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Dealing with High/Low Line Voltage Problems

Line voltage may vary widely at an installation, especially if local or total line loading varies widely, which it often does. A certain range of such variation is acceptable, but wider variations can cause trouble. This issue discusses the problems that can be caused by improper voltage and the steps that can be taken to correct them.

Power companies in the United States commonly supply line voltages of 120, 208, 240 and 480 volts. (Power companies vary in how much they allow variation from these nominal voltages, but in general they hold to a range of plus or minus two or three percent.) On the other hand, motor nameplate voltages are 115, 200, 230 and 460 - the voltages at which motors are generally designed to perform best. The reason for these differences between rated line voltages and rated equipment voltages is to allow for a three to five percent voltage drop in the lines from the transformer to the equipment (e.g. from 240 to 230 volts, from 480 to 460 volts).

It is important to note that, in accordance with NEMA standards, motors are designed to drive their rated horsepower loads on voltages 10% above or below their nameplate rating. Even so, voltage variations within this 10% range can have some effect on motor and pump operation.

Also, experience has shown that low line voltage problems occur in the field more often than high voltage problems. This is because overall effects change more rapidly at low voltage and because low voltage occurs more often than high voltage. High horsepower single-phase motors frequently experience low voltage problems because they are often far down the line from their power source.

Effects of Improper Voltage. A list of some typical effects of voltage changes on submersible pumps follows.

High voltage - up to 110% of nameplate rating.
- Slight increase in pump delivery.
- Slight increase in motor amps.

High voltage - over 110% of nameplate rating.
- Increase in amps and pump delivery.
- Starting amps and torque are high. May blow fuses or breakers, burn out control devices, and shorten contact life. Excessive torque can loosen impellers, break shafts and unscrew drop pipe.

Low voltage - down to 90% of nameplate rating.
- Slight drop in pump delivery.
- Amps increase about the same percent as volts decrease, but they increase more if the motor loading is above its rated horsepower.

Low voltage - below 90% of nameplate rating.
- Rapid increase in amps and drop in pump delivery.
- Overload protection trips; possible motor burnout if protection is inadequate.
- Possible failure to start.
- Control contactor or relay chatter; possible motor failure.

Correction of Improper Voltage. To confirm that a voltage problem exists, the installer may need to take repeated voltmeter readings at different times of the day, or attach a recording voltmeter. To be sure that the incorrect voltage is a supply problem and not an installation problem, the voltage should be measured at the input to the motor control.

If the supply voltage is found to be incorrect, the power company should be asked to correct it. They can usually do this by one of the following means.

- Changing taps on the distribution or substation transformers.
- Changing the distribution transformer(s) to a larger size or to a special stepdown ratio.
- Adjusting supply voltages to compensate for varying line loading.

Have you registered for a seminar yet?

Our 2001 Submersible Training Seminars are fast approaching, and sessions are filling up fast. If you have not yet registered, don't wait! You can sign up online at www.franklin-electric.com, or by calling our Submersible Service Hotline at 1-800-348-2420. Below is a list of this year's dates and locations for quick reference.

October 2	Barrie, ON	**October 30**	Seattle, WA	**November 27**	Escondido, CA
October 4	Halifax, NS	**November 1**	Billings, MT	**November 27**	Columbus, OH
October 9	Spokane, WA	**November 6**	Fort Collins, CO	**November 29**	Monterrey, Mexico
October 11	Calgary, AB	**November 6**	St. Cloud, MN	**November 29**	Fresno, CA
October 16	Knoxville, TN	**November 8**	West Des Moines, IA	**November 29**	Indianapolis, IN
October 16	Mandan, ND	**November 13**	Amarillo, TX	**December 4**	Middletown, NY
October 18	Fayetteville, NC	**November 13**	Montgomery, AL	**December 4**	Oklahoma City, OK
October 18	Sioux Falls, SD	**November 15**	Fort Worth, TX	**December 6**	Portsmouth, NH
October 25	New Cumberland, PA	**November 15**	Macon, GA		
October 25	Mount Pleasant, MI	**November 27**	Guadalajara, Mexico		

In one example of a low voltage problem, a 10 horsepower, 230V, single-phase pump running at the end of a long rural power line experienced repeated overload trips and two motor failures within five years. The voltage checked at 214V and may have been lower at peak load times. The installer contacted the power company and was able to persuade them to replace the transformer with a special ratio type which raised the line voltage to 238V. The high amp loading was corrected, overload tripping stopped, and the pump is now running reliably.

In another example, the pump loading at 230V on a 10 horsepower single-phase motor was 12.2 horsepower - well above the service factor horsepower of 11.5. In the installation, line voltage was below 200V, resulting in current of 68A and overload protection tripping. Correction of the installation voltage eliminated protection tripping, but the pump design was also changed to reduce the loading and to allow more margin for operational conditions.

In summary, in all new installations and in any problem installations, the voltage should be checked with the pump running, and the power company should be contacted if the supply voltage is incorrect.

Finding Other Sources of Low Voltage. Still, there may be times when the supply voltage to a pump installation appears to be correct, but the system continues to exhibit a voltage problem: high current, protection trip-out, fuse blowing or component overload. In these situations, the installer can use the following procedures to track the problem down.

Caution: Avoid the hazard of electric shock when performing these voltage check procedures. Do not touch any metal parts of the electrical circuit. These check procedures should always be performed by a qualified electrician.

First, check the control panel. The output voltage from the control panel to the motor leads should be within two volts of the supply voltage with the motor running. If this difference is more than two volts, there is a possibility of a fault in the control panel circuit. Remember that typically the main power in a pump control panel passes through a circuit breaker or fused disconnect switch, leads and connectors, and the magnetic starter. Therefore, you can trace and isolate the cause of excessive voltage drop in the control panel by measuring the voltage at the different points on the control panel circuit.

Next, with the power turned off, examine the leads and connections of the system. If you find signs of burned insulation or discolored metal, they indicate that overheating is occurring. Clean and tighten any loose or overheating connections and make sure that the motor cable is no smaller than the size recommended for its length by the motor or pump manufacturer.

Other Solutions. If the problem is not found in the installation after these checks, and if for some reason the power company cannot or will not increase the voltage supply, the installer can turn to other methods to correct the fault.

1. *Boost transformer.* Boost transformers raise low voltage from the distribution transformer into the normal range for the installation. They are available through some electrical supply houses and power companies.

2. *Heavier cable.* Heavier cable to the pump is able to improve the system's operation when the supply voltage is low, but the gain from using heavier cable will not be large if the existing cable meets manufacturer recommendations. That is because most motor and pump recommendations limit cable voltage drop to 5% maximum. Therefore, the voltage gain at the motor at best will be well under 5%, even with much larger cable.

TOLL-FREE HELP FROM A FRIEND

Phone Franklin's toll-free SERVICE HOTLINE for answers to your installation questions on submersible pump motors. When you call, a Franklin expert will offer assistance in troubleshooting submersible systems and provide immediate answers to your motor application questions.

Franklin Electric SERVICE HOTLINE 800-348-2420 FAX 219-827-5102
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