# FRANKLIN AID

Franklin Electric

The Company You Trust Deep Down


Franklin Application/Installation Data (AID)... For The Professional Pump Installer and Driller

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## WHY SUBMERSIBLE MOTORS FAIL - Part 2

**Voltage Surges and Spikes:** High voltage surges and voltage spikes are the result of close proximity lightning strikes, opening of powerline switch gear, fast current-limiting power line switch gear, or the removal of large inductive loads from the powerlines. These spikes and surges can travel to the motor windings, where they attempt to break down the insulation resistance. While Franklin motors can handle voltage surges in the magnitude of 10,000 volts, unfortunately, power surges do not limit themselves to this voltage. This is why a good surge arrestor, capable of multiple hits, is needed for submersible motors without internal arrestors (4-inch single-phase motors have built-in arrestors). Remember, there is little advantage to installing an arrestor unless it is grounded to the water strata. Surge arrestors over the years have also been known as lightning arrestors. While a direct lightning strike of millions of volts to the motor is almost impossible to protect against, voltage surge related motor failures can be prevented with good arrestors and proper grounding.

1-phase

3-phase

Joslyn Manufacturing's single phase arrestor is available through Franklin Electric, while the 3 phase arrestor is used in Franklin's SubMonitor Premium kits. These arrestors are also sold separately in the market.

Now that we have addressed electrical failures in submersible motors, let's focus on how mechanical problems affect motor life.

When reviewing mechanical failures, the typical problems are shaft spline damage, broken or twisted shafts, and radial bearing, thrust bearing, or up thrust bearing damage.

**Shaft Damage:** Spline wear can be attributed to sand deposits, lime deposits, mis-alignment between the pump and motor, upthrusting, a loose fitting coupling, or any combination of these. Before assembling the spline coupling to the motor shaft, the coupling should be filled with a non-toxic FDA approved water proof grease (Mobil FM 102, Texaco Cygnus 2661 or FDA approved equivalent). This inhibits the entrance of sand or lime deposits into the spline area.

**Broken or Twisted Shafts:** Broken or twisted shafts are typically the result of a motor starting while back-spinning, a "machine gunning" starter, a water logged pressure tank, or continuous shaft side load.

Back-spinning is caused by a failed check valve or a lack of check valves. If the motor is started while back-spinning, this sudden reversal severely strains the pump and motor assembly and can cause shaft damage.

"Machine gunning", or ultra-rapid starting and stopping of the motor, places excessive stress loads on the motor shaft, coupling, and pump shaft. This is caused by a problem in the control circuit. Loose electrical connections and partial shorts to ground are some of the conditions that will cause "machine gunning" of a starter.

A water logged pressure tank also causes rapid cycling that results in broken or twisted shafts. This condition shock loads the motor's thrust bearing and can contribute to thrust bearing failure, as well.

A fixed or continuous shaft side load can cause a broken or twisted shaft and/or radial bearing damage. Pump bolts working loose, mis-alignment between the pump and motor, or bent shafts can cause shaft side load. Excessive side loading overloads the top motor bearing journal. This can cause the shaft to overheat and twist off in the journal area.

**Radial Bearing Damage:** Radial bearing or shaft side-load bearing failures are typically the result of sand or abrasive entry into the motor after the shaft seal is worn out. However, continuous side loading of the shaft, as mentioned above in the broken shaft section, can also cause radial bearing failure prior to shaft breakage. Once the radial bearing fails, the resulting debris from the radial bearings can produce excessive wear on the thrust bearing and lead to eventual failure of the motor.

**Thrust Bearing Damage:** In addition to the water logged pressure tank mentioned earlier, water hammer, dead-heading the pump, insufficient water flow past the motor, and back-spinning damages thrust bearings.

The shock wave caused by water hammer, shatters the thrust bearing. The shock wave travels down the water column to the pump shaft and onto the motor's thrust bearing. This shock wave is similar to a train engine coupling to a line of freight cars. When the engine hits the first car, it hits the second and so forth, all the way to the caboose. The thrust bearing is the caboose of a submersible motor and pump.

Dead-heading (running the motor, but not moving any water) and insufficient water flowing past the motor causes extreme heating of the motor fill solution. These conditions are usually caused by running against a closed valve, frozen water line, or blocked outlet. Top-feeding wells, motors installed in open bodies of water, or motors buried in mud or sand, do not allow enough water to move past the motor, unless a flow sleeve is used. Once the fill solution heats up and turns to steam, all bearing lubrication is lost and the thrust system fails.

Back-spinning of the pump allows the water to flow back through the pump as the water column drops to static level. While the water is draining back, the pump spins the motor at a low RPM. The speed of the motor is typically not high enough to properly lubricate the thrust bearing and bearing failure results.

**Upthrust Damage:** Upthrusting occurs when the pump is moving more water than it is designed to pump. On a pump curve, this typically means the pump is running to the "right side" of the curve, with less head or back pressure on the system than intended. With most pumps, this causes an uplifting or upthrusting on the impeller/shaft assembly in the pump. While Franklin submersibles have upthrust bearings which allow limited upthrust without motor damage, it should be avoided to minimise wear in the pump and motor. Continuous upthrusting damages the motor's upthrust bearing, imparts debris into the motor, and eventually causes a thrust bearing failure.

The final system failure category is mechanical failures that progress into electrical failure. In the which came first, the chicken or the egg scenario, electrical failures will rarely cause mechanical failures. However, many mechanical failures progress into electrical failures once the radial bearings wear enough to allow the rotor to rub the stator liner. When the stator liner is breached, the motor is taken (DTE) Down To Earth or grounded.

During our motor review process and system analysis, we also track stator winding failures and their direct relation to control circuit problems. Control circuit difficulties cause winding failures through the increased internal temperatures caused by repeated high inrush current. This destroys starter and pressure switch contacts, which can lead to low voltage or single-phasing.

In the last two issues of the Franklin AID, we have reviewed how system problems contribute to motor failure. By understanding the cause and effect relationship, we hope our readers may recognize some of these system problems and be able to take the necessary steps to get the longest life from their motor. If you have any questions or need assistance, don't hesitate to contact us on **1300 FRANKLIN.**

## TOLL FREE HELP FROM A FRIEND

**Phone Franklin toll-free on 1300 FRANKLIN for answers to your installation questions on submersible pumps and motors. When you call, we will offer assistance in troubleshooting submersible systems and provide answers to your pump and motor application questions.**

**www.franklin-electric.com.au**

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