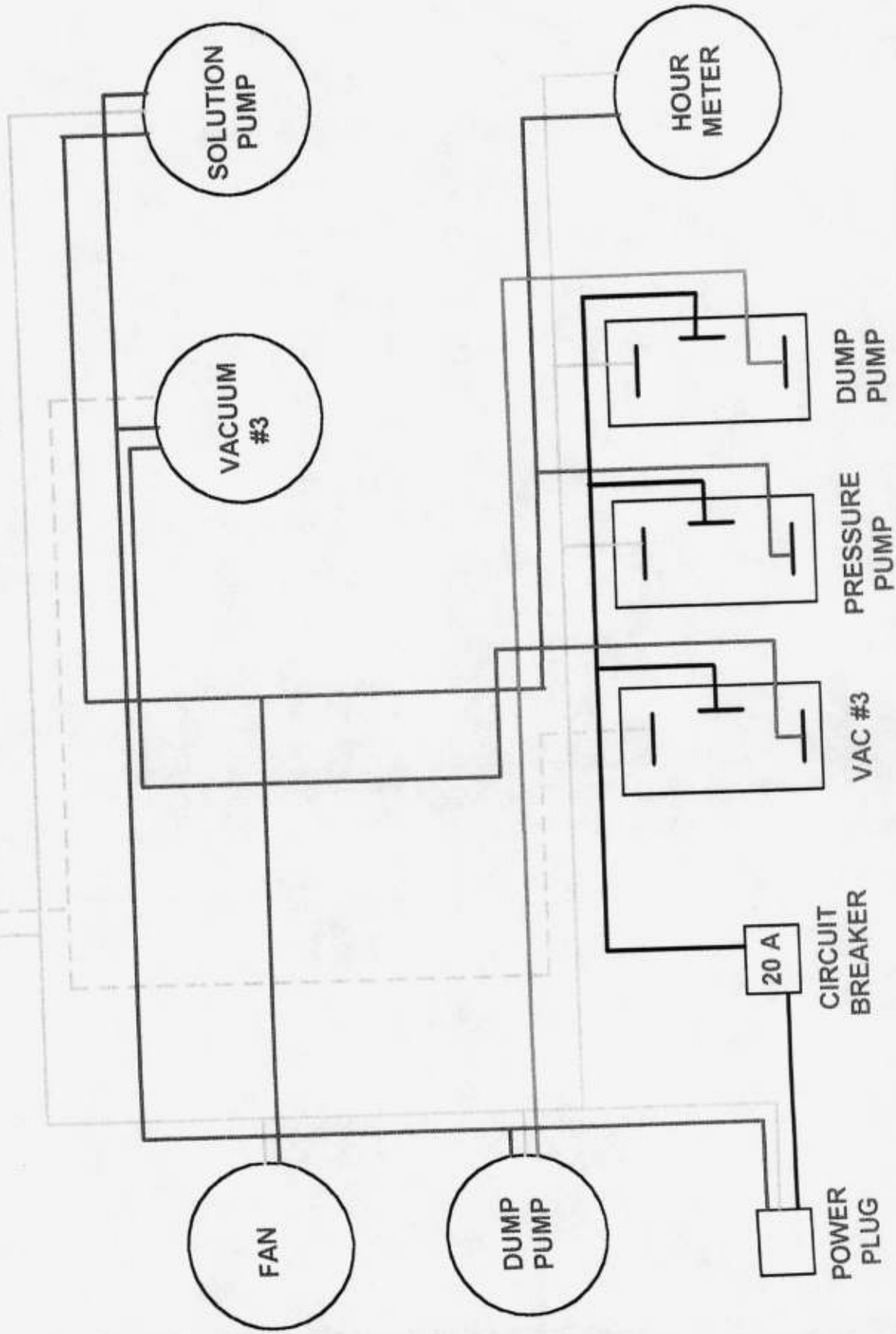
- 1) Carpet cleaning wastewater makes up less than 1/2 of 1 percent of the total wastewater problem.
- 2) Wastewater should be disposed of properly, primarily because it is the right thing to do.
- 3) Never dispose of wastewater directly into the streets or storm sewer system.
- 4) Before disposing of wastewater, it should be filtered to remove fuzz, lint, carpet fibers and other large particles.
- 5) Wastewater that is produced by the cleaning process is classified as either industrial waste or hazardous waste.
- 6) The use of most preconditioners and carpet rinsing detergents in the hot water extraction cleaning process normally results in industrial wastewater that does not contain hazardous materials.
- 7) The pH of industrial wastewater should be between 5 and 10.
- 8) Spotting procedures should be performed after the regular cleaning process. Harsh alkaline or acid spotting solutions must be neutralized prior to being extracted. Spotting solutions should not be used in quantities larger than 8 ounces per 1000 square feet cleaned.
- 9) The best way to dispose of cleaning industrial wastewater is by directly placing it into an outlet which directly goes to the sanitary sewage treatment system. This can best be accomplished by waste pumping systems or by large capacity wastewater holding tanks.
- 10) Cleaners who use portable cleaning equipment must follow the same rules.
- 11) Cleaning wastewater disposal falls under the jurisdiction of local, state, and federal regulations.
- 12) Some jurisdictions allow for the disposal of industrial cleaning wastewater onto the ground far from a water supply. In general, it is still better to dispose of it into the sewage treatment system.
- 13) Generally, do not dispose of industrial cleaning wastewater into septic tank systems without re-establishing the enzyme balance within the septic system.
- 14) Industrial cleaning wastewater can be harmful to fish and other water wildlife.
- 15) In dealing with regulatory agencies, you should:
 - a. Be honest and demonstrate a commitment to being in compliance with regulations;
 - b. Have Material Safety Data Sheets for the chemicals that you use to clean with ready to present at all times;
 - c. Allow, even request, that they test your wastewater;
 - d. If dealing with an unreasonable person, be courteous but ask to speak with his/her supervisor; and
 - e. Maintain a posted and written policy for your company for disposing of wastewater.

- 16) Pre-existing chemical residues are the responsibility of the carpet owner.
- 17) If the cleaning wastewater is hazardous, it must be treated as such and disposed of properly and legally.
- 18) All carpet cleaning methods produce waste that must be handled and disposed of properly.
- 19) If you choose to ignore these rules, then you are on your own.

To Level Sensor - See diagram #3

900 ULTRAMATIC 900 WIRING DIAGRAM #1

(Circuit A)



PURPLE — RED — GREEN — BLACK — BLUE —

To Level Sensor - See diagram #3

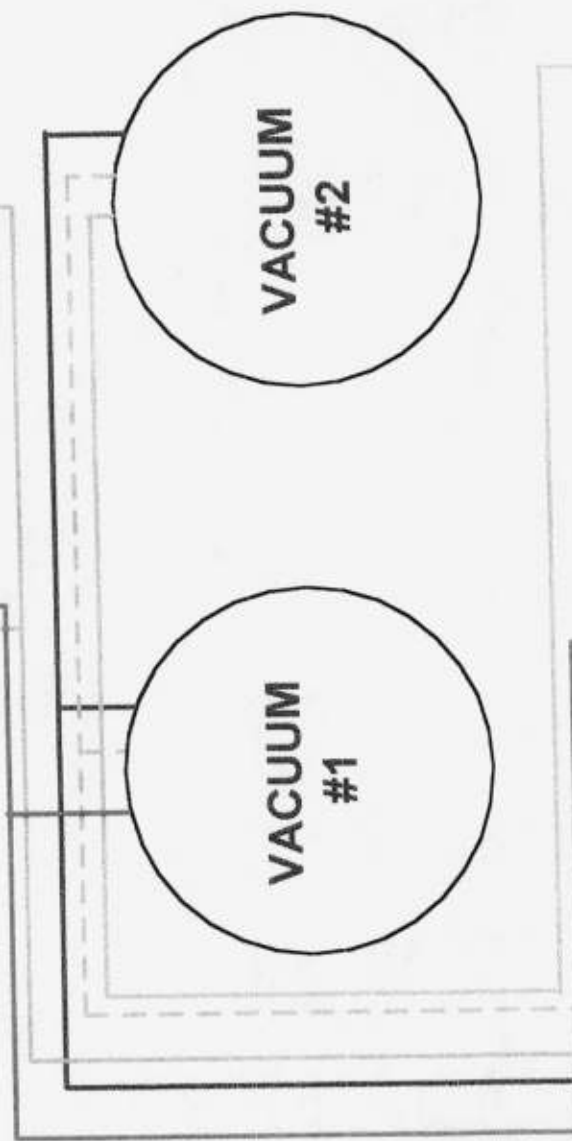
00 ULTRAMATIC 900 WIRING DIAGRAM #2

(Circuit B)

- GREEN ———
- WHITE ———
- BLACK ———
- WHITE - - - -
- YELLOW ———
- RED ———

AC POWER (120V)

