PUMP TROUBLESHOOTING GUIDE

Introduction

In nearly all instances, pump failure is the result of improper installation or operation rather than normal wear. One of the most common causes of pump failure is improper or unnecessary service, often as a result of the operator attempting the service.

The pump is generally the most dependable and well-constructed components in a washdown system. All pump parts will wear and eventually need replaced. Our pumps can be maintained by just about anyone.

Searching for the reason for pump failure is like uncovering clues at a crime scene – you need to have a plan, run through it systematically, and be careful to not manipulate any evidence along the way. Your plan should go as follows:

- Ask questions
- Make observations
- Examine evidence
- Come to conclusions

The most important thing is to go step by step in order. Do not assume or jump to conclusions before completing each step.

Ask Questions

Most of the questions to be asked are obvious. Here are a few examples to get started:

- How was the pump used before it failed?
- Were there any noises at the time of failure?
- Was there unusual vibrations, water, or oil leaking from the pump?
- What happened to the pressure? A smooth gradual loss or sudden loss?
- When was the pump last serviced?

Make Observations

Now the detective work begins. All of the following quick checks should be done with the customer present. You do not need anything more than a pressure gauge and correct nozzle size.

Check the outside of the pump.

- Is the pump protector removed?
- Are the hose connections tight/secure?
- Is there any discoloration on brass inlet connections? Black color is chemical oxidation. Dark bluish black is heat.
- Are there signs of oil leaks?

Check the oil.

- How much is there?
- What does it look like?

Oil level should be checked that it is within normal ranges regularly, but that is not all that your attention requires. Old oil is black and a lot thicker than fresh oil, maybe even sludgy. This kind of oil is typically found in pumps that have oil added, but never drained. Burned and overheated oil will be similar in appearance.

Sparkling metal particles in the oil will be a clue to the failure. Save them and check if they are magnetic. Fresh, clean oil should make you suspect that oil was added after the failure, a little too late. If it was added after the failure, it will float on top of old, burned oil. When you drain the oil later, pay attention to the color as it drains.

Check the inlet strainer.

- Is it clogged? Damage?
- Are there any “dirt trails” around the seals and check valves, indicating dirt was by-passing the filter?

- Is the strainer installed with the arrow pointing the right direction?

Dirt is death to a pump. If it gets into the pump through damaged strainers, damage will occur to the seals, piston, bearings, and check valves.

Dirt can be a problem even if it does not get into the pump. If the strainer becomes clogged, the lack of flow can damage the pump internals as well, leading to failure.

Check for proper water supply.

- Is the pump cavitating?
- If the pump is connected to a water supply tank, does pressure increase when the pump is connected directly to the city water supply (garden hose)?
- Is the pump inlet port connected to a filter, 90° elbow, or other fittings that could restrict flow?

Pump chattering caused by heavy cavitation can be mistaken for a broken connecting rod. To determine if cavitation is the source of the problem, open the upstream chemical injector completely while operating the system. If the noise stops, it is cavitation. If the system does not have an upstream injector, hook up a positive feed system to the pump and operate the system.

Set up a check list.

EXCESSIVE NOISE:	
☐ Hot Water	☐ Belts
☐ Cavitation	☐ Connecting Rods
☐ Vibrations in system	☐ Plunger Rod Pins
☐ Worn Valves	☐ Pulleys
☐ Worn O-Rings	☐ Bearings
☐ Mounting Bolts	
OIL LEAKS:	
☐ Shipping cap has not been removed	☐ Bad Seals
LOSS OF PRESSURE:	
☐ Worn Nozzle	☐ Bad Pressure Gauge
☐ Valve Seat O-Rings	☐ Low RPM
☐ Low Inlet Pressure	☐ Low Flow
☐ Valves	

How to Start

Ask the Right Questions at the Right Time

Isolate the Problem

- Set up a diagnostic procedure
- Simple to difficult
- Logical progression

Use Simple Tools

- Eyes
- Ears
- Nose
- Brain

Start with Observation

- Physically inspect and observe
- Carefully observe equipment in operation
- Trace the fluid flow

Potential Pump Failures:

