**Troubleshooting Hints**

Many of the failures in a hydraulic system show similar symptoms: a gradual or sudden loss of pressure or flow, resulting in loss of power or speed in the cylinders or hydraulic motors. In fact, the cylinders may stall under light loads or may not move at all. Often the loss of power is accompanied by an increase in pump noise, especially as the pump tries to build up pressure.

Any one of the system’s components - pump, relief valve, directional valve, or cylinder could be at fault.

By following an organized step-by-step testing procedure, the problem can be traced to a general area, then if necessary, each component in that area can be tested, repaired or replaced.

Familiarize yourself with the circuitry of the hydraulic system to be tested. Review of the Service Manual is critical to learn the circuitry and location of various components: reservoir, hydraulic pump, relief valve, control valves, cylinders and hydraulic motors. The Service Manual should also provide operating specifications on fluid temperature, relief valve setting and pump delivery at specific RPMs.

Check the obvious. Is there sufficient fluid in the reservoir? Is it dirty? Is the filtering system in proper condition? Are there any bent linkages or pinched hoses? Are quick couplers functioning properly?

Before you start troubleshooting a system, it is helpful to ask questions and find out about the problem:
1. Has the system been working fine and then it just quit and stopped working?
2. Has the system been working fine and then it started to slowly change in the way it works?
3. Does the system work fine when first started and then changes as it is used and as the system heats up?
4. Did the system stop working after something else was fixed or replaced?
5. Did the system ever work or work properly after it was assembled?

When troubleshooting a hydraulic system there are a few tools which will aid in finding and repairing a problem.

1. Pressure Gauge; To measure the System Pressure (P.S.I.).
2. Flow Meter; To measure Gallons per Minute (G.P.M.).
3. Temperature Gauge; To measure Heat.
4. Needle Valve; To Load / Restrict the System being tested.
5. And Your Senses;
   - A. Seeing; Is that suppose to be BENT?
   - B. Hearing; Is it suppose to be that LOUD?
   - C. Smell; Is it suppose to SMELL BURNT?
   - D. Touch; I can’t it’s too HOT!
   - E. Common; Do I want to get in there while it’s WORKING? I DONT THINK SO!

With items 1, 2, 3, 4, and the necessary fittings and hoses, a Hydraulic System Analyzer can be built and most hydraulic system problems can be diagnosed and repaired.

Make sure the items are sized properly for the system being tested, don’t use a 200 PSI Gauge in a 3000 PSI System or a 5 GPM Flow Meter or Needle Valve in a 50 GPM System. Verify and make sure that all the components are rated at, or exceed the pressures and flows being tested.
A Hydraulic Analyzer can be used to check the following:

1. **Fluid Temperatures, using the temperature gauge provided.** Fluid should be flowing through the analyzer for several minutes to obtain an accurate reading.

2. **Flow rates, using the flow meter provided.** With the needle valve wide open, the monitor will show the rate at minimum pressure loss. The flow rate can be restricted by turning in on the needle valve from wide open to show the flow at various pressure loads.

3. **System or operating pressure, by referring to the pressure gauge.** To prevent possible component damage, always be sure the needle valve on your analyzer is in the wide open position prior to starting system and if possible, have a relief valve between pump and analyzer.

**Example Test for Hydraulic Pump Performance:**

1. With system off and needle valve on analyzer in wide open position, install the analyzer in the line with fluid to be flowing in the direction of the arrow on the flow monitor scale.
2. Tighten all fittings to prevent unnecessary leakage.
3. Allow fluid to flow through the analyzer by turning on system.
4. Check the system Service Manual to see what specifications the pump is rated at. Example: 15 gpm @ 1500 psi.
5. With full flow flowing through the analyzer, start turning in the analyzer needle valve, gradually restricting the flow and at the same time, increasing pressure load on the pump. When reaching the rated pressure of the system pump, determine if the pump is operating efficiently (proper flow rate) or if it may need replacing or rebuilding. If the system relief valve is set below test pressure, the relief may have to be increased slightly to test the pump. Be sure to turn the relief valve back to its previous setting when tests have been completed.