VAC 1&2



VACUUM #2

VACUUM #1

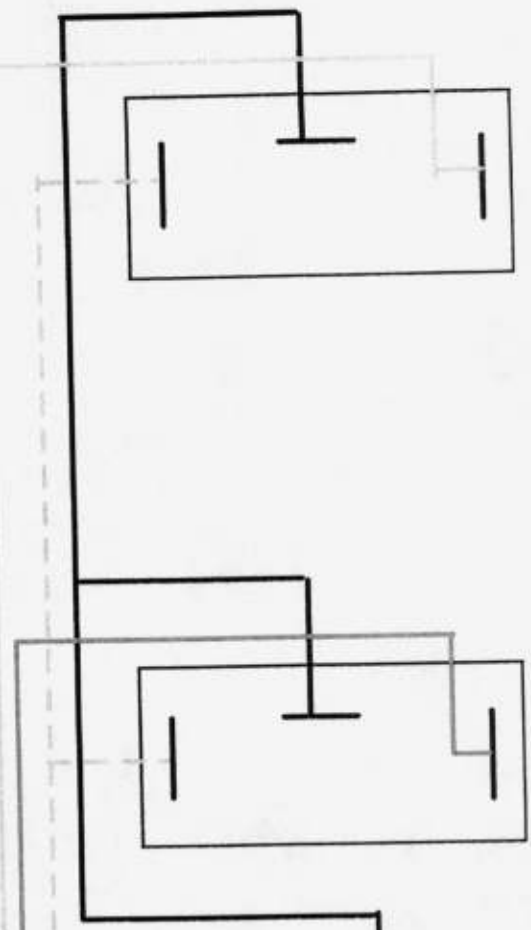


POWER SUPPLY



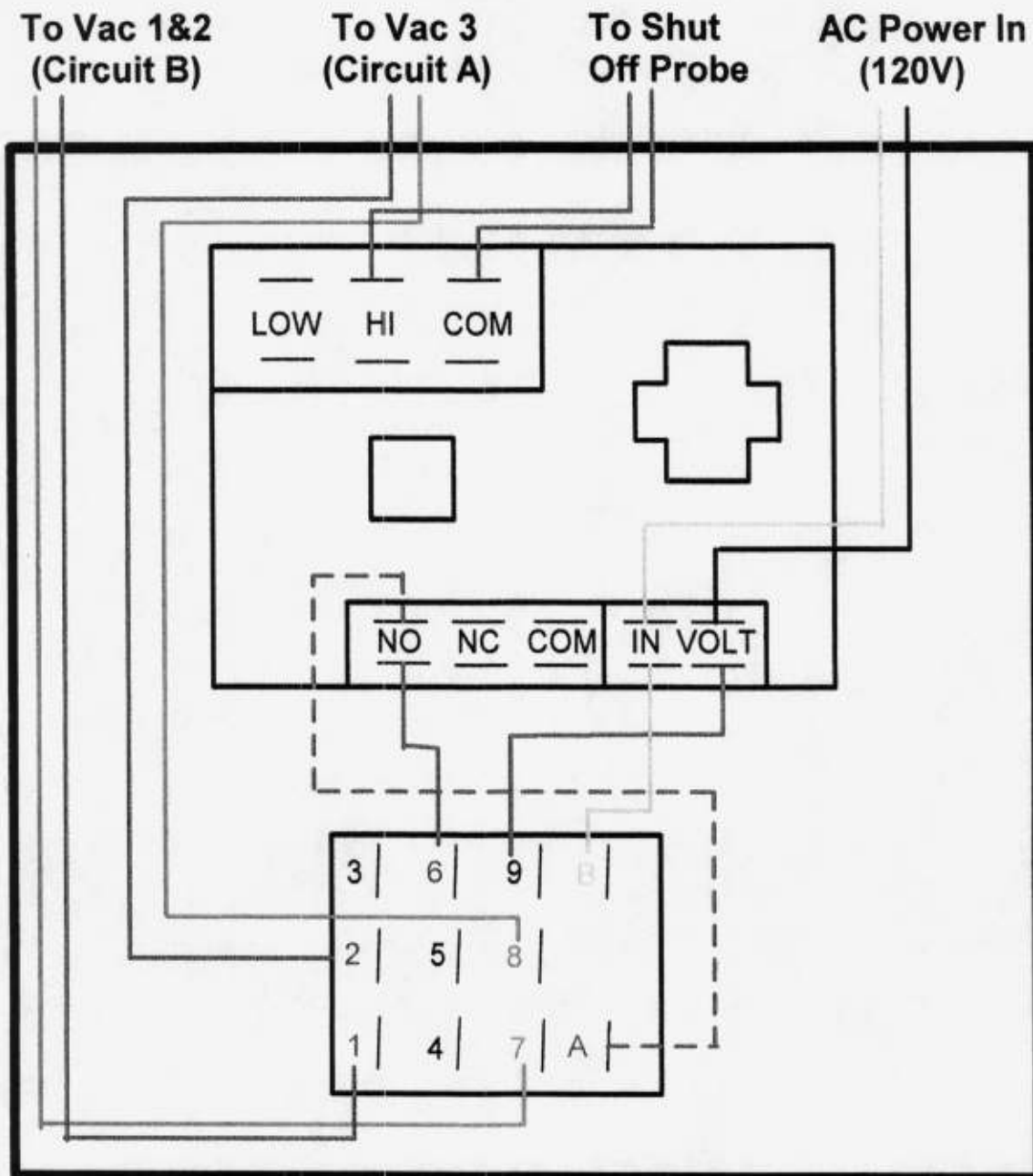
20A

CIRCUIT BREAKER

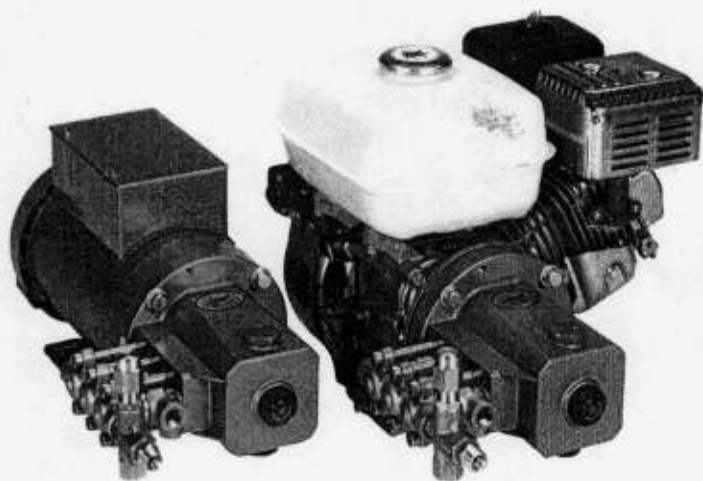


VAC #1

VAC #2



900 ULTRAMATIC 900 WIRING DIAGRAM #3
Level Sensor Assembly



Electric Motor or Gas Engine must be purchased separately.

Triplex Direct Drive Plunger Pump

Model

2SF

PUMP FEATURES

- UNIFLOW design provides continuous liquid flow forward through the pump, reduces cavitation risk and increases pump life.
- Triplex design with unique spring loaded inlet valves and the flow through ceramic plungers provides a smooth, steady flow.
- Ultimate portability—less than 11 pounds—less than 10" long.
- Standard shaft pump for direct mounting or special SOLID SHAFT and LOW RPM models.
- Regulating Unloader is standard on each pump to assure system pressure control and pump protection.
- Special Hi-Temp seal option for pumping 190°F water.
- Optional Thermo Valve mounts directly into by-pass hose for optimum heat protection while in by-pass.

COMMON PUMP SPECIFICATIONS

	(Standard)	Flooded to 75 PSI (Flooded to 5.25 BAR)	(Hi-Temp)	30 to 75 PSI (2.1 to 5.25 BAR)
Bore	0.708"	(18 mm)		
Max. Liquid Temperature	160°F (71°C)		190°F (88°C)	
Crankcase Capacity	11.83 oz. (.35 L)			
Inlet Ports (1)	3/8" NPTF	(3/8" NPTF)		
Discharge Ports (2)	3/8" NPTF	(3/8" NPTF)		
By-Pass Ports (1)	1/4" NPTF	(1/4" NPTF)		
Weight (Pump Only)	10.6 lbs.	(4.8 kg)		
Dimensions (Pump Only)	9.13 x 6.65 x 6.50"	(232 x 169 x 165mm)		

Refer to pump Service Manual for important Inlet Condition Check-List, Start-up Procedure, Tech Bulletins and Pump Maintenance information.

SPECIFICATIONS

MODEL	U.S. Measure	Metric Measure	U.S. Measure	Metric Measure
MODEL			2SF10ES	
Flow			1.0 GPM	(3.8 L/M)
Max. Discharge Pressure			2000 PSI	(140 BAR)
Max. RPM			3450 RPM	(3450 RPM)
Stroke			0.067"	(1.7 mm)

MODEL	U.S. Measure	Metric Measure	U.S. Measure	Metric Measure
MODEL			2SF20ES	
Flow	2.0 GPM	(7.6 L/M)	2.2 GPM	(8.3 L/M)
Max. Discharge Pressure	2000 PSI	(140 BAR)	2000 PSI	(140 BAR)
Max. RPM	3450 RPM	(3450 RPM)	3450 RPM	(3450 RPM)
Stroke	0.122"	(3.1 mm)	0.132"	(3.35 mm)

MODEL	U.S. Measure	Metric Measure	U.S. Measure	Metric Measure
MODEL			2SF22ES	
Flow			2.2 GPM	(8.3 L/M)
Max. Discharge Pressure			2000 PSI	(140 BAR)
Max. RPM			1725 RPM	(1725 RPM)
Stroke			0.248"	(6.3 mm)

MODEL	U.S. Measure	Metric Measure	U.S. Measure	Metric Measure
MODEL			2SF22ELS	
Flow			2.2 GPM	(8.3 L/M)
Max. Discharge Pressure			2000 PSI	(140 BAR)
Max. RPM			1725 RPM	(1725 RPM)
Stroke			0.248"	(6.3 mm)

MODEL	U.S. Measure	Metric Measure	U.S. Measure	Metric Measure
MODEL			2SF22SLS	
Flow			2.2 GPM	(8.3 L/M)
Max. Discharge Pressure			2000 PSI	(140 BAR)
Max. RPM			1725 RPM	(1725 RPM)
Stroke			0.248"	(6.3 mm)

MODEL	U.S. Measure	Metric Measure	U.S. Measure	Metric Measure
MODEL			2SF29ELS	
Flow	2.85 GPM	(10.8 L/M)	3.0 GPM	(11.4 L/M)
Max. Discharge Pressure	1500 PSI	(105 BAR)	1500 PSI	(105 BAR)
Max. RPM	1725 RPM	(1725 RPM)	3450 RPM	(3450 RPM)
Stroke	0.335"	(8.5 mm)	0.177"	(4.5 mm)

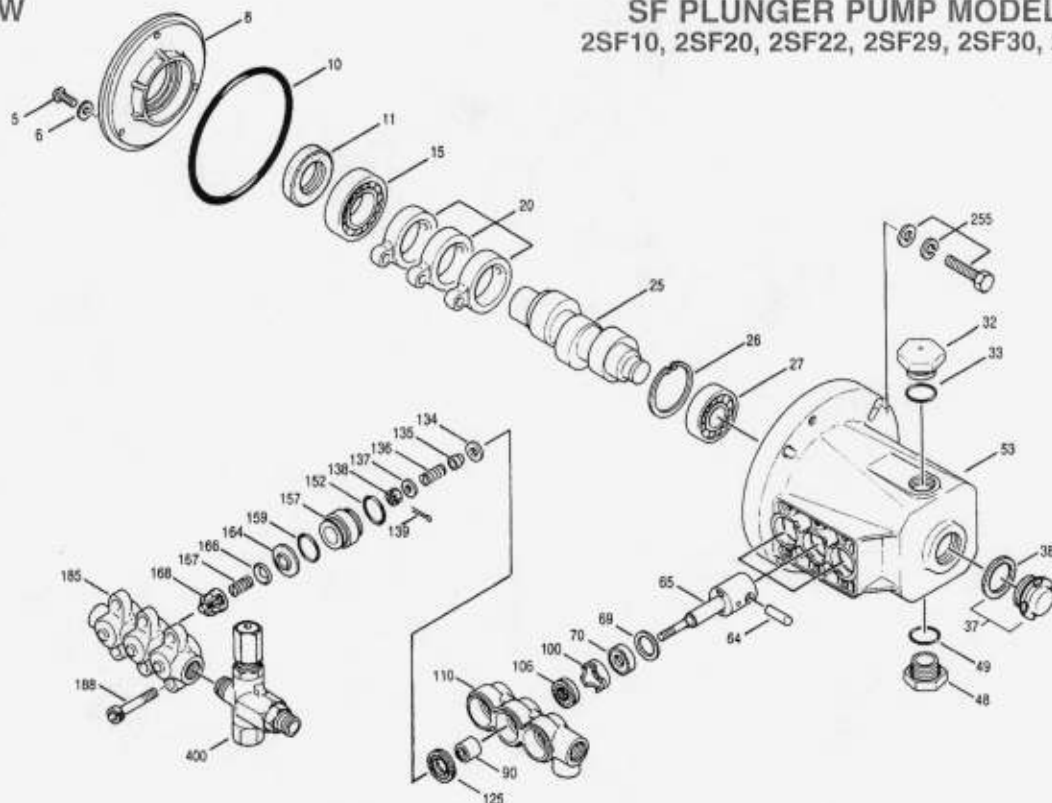
MODEL	U.S. Measure	Metric Measure	U.S. Measure	Metric Measure
MODEL			2SF30ES	
Flow			3.0 GPM	(11.4 L/M)
Max. Discharge Pressure			2000 PSI	(140 BAR)
Max. RPM			3450 RPM	(3450 RPM)
Stroke			0.185"	(4.7 mm)

MODEL	U.S. Measure	Metric Measure	U.S. Measure	Metric Measure
MODEL			2SF30GS	
Flow			3.0 GPM	(11.4 L/M)
Max. Discharge Pressure			2000 PSI	(140 BAR)
Max. RPM			3450 RPM	(3450 RPM)
Stroke			0.185"	(4.7 mm)

Optional Electric-3/4" Shaft - 2SF30GES, 2SF35GES

ES, ELS = Electric 5/8" hollow shaft with bolt mount, GES = Electric 3/4" hollow shaft with bolt mount, GS = Gas 3/4" hollow shaft with bolt and adapter mount, SLS = Electric 3/4" solid shaft complete with bracket mount. Add "3" to PN for Hi-Temp version.