- Improper use
- Insufficient or dirty water
- Plugged filters
- Kinked or plugged hoses
- Cavitation
- Lack of maintenance

FLUID SYSTEM

No Flow:

- No power to the pump
- Trigger gun not opening
- No water source
- Clogged spray nozzle
- Clogged inlet filter
- Stuck float valve
- Faulty unloader
- Pinched or clogged inlet hose
- Inlet valve(s) not open

Low Pressure with Adequate Flow:

- Worn, wrong, no-spray nozzle
- Variable pressure set on low pressure setting
- Unloader/regulator improperly adjusted
- Pressure gauge inaccurate or broken
- Worn pump packings

Low Pressure, Low Flow

- Volume improperly adjusted
- Discharge leaks
- Chemical injector orifice blocked

- Drive belts loose
- Pump or motor not running at rated speed
- Stripped pump drive coupling
- Defective easy start valve
- Malfunctioning motor or engine

Low Pressure with Very Low Flow:

- Unloader stuck in by-pass
- Outlet restriction
- Clogged nozzle
- Restriction in the high pressure hose/fittings
- Debris in the system
- Cavitation
- Clogged inlet hose of filter

High Pressure:

- Spray nozzle too small and high RPM
- Faulty pressure gauge
- Unloader/regulator improperly adjusted
- Faulty unloader/regulator

Pump Chatters:

- Air in the system
- Chemical line not submerged
- Inlet line kinked, restricted, or internal hose separation
- Inadequate water supply
- Float valve is stuck
- Turbulence in the float/supply tank
- Cavitation
- Inlet of inlet strainer clogged
- Water supply too hot

Inlet Line Vibration:

- Air in the system
- Debris in the valves

Outlet Line Vibration:

- Air in the system
- Debris in the discharge valves
- Damaged pump seals

Inlet & Outlet Line Vibration

- Inlet and/or discharge valves fouled
- Other downstream restrictions
- Air in the system

Unloaders/Regulators Very Low/No Flow

- Unloader stuck in by-pass

Unloader Cycles with System Under Pressure

- Improper flow or piston sticking from hard water
- Nozzle too small/clogged
- Improper unloader orifice
- Unloader orifice clogged
- Injector orifice clogged

Unloader Cycles with the System in By-Pass

- No restriction in unloader or hose too long
- Weep gun in the system
- Downstream leakage
- Accumulator downstream

Unloader Produces Smooth Flow & Low Volume

- Unloader adjusted too low
- Spray nozzle clogged
- Spray nozzle too small
- Injector orifice blocked
- Unloader stuck in by-pass
- Restriction in system

Unloader Produces Low Flow & Normal Pressure

- Nozzle too small

Unloader Pressure Increases when Trigger is Released

- Unloader piston is stuck or frozen
- By-pass port is clogged or restricted
- Excessive tension on the main spring

Leaking at…

- Inlet: Bad inlet hose, loose clamps or connections
- Tank: Full of water or float valve is stuck
- Pressure Fittings: Fittings not tight/sealed
- Quick Connects: Bad o-rings
- Pump: Bad low pressure seals, cracked plunger, damage manifold
- Trigger Gun: Bad piston o-ring, stripped connection
- Nozzle: weep gun, damaged gun, valve ball and seat
- Pop off valve: system over pressure, clogged nozzle, trigger gun not working, excessive pressure spikes, wear on the ball and seat

TRIGGER GUN

No Flow from Nozzle when Trigger is Depressed

- Broken rod in gun
- Blockage in system past the gun

Excessive Pressure when the Gun is Released

- Excessive pressure spike
- Malfunctioning unloader

Flow Does Not Stop when the Trigger is Released

- Broken return spring
- Debris in gun valve

Trigger Action Sticks

- Keeper is too tight

DETERGENT SYSTEM

No Detergent

- Detergent valve is closed
- Detergent foot strainer is clogged
- Detergent line is kinked or sucking air
- No adjustment for low pressure
- Detergent nozzle not sized properly
- Wrong size detergent orifice
- Float tank restriction

