

Irrigation Pumping Plant Safety

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Agricultural irrigation systems move large quantities of water over short periods of time, consuming and creating a significant amount of energy in the process. So these systems require caution during operation and service.

Because of the inherent risks involved with irrigation pumping plants, everyone working around these systems should be familiar with basic safety concerns and precautions. Operators who will spend significant time around irrigation pumping plants should be thoroughly familiar with the proper operating condition and parameters of all moving parts and should become aware of unusual sounds, smells, heat, vibration and installation concerns. The ability to recognize and avoid or to correct any potentially dangerous situation is the most important aspect of continued safety around irrigation pumping plants.

This publication is intended to introduce operators, technicians and irrigators to the fundamental safety requirements of irrigation pumping plants.

General Safety Issues When Working Around Irrigation Pumping Plants

Due to the mechanical nature of lifting, pressurizing and transporting water, irrigation pumping plants universally consist of rotating parts. Common rotating components include belt drives, drive shafts, fan blades, pump vanes, right-angle drives, motors, etc. Two primary

and acute safety risks associated with rotating components are 1) personal entanglement during startup and operation and 2) dislodged debris from component failure, both having the potential for severe personal injury, dismemberment and death.

To reduce these risks, guards and shields are required for all rotating or moving parts (Figure 1). Ideally, a guard or shield should prevent accidental contact with any rotating component AND be able to contain debris in the case of equipment failure. Shafts often rotate in reverse direction after disengagement, which is when component failure may occur. Slow startup of components is preferable to rapid or abrupt changes in speed or direction.



Figure 1. Irrigation pumping plant without a shield for V-belt drive.

Personal Safety When Working Around Irrigation Pumping Plants

Following safety rules and safe work practices can help prevent accidents and injuries at pumping plants, but the rules only provide protection to an individual who follows them. Owners and supervisors should provide clear direction and training to promote safe working environments and encourage all employees to keep safety as a priority. Each individual should make a commitment to operate under proper practices to ensure his or her personal safety and well-being.

Always follow these universal safety precautions:

- A person should only work on or around equipment he or she is familiar with. Irrigation pumping equipment is powerful and potentially dangerous, thus not a place to learn by mistakes. If there are questions related to irrigation pumping plants, an individual should seek advice from an irrigation dealer, electrician, Extension Service irrigation specialist or other relevant professional.
- Appropriate clothing and equipment should be worn and used at all times. Referred to as personal protective equipment, or PPE, it varies with specific circumstances. Common personal protective equipment includes, but is not limited to:

- Work clothes with long pants and long-sleeve shirts made of durable, natural materials to provide basic protection from the elements; protection from abrasion, heat and pressure jets; and resistance to fire or sparks. Clothing should be comfortable and not limit movement. Clothing should not fit loosely and be bulky, however, since that could pose a risk for entanglement.
- Sturdy closed-toe boots should be worn at all times. Steel-toe boots and/or rubber, waterproof boots should be worn when conditions merit.
- Hats should be worn when working on or around pumping plants to provide protection from the elements and keep hair secured. Hard hats should be used at all times when there is a tangible risk of falling parts. This is especially important when working on or around overhead irrigation systems.
- Eye and ear protection should be worn whenever working on or around an operating pumping plant. Properly rated American National Standards Institute and Occupational Safety and Health Administration approved safety glasses can prevent eye injury caused by pump debris and high pressure water jets. Ear plugs and/or muffs provide protection against sustained and acute noises, especially near engines.



Figure 2. Commercial drive shaft shield for engine.



Figure 3. Commercial drive shaft shield open for lubrication access.

- High-dexterity gloves are recommended at all times when working on or around irrigation pumping plants. They provide protection against heat and abrasion while not dramatically inhibiting fine motor skills. Take precautions when selecting gloves, since the synthetic fibers used in many such gloves are highly flammable.

- Stop and look at the irrigation pumping plant before approaching it. Look for unsafe conditions and/or things that do not look normal. Perform a quick site inspection to make sure all items are in the proper working condition and that the area is safe to work in. Listen for sounds that do not seem normal. If a pump is not operational, look to see why – before approaching it. There could be a short circuit or electrocution hazard a considerable distance from the pumping plant. Be aware of footing conditions around an irrigation pumping plant, since there typically is a mixture of wet ground and various oil and grease products. Many workplace hazards are the result of an inadvertent slip that leads to a much more significant accident. Shovel dry soil into specific areas where sustained work will be performed to minimize this risk. Consider nonslip permanent concrete work surfaces where it is not possible to maintain dry level surfaces. Direct air-vacuum breaker discharges away from the irrigation pumping plant. Repair leaking components



Figure 4. Drive shaft shield made from 10-inch diameter PVC pipe.

such as check valves and pressure reliefs (Figure 7).