"Customer confidence is our greatest asset"



PARTS LIST

ITEM	P/N	MATL	DESCRIPTION	MODEL USED	QTY	ITEM	P/N	MATL	DESCRIPTION	MODEL USED	QTY
5	89551	STZP	Screw, HHC (M6 x 16)	All Models	3	135	44871	S	Spacer, Inlet	All Models	3
6	150810	NBR	Washer, Seal (M6)	All Models	3	136	44872	S	Spring, Inlet Valve	All Models	3
8	44857	AL	Cover, Bearing, Inner	All Models	1	137	88575	S	Washer, Conical (M6)	All Models	3
10	14044	NBR	O-Ring, Bearing Cover	All Models	1	138	27000	S	Nut, Slotted (M6)	All Models	3
11	44859	NBR	Seal, Oil	All Models	1	139	14158	S	Cotterpin	All Models	3
15	44888	STL	Bearing, Ball, Inner	All Models	1	152	26089	NBR	O-Ring, Adapter, Inner - 80D	All Models	3
20	45876	HS	Rod, Connecting	All Models	3	11377	FPM	O-Ring, Adapter, Inner - 80D	All Models	3	
25	543135	FCM	Crankshaft, 3450 RPM, 5/8", 1.7mm	10ES	1	157	44878	BB	Discharge Valve Adapter	All Models except 29ELS	3
	45092	FCM	Crankshaft, 3450 RPM, 5/8", 3.1mm	20ES	1	45430	BB	Discharge Valve Adapter	29ELS	3	
	44933	FCM	Crankshaft, 3450 RPM, 3/4", 3.35mm	22GS	1	159	26089	NBR	O-Ring, Adapter, Outer - 80D	All Models	3
	44929	FCM	Crankshaft, 3450 RPM, 5/8", 3.35mm	22ES	1	11377	FPM	O-Ring, Adapter, Inner - 80D	All Models	3	
	542441	FCM	Crankshaft, 3450 RPM, 3/4", 4.7mm	30GS	1	164	44881	S	Seat	All Models	3
	44931	FCM	Crankshaft, 3450 RPM, 5/8", 4.5mm	30ES	1	166	43723	S	Valve	All Models	3
	45096	FCM	Crankshaft, 3450 RPM, 5/8", 5.6mm	35ES	1	167	541062	S	Spring	All Models	3
	45100	FCM	Crankshaft, 3450 RPM, 3/4", 5.6mm	35GS	1	168	44565	PVDF	Retainer, Spring	All Models	3
	45160	FCM	Crankshaft, 1725 RPM, 5/8", 6.3mm	22ELS	1	185	44879	BB	Manifold, Discharge	All Models	1
	45426	FCM	Crankshaft, 1725 RPM, 5/8", 8.5mm	29ELS	1	188	87859	STZP	Screw, HSH (M8x75)	All Models	6
	45146	FCM	Crankshaft, 1725 RPM, Solid, 3/4", 6.3mm	22SLS	1	249	30968		Kit, Adapter Mount, Gas	30G, 35G	1
26	12385	STL	Ring, Retaining	All Models	1	15845	STZP	Lockwasher, Split (M8)		4	
27	15710	STL	Bearing, Ball, Outer	All Models	1	44843	STZP	Screw, HH (5/16-24)		4	
32	45690	RTP	Cap, Oil Filler	All Models	1	44942	AL	Flange		1	
33	14179	NBR	O-Ring, Oil Filler Cap - 70D	All Models	2	12489	STZP	Washer, Flat (M8)		4	
37	92241		Gauge, Bubble Oil w/Gasket - 80D	All Models	1	255	30517	STZP	Kit, Bolt Mount	All Models	1
38	44428	NBR	Gasket, Flat Flex., Oil Gauge - 80D	All Models	1	30980	STZP	Washer, Flat (3/8")		4	
48	44842	NY	Plug, Drain (1/2" NPT)	All Models	1	30921	STZP	Lockwasher, Split (3/8")		4	
49	14179	NBR	O-Ring, Drain Plug - 70D	All Models	1	34100	STZP	Screw, HH (3/8"-16 x 1-3/8")		4	
53	45702	AL	Crankcase	All Models	1	6106		Lubricant, Antiseize		1	
64	16948	CM	Pin, Crosshead	All Models	3	30050	STL	Key (3/16" x 3/16" x 1-1/4" HD)		1	
65	44865	SZZ	Rod, Plunger	All Models except 29ELS	3	259	30973	STZP	Kit, Mounting Bracket (Incl. w/Pump)	22SL	1
	45427	SZZ	Rod, Plunger	29ELS	3			(Incl. Bracket, Washers, Bolts, Nuts)			
69	20017	STZP	Washer (M24)	All Models	3	285	80228	STL	Screw (M8-1.25x80)	All Models	1
70	25461	NBR	Seal, Oil	All Models	3	300	34053	NBR	Kit, Seal (Incl. 106, 125, 139, 152, 159)	All Models	1
90	45847	CC	Plunger (M18x14)	All Models except 29ELS	3	33953	HT	Kit, Seal - Hi-Temp (Incl. 106, 125, 134, 139, 152, 159)	All Models	1	
	45429	CC	Plunger (M18x16)	29ELS	3	33453	FPM	Kit, Seal (Incl. 106, 125, 139, 152, 159)	All Models	1	
100	44869	PVDF	Retainer, Seal	All Models	3	310	34052	NBR	Kit, Valve (Incl. 152, 159, 164, 166, 167, 168)	All Models	1
106	44876	NBR	Seal, LPS w/S-Spg	All Models	3	311	34668	NBR	Kit, Inlet Valve (Incl. 134-137, 139, 152, 159)	All Models	1
	545192	FPM	Seal, LPS w/S-Spg	All Models	3	352	44050	STZP	Tool, Oil Gauge Removal	All Models	1
110	44874	BB	Manifold, Inlet	All Models	1	400	7500S	BB	Unloader, Regulating	All Models	1
125	43245	SNB	Seal, HPS w/S	All Models	3		34455		Assembly, Pulsator	All Models	1
	46652	HT	Seal, Hi-Temp (190° Max)	All Models	3		6565.8		Service Video, Section 8	All Models	1
134	45854	S	Valve, Inlet	All Models	3						
	33873	NY	Valve, Inlet, Hi-Temp	All Models	3						

Industrial discount. Bold print part numbers are unique to a particular pump model. Italics are optional items.

See Tech Bulletins 02, 24, 36, 43, 55, 60, 64, 65, 70, 73, 74 and 83 for additional information.

NOTE: Discard Key which may come standard with most motors and engines and use only the key included in this kit. Add "3" to Part Number for special 190°F Hi-Temp seals.

MATERIAL CODES (Not Part of Part Number): AL=Aluminum BB=Brass CC=Ceramic CM=Chrome-Moly FCM=Forged Chrome-moly FPM=Fluorocarbon (Viton®)

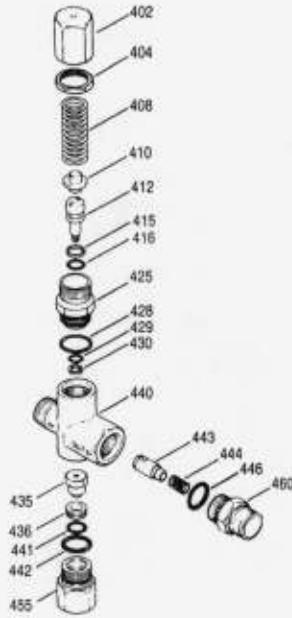
HS=High Strength HT=Hi-Temp (EPDM Alternative) NBR=Medium Nitrile (Buna-N) NY=Nylon PVDF=Fluoroplastic (High Strength) RTP=Reinforced Composite

S=304SS STL=Steel STZP=Steel/Zinc Plated SZZ=304SS/Zamak ZZ=Zamak

Center raised pilot guide on the Adapter Plate assures proper alignment of pump and engine. Before mounting pump onto engine inspect engine for recessed seal and bearing guide to permit adapter to completely seat into recess and four bosses to be flush with engine face.

UNLOADER SPECIFICATIONS

MODEL 7500S	U.S. Measure	Metric Measure
GPM.....	0.5-6.0 GPM	(2-23 L/M)
PSI.....	100-2000 PSI	(7-140 BAR)
Inlet Port - Rear.....	3/8" NPTF	(3/8" NPTF)
Discharge Port - Front.....	M18x1.0	(M18x1.0)
By-pass Port - Bottom.....	3/8" NPTF	(3/8" NPTF)
Weight.....	14 oz.	(0.43 kg)
Dimensions.....	3.0x1.0x4.25"	(76x25x108 mm)



ITEM	P/N	MATL	DESCRIPTION	QTY.
402	540081	BB	Cap, Hex Adjusting	1
404	31047	BB	Nut, Locking (M18x1)	1
408	32094	STZP	Spring, Coil	1
410	107672	BB	Retainer, Spring	1
412	45694	S	Stem, Piston (M5)	1
415	20184	PTFE	Back-up-Ring, Piston Stem	1
416	14190	NBR	O-Ring, Piston Stem - 70D	1
425	107673	BB	Retainer, Piston	1
428	13969	NBR	O-Ring, Piston Retainer - 70D	1
429	14759	NBR	O-Ring, Body	1
430	107675	PTFE	Back-up-Ring, Body	1
435	45696	BB	Valve and Ball Assembly (M5)	1
436	107680	S	Seat	1
440	—	BB	Body	1
441	13963	NBR	O-Ring, Valve	1
442	13969	NBR	O-Ring, By-Pass Fitting - 70D	1
443	541060	BB	Valve, Check w/O-Ring	1
444	45924	S	Spring - 85G	1
446	13969	NBR	O-Ring, Discharge Fitting - 70D	1
455	45695	BB	Fitting, By-Pass (3/8" NPTF)	1
460	107681	BB	Fitting, Discharge (3/8" NPTF)	1
465	7090	—	By-Pass Hose (15" x 3/8") 160°F	1
466	7090.40	—	By-Pass Hose w/Thermo Valve	1
468	32097	NBR	Kit, O-Ring (Incls: 415, 416, 428, 429, 430, 441, 442, 446)	1
485	7140	BB	Valve, Thermo	1
486	34600	BB	Tee, T.V. Mount	1
487	—	BB	Nipple, T.V. Mount	1

Italics are optional items.

MATERIAL CODES (Not Part of Part Number): BB=Brass NBR=Medium Nitrile (Buna-N) PTFE=Pure Teflon® S=304SS STZP=Steel/Zinc Plated

OPERATION

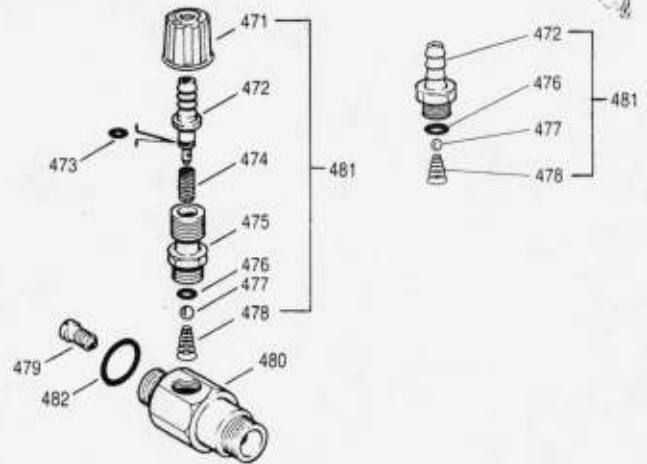
A Regulating Unloader comes with each 2SF pump to provide system pressure regulation and pump protection. For suction feed consult factory. By-pass for the regulating unloader may drain to the ground, drain to a reservoir or connect to the special 1/4" by-pass port on the underside of the inlet manifold. A 3/8" flexible hose and Thermo Valve (7090.40) are recommended. **DO NOT EXCEED 6 MINUTES in BY-PASS when Thermo Valve is not installed.**

Hi-Temp Units with special Hi-Temp seals do not use the by-pass hose back to the pump inlet or the Thermo Valve. Use optional Dual Pressure Switches and Mechanical Relay in Auto Shut Off Kits 34870 and 34871.