**Troubleshooting Heated Fluid:**

When analyzing a hydraulic system in which the fluid temperature is higher than normal, it should be kept in mind that hot fluid can produce unusual flow and operating characteristics. A flow monitor with a minimal sensitivity to temperature variation should be used. When fluid gets hot, the viscosity decreases (the fluid gets much thinner). This thinner fluid can pass through much smaller openings or, in other words, more fluid will pass through the same original opening.

**When the System Heats Up:**

1. Pumps usually slip more fluid through standard clearances. High pressure settings usually cannot be obtained.
2. When the fluid thins down, the parts run closer together and wear faster. Particles of dirt which may not have been a problem with thicker fluid may now be very damaging.
3. Valves, cylinders and actuators will slip more fluid through standard clearances.

   All-in-all, excessive heat in a system will not only cause excessive and faster wear, but the system will seem very sluggish because of the lack of fluid supply and operating pressure.

Knowing the potential of your analyzer, the effects of fluid temperature and pressure drop will always insure confidence in analyzing and troubleshooting any service problem areas. The analyzer is only as good as the operator and the less complicated the unit, the more it will be used.
Troubleshooting Hints

Basic Troubleshooting Steps:

Step 1 - Pump Suction Strainer...

Probably the field trouble encountered most often is cavitation of the hydraulic pump inlet caused by restriction due to a dirt build-up on the suction strainer. This can happen on a new as well as on an older system. It produces systems such as: increased pump noise, loss of high pressure and/or speed.

If the strainer is not located in the pump suction line it will be found immersed below the oil level in the reservoir, as at Point A. Some operators of hydraulic equipment never give the equipment any attention or maintenance until it fails. Under these conditions, sooner or later, the suction strainer will probably become sufficiently restricted to cause a breakdown of the whole system and damage to the pump.

The suction strainer should be removed for inspection and should be cleaned before reinstallation. Wire mesh strainers can best be cleaned with an air hose, blowing from inside out. They can also be washed in a solvent which is compatible with the reservoir fluid. Kerosene may be used for strainers operating in petroleum based fluid. Do not use gasoline or other explosive or flammable solvents. The strainer should be cleaned even though it may not appear to be dirty. Some clogging materials cannot be seen except by close inspection. If there are holes in the mesh or if there is mechanical damage, the strainer should be replaced.

When reinstalling the strainer, inspect all joints, as at Point B for possible air leaks, particularly at union joints. There must be no air leaks in the suction line. Check the reservoir oil level to be sure it covers the top of the strainer by at least 3" at minimum oil level, which is with all cylinders extended. If it does not cover to this depth there is danger of a vortex forming which may allow air to enter the system when the pump is running.

Step 2 - Pump and Relief Valve...

If cleaning the pump suction strainer does not correct the trouble, isolate the pump and relief valve from the rest of the circuit by disconnecting at Point E so that only the pump, relief valve, and pressure gauge remain in the pump circuit. Cap or plug both ends of the plumbing which was disconnected. The pump is now deadheaded into the relief valve. Back out relief valve pressure adjustment. Start the pump and watch for pressure buildup on the gauge while tightening the adjustment on the relief valve. If full pressure can be developed, obviously the pump and relief valve are operating correctly, and the trouble is to be found further down the line. If full pressure cannot be developed in this test, continue with Step 3.

Step 3 - Pump or Relief Valve?...

If high pressure cannot be obtained in Step 2 by running the pump against the relief valve, further testing must be conducted to see whether the fault lies in the pump or in the relief valve. Proceed as follows:

If possible, disconnect the reservoir return line from the relief valve at Point H. Attach a short length of hose to the relief valve outlet. Hold the open end of this hose over the reservoir filler opening so the rate of oil flow can be observed. Start the pump and run the relief valve adjustment up and down while observing the flow through the hose. If the pump is bad, there will probably be a full stream of oil when relief valve adjustment is backed off, but this flow will diminish or stop as the adjustment is increased. If a flowmeter is available, the flow can be measured and compared with the pump catalog rating.
**Troubleshooting Hints**

If a flowmeter is not available, the rate of flow on small pumps can be measured by discharging the hose into a bucket while timing with the sweep hand on a watch. For example, if a volume of 10 gallons is collected in 15 seconds, the pumping rate is 40 GPM, etc.