Excessive Detergent

- Valve improperly adjusted
- Restrictor in float tank
- Injector too small

SPRAY NOZZLE

Irregular Spray Pattern

- Clogged/Worn nozzle

Proper Flow/Low Pressure

- Nozzle is too large and internal nozzle wear

Proper Pressure/Low Flow

- Clogged nozzle

PRESSURE PUMP

Oil between the Crankcase and Pump Manifold

- Worn plunger rod oil seals

Oil Leaking in the Crankshaft Area

- Worn crankshaft oil seals
- Bad bearings

Excessive Play in the Crankshaft Pulley Area

- Worn bearings from excessive belt tension

Oil from Under the Crankcase

- Leaking plunger rod, side cover, rear cover, or crankshaft oil seals or o-rings

Loud Knocking Noise in the Pump

- Pulley loose on the crankshaft
- Broken or worn bearing, connecting rod, or plunger rod
- Cavitation

Frequent or Premature Packing Failure

- Scored, damaged, or worn plunger
- Overpressure to the inlet manifold
- Abrasive material in the fluid being pumped
- Excessive pressure and/or temperature of the fluid being pumped
- Pump running dry
- Cavitation

High Crankcase Temperature

- Wrong oil
- Low oil level
- Old oil
- Contaminated oil
- Oil breakdown

Water in the Crankcase

- Worn down pressure seals
- Cracked plunger
- Worn plunger rod o-ring
- Humid air condition
- Water running over the pump
- Pressure washing pump injecting water into vent cap

CAVITATION

This can mean different things to different people. It has been described as:

- A reduction in pump capacity
- A reduction in the head of the pump
- The formation of bubbles in a low pressure area of the pump manifold
- A noise that heard when the pump is running
- Damage that can be seen on the pump seals, retainers, and check valves

Just what thin is this thing called cavitation? Actually, it is all of the above. Cavitation implies cavities or holes in the fluid we are pumping. These holes can also be described as bubbles, so cavitation is really about the formation of bubbles and their collapse.

The Capacity of the Pump is Reduced

- Because bubbles take up space and you cannot have bubbles and liquid in the same place at the same time
- If the bubble gets big enough at the manifold inlet, the pump will lose its suction and will require priming.

The Head is Often Reduced

- Bubbles, unlike liquid, are compressible and this ability can change the head pressure

The Bubbles form in a Lower Pressure Area because they cannot in High Pressure Areas

- Keep in mind that as the velocity of a fluid increases, the pressure of the fluid decreases
- By definition then, a high velocity liquid is a lower pressure area, which can cause problems any time a liquid flows through a restriction in the piping, filter, or changes direction suddenly.
- The fluid will accelerate as it changes direction, and the same acceleration takes place as the fluid flows in the small area between the tip of the ceramic plunger and the manifold packing assembly area.

A Noise is Heard

- Any time a fluid moves faster than the speed of sound in the medium you are pumping, a sonic boom will be heard.
- The bubble tries to collapse on itself. This is called imploding and is the opposite of exploding. The bubble is trying to collapse from all sides, but if the bubble is laying against a piece of metal, then it cannot collapse from that side, so the fluid comes in from the opposite side at this high velocity, preceded by a shock wave that can cause all kinds of damage.
- There is a very characteristic round shape to the liquid as it bangs against the metal creating the impression that the metal was hit with a “ball peen hammer.”

- The damage in the preceding image would normally occur at right angles to the metal, but experience shows that the high velocity liquid seems to come at the metal from a variety of angles.
- This can be explained by the fact that dirt particles get stuck on the surface of the bubble and are held there by the surface tension of the fluid. Since the dirt particle has weakened the surface tension of the bubble it becomes the weakest part and the section where the collapse will probably take place.

The higher the capacity of the pump the more likely cavitation will occur.

CONNECT A PRESSURE WASHER TO A WATER SUPPLY TANK

When the water level inside the supply tank reaches a point in which the head pressure does not exceed the suction from the pump, a vortex forms allowing air to siphon into the pump. Installing a baffle or elbow positioned to force the pump to siphon water from the bottom of the tank, will prevent the formation of a vortex.

As the water level drops you have a reduction in head pressure. If the supply line is too small, a restriction to the pump will cause cavitation and damage the pump.