- Maintain a safe distance and a proper body position when starting an irrigation engine, motor or system. For example, never reach over a drive shaft or belt to start an engine or adjust the speed. On electric motors or drives, stand clear of the panel door (not in front of it) and start the motor using only one hand, typically the left hand. Shields and covers should be in place for any rotating parts. (See Figures 2-5 for examples.)

- Be careful around hot surfaces such as exhaust manifolds, bearings (especially those that are worn), panels, oil lines, fuel lines and electric motors. Wear gloves appropriate for servicing hot engines.

- Take special precaution when working near pressurized hydraulic systems (water and hydraulic fluid). High-pressure streams can cause severe injuries and death if the stream hits exposed areas of soft tissue such as the eyes or unprotected skin (Figure 6).



Figure 5. Self-made drive shaft shield constructed to allow lubrication access.



Figure 6. Injury from water jet.

- Use fall protection measures and devices when working at a standing height of 5 feet above ground, such as when working on overhead irrigation systems. Occupational Safety and Health Administration approved harnesses and rigging should be used to protect against the danger of falls.

- Use safe lifting methods when lifting irrigation system components, especially heavier items such as pumps, pipes and poly tube rolls. Use lifting equipment or rigging for very heavy equipment. If you have to manually lift or handle heavy objects, use safe lifting practices to reduce the chance of a back injury:

- Bend your knees while keeping your back straight.
- Get a firm grip on the object to be lifted.
- Stand up using the strength of your leg muscles to lift the object while keeping your back straight.

Electrical Safety When Working Around Irrigation Pumping Plants

Electricity is a common power source for irrigation pumping plants, primarily due to ease of use and cost effectiveness. Although electricity generally is considered a safe power source, electric irrigation pumping plants can present particularly hazardous conditions.

The increased hazards result from the presence of high voltage and water combined with unprotected exposure to the elements and an increased probability of deferred maintenance (Figure 8 and Figure 9). This is further compounded in agricultural areas where electrical codes may not be mandated or followed.

The most common safety issues with electric service at irrigation pumping plants include:

- Service entries, panels, fuses and contacts that have exceeded their useful life.
- Loose connections, exposed wires and open conduit.
- Poor or nonexistent circuit and panel grounding.
- Water leaks, valves and air relief ports that face control panels and electric motors.



Figure 7. Electric motors and pumps can create unsafe and dangerous conditions. In this case, a leaking check valve is spraying a deteriorated power cable, which could lead to a shock or electrocution hazard if the wire insulation or motor failed. Wet conditions near the pump also create slipping hazards.

More than a thousand people are killed each year in the United States due to electric current, and several thousand more are injured. High voltage accidents can cause deep burns, cardiac arrest and death. Electric current often causes involuntary



Figure 8. Failed conduit and exposed conductors allow moisture, dust and insects to enter the enclosure. This is an unsafe condition and should be corrected. The enclosure is rusted and worn and it retains more heat than when new, contributing to degradation of the internal components and insulation.

and sustained contraction of the muscles, which means victims cannot physically let go of the current source. The brain and the heart are the most sensitive organs, and alternating current, or AC, with a voltage of 480 volts can penetrate and burn skin. While 110 volts may or may not result in a dangerous current, contact with 600 volts

and higher almost always results in serious physical harm or death.

An arc flash is a flash of light and heat (up to 35,000 degrees Fahrenheit) produced by an electrical arc from a low resistance connection between a ground and a voltage phase. An arc can cause electrical equipment to explode and can vaporize copper and insulation instantly. The risk of an arc flash is low on 208- and 220-volt systems, but high on 480-volt systems. Care should be taken working on an irrigation pump panel to ensure an arc flash is not created which could cause blindness, deafness and first- and second-degree burns.

It is **strongly recommended** to use licensed electricians when access to a high-voltage panel is required. Any time a motor control panel is to be opened for inspection, service or operation troubleshooting, follow these precautions:

- Never work alone around high-voltage electrical equipment. Have an assistant or someone else with you who can observe potential risks, shut down power or seek medical attention, if necessary. If a person is caught in an electrical circuit,



Figure 9. Broken main contact switch in a pump panel (left). Broken parts kept contact closed even though switch moved between on and off positions (right).

the assistant should never attempt to free him or her until all electrical power is stopped and the circuit is de-energized. The assistant also is vulnerable to being caught in the same circuit as the victim.

- De-energize equipment before beginning service work. Make sure the controls adequately prevent operation (lock-out, tag-out procedures) and all stored energy is dissipated prior to working on the system. Check voltage with a voltage meter before proceeding, checking each leg to an earth ground and checking human contact points for stray voltage (on/off switches, panel locks, latches, etc.). On newer systems, a main disconnect may be located near the meter. Don't assume a switch or lever de-energizes! Always check with a meter first before touching a cabinet or motor.

- All electrical panels should be approached from the side away from the swing of the panel door to ensure the person inspecting the panel is free from a swinging door and flash path in the case of an electrical explosion. For most agricultural panel boxes, this will require a person to approach the panel on the right side and work on the panel using his or her left hand – again, standing clear of the door path.