If the gauge pressure does not rise above a low value, say 100 PSI, and if the volume of flow does not substantially decrease as the relief valve adjustment is tightened, the relief valve is probably at fault, and should be cleaned or replaced as instructed in Step 5.

If the oil flow substantially decreases as the relief valve adjustment is tightened, and if only a low or moderate pressure can be developed, this indicates trouble in the pump. Proceed to Step 4.

**Step 4 - Pump...**

If a full stream of oil is not obtained in Step 3, or if the stream diminishes as the relief valve adjustment is tightened, the pump is probably at fault. Assuming that the suction strainer has already been cleaned and the inlet plumbing has been examined for air leaks, as in Step 1, the oil is slipping across the pumping elements inside the pump. This can mean a worn-out pump, or too high an oil temperature. High slippage in the pump will cause the pump to run considerably hotter than the oil reservoir temperature. In normal operation, with a good pump, the pump case will probably run about 20° F above the reservoir temperature. If greater than this, excess slippage, caused by wear, may be the cause.

Check also for slipping belts, sheared shaft pin or key, broken shaft, broken coupling, or loosened set screw.

**Step 5 - Relief Valve...**

If the test of Step 3 has indicated the trouble to be in the relief valve, D, the quickest remedy is to replace the valve with another one known to be good. The faulty valve may later be disassembled for inspection and cleaning. Pilot operated relief valves have small orifices which may be blocked with accumulations of dirt. Blow out all passages with an air hose and run a small wire through orifices. Check also for free movement of the spool. In a relief valve with pipe connections in the body, the spool may bind if pipe fittings are over tightened. If possible, test the spool for bind before unscrewing threaded connections from the body, or, screw in fittings tightly during inspection of the valve.

**Step 6 - Cylinder...**

If the pump will deliver full pressure when operating across relief valve in Step 2, both pump and relief valve can be considered good, and the trouble is further downstream. The cylinder should be tested first for worn out or defective seals.

Run the cylinder to one end of its stroke. Disconnect the fluid line which was allowing oil to exhaust from the cylinder. Plug or cap the valve side of this disconnected line to avoid oil spillage caused by any back pressure in the tank return line. Attach a hose to the cylinder fitting where the fluid line was disconnected. Place open end of attached hose into a barrel or bucket. Start the pump and activate the valve to continue to stroke the cylinder the same direction. With the cylinder at the end of its stroke, check for any oil flowing from hose into barrel. If flow is excessive the cylinder may need repaired or replaced. Pistons with metal rings can be expected to have a small amount of leakage across the rings, and even those “leaktight” soft seals may have a small bypass during break in of new seals or after the seals are well worn. After checking, reinstall the lines and run the piston to the opposite end of the barrel and repeat the test. Occasionally a cylinder will leak at one point in its stroke due to a scratch or dent in the barrel. Check suspected positions in mid stroke by installing a positive stop at the suspected position and run the piston rod against it for testing. Once in a great while a piston seal may leak intermittently. This is usually caused by a soft packing or O-ring moving slightly or rolling into different positions on the piston, and is more likely to happen on cylinders of large bore.

**Step 7 - Directional Control Valve...**

If the cylinder has been tested (Step 6) and found to have reasonably tight piston seals, the 4-way valve should be checked next. Although it does not often happen, an excessively worn valve spool can slip enough oil to prevent build-up of maximum pressure. Symptoms of this condition are a loss of cylinder speed together with difficulty in building up to full pressure even with the relief valve adjusted to a high setting. This condition would be more likely to occur with high pressure pumps of low volume output, and would develop gradually over a long period of time.

**Other Components**

Check other components such as by-pass flow controls, hydraulic motors, etc. Solenoid 4-way valves of the pilot operated type with tandem or open center spools may not have sufficient pilot pressure to shift the spool.
Troubleshooting Hints

System Inoperative:

1. **Insufficient or No fluid in system.**
   - Refill system with proper grade and type of fluid.
   - Filter new oil being added as recommended.
   - Refill oil reservoir with cylinders in closed position.
   - If refilled while cylinders are extended the reservoir may over flow when or as the cylinders retract.
   - Check for leaks.

2. **Pump is not engaged.**
   - Is pump shaft turning?
   - Check if PTO (power take off) is engaged.
   - Variable control mechanism out of adjustment.
   - Adjust to machine service manual specifications.