The use of elbow and filters in the supply line will cause water restriction that damages the pump. *Testing for Proper Water Supply*

Record pressure from your pressure washer using a positive feed water supply. Then operate as installed to your supply tank and compare pressure readings. If there is even a slight drop in pressure you have a restriction which will damage your pump. Increase the size of filters, valves, bushings, and other fittings to increase the flow of water to the pump.

TROUBLE SHOOTING CHART

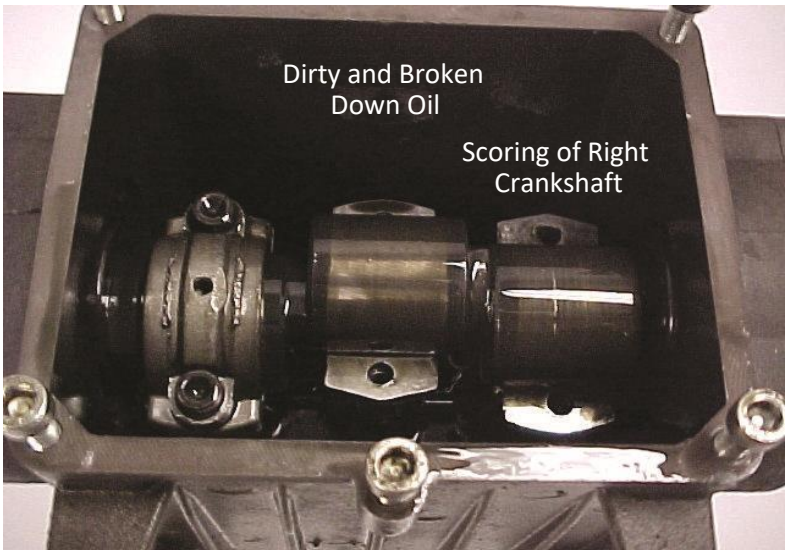
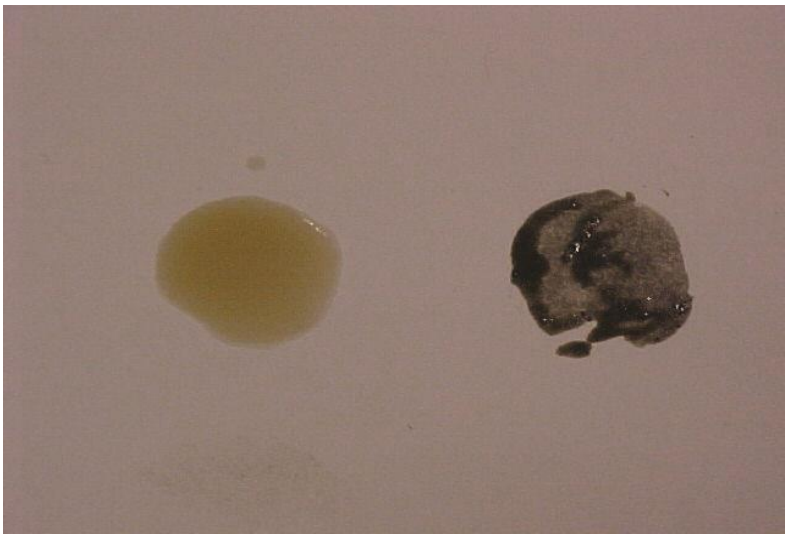
PROBLEM	POSSIBLE CAUSES	REMEDY
LOW PRESSURE	Worn nozzle	Replace nozzle, of proper size
	Belt slippage	Tighten or replace – use correct belt
	Air leak in inlet plumbing	Disassemble, reseal, and reassemble
	Relief valve stuck, partially plugged, or improperly adjusted valve seat worn	Clean, adjust relief valve, check for worn and dirty valve seats. Kit available
	Inlet suction strainer clogged or improperly sized	Clean. Use adequate size. Check more frequently
	Worn packing	Install proper filter
	Abrasives in pumped fluid or severe cavitation. Inadequate water	Suction at inlet manifold must be limited to lifting less than 20 ft or water or -8.5 PSI vacuum
	Fouled or dirty inlet or discharge valves	Clean inlet and discharge valve assemblies
	Worn inlet discharge valve blocked or dirty. Leaky discharge hose	Replace worn valves, valve seats and/or discharge hose
PUMP RUNS EXTREMELY ROUGH, PRESSURE VERY LOW	Restricted inlet or air entering the inlet plumbing	Proper size inlet plumbing. Check for airtight seal