- Inspect live circuits for stray voltage by placing one lead of a voltage meter into the ground and specifically checking the human contact points. 0-1 VAC stray voltage is common, but stray voltage reaching 5 VAC is a sign of possible danger, indicating the circuit should be mechanically inspected in a de-energized condition. A less precise testing method is to lightly swipe the back of the hand across panels and control boxes prior to working on them, with the slightest sign of electrical shock or tingling indicating stray voltage. This test is not endorsed, but using the back of the hand is reasonably better than addressing the electrical components with the palm side of the hand because a shock will cause the hand to close and break free of the circuit rather than contract and lock onto the circuit. Further, it is highly advisable to only touch any panel or control box with one hand to reduce the risk of completing a circuit.

- Wear rubber-sole boots and stand on dry plywood (or a pallet) or other nonconductive material when working in front of an electrical cabinet to provide additional insulation from stray or direct shock, especially in the case of wet soil.

- All equipment used should be rated for 600-1,000 volts and class 0 for irrigation systems. Most older digital multimeters are only rated to 600 volts, although this can be exceeded in rare cases. It is highly recommended that True RMS (root mean square) clamp meters rated for 1,000 volts for CAT II or 600 volts for CAT III or higher be used when working on electrical irrigation pumping plants. CAT III meters are superior to CAT I and CAT II equipment.

- Where applicable, electrical specific personal protective equipment should be used. Determining whether or not this PPE equipment is needed depends on the arc flash risk. To determine the level of protection needed, an arc flash hazard analysis should be conducted. There may be a sticker indicating the hazard risk category of protection needed on newer panels. Generally, if a live panel is going to be accessed, or voltage or current measurements will be taken, PPE that is rated for hazard risk category level 2 is needed and should provide adequate protection for most irrigation pumping plants less than 200 horsepower with fused or breaker protection. Keep in mind, however, that variable frequency drive pump panels often are protected with breakers and have a much higher arc flash hazard than traditional fuse-protected pump panels. All of the recommended items listed below can be obtained online or at electrical equipment dealers:

- Face shield or hood, especially where an arc flash is possible.

- Gown/shirt/jacket/overalls/coveralls. Special nonconductive arc flash garments are available and should be worn. Get clothing that is specially rated to retard fire exposure. It is rated in "cal" or calories per centimeters. Minimum cal/cm is 8 cal.

- Safety glasses.
- Ear plugs.
- Face shield and hard hat.
- Hood or balaclava.
- Gloves for working in high-voltage cabinets should be used if the cabinet is to be accessed. Class 0 gloves are rated for 1,000 volts, which is the nominal voltage expected in an irrigation pumping plant. These gloves often include an inner rubber liner and an outer leather protector. Some gloves have contrasting colors so they can be checked for damage from abrasion or tears. Gloves that have been damaged should be discarded.
- Dielectric or insulated shoes or rubber boots.
- Remove conductive jewelry, clothing or accessory items such as pocket knives and pliers that could come into contact with live circuits while you are working.
- Install probes and equipment with power off, when possible. Use alligator clamps instead of probes when doing tests. Connect ground probes first and double-check to make sure they have made a solid connection and will not come loose accidentally.
- Do not stand in front of panel to conduct testing, unless absolutely necessary. If equipment allows, conduct tests while standing to the side of the panel in the event a short occurs by accident (such as by an alligator clip that has come loose). The risk of harm is much less with greater distance between you and the conductors or anywhere an arc flash could occur.
- If there is any concern about the safety or condition of the panel when attempting a test, evaluation or regular maintenance, contact a licensed electrician and the utility company to be sure the equipment is in safe operating condition.

Designing for Safety and Reliability Lowers Cost By Extending Operational Life Expectancy of the Irrigation System.

- Use components properly rated for the operating pressures, chemical resistance and expected loads to minimize early system failures.
- Bring the system up to operating condition and speed gradually to minimize “water hammer” effects that fatigue pipes and other components. Engage clutches only when an engine is at idle after it has warmed up. Be sure valves are open before starting a pump for a test. Water can boil and become superheated if forced to remain in an active pump.
- Components must be selected that fit field conditions. For example, using non-UV resistance PVC pipe outdoors or burying untreated aluminum pipe will result in unsafe early system deterioration and unexpected failure. Such failures often lead to hazardous conditions.

Summary

Irrigation pumping plants can be dangerous environments because of wet conditions and moving parts coupled with oil, grease and electricity. Exercise care and preventive maintenance to maintain safe operating conditions near pumping plants. Accessing electric pump panels should be done by trained professionals. If you must access them, however, for testing or troubleshooting, use extreme care in checking for stray voltage and wear appropriate personal protective equipment. Recognize unsafe conditions and correct them before they lead to an accident.

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