3. **Slipping or broken pump drive.**
   - Check pump drive mechanism (drive key, flex coupler) for damage.
   - Check for proper alignment or tension.

4. **Pump inlet line plugged.**
   - Drain oil and replace filter or filter element.
   - Check for clogged oil strainers.
   - Oil lines dirty or collapsed.
   - Check if correct inlet hose is used, inner liner may be collapsed.
   - Never use a pressure type hose as a pump inlet suction hose.
   - Check if supply shut off or gate valve is closed.
   - Check in reservoir for other possible obstructions.

5. **Pump speed too slow.**
   - Check minimum drive speed.
   - May be too slow to prime pump.

6. **Wrong fluid in system.**
   - Oil viscosity too heavy for pump to pick up a prime.
   - Drain complete system. Add new fluid of proper viscosity.

7. **Air leaks at intake. Pump not priming.**
   - Circuit must be tested at inlet connections.
   - At pump intake piping joints, test by pouring oil on joints while listening for a change in sound of operation.
   - Determine where air is being drawn into line connection and tighten.
   - At pump shaft, Test by pouring oil on shaft seal while listening for a change in sound of operation.
   - Follow manufacturer’s recommendation when changing seals.
   - Air drawn in through intake pipe opening.
   - Check to be certain suction and return lines are well below oil level in reservoir. Add oil to reservoir if necessary.

8. **Pump driven in wrong direction of rotation.**
   - Most pump assemblies will have an arrow showing correct rotation.
   - On gear type pumps, the pressure port / output will be on the side where the gears come together and mesh.
   - Check to assure correct pump rotation was applied during assembly.

9. **Leakage.**
   - Check all components, particularly the relief valve for proper settings.
   - Refer to technical manuals.

10. **Broken or badly worn components (pump, valves, cylinders, etc.).**
    - Examine and test for internal or external leakage.
    - Analyze the conditions that brought on the failure and correct them.
    - Repair or replace the faulty components according to technical manual specifications.

11. **Excessive load.**
    - Check unit specifications for load limits.

System Develops No Pressure:

1. **Pump not delivering fluid.**
   - Follow the remedies mentioned above.

2. **Incorrect valve position or setting.**
   - Check and engage valve.
   - Install pressure gauge and adjust to correct pressure.

3. **Vanes in vane pump sticking.**
   - Check for burrs or metal particles that might hold vanes in their slots.
   - Repair or replace if necessary.
   - Clean system if contaminants are found.

4. **Fluid recirculating back to reservoir and not going to functions.**
   - Mechanical failure of some other part of the system, especially a relief valve.
   - If contamination is involved, clean and refill with proper fluid.

5. **Piston pump or valve broken, or stuck open allowing fluid to return to inlet side.**
   - Disassemble the pump, determine the cause and correct it.
   - Repair according to technical manual instructions.

System Operates Erratically:

1. **Air in system.**
   - Check suction side for leaks. Repair.

2. **Cold oil.**
   - Allow ample warm-up period.
   - Operate only at recommended operating temperature ranges.

3. **Wrong fluid viscosity.**
   - Oil viscosity too heavy.
   - Drain complete system. Add new fluid of proper viscosity.
Troubleshooting Hints

4. **Pump speed too slow.**
   - Increase engine speed.
   - Check manual for recommendations.

5. **Dirty or damaged components.**
   - Clean or repair as necessary.

6. **Restriction in filters or lines.**
   - Clean and/or replace elements or lines.

7. **Internal pump parts are sticking.**
   - Dismantle and repair according to technical manual instructions.
   - Look for burrs on parts or metal particles in fluid.
   - If contaminants are the cause, clean and refill with proper fluid.

8. **Distance between internal parts has increased due to wear.**
   - Dismantle and repair.
   - If wear is abnormal, determine the cause by checking the operation and maintenance records as well as by examining the pump and system.

System Operates Slowly:

1. **Oil viscosity too high, cold oil.**
   - Allow oil to warm up before operating machine.

2. **Low pump drive speed.**
   - Increase engine speed (check manual for recommendations).
   - If clutch or belt-driven, check for proper tension.

3. **Low oil level.**
   - Check reservoir and add oil as necessary.

4. **Air in system.**
   - Check suction side for leaks. Repair.