If unit is INFREQUENTLY USED OR PERIODICALLY STORED, seals may become dry. System should be PURGED BEFORE OPERATION (system liquid must flow through the pump without discharge restriction) to assure full system pressure is reached.

CHEMICAL INJECTOR SPECIFICATIONS

MODEL	Standard	Optional
7193	7193	7194
Flow.....	3-4 GPM	4-5 GPM
Nozzle Orifice.....	2.1mm	2.3mm
Hose Barb.....	1/4"	1/4"
Inlet Port.....	M18x1.0	M18x1.0
Discharge Port.....	3/8" NPTM	3/8" NPTM
Weight.....	6.3 oz.	6.3 oz.
Dimensions.....	2 x 1 x 3"	2 x 1 x 3"



ITEM	P/N	MATL	DESCRIPTION	QTY.
471	33949	NY	Cap, Adjustment	1
472	32941	BB	Hose Barb	1
473	33503	NBR	O-Ring, Hose Barb	1
474	33500	S	Spring	1
475	33946	BB	Retainer, Ball Seat	1
476	33504	FPM	O-Ring, Retainer	1
477	34620	SS	Ball	1
478	33501	SS	Spring, Tapered	1
479	32373	S	Orifice, Injector (2.1mm) Standard	1
—	32374	S	Orifice, Injector (2.3mm)	1
480	—	BB	Body	1
481	33481	BBNY	Barb, Assy, Adjustable (Incls: 471, 472, 473, 474, 475, 476, 477, 478)	1
—	33480	BB	Barb, Assy, Fixed (Incls: 472, 476, 477, 478)	1
482	13969	NBR	O-Ring, Body - 70D	1

Italics are optional items.

MATERIAL CODES (Not Part of Part Number): BB=Brass FPM=Fluorocarbon (Viton®) NBR=Medium Nitrile (Buna-N) NY=Nylon S=304SS SS=316SS

CHEMICAL INJECTOR PERFORMANCE CHART Optional Special Ported Chemical Injector for Unloader Mounting

Standard Pump Model	Injector Orifice Size	Lo-Pressure Nozzle Rating (Maximum Downstream) (Press for Injector)	Max. Chem. Draw (0 PSI) (Downstream)	Hi-Press Nozzle "Deduction" (Press drop across In.)
2SF20	2.1 mm (7193)	100 PSI	50 oz/min	100 PSI
2SF22	2.1 mm (7193)	75 PSI	50 oz/min	100 PSI
2SF29, 2SF30	2.1 mm (7193)	225 PSI	50 oz/min	150 PSI
2SF35	2.3 mm (7194)	150 PSI	50 oz/min	150 PSI

Optimum performance of chemical injector occurs with a 35 ft. high pressure hose and a minimum 3/8" I.D. The type of hose, extended lengths, reduced I.D. and fittings may create back pressures in excess of the low pressure nozzle rating and prevent the injector from drawing chemical. **Deduct hose friction loss from above low PSI Nozzle. Contact factory for assistance with other options.** Refer to Hose Friction Loss Chart in the Service Manual for pressure loss with longer hose.

An optional, specially ported chemical injector may be mounted directly to the discharge of the unloader. Remove o-ring, check valve and spring from discharge fitting of unloader; insert into injector and thread into unloader discharge port. **Discard o-ring and discharge fitting.** Refer to the performance chart to determine the orifice size best suited to the system flow. **Chemical draw occurs under low pressure.** Select the Change Over Nozzle (32149), Adjustable Nozzle (32151), or Vari-Nozzle (7930-7980) to permit the adjustment from low to high pressure.

For optimum performance when using a chemical injector, use a single wire braid hose on the discharge line. Too flexible a hose will prevent the unloader from receiving the full pressure signal to activate the by-pass mode.

For correct nozzle selection, read system pressure at the pump. **DO NOT READ SYSTEM PRESSURE AT THE HIGH PRESSURE GUN.** Incorrect pressure reading may result in: pump operation at excessive pressures, inconsistent chemical draw, or possible damage to the pump or unloader.

MOTOR SPECIFICATIONS

Common Motor Specifications

Max. Operating Temp.	104°F
Capacitor Start	Yes
Thermal Overload-Manual Reset	Yes
U.L. Construction Reference	
(8050,8055)	E49747
(8052, 8057, 8060, 8062)	E44549
U.L. Insulation Reference (All)	E37878
CSA Reference	
(8050)	LR45148
(8052, 8057, 8060, 8062)	LR4642
(8055)	LR2025

Note: Motor Start-Up AMPS may vary, then settle within FULL LOAD AMPS rating after initial run in time.
 ★ ★ Before mounting pump on motor, apply P.N. 6106 Antiseize Lubricant to pump shaft.
 ★ ★ Refer to Tech Bulletin #55 for instructions on removing pump from gas engine or electric motor.
 Add .50 for 50 Hz (1450 or 2850 RPM)

Model 8050

Horsepower	1.5
Shaft Diameter	5/8"
Max. Volts	115/230
FULL LOAD AMPS	12.1
RPM	3450
Weight	32.1 lbs.
Phase	Single
Frame Size	56-C TEFC
Service Factor	1.15

Model 8055

Horsepower	3.0
Shaft Diameter	3/4"
Max. Volts	208/230
FULL LOAD AMPS	15.2/13.6
RPM	3450
Weight	46.3 lbs.
Phase	Single
Frame Size	56-C TEFC
Service Factor	1.15

★ Model 8060

Horsepower	1.5
Shaft Diameter	5/8"
Max. Volts	115/230
FULL LOAD AMPS	14.0/7.0
RPM	1725
Weight	40 lbs.
Phase	Single
Frame Size	56-C TEFC
Service Factor	1.2

Model 8052

Horsepower	2.0
Shaft Diameter	5/8"
Max. Volts	115/230
FULL LOAD AMPS	17.0/9.2-8.5
RPM	3450
Weight	32.5 lbs.
Phase	Single
Frame Size	56-C TEFC
Hertz	60
Service Factor	1.15

Model 8057

Horsepower	5.0
Shaft Diameter	3/4"
Max. Volts	230
FULL LOAD AMPS	22.0
RPM	3450
Weight	40 lbs.
Phase	Single
Frame Size	56-C OPEN DRIP
Service Factor	1.15

★ Model 8062

Horsepower	1.2
Shaft Diameter	5/8"
Max. Volts	115/230
FULL LOAD AMPS	17.0/8.5
RPM	1725
Weight	43.7 lbs.
Phase	Single
Frame Size	56-C TEFC
Service Factor	1.15

For warranty consideration contact CAT PUMPS for the local Authorized Service Center. If you are uncertain as to the cause of failure (Pump or Motor), secure Returned Goods Authorization number and return complete assembly PREPAID to CAT PUMPS for evaluation.

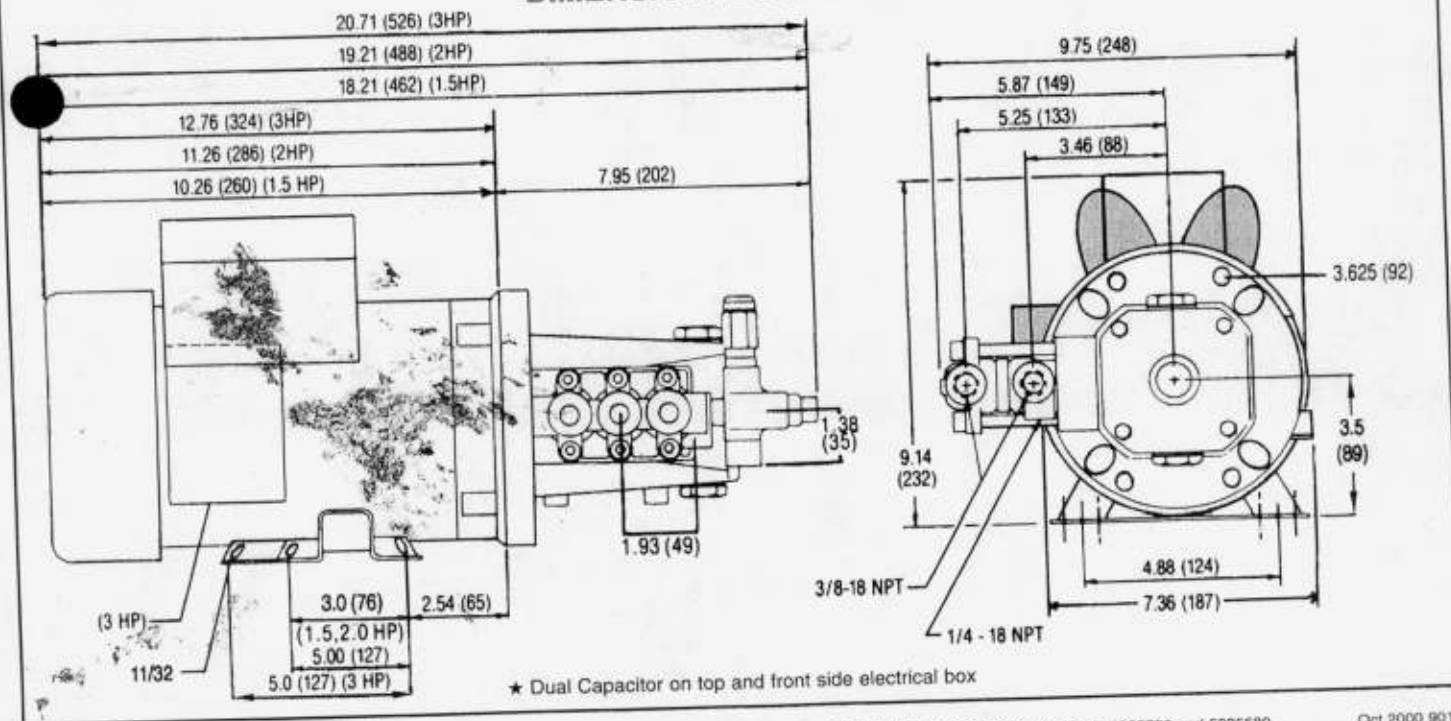
HORSEPOWER REQUIREMENTS

FLOW	PRESSURE					PUMP RPM	
	PSI 700	PSI 1000	PSI 1200	PSI 1500	PSI 2000		
U.S. GPM	Metric L/M	BAR 50	BAR 70	BAR 85	BAR 105	BAR 140	
1.0	3.8	.44	.69	.82	1.0	1.4	3450
2.2	8.3	1.1	1.5	1.8	2.3	3.0	3450
2.85	10.8	1.4	2.0	2.3	2.9	N/A	1725
3.0	11.4	1.4	2.1	2.5	3.1	4.2	3450
3.5	13.2	1.7	2.4	2.9	3.6	N/A	3450

DETERMINING THE REQUIRED H.P.

$$\frac{\text{GPM} \times \text{PSI}}{1460} = \text{Electric Brake H.P. Required}$$

DIMENSIONAL DRAWING



★ Dual Capacitor on top and front side electrical box

Products described herein are covered by one or more of the following U.S. patents 3558244, 3652188, 3809508, 3920356, 3930756 and 5035580 Oct 2000 9018

World Headquarters

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 Phone Fleet 44 1252-622031 — Fax 44 1252-626655

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 e-mail: catpumps@t-online.de www.catpumps.de

SF PLUNGER PUMP SERVICE MANUAL



2SF, 2SFX, CEE, SEEL MODELS:
2SF10, 2SF20, 2SF22,
2SF25, 2SF29, 2SF30, 2SF35
2SF10, 25, 29, 35SEEL

CAUTION: CAT PUMPS are positive displacement pumps. Therefore, a properly designed pressure RELIEF OR SAFETY VALVE MUST BE INSTALLED in the discharge piping. Failure to install such a relief

4SF MODELS:
4SF32ELS, 4SF40ELS, 4SF45ELS, 4SF50ELS,
4SF30GS1, 4SF35GS1, 4SF40GS1, 4SF45GS1,
4SF45GS118, 4SF50GS1

mechanism could result in personal injury or damage to the pump or system. CAT PUMPS does not assume any liability or responsibility for the operation of a customer's high pressure system.