	Inlet restrictions and/or air leaks. Stuck inlet or discharge valve	Replace worn cup(s), clean out foreign debris, and replace worn valves
WATER LEAK FROM UNDER MANIFOLD; SLIGHT LEAK	Worn packing	Install new packing
OIL LEAK BETWEEN CRANK-CASE AND PUMP	Worn crankcase piston rod seals, o-rings on plunger retainer worn	Replace crankcase piston rod seals. Replace o-rings
OIL LEAKING IN CRANKSHAFT AREA	Worn crankshaft seal or improperly installed oil seal o-ring	Remove oil seal retainer and replace damaged o-ring or seals
	Bad bearing	Replace bearing
EXCESSIVE PLAY NEAR END OF CRANKSHAFT PULLEY	Worn main bearing from excessive tension on drive belt	Replace crankcase bearing and/or tension drive belt
WATER IN CRANKCASE	May be caused by humid air condensing into water inside the crankcase	Change oil intervals; use any high grade auto-motive 30 weight non-detergent oil
	Worn packing and/or piston rod sieve, o-rings on plunger retainer worn	Replace packing. Replace o-rings
OIL LEAK UNDER CRANKCASE	Worn crankcase piston rod seals	Replace seals
OIL LEAK AT REAR PORTION OF CRANKCASE	Damaged crankcase, rear cover o-ring, drain plug	Replace cover o-ring, drain plug o-ring, or sight glass
	O-ring or sight glass o-ring	Replace o-ring
LOUD KNOCKING NOISE IN PUMP	Pulley loose on crankshaft	Check key and tighten set screw
	Broken or worn bearing	Replace bearing
FREQUENT OR PREMATURE FAILURE OF PACKING (SEALS)	Score, damaged, or worn plunger	Replace plungers
	Overpressure to inlet manifold	Reduce inlet pressure
	Abrasive material in fluid being pumped	Install proper filtration to pump inlet
	Excessive pressure and/or temperature of fluid being pumped	Check pressures and fluid inlet temperature; be sure they are within specified range