5. **Badly worn pump, valves, cylinders, etc.**
   - Repair or replace as needed.

6. **Restriction in filters or lines.**
   - Clean and/or replace elements or lines.

7. **Improper adjustments.**
   - Check orifices, relief, unloading, flow control valves, etc.
   - Adjust per manual.

8. **Oil leaks.**
   - Tighten fittings, replace seals or damaged lines.

3. **Incorrect oil, low oil, dirty oil.**
   - Use recommended oil, fill reservoir, clean reservoir, replace filter element.

4. **Engine running too fast.**
   - Reduce engine speed.

5. **Excessive component internal leakage.**
   - Check stall leakage past pump, valve, motor, cylinder or other components.
   - Repair or replace component as necessary.

6. **Restriction in filters or lines.**
   - Check if line I.D.'s are too small causing high velocity.
   - Check if valvings too small, causing high velocity.
   - Clean and/or replace elements or lines.

7. **Malfunctioning oil cooler / heat exchanger.**
   - Check if water is shut off, if water cooled.
   - Check for clogging.
   - Clean repair.

8. **Insufficient heat radiation.**
   - Check for proper air circulation around reservoir.
   - Ambient temperature too high for system design.
   - Clean dirt and mud from reservoir and components.

9. **Reservoir sized too small.**
   - Increase reservoir size.
   - Add oil cooler or heat exchanger.

10. **Reservoir assembled without or insufficient baffling.**
    - Add baffling to allow fluid time to cool.

Foaming of Oil:

1. **Incorrect oil, low oil, dirty oil.**
   - Replace, clean or add as needed.

2. **Air leaks.**
   - Check suction line and component seals for suction leaks. Repair or replace.

3. **Return of tank line not below fluid level.**
   - Repair or replace.

4. **Inadequate baffles in reservoir.**

5. **Lack of anti-foaming additives in oil.**
   - Replace fluid with proper grade.

System Operates Too Fast:

1. **Wrong size or incorrectly adjusted restrictor or flow control.**
   - Replace or adjust as necessary.

2. **Engine running too fast.**
   - Reduce engine speed.

Overheating of Oil in System:

1. **Oil passing thru relief valve for excessive time.**
   - Return control valve to neutral when not in use.
   - System stalling under load, etc.
   - Fluid viscosity too high.

2. **Relief or unloading valve set too high.**
   - Install pressure gauge and adjust to correct pressure.
Troubleshooting Hints

Noisy Pump:
1. Air leak in intake, or air is being drawn through the inlet line.
   Repair or make sure the inlet line is submerged in fluid in the reservoir.
   To check for leaks, pour fluid around the joints and listen for a change in sound of operation.
2. Low oil level, incorrect oil, foamy oil.
   Check if oil viscosity too high or operating temperature too low.
   Replace, clean or add proper grade and type of fluid as needed.
   With rare exception all return lines should be below fluid level in reservoir
3. Pump inlet line or inlet screen is restricted or clogged.
   Clean or replace as needed.
4. Reservoir breather vent clogged.
   Clean or replace as needed.
5. Worn or damaged pump.
   Check and correct cause of parts failure.
   Repair or replace as needed.
   Operate pump within recommended speed.
7. Drive coupling mis-aligned.
   Align unit and check condition of seals and bearings.
   Misalignment will cause wear and subsequent high noise level in operation.
8. Relief or unloading valve set too high.
   Use reliable gauge to check operating pressure.
   Relief valve may have been set too high with a damaged pressure gauge.
   Check unloading devices to see that they are properly controlling the pump delivery.

Excessive Pump Wear:
1. Abrasive contaminants or sludge in the fluid.
   Check for the cause of contaminants.
   Replace or repair worn parts according to service manual.
   Install or change fluid filter.
   Replace fluid with recommended grade and quality.
2. Viscosity of fluid too low or too high.
   Replace fluid with proper grade and type.
3. Sustained high pressure above maximum pump rating.
   Check for possible relief valve malfunction or other parts failure.
4. Air leaks or restriction in system causing cavitation.
   Eliminate any leaks in system.
5. Drive shaft misaligned.
   Check and correct according to technical manual specifications.