INSTALLATION AND START-UP INFORMATION

Optimum performance of the pump is dependent upon the entire liquid system and will be obtained only with the proper selection, installation of plumbing and operation of the pump and accessories.

SPECIFICATIONS: Maximum specifications refer to individual attributes. It is **not** implied that all maximums can be performed **simultaneously**. If more than one maximum is considered, check with your CAT PUMPS supplier to confirm the proper performance and pump selection.

LUBRICATION: Fill crankcase with special CAT PUMP Hydraulic oil per pump specifications. **DO NOT RUN PUMP WITHOUT OIL IN CRANKCASE.** Change initial fill after 50 hours running period. Thereafter, change oil every 3 months or 500 hour intervals.

MOTOR SELECTION: Identify the pump shaft size. (2SF) "ES" and "ELS" models have 5/8" electric shaft; "GES" models have 3/4" electric shaft; "GS" and "GZ" models have 3/4" gas shaft. (4SF) "ELS" models have 1-1/8" electric shaft; "GS" models have a 1" gas shaft. The motor or engine driving the pump must be of adequate horsepower to maintain full RPM when the pump is under load. Select the electric motor from the Horsepower Requirement Chart according to required pump discharge flow and maximum pressure at the pump! Consult the manufacturer of gas or diesel engine for selection of the proper engine.

MOUNT THE PUMP: All 2SF and 4SF are direct drive and do not need to be mounted to another surface. Only the solid shaft 2SF22SLS with attachment brackets needs to be mounted to a rigid, horizontal surface. An uneven mounting surface will cause extensive damage to the pump base. Use the correct belt; make sure pulleys are aligned. Excessive belt tension may be harmful to the bearings. To minimize piping stress, use appropriate flexible hose to inlet and discharge ports. Before mounting pump to motor or gas engine, apply PN 6106 antiseize lubricant to pump shaft. Refer to Technical Bulletin #055 for instructions on removing pump from gas engine or electric motor.

LOCATION: If the pump is used in extremely dirty or humid conditions, it is recommended pump be enclosed. Do not store or operate in excessively high temperature areas or without proper ventilation.

INLET CONDITIONS: Refer to complete Inlet Condition Check-List in this manual before starting system. **DO NOT STARVE THE PUMP OR RUN DRY.**

DISCHARGE PLUMBING: OPEN ALL VALVES BEFORE STARTING SYSTEM to avoid deadhead overpressure condition and severe damage to the pump or system.

A reliable Pressure Gauge should be installed near the discharge outlet of the high pressure manifold. This is extremely important for adjusting

pressure regulating devices and also for proper sizing of the nozzle or restricting orifice. The pump is rated for a maximum pressure; this is the pressure which would be read at the discharge manifold of the pump. **NOT AT THE GUN OR NOZZLE.**

All 2SF and 4SF Pumps come complete with a Pressure Regulating Unloader. NOTE: Except "CEE" and "SEEL" Models. A Pressure Regulator or Unloader Valve must be installed to prevent over pressurizing the pump in the event the discharge or downstream plumbing becomes plugged or is turned off. Severe damage to the pump will result if this condition occurs without a relief valve in the line. **CAUTION:** Failure to install such a safety valve will void the warranty on the pump. Discharge regulating devices should be at minimum pressure setting at start-up. On systems over 2000 PSI SECONDARY PROTECTION is recommended by installing a pop-off valve, safety valve or rupture disc. **START SYSTEM WITH ALL VALVES OPEN OR IN THE LOW PRESSURE SETTING.**

When the high pressure system is left running with the trigger gun off, the by-pass liquid can be routed to drain or to the pump inlet. If routed to the pump inlet, the by-pass liquid can quickly develop excessive heat and result in damage to the pump. A THERMO VALVE installed in the by-pass line is recommended to protect the pump. An AUTO SHUT-OFF ASSEMBLY may also be used.

Use PTFE liquid (sparingly) or tape to connect accessories or plumbing. Exercise caution not to wrap tape beyond the last thread to avoid becoming lodged in the pump or accessories. This condition can cause a malfunction of the pump or system.

NOZZLES: A worn nozzle will result in loss of pressure. Do not adjust pressure regulating device to compensate. Replace nozzle and reseat pressure regulating device to system pressure.

PUMPED LIQUIDS: Some liquids may require a flush between operations or before storing. For pumping liquids other than water, consult your CAT PUMPS supplier.

STORING: For extended storing or between use in cold climates, do not pump liquids from pump and flush with antifreeze solution to prevent freezing and damage to the pump. **DO NOT RUN PUMP WITH FROZEN LIQUID** (refer to Tech Bulletin 083).

Products described herein are covered by one or more of the following U.S. patents 3558244, 3652188, 3809508, 3920356, 3930756 and 5035580

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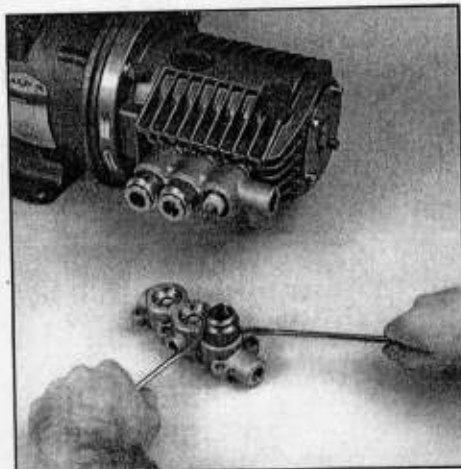
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CAT PUMPS DEUTSCHLAND G

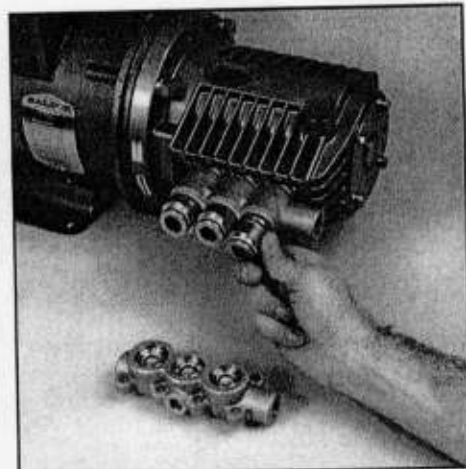
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Removal of Discharge Manifold



Removal of Adapter from Discharge Manifold



Removal of Adapter from Inlet Manifold

SERVICING THE PUMPING SECTION

Disassembly of the Discharge Valve Assembly

1. Disconnect all plumbing and remove unloader for ease in servicing.
NOTE: CEE and SEEL models do not come with standard unloader.
2. Inspect oil for proper level, presence of water or discoloration and replace as needed.
3. Using a standard M6 allen wrench remove the six (6) (2SF) or eight (8) (4SF) Socket Head Screws from the manifold. Remove the outer screws first, then the center screws.
4. Using a soft mallet tap the back side of the Discharge Manifold from alternate sides to maintain alignment and avoid damage to the plungers.
5. Grasp the Discharge Manifold from the from underside and gradually lift manifold while you pull away from the Crankcase.
6. The Adapter/Spacers may stay with either the Discharge or Inlet Manifold. By inserting two opposing screwdrivers between Spacer and manifold you can easily pry them out of the Discharge Manifold. If they stay in the Inlet Manifold, gently work up and down as you pull away from the Inlet Manifold.
7. The valve assemblies are in the Discharge Manifold ports and will fall out when manifold is turned over. A complete valve assembly includes: Retainer, Spring, Valve and Seat.
NOTE: On "X" versions the Valve and Spacer are one-piece.
NOTE: The "GZ" models use the standard "SF" Valve Kit.

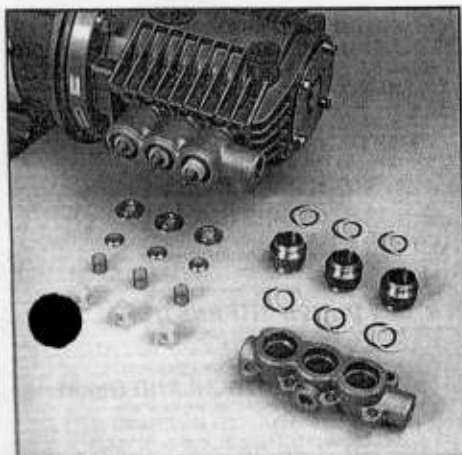
Disassembly of the Seal Assembly

1. Remove the Inlet Valve Assembly from the exposed plunger rod ends, including Cotterpin, Nut, Washer, Spring, Spacer and Inlet Valve.
2. Grasp the Inlet Manifold from the front and underside and pull to remove from Plunger Rods.
3. Carefully examine back side of Lo-Pressure Seal before removing from manifold as it will be damaged during removal. If worn, insert screwdriver into I. D. of seal and pry out. Exercise caution to avoid damage to the Inlet Manifold.

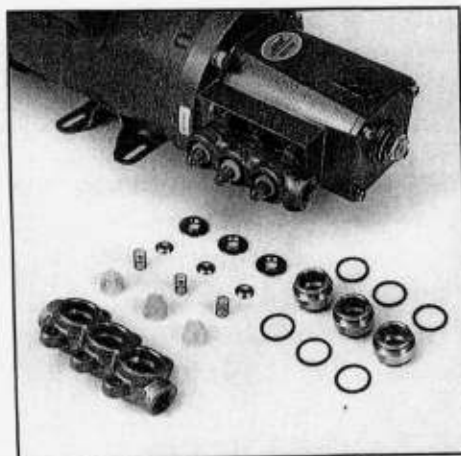
4. Press ceramic Plunger with thumb or soft tool from **back side of Inlet Manifold**.
On the Model 2SF the Hi-Pressure Seal may stay with the plungers or remain in the Inlet Manifold. If on the plungers, slide off by hand. If in the manifold, use a reverse pliers to remove.
On the Model 4SF the V-Packing and Adapters may stay with the plungers or remain in Inlet Manifold. If on the plungers, slide off by hand. If in the manifold, use a reverse pliers to remove.
5. Remove Seal Retainers from Crankcase by grasping tab with pliers and pulling out.
6. Examine Crankcase Oil Seal to determine if Crankcase servicing is needed.
7. Examine Ceramic Plunger, Lo-Pressure Seals, V-Packings for scoring, cracks and wear and replace.

Reassembly of Seal Assembly

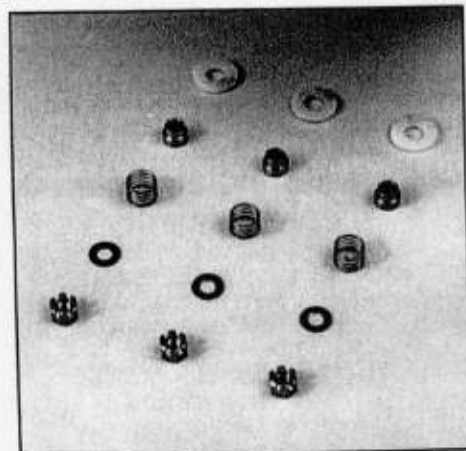
1. Examine Seal Retainers and replace if worn or damaged. Install on Plunger Rod and press into Crankcase **with tab out**.
2. Place Inlet Manifold on work surface with **Crankcase side up**.
3. Lubricate new Lo-Pressure Seals and press into position with **garter spring down**. Be certain the seal is seated squarely on the shoulder on the inlet manifold chamber.
4. Place Inlet Manifold on work surface with **Crankcase side down** (larger I.D. ports up).
5. On the Model 4SF place new Female Adapter into Inlet Manifold chamber with **v-groove facing up**.
6. Carefully examine the Plungers for scoring or cracks and replace if worn.
7. On the Model 2SF lubricate Ceramic Plungers and new Hi-Pressure Seals. Press the plunger into the seal and position seal in middle of plunger.
NOTE: Place the deeper recessed end of the plunger into the seal from the metal back side.
NOTE: The "Hi-Temp" 2SF models use a special Hi-Pressure Seal and Hi-Temp Seal Kit.
On the Model 4SF lubricate Ceramic Plungers and new V-Packings. Press Plunger into the V-Packings and position in the middle of plunger.
NOTE: The deeper recessed end of the plunger should face the same direction as the v-groove on the V-Packing.