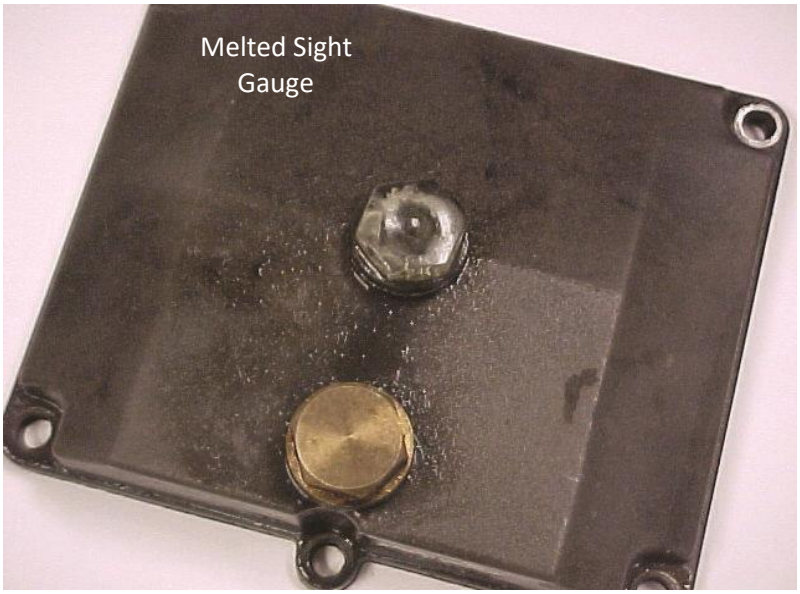
MAINTENANCE LOG

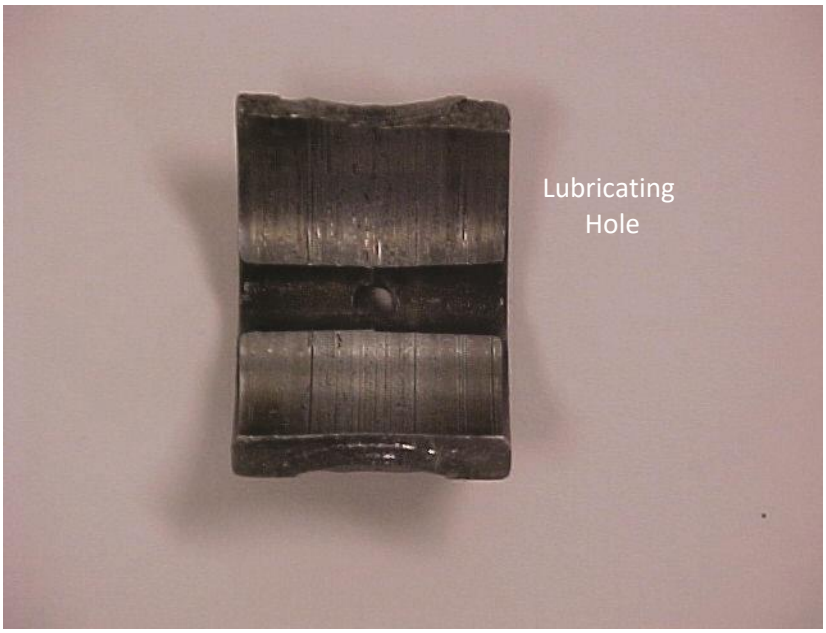
Regular maintenance can prevent many problems before they begin. Use this form to log maintenance service as it's performed on each pump. You can track service intervals by hours of operation, calendar date, or both.

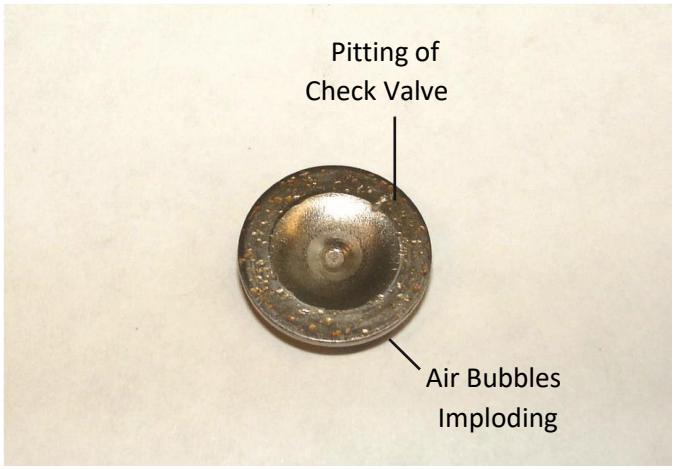
OIL CHANGE							
Hours							
Date							
GREASE							
Hours							
Date							
PACKING REPLACEMENT							
Hours							
Date							
PLUNGER REPLACEMENT							
Hours							
Date							
VALVE REPLACEMENT							
Hours							
Date							