Leaky Pump or Motor:
1. Damaged or worn shaft seal.
   Check and replace.
   Check for misalignment.
   Check that chemicals in fluid are not destroying packing or seals
2. Loose or damaged parts.
   Tighten or replace.

Internal Pump Parts Breakage:
1. Excessive pressure above maximum limits for pump.
   Check for parts malfunction and cause.
   Repair according to machine technical manual.
2. Seizure due to lack of fluid.
   Check reservoir fluid level, as well as fluid inlet line for restriction.
   Check for plugged inlet filter or strainer.
3. Abrasive contaminants in fluid are getting past the filter.
   Check for plugged inlet filter or strainer.
   Check for malfunctioning filter bypass valve.
4. Excessive torquing of housing bolts.
   Replace damaged parts.
   Torque to proper specifications.

Load Drops with Control Valve in Neutral:
1. Leaking cylinder seals or fittings.
   Replace worn parts.
2. Control valve not centering when released.
   Check linkage.
   Check spool for binding.

Control Valve Sticking (Binding):
1. Valve linkage misaligned.
   Repair.
2. Tie-bolts too tight (stack valves).
   Loosen and retighten as necessary.
3. Valve damaged.
   Repair or replace.

Control Valve Leaks:
1. Tie-bolts too loose (stack valves).
   Tighten as necessary.
2. Seals damaged or worn.
   Replace.

Relief Valve Noisy:
1. Relief valve setting too close to operating pressure.
   Install pressure gauge and adjust to correct pressure.
2. Worn or scored poppet and seat.
   Replace.
   Replace spring and adjust to correct pressure.
**Troubleshooting Hints**

Cylinder Seal Leakage:

1. **Slow, Uniform Leakage:**
   - A. Poor low-pressure sealability (especially if a lip seal).
   - B. Too little initial interference (if squeeze-type seal).
   - C. Loss of interference or squeeze due to wear or compression set.
   - D. Seal shrinkage after installation (possibly chemically induced, or a result of leaching of plasticizers by solvent action).
   - E. Possible omission or failure of static seal(s).
   - F. Microscopic debris lodges under seal lip (lint, fiber, etc.).
   - G. Scored lip due to passage of sharp particle under seal, leaving cut or nick.
   - H. Seal lip is nicked or cut during installation (note whether leak starts immediately after seal installation).
   - I. Non-repetitive overheating hardens compound (which loses its ability to conform to dynamic surface deviations).
   - J. Off-center alignment puts all clearance on one side, all compression on the other (due to bearing wear, excessive side loads, etc.).
   - K. Check static surfaces of dynamic seal (groove surfaces). They may have problems F, G, or H hidden from view, and without self-cleaning tendency.

2. **Gradually Increasing Leakage:**
   - A. Progressive wear.
   - B. Increasing compression set.
   - C. Progressive tear or erosion from initial nick.
   - D. Fine score mark on dynamic surface progressively abrades seal lip.

3. **Sudden Copious Leakage:**
   - A. Extruded seal.
   - B. Torn seal lip (see 1-D, -E, -F, -G, -H, & -I, and 2-D).
   - C. Twisted seal.
   - D. Dramatic bearing failure due to excessive side load, shock, etc.
   - E. Spiral failure.
   - F. Massive infusion of contamination (due to incorrect fluid added to system, or to upstream introduction of dirt or wear debris).
   - G. Slow rod leakage builds up behind tight wiper, then dumps ... giving appearance of catastrophic seal failure. If leak rate continues, look for slow leak or erratic leak causes. If high leak rate continues, look for true catastrophic leak origin.
   - H. Reverse-pressure blowout of piston seal due to pressure trap or failure of opposed seal.

4. **Erratic (start-stop) Leakage:**
   - A. Cold start-up shrinks seal; friction/liquid heating restores size.
   - B. Intermittent eccentric loading.
   - C. Fibrous contamination working its way past seal lips.
   - D. Unstable seal (twists and returns, cocks, etc.) usually caused by shock loading.
   - E. Rod seal leaks slowly, tight wiper periodically dumps accumulated leakage (see 3-G).
   - F. Fluid viscosity changes as temperature cycles (e.g., forklift truck alternately entering and leaving cold storage area).