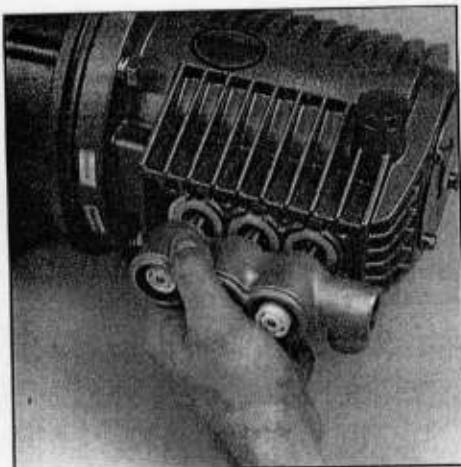
Discharge Valve Assembly (4SF)



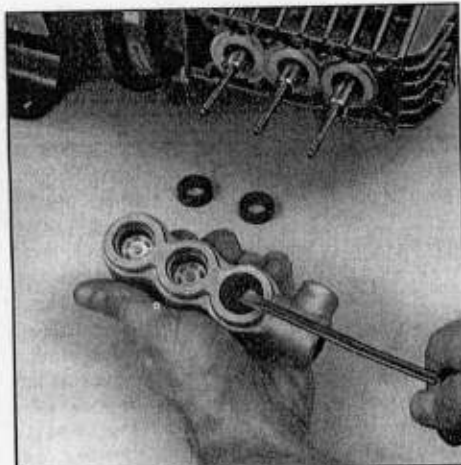
Adapter and Discharge Valve Assembly (2SF)



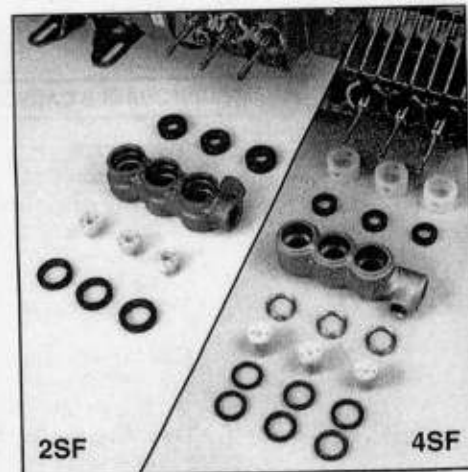
Inlet Valve Assembly



Removal of Inlet Manifold



Removal of Lo-Pressure Seal



Plunger, Seals and V-Packing Arrangement

8. Insert the Plungers into the manifold ports (4SF with **v-groove facing up**). Press into position using the **larger I.D. end of Discharge Valve Spacer**. Note the "S" versions of the 4SF pumps have a replaceable Sleeve. Examine the Sleeve for grooves or scale build up and replace as needed. Grasp the Sleeve by hand and pull from the Plunger Rod. Examine the O-Ring and Back-up-Ring under the Sleeve for cuts or wear and replace. Examine the Barrier Slinger for wear and replace as needed. Install the Barrier Slinger with the concave side facing away from the Crankcase. Lubricate the Plunger Rod O-Ring to avoid cutting during installation. Install the Back-up-Ring first then the O-Ring into the groove on the Plunger Rod. Install the Sleeve with the tapered end facing out. Gently press towards the Plunger Rod shoulder until flush with the Barrier Slinger.
9. Carefully install Inlet Manifold over Plunger Rod ends and slowly press into Crankcase.
10. Examine Inlet Valve and replace if worn. **Inlet valves cannot be reversed if worn.** The S.S. Inlet Valves may be lapped if not badly worn. Install the S.S. Inlet valves with **square edges towards the plungers** (round edges towards the discharge). Install the Nylon Inlet Valve with **ridged side towards the discharge**. **NOTE: The "Hi-Temp" 2SF models use a Nylon Inlet Valve (order individual parts, not standard Inlet Valve Kit).**
11. Examine Spacers for wear and replace as needed. Install Spacer on each Plunger Rod with **smaller O.D. towards inlet valve**.
12. Examine Springs for damage or fatigue and replace as needed. Place on Plunger Rods.
13. Install Washers next with **concave side towards Inlet Manifold**.
14. Install Nuts and torque per chart.
15. On 2SF and 4SF models **always install new Cotterpins** and turn ends to secure in position. **NOTE: "X" version does not use Cotterpin.**

Reassembly of the Discharge Valve Assembly

1. Examine Adapter Spacer O-Rings and replace if worn. Lubricate and install O-Rings and Back-up-Rings on **both front and rear of the Adapter Spacer**.

2. Examine the Valve Retainers for scale build up or wear and install into each Discharge Manifold port with tab down into the manifold chamber.
3. Replace worn or damaged Springs and place into Retainers.
4. Examine Valve and Seats for pitting, grooves or wear and replace as needed.
5. Place Valves over Springs with **concave side down**.
6. Place Valve Seats on Valves with **concave side down**. **NOTE: On 2SF "X" models, Seat and Adapter are one-piece.**
7. Lubricate O.D. of Adapter/Spacer and insert **smaller I.D. into Discharge Manifold ports**. Snap into position. Exercise caution not to cut or pinch o-rings.
8. Carefully guide Discharge Manifold with Spacers over Plunger Rod ends and press into Inlet Manifold.
9. Replace Socket Head Screws and torque per chart. Use torque sequence chart.
10. If oil was not changed, be certain oil is to mark on Oil Gauge before resuming operation.

2SF Torque Sequence



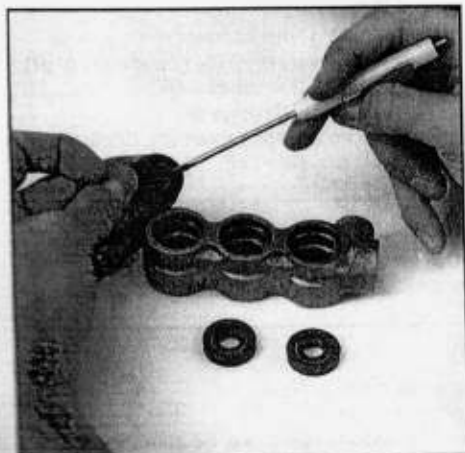
4SF Torque Sequence



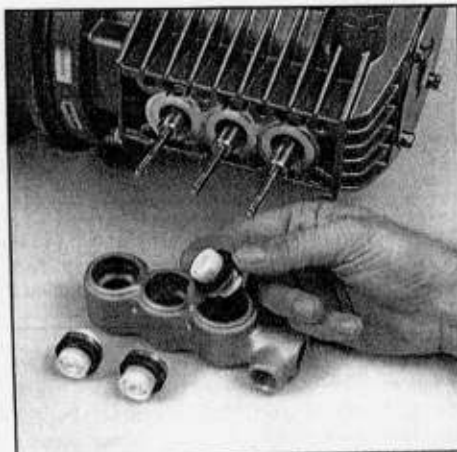
Torque diagonally in order shown. The outer four (4) screws then center screws all hand tight. Then repeat series to specifications in torque chart.

SERVICING THE CRANKCASE SECTION

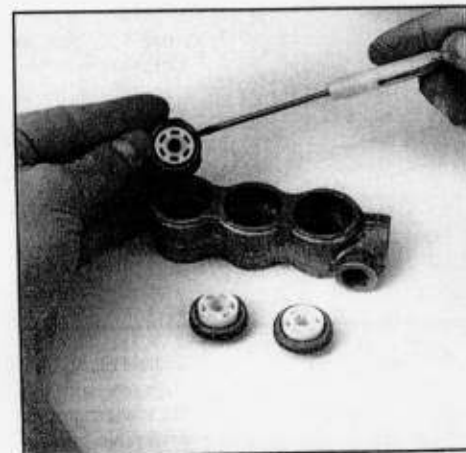
1. While Inlet Manifold, Plungers and Seal Retainers are removed, examine Crankcase Seals for wear.
2. Check oil level and for evidence of water in oil.
3. Rotate Crankshaft by hand to feel for smooth bearing movement.
4. Examine Crankshaft Oil Seal externally for drying, cracking or leaking.
5. Consult factory or your local distributor if Crankcase service is required.



Installation of Lo-Pressure Seals



V-Packing Positioning



Installation of V-Packings

PREVENTATIVE MAINTENANCE CHECK-LIST

Check	Daily	Weekly	50 hrs.	500 hrs.*	1500 hrs.**	3000 hrs.**
Clean Filters	x					
Oil Level/Quality	x					
Oil Leaks	x					
Water Leaks	x					
Belts, Pulley		x				
Plumbing		x				
Initial Oil Change			x			
Oil Change				x		
Seal Change					x	
Valve Change						x
Accessories					x	

* If other than CAT PUMPS special multi-viscosity ISO68 oil is used, change cycle should be every 300 hours.

** Each system's maintenance cycle will be exclusive. If system performance decreases, check immediately. If no wear at 1500 hours, check again at 2000 hours and each 500 hours until wear is observed. Valves typically require changing every other seal change.

Duty cycle, temperature, quality of pumped liquid and inlet feed conditions all effect the life of pump wear parts and service cycle.

** Remember to service the regulator/unloader at each seal servicing and check all system accessories and connections before resuming operation. Refer to Service Manual and video for additional assistance.

TORQUE CHART

Pump Item	Thread	Tool Size [Part No.]	Torque in. lbs. ft. lbs. Nm		
Outer Bearing Case Screw	M6	M10 Hex/Phil. [25082]	50	4.0	6
Inner Bearing Case Screw	M6	M10 Hex/Phil. [25082]	50	4.0	6
Manifold Screw	M8	M6 Allen [30941]	115	9.4	13
Plunger Rod Nut	M6	M10 Hex [25082]	55	4.4	6
Bubble Oil Gauge	M28	Oil Gauge Tool [44050]	45	3.6	5
Mounting 2SF					
Adapter Plate to Gas Engine	5/16-24	1/2" Hex	90	7.2	10
Pump to Adapter Plate	3/8-16	9/16" Hex	110	9.0	12
Pump to Electric Motor	3/8-16	9/16" Hex	110	9.0	12
Mounting 4SF					
Adapter Plate to Gas Engine	3/8-16	9/16" Hex	110	9.0	12
Pump to Adapter Plate	1/2-13	3/4" Hex	150	12.5	17
Pump to Electric Motor	1/2-13	3/4" Hex	150	12.5	17

TECHNICAL BULLETIN REFERENCE CHART

No.	Subject	Models
002	Inlet Pressure VS Liquid Temperature	All Models
024	Lubrication of Lo-Pressure Seals	All Models
043	LPS and HPS Servicing	All Plunger Models
055	Removing Pumps from Gas Engine or Electric Motor	2SF, 2SFx, 2DX, 4SF, 5DX, 6DX
057	Set Screw and Hardened Key	4SF
064	By-Pass Hose Sizing	All Unloaders/Regulators
065	Higher Performance Ratings	2SF and 4SF
070	Maximum Performance	2SF and 4SF
073	Hi-Temp HPS	3PFR, 5PFR, 2SF
074	Torque Chart	Piston and Plunger Pumps
075	Sleeved Plunger Rod	4SF-S*
083	Winterizing a Pump	All Models

INLET CONDITION CHECK-LIST

Review Before Start-Up

Inadequate inlet conditions can cause serious malfunctions in the best designed pump. Surprisingly, the simplest of things can cause the most severe problems or go unnoticed to the unfamiliar or untrained eye. REVIEW THIS CHECK-LIST BEFORE OPERATION OF ANY SYSTEM. Remember, no two systems are alike, so there can be no ONE best way to set-up a system. All factors must be carefully considered.