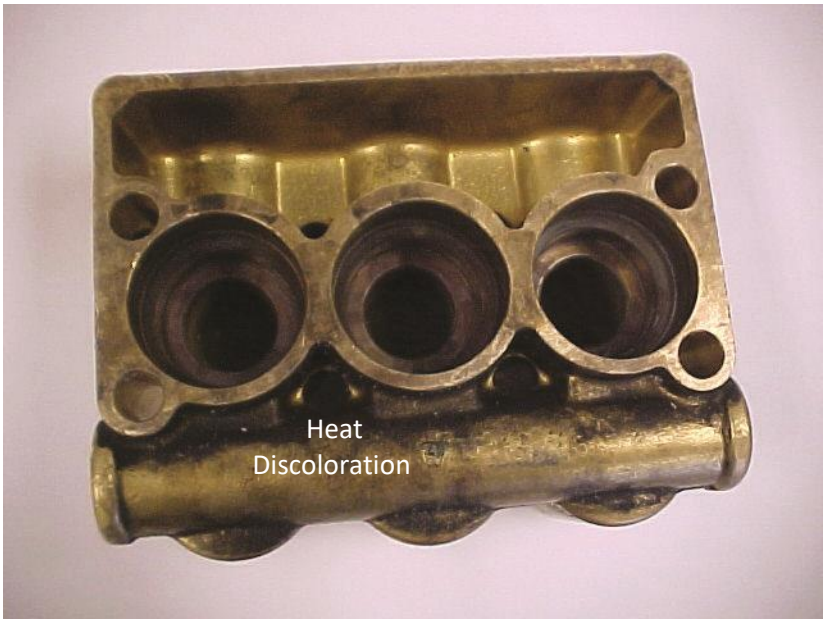
DESCRIPTION OF PUMP FAILURES

DESCRIPTION OF DEFECT	RESPONSE
The right crankshaft and connecting rod had abnormal striations.  	Damage was caused by lack of lubrication. After so many hours of use, oil will start to break down and lose its ability to lubricate.
	The oil from this pump was black and had particles indicating lack of maintenance. The operator's manual recommends oil change at first 2 hours, then 300 hours or every three months. When compared to a pump which had 20 hours, this pump oil was not changed as recommended

DESCRIPTION OF DEFECT	RESPONSE
This picture shows a section of the connecting rod with dirty oil and striations.  	Inspection shows signs of lack of maintenance because the oil is dirty, black, and stripy. After a length of time, oil will start to break down and will no longer lubricate. This lack of lubrication will produce heat, causing thermal expansion and scoring the connecting rod and crankshaft.
The melted sight gauge indicates heat associated with the lack of lubrication.  	The sight gauge will melt when temperatures exceed the ratings of the material.

DESCRIPTION OF DEFECT	REPONSE
Crankshaft shows signs of heat and lack of lubrication.  	When one connection rod and crankshaft surface is damaged and the other two look normal, except for signs of heat, then suspicion would lead to running this pump at an angle, which causes oil to move away from the damaged surfaces. This does not negate changing the oil but could explain the damage to only one connecting rod.
Broken connecting rod.  	If the pump was not operated on a level surface the oil will move away from the lubricating hole preventing adequate lubrication. The combination of dirty oil and operating in this condition causes failure to one connecting rod, not all three.

DESCRIPTION OF DEFECT	REPONSE
This picture also shows a crack in the ceramic plunger with associated marking on the packing. The seal lip torn.   	This pressure washer has multiple signs of running without water as indicated in these pictures. The ceramic plungers crack from thermal shock, running without a water supply causing an increase in temperature. When water is restored the hot ceramic cracks from this rapid change in temperature. These pictures show chunks of the packing missing, which indicates lack of water supply. The check valve was pitted which is an indication of cavitation (lack of water flow). Air bubbles form then collapse on themselves. This is called imploding, the opposite of exploding.
The check valve was pitted, which is an indication of cavitation (lack of water flow). Air bubbles form, then collapse on themselves. This is called imploding, or the opposite of exploding.  	The bubble is trying to collapse from all sides, but if the bubble is laying against a piece of metal such as the check valve it cannot collapse from that side, so the fluid comes in from the opposite side at a high velocity proceeded by a shock wave that can cause all kinds of damage. There is a very characteristic round shape to the liquid as it bangs against the metal creating the impression (pitting) as if the metal was hit with a "ball peen hammer". Check valve assembly showing pitting from the hammering effect of cavitation.

DESCRIPTION OF DEFECT	RESPONSE
This picture shows signs of temperature discoloration which is another sign of cavitation.  	Brass will change colors from chemicals and heat. This pump manifold shows obvious signs of heat discoloration.
This high-pressure packing has a hole which is the area in which the air bubble from cavitation imploded.  	Implosion of air bubbles has the same effect on high pressure packings as it did on the previously mentioned check valves. Air bubbles formed from cavitation collapse with a force strong enough to punch a hole in this packing.

DESCRIPTION OF DEFECT	RESPONSE
The brass retainer is damaged as shown. 	The discoloration of the brass retainer indicates heat which is caused by a restriction of water supply to pump. This restriction causes cavitation, which damages the inside of the pressure packing, and transfers this implosion force outward to the brass retainer.