5. **Stick-slip Operation:**
   - B. Breakdown of fluid lubricity due to contamination or deterioration of fluid.
   - C. Viscosity change due to temperature.
   - D. Excessive burnishing of dynamic surface to finer finish destroys ability of surface to maintain lube film (e.g., may go from 12 RMS to 4 RMS).

6. **Seizing:**
   - A. Seal and bearing swell due to incompatible fluid and compound (possibly running hotter than temperature at which fluid is compatible).
   - B. Thermal expansion of compound.
   - C. Pressure trap between dual squeeze seals or incorrectly installed lip seals.
   - D. Wedging of seal or backup device into extrusion gap (if used, it is usually the backup device that extrudes).
   - E. In low-pressure systems, shock or other factors cock, cant or misorient the seals in grooves.
   - F. Bent rod, cocked head, etc.

7. **Scored Rod or Ram:**
   - A. Internally generated contamination.
   - B. Externally introduced rod dirt, dirty makeup or disassembly/ reassembly dirt.
   - C. Misoriented exclusion devices (wiper/scraper); eccentric installation.
   - D. Misaligned (eccentric) loads cock ram into metal-to-metal contact with head.
   - E. Wiper in vertical ram forms catch-all pocket.

8. **Drift:**
   - A. Inspect valve for leakage and full closure before disassembly. (disconnect return line on valve and inspect visually for leakage).
   - B. See problems 1 and 2 as applied to piston seals.
   - C. Misapplied cast-iron rings in a "hold" cylinder (right ring in the wrong job).
   - D. In "retract-mode" creep, check rod seal as well as piston seal.
   - E. Static internal seal may provide leakage path past piston.
9. Increasing Cylinder Drag:
   A. Seal swell caused by improper (incompatible) installation lubricant (e.g., EPR seal lubed with petro-based grease or oil).
   B. Packing of contaminants into wiper groove of vertical ram.
   C. Thermal expansion of bearings and/or seals.
   D. Apparent drag increase due to undetected flow restriction in supply or return line . . . or bypassing of pressure though improperly closing valve . . . or obstructed check valve, etc.
   E. Cocked or twisted seal bypassing fluid and wedging into extrusion gap.

10. Increasing Cylinder/Rod Temperature:
    A. See causes for problem 9. In their earlier stages, these problems may appear as hotter-running cylinders.
    B. Internal leakage “throttling” past seal can cause rapid heating.
    C. Decreased lubricity of fluid can boost friction and heating (hotter fluid has lower viscosity, etc.). Contaminated or deteriorated fluid can cause same cycle.
    D. Diluted fluid can boost friction, etc.
    E. Condensation in reservoirs can emulsify or hit cylinder as slugs of fluid with near-zero lubricity. Also, hot water can swell compounds such as urethanes, increasing friction.

11. Telescopic sleeve undersized, out of round or bulged.
    A. Check with micrometers to see if sleeve/tube is within specifications.

Cylinder will not Operate or Move:
1. Pump or PTO is not engaged, system not receiving fluid.
   Engage pump, correct pump flow problem.
2. Control valve not engaged.
   Engage valve, check for linkage alignment and damage.
3. Pressure too low.
   Check pressure at cylinder to make sure it is to circuit requirements.
   Check for internal scoring, damaged or worn seals, internal cracks.
5. Cylinder overloaded for rated capacity.
   Reduce load.
6. Cylinder too small or not rated for application.
   Install correct cylinder.
7. Piston rod broken at piston end.
   Disassemble and replace piston rod.
8. Hose quick disconnect not attached.
   Check if hose quick disconnect is connected properly.

Cylinder not Holding Load or Drifts:
1. Cylinder bypassing internally.
   Check for internal scoring, damaged or worn seals, internal cracks. 
   Pressure one side of cylinder and disconnect fluid line at opposite port. Observe leakage. One to three cubic inches per minute is considered normal for piston rings. Virtually no leak with soft seals on piston. Replace cylinder barrel or seals as required.

2. Other circuit leaks.
   Check for leaks thru operating valve and correct.
   Correct leaks in connecting lines.
3. Incorrect Valving.
   Open center valve with conventional single rod cylinder will creep if restriction on tank port is sufficiently high. Use tandem type valve spool configuration or spool with pump dumped through one cylinder port with the other blocked.
   Closed center valve can cause similar results except creep will be according to amount of clearance flow in the valve. Proper notching of valve spool can prevent building up pressure in cylinder lines between cycles.
   Spools with pressure blocked and cylinder ports completely relaxed will also prevent drift if no moving element is not affected by gravity or vibration.
   Pilot operated check valves can positively lock fluid in cylinder lines. Care must be exercised to insure adequate pilot pressure when rod differential may cause intensification.