INLET SUPPLY should be adequate to accommodate the maximum flow being delivered by the pump.

- Open inlet shut-off valve and turn on water supply to avoid cavitating pump. **DO NOT RUN PUMP DRY.**
- Avoid closed loop systems without a Thermo Valve high temperature protection.
- Avoid low vapor pressure and high viscosity liquids.
- Higher temperature liquids tend to vaporize and require positive heads.
- When using an inlet supply reservoir, size it to provide adequate liquid to accommodate the maximum output of the pump, generally a minimum of 6-10 times the GPM (however, a combination of system factors can change this requirement); provide adequate baffling in the tank to eliminate air bubbles and turbulence; install diffusers on all return lines to the tank.

INLET LINE SIZE should be adequate to avoid starving the pump.

- Line size must be a minimum of one size larger than the pump inlet fitting. Avoid thick walled fittings, tees, 90 degree elbows or valves in the inlet line of the pump to reduce the risk of flow restriction and cavitation.
- The line MUST be a FLEXIBLE hose, NOT a rigid pipe, and reinforced on SUCTION systems to avoid collapsing.
- The simpler the inlet plumbing the less the potential for problems. Keep the length to a minimum, the number of elbows and joints to a minimum (ideally no elbows) and the inlet accessories to a minimum.
- Use pipe sealant to assure air-tight, positive sealing pipe joints.

INLET PRESSURE should fall within the specifications of the pump.

- Optimum pump performance is obtained with +20 PSI (1.4 BAR) inlet pressure. With adequate inlet plumbing, most pumps will perform with flooded suction. Maximum inlet pressure is 75 PSI (5.25 BAR).
- After prolonged storage, pump should be purged of air to facilitate priming. Disconnect any discharge port and allow liquid to pass through pump.

INLET ACCESSORIES are designed to protect against over pressurization, control inlet flow, contamination or temperature and provide ease of servicing.

- A shut-off valve is recommended to facilitate maintenance.
- A stand pipe can be used in some applications to help maintain a positive head in the inlet line.
- Inspect and clean inlet filters on a regular schedule.
- A pressure gauge is recommended to monitor the inlet pressure and should be mounted AS CLOSE TO THE PUMP INLET as possible. **Short term, intermittent cavitation will not register on a standard gauge.**
- All accessories should be sized to avoid restricting the inlet flow.
- All accessories should be compatible with the solution being pumped to prevent premature failure or malfunction.

BY-PASS TO INLET Care should be exercised when deciding the method of by-pass from control valves.

- It is recommended the by-pass be directed to a baffled reservoir tank, with at least one baffle between the by-pass line and the inlet line to the pump.
- The 2SF and 4SF come standard with a Regulating Unloader to handle by-pass liquid directed to the inlet line of the pump. If other than standard valve is used, exercise caution to use proper flexible hose and adequate diameter. A PRESSURE REDUCING VALVE may be needed on the inlet line (**BETWEEN THE BY-PASS CONNECTION AND THE INLET TO THE PUMP**) to avoid excessive pressure to the inlet of the pump. It may also be necessary to use a THERMO VALVE in the by-pass line to monitor the temperature build-up in the by-pass loop to avoid premature seal failure.
- A low-pressure, **FLEXIBLE CLOTH BRAID** (not metal braid) hose should be used from the by-pass connection to the inlet of the pump.
- If standard unloader valve is not used, check the pressure in the by-pass line to avoid over pressurizing the inlet.

HOSE FRICTION LOSS

Water* Flow Gal/Min	PRESSURE DROP IN PSI PER 100 FT OF HOSE WITH TYPICAL WATER FLOW RATES Hose Inside Diameters, Inches						
	1/4	5/16	3/8	1/2	5/8	3/4	1"
0.5	16	5	2				
1	54	20	7	2			
2	180	60	25	6	2		
3	380	120	50	13	4	2	
4		220	90	24	7	3	
5		320	130	34	10	4	
6			220	52	16	7	1
8			300	80	25	10	2
10			450	120	38	14	3
15			900	250	80	30	7
20			1600	400	121	50	12
25				650	200	76	19
30					250	96	24
40					410	162	42
50					600	235	62
60						370	93

*At a fixed flow rate with a given size hose, the pressure drop across a given hose length will be directly proportional. A 50 ft. hose will exhibit one-half the pressure drop of a 100 ft. hose. Above values shown are valid at all pressure levels.

WATER LINE PRESSURE LOSS PRESSURE DROP IN PSI PER 100 FEET

Water GPM	Steel Pipe—Nominal Dia.					Brass Pipe—Nominal Dia.					Copper Tubing O.D. Type L							
	1/4	3/8	1/2	3/4	1 1/4	1 1/2	1/4	3/8	1/2	3/4	1 1/4	1 1/2	1/4	3/8	1/2	5/8	3/4	7/8
1	8.5	1.8				6.0	1.6						120	13	2.9	1.0		
2	30	7.0	2.1			20	5.6	1.8					400	45	10	3.4	1.3	
3	60	14	4.5	1.1		40	11	3.6					94	20	6.7	2.6		
5	150	36	12	2.8		100	28	9.0	2.2				230	50	17	6.1	3.0	
8	330	86	28	6.7	1.9	220	62	21	5.2	1.6			500	120	40	15	6.5	
10	520	130	43	10	3.0	320	90	30	7.8	2.4			180	56	22	10		
15	270	90	21	6.2	1.6	190	62	16	5.0	1.5			120	44	20			
25	670	240	56	16	4.2	2.0	470	150	40	12	3.8	1.7	330	110	50			
40				66	17	8.0				39	11	5.0	550	200	88			
60					37	17												
80					52	29												
100					210	107	48											

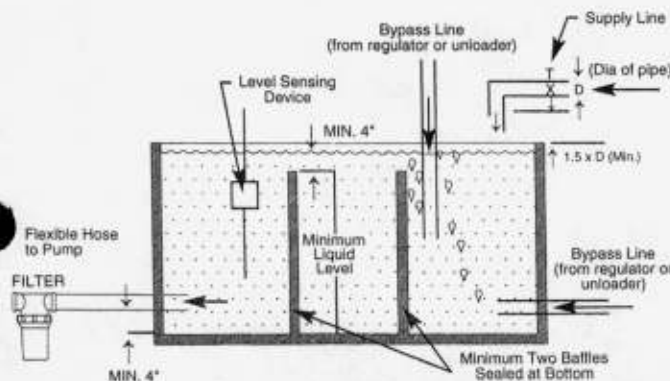
RESISTANCE OF VALVES AND FITTINGS

Nominal Pipe Size Inches	Inside Diameter Inches	Equivalent Length of Standard Pipe in Feet									
		Gate Valve	Globe Valve	Angle Valve	45° Elbow	90° Elbow	180° Close Ret	Tee Thru Run	Tee Thru Branch		
1/2	0.622	0.41	18.5	9.3	0.78	1.67	3.71	0.93	3.33		
3/4	0.824	0.54	24.5	12.3	1.03	2.21	4.90	1.23	4.41		
1	1.049	0.69	31.2	15.6	1.31	2.81	6.25	1.56	5.62		
1 1/4	1.380	0.90	41.0	20.5	1.73	3.70	8.22	2.06	7.40		
1 1/2	1.610	1.05	48.0	24.0	2.15	4.31	9.59	2.40	8.63		
2	2.067	1.35	61.5	30.8	2.59	5.55	12.30	3.08	11.60		
2 1/2	2.469	1.62	73.5	36.8	3.09	6.61	14.70	3.68	13.20		
3	3.068	2.01	91.5	45.8	3.84	8.23	18.20	4.57	16.40		
4	4.026	2.64	120.0	60.0	5.03	10.80	23.90	6.00	21.60		

Arriving at a total line pressure loss, consideration should then be given to pressure loss created by valves, fittings and elevation of lines.

If a sufficient number of valves and fittings are incorporated in the system to materially affect the total line loss, add to the total line length, the equivalent length of line of each valve or fitting.

TYPICAL RESERVOIR TANK RECOMMENDED 6 TO 10 TIMES SYSTEM CAPACITY



Handy Formulas to Help You

Q. How can I find the RPM needed to get specific GPM (Gallons Per Minute) I want?

$$A. \text{Desired RPM} = \text{Desired GPM} \times \frac{\text{Rated RPM}}{\text{Rated GPM}}$$

Q. I have to run my pump at a certain RPM. How do I figure the GPM I'll get?

$$A. \text{Desired GPM} = \text{Desired RPM} \times \frac{\text{Rated GPM}}{\text{Rated RPM}}$$

Q. Is there a simple way to find the approximate horsepower I'll need to run the pump?

$$A. \text{Electric Brake Horsepower Required} = \frac{\text{GPM} \times \text{PSI}}{1460} \quad (\text{Standard } 85\% \text{ Mech. Efficiency})$$

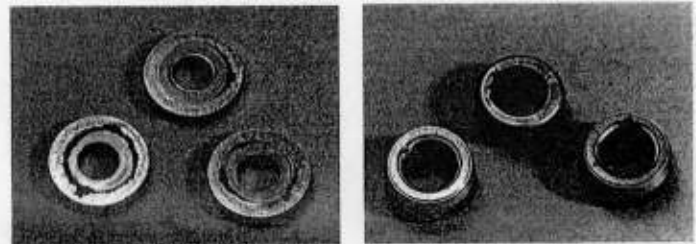
Q. What size motor pulley should I use?

$$A. \text{Pump Pulley (Outer Diameter)} \times \frac{\text{Pump RPM}}{\text{Motor/Engine RPM}} \quad (\text{Consult Engine Mfr.})$$

Q. How do I calculate the torque for my hydraulic drive system?

$$A. \text{Torque (ft. lbs.)} = 3.6 \left(\frac{\text{GPM} \times \text{PSI}}{\text{RPM}} \right)$$

Avoid Cavitation Damage



One or several of the conditions shown in the chart below may contribute to cavitation in a system resulting in premature wear, system downtime and unnecessary operating costs.

CONDITION	SOLUTION
Inadequate inlet line size	• Increase line size to the inlet port or one size larger
Water hammering liquid acceleration/ deacceleration	• Install C.A.T. Tube • Move pump closer to liquid supply
Rigid Inlet Plumbing	• Use flexible wire reinforced hose to absorb pulsation and pressure spikes
Excessive Elbows in Inlet Plumbing	• Keep elbows to a minimum and less than 90°
Excessive Liquid Temperature	• Use Thermo Valve in bypass line • Do not exceed pump temperature specifications • Substitute closed loop with baffled holding tank • Adequately size tank for frequent or high volume bypass • Pressure feed high temperature liquids • Properly ventilate cabinets and rooms
Air Leaks in Plumbing	• Check all connections • Use Teflon tape
Agitation in Supply Tank	• Size tank according to pump output — Minimum 6-10 times system GPM • Baffle tank to purge air from liquid and separate inlet from discharge
High Viscosity Liquids	• Verify viscosity against pump specifications before operation • Elevate liquid temperature enough to reduce viscosity • Lower RPM of pump • Pressure feed pump • Increase inlet line size
Clogged Filters	• Perform regular maintenance or use clean filters to monitor build up • Use adequate mesh size for liquid and pump specifications