Cylinder operates erratically or chatters:
1. Telescopic cylinder sleeves mistaging.
   Check for tight seals or bearings.
2. Excessive friction due to damaged or improper / misaligned mounting.
   Repair or replace as needed.
3. Cylinder sized too close to load requirements.
   Reduce load or install larger cylinder.
4. Large difference between static and kinetic friction.
   Install speed control valves to provide back pressure to control stroke.

Oil Spilling Out of Tank:
1. Oil is foaming.
   (Refer to Foaming of Oil section)
2. Oil reservoir filled while cylinders were extended.
   Fill while cylinders in the retract or closed position.

Foreign Matter Sources in the Circuit:
1. Pipe scale not properly removed.
   Lines need cleaned and flushed before installation.
2. Sealing compound (pipe dope, teflon tape) allowed to get inside fittings.
   Use care when applying sealants.
3. Improperly screened fill pipes and air breathers.
   Repair or replace as required.
4. **Burrs inside piping components.**
   Deburr before installation.

5. **Tag ends of packing coming loose.**
   Check if packing is system compatible.
   Replace packing.

6. **Seal extrusions from pressure higher than compatible with the seal or gasket.**
   Replace seal or gasket with compatible item.

7. **Human element.**
   Not protecting components while being repaired.
   Repaired components not properly protected while stored. (Rust and other contaminants.)
   Lines left open and unprotected.

8. **Wipers or boots damage or not provided.**
   Check cylinders or rams.
   Add or replace where necessary.

**Preventing repeat failures:**
When a hydraulic system (pump or cylinder or other major component) has a failure, implementing this 13-step checklist can help prevent repeat failures.

1. Determine cause of failure.
2. Eliminate cause of failure.
3. Retract all cylinders and drain tank.
4. Flush tank. Using diesel fuel under pressure, flush tank thoroughly and wipe with clean cloths.
5. Install new filter elements.
   A. Check to make sure filter is 10 microns or better.
   B. If machine does not have filtration, install a 10 micron filter on the return line.
6. Install new component.
7. Fill the tank with new oil.
   A. Be sure recommended oil is used.
   B. NOTE: You’re filling the system, not just the oil supply tank. Pump failure due to lack of oil can result if filling is not done correctly.
   Keep a close check on the oil level as you complete the following steps.
8. Disconnect all lines to cylinders and/or motors at the cylinder or motor. Be sure all implements are securely blocked and all accumulators are bled before disconnecting lines. NOTE: It may be necessary to remove, inspect, and flush the fittings that are connected to the pump, valves, and/or cylinders to remove any foreign objects that may have become lodged or stuck inside them.
9. Activate each circuit by moving control valve handle so lines are flushed with new oil. This flushes the lines and valves from pump to all cylinders and motors.
   Be sure to check oil level, and add new oil if necessary.
10. Connect lines to blind end of cylinders and all fluid motors. Leave rod end disconnected and with engine at one-fourth throttle, activate circuits slowly until cylinder bottoms out. New oil will be put in the blind end of the cylinder and old dirty oil flushed out the rod end. Do this for all cylinders on the machine.
11. Connect lines to rod end of cylinders. Again, check oil level and add new oil as required.
12. Operate all cylinders and motors alternately for 30 minutes at normal operating speed.
13. Change filter element, check oil level and add oil as needed.

The above procedure, if followed, will allow you to install a new pump or cylinder with confidence, knowing that you’ll get satisfactory life. Cutting short these steps can cause premature hydraulic component failure; a pump, nor a cylinder will run long on a contaminated system.

In nearly all cases, a replacement component will fail in a shorter time than the original preceding it unless the system is thoroughly cleaned.

In addition, to ensure good service from your equipment, the hydraulic system must be properly maintained, including frequent oil level checks, daily inspection for leaks, filter element and oil changes at recommended intervals (using correct filters and recommended grade of oil), and finally, practicing good operating techniques.