DIAGNOSIS AND MAINTENANCE

PROBLEM CASE	SOLUTION
<ul style="list-style-type: none"> • Low Pressure 	<ul style="list-style-type: none"> • Worn nozzle • Air leak in inlet plumbing • Pressure gauge inoperative or not registering accurately • Relief valve stuck partially plugged or improperly adjusted • Worn seat or valves • Inlet filter clogged or improperly sized • Worn seals. Abrasives in pumped liquid. • Severe cavitation; inadequate water supply, stressful inlet conditions • Fouled or dirty inlet or discharge valves • Leaky discharge hose • Belt slippage
<ul style="list-style-type: none"> • Pulsation, pump runs extremely rough, pressure low 	<ul style="list-style-type: none"> • Restricted inlet or air entering inlet plumbing • Stuck inlet or discharge valve • Worn Hi-Pressure Seals • Foreign particles in the inlet or discharge valve • Worn or pitted inlet and/or discharge valves
<ul style="list-style-type: none"> • Water leakage from under the manifold *Slight leakage 	<ul style="list-style-type: none"> • Worn V-Packings and Lo-Pressure Seals • Worn adapter
<ul style="list-style-type: none"> • Frequent or premature failure of seals and packings 	<ul style="list-style-type: none"> • Excessive heat from prolonged by-pass • Abrasive in liquid • Scored plungers • Excessive inlet pressure • Running pump dry
<ul style="list-style-type: none"> • Oil leak between crankcase and pumping section 	<ul style="list-style-type: none"> • Worn crankcase oil seals
<ul style="list-style-type: none"> • Oil leaking around crankshaft 	<ul style="list-style-type: none"> • Worn crankshaft oil seal • Bad bearing
<ul style="list-style-type: none"> • Excessive play in the end of the crankshaft 	<ul style="list-style-type: none"> • Worn bearing
<ul style="list-style-type: none"> • Water in crankcase 	<ul style="list-style-type: none"> • Humid air condensing into water inside of the crankcase • Continued operation with worn seals and packings • Crankcase oil seals leaking or seals installed backward
<ul style="list-style-type: none"> • Loud knocking noise from pump 	<ul style="list-style-type: none"> • Worn bearing, connecting rod or crankshaft • Stressful inlet conditions
<ul style="list-style-type: none"> • Frequent or premature failure of the packings 	<ul style="list-style-type: none"> • Scored plungers • Over pressure to inlet manifold • Abrasive material in the liquid being pumped • Excessive pressure and/or temperature of liquid being pumped • Running pump dry

OPERATING AND INSTALLATION INSTRUCTIONS

1. INSTALLATION INSTRUCTIONS

A. MOUNTING

Design Application Considerations—The motor working air and ventilating air must be separated to prevent overheating of the motor due to air recirculation. To provide for shock mounting, air sealing and electrical insulation, the peripheral discharge by-pass vacuum motors are designed to be mounted between two rubber rings—Figure No. 1. These rings are compressed to provide an air tight seal between the cooling and working air in the vacuum chamber. Care should be exercised in clamping the motor between the two rubber rings to provide sufficient pressure to resist the start-up torque of the motor. Care should also be exercised not to compress the mounting rings to the extent that the mechanical shock mounting advantage is lost or the fan case is damaged. Motor should be shielded such that rotating parts and live parts are not accessible to a ¼" diameter rod.

For tangential discharge by-pass vacuum motors, a single rubber ring is used and the ring compressed using the motor mounting lugs—see Figure No.2 To prevent electrical shock hazard, motors must always be grounded. Since the motor cooling air passes directly over the motor windings, the air flow over the motor must be dry and dust free.

B. HANDLING

Vacuum motors must be handled only by the motor frame or fan case. Do not handle the motor by the lead wires as this could cause damage to the motor.

C. CONNECTION TO GROUND

Bypass vacuum motors must be connected to a grounding or earthing point within your machine in the following manner:

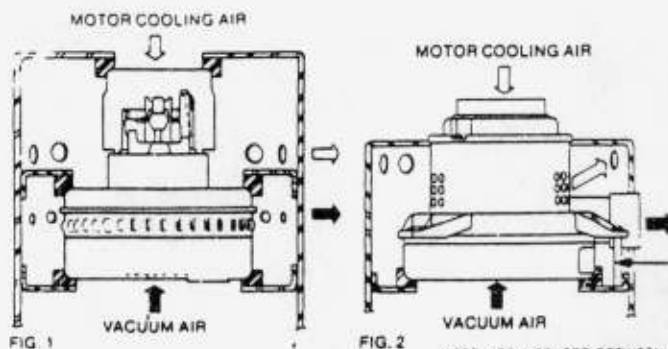
- 1) The 5.7" and 7.5" diameter by-pass motor includes provision for grounding.
- 2) The 7.2" diameter by-pass vacuum motor has three lead wires. The green or green with yellow tracer wire is for connection to ground only.

You should contact Underwriters' Laboratories, Inc. or other appropriate safety related testing agency for acceptable methods of connecting your machine to a grounding or earthing point. Do not use motor thru-bolts to connect ground wires.

2. SAFETY PRECAUTIONS FOR USE

A. In the application of AMETEK, Lamb Electric motors as a component in your product you must exercise the following minimum precautions:

- 1) The motors must be connected to a proper and effective ground or mounted in a manner that will guarantee electrical isolation and insulate the user and others from electric shock. For those motors equipped with a green hex head ground screw for grounding, the screw should be used for no other purpose. See previous discussion in Item 1C, "Connection to Ground"



2) Universal motors must not be used in an area contaminated by volatile or flammable materials since sparking can be expected in the normal operation of the motor and may ignite the contaminants causing a dangerous explosion. At your request, Lamb Electric can supply special electric motors designed specially for use in hazardous duty locations. See AMETEK, Lamb Electric Bulletin 2-VX752-0001 for motors that are designed for use under certain hazardous conditions.

3) The rotation of the motor shaft or anything mounted on the shaft is a potential source of injury and must be taken into account in the design of your end product. You must provide the necessary guarding or housing as required by the finished product and you must indicate to the user the direction of rotation.

4) The motors must not be exposed to moisture or liquid or used outdoors, except in equipment which is specifically designed for outdoor use and meets the Underwriters' Laboratories Inc. requirements for outdoor use. Moisture, liquid or foam can damage the motor and defeat the electrical insulation resulting in an electric shock to the user.

5) Equipment incorporating vacuum motors/blowers must be designed by you so as to prevent the vacuum or air pressure from being concentrated in a manner that can expose the user to bodily injury by coming into contact with any body area, such as eyes, ears, mouth, etc.

6) Lamb motors must not be operated above the design voltage which is stamped on the motor. Over voltage conditions can cause excessive speed of the motor and can result in electrical shock and/or other traumatic injury to the operator.

Lamb Electric vacuum motors may be operated at voltages below the rated voltage successfully. By reducing the voltage, performance will be lowered and the life expectancy of the motor will be enhanced. Care must be taken in such reduced voltage applications to insure that a pure resist-

ance is used to lower the voltage. When using alternating current, universal motors require a full sine wave for proper commutation and such pure resistance devices as a transformer or Variac should be used to reduce voltage to the motor.

- 7) Precautions must be exercised to ensure motor leads are properly routed and connected in your equipment. Lead wires must be routed and retained to ensure that they do not become pinched or come in contact with rotating parts during assembly or subsequent operation. Connections must be designed so that proper electrical contact is established and the connections must be properly insulated.
- 8) Disassembly or attempted repairs: If accomplished incorrectly, repairs can create an electrical shock hazard. It is recommended that repairs be made only by AMETEK, Inc., Lamb Electric Division and not by others.

B. WARNING

SINCE THE FAILURE TO OBSERVE THE ABOVE SAFETY PRECAUTIONS COULD RESULT IN SERIOUS BODILY INJURY, INCLUDING DEATH IN EXTREME CASES, we recommend that you provide adequate instructions and warnings on your equipment; including labels setting forth the precautions listed above to the user of your product.

In setting forth the above listed recommendations with regard to precautionary steps that you must consider, we in no way intend to imply that if these steps are taken your product will meet safety standard applicable to the product. We at AMETEK are not sufficiently conversant with the specific safety hazards which may be associated with your particular product. We can only advise you on precautions to be employed generally for the safe use of electric motors as components. For testing specifically related to the safety of your product, we recommend that you contact Underwriters' Laboratories, Inc., or other appropriate testing agencies as indicated by the type of product you manufacture.

3. REPAIRS

Lamb Electric recommends that all repairs be made at its own Service Center. Warranty repairs must be returned through the original purchaser. For non-warranty repairs, return the motor to:

AMETEK, LAMB ELECTRIC DIVISION
Service Center
627 Lake Street
Kent, Ohio 44240

You will be quoted a flat repair charge for the non-warranty repair of the motor.

Where brush change is required, the brushes should be changed BEFORE the brush stunt touches the commutator. On reassembly and handling, the lead wires must be kept away from rotating parts and motor frame.

To achieve best performance, the new brushes should be seated on the commutator before full rated voltage is applied. After brush change, apply 50% to 75% of rated voltage for thirty minutes to accomplish this seating. The motor will return to full performance after thirty to forty-five minutes of running at full rated voltage. The motor must not be run with the vacuum air inlet sealed off.

DIRECT APPLICATION OF FULL RATED VOLTAGE AFTER CHANGING BRUSHES WILL CAUSE ARCING, COMMUTATOR PITTING, AND REDUCED OVERALL LIFE.

If reduced voltage is unavailable, connecting two motors of similar rating in series for thirty minutes will accomplish the brush seating.

4. LIMITED WARRANTY

Seller warrants products manufactured and sold by it against defects in material and workmanship arising under normal usage and care for a period of twelve months from the date of original sale. The aforesaid warranty shall extend only to the original purchaser and it is not assignable to any other person. For application of product warranty, return the motor to the original source of supply. Seller's obligation the aforesaid warranty is limited to repairing or replacing, at its option, such products or parts therefore which are returned to Seller's factory, freight prepaid, within the warranty period and are found to be defective in materials or workmanship, and does not include the cost of furnishing any labor in connection with the installation of such repaired or replaced products or parts or the responsibility or cost for transportation. Seller assumes no liability for delay in performing its obligations under the aforesaid warranty. Seller assumes no liability for failure in performing its obligations thereunder if failure results, directly or indirectly, from any cause beyond its control, including but not limited to, acts of God, acts of government, floods, fires, shortages of materials, strikes and other labor difficulties or delays or failures of transportation facilities.

SELLER MAKES NO WARRANTY, EXPRESS OR IMPLIED, INCLUDING WITHOUT LIMITATION, ANY WARRANTIES OF FITNESS OR MERCHANTABILITY, EXCEPT AS EXPRESSLY SET FORTH ABOVE WITH RESPECT TO SUCH PRODUCTS OR PARTS THEREFORE, NOR SHALL SELLER HAVE INCURRED ANY OTHER OBLIGATIONS OR LIABILITIES ON ITS PART OR BE LIABLE FOR ANY ANTICIPATED OR LOST PROFITS, INCIDENTAL DAMAGES, CONSEQUENTIAL DAMAGES, TIME CHARGES OR ANY OTHER LOSSES INCURRED IN CONNECTION WITH THE PURCHASE, INSTALLATION, REPLACEMENT OR REPAIR OF SUCH PRODUCTS OR ANY PARTS THEREFORE WHETHER ORIGINAL EQUIPMENT OR INSTALLED AS A REPLACEMENT, COVERED BY THIS WARRANTY OR OTHERWISE; AND SELLER DOES NOT AUTHORIZE ANY PERSON TO ASSUME FOR SELLER ANY OTHER LIABILITY IN CONNECTION WITH THE PRODUCTS OR PARTS THEREFORE.

Motors showing any of the following typical signs of abuse will not be considered in-warranty failures:

- Damaged in shipment—the title of goods is transferred to the customer at the time the carrier signs the bill of lading at our dock. The carrier acts as customer's agent and assumes all responsibility including internal damage.
- Moisture damage.
- Rust and corrosion caused by detergents and moisture.
- Dirty motors, failure of which was caused by inadequate filtration.
- Broken brush holders, brackets, etc., caused by heavy impact.
- Holes drilled in motor for adapting other devices, unless approved by Lamb Electric Engineering Department.
- Paint being sprayed into motor, particularly at commutator end.
- Improper application or installation of the motor in end product usage.
- Any motor where commutator wear indicates the motor has been used to full extent of its normal life expectancy, regardless of the date stamp.
- Rewound armatures or fields.
- Evidence of disassembly or attempted field repair.
- Introduction in the fan eye of a foreign object not of Lamb Electric manufacture.

AMETEK

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