Understanding Irrigation Electrical Safety for NRCS Employees

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Understanding Irrigation Electrical Safety for NRCS Employees

- Part 1: Why are we concerned? (A separate webinar)
  - Safety rules & regulations you need to be aware of
  - Human response to electrical current
  - Types of irrigation electrical safety hazards

- Part 2: How to be safe in the field
  - Understand the equipment and how it connects together
  - Identify suspect equipment installation, potentially unsafe conditions and hazardous conditions.
  - Understand the safe work practices, PPP, PPE and how to apply them to keep yourself safe.

Irrigation Systems Contain

- **A Pumping System**
  - One or more pumps generally powered by fossil fuel engines or electric motors.
  - Connects to water distribution system and ultimately to irrigation system.

- **An Irrigation (Distribution) System**
  - Many different types (ditch, gated pipe, center pivots, side-roll, big-gun, etc.), many utilizing electrical powered motors and drive-trains to move the system over/across the field.

Visually Inspect the System/Area

- Locate the disconnect switches for the irrigation equipment
  - pump(s), irrigation machine(s), other equipment
- Look for missing lids & enclosure covers exposing live electrical parts.
- Look for damage from equipment or livestock on exposed electrical panels and cords.
- Look for missing guards on moving and rotating equipment.

Look for Damaged Equipment & Other Hazards

- **Damaged Equipment**
  - Damaged insulation on cords and cables
  - Cords laying unprotected on the ground.
  - Damaged enclosures
    - Lids that don't close or holes in the enclosures
    - Water in enclosures
    - Enclosures or equipment laying unprotected on the ground
- **Missing Guards/Covers**

Is there a good chance for this cord to be damaged due to it's location?

It deserves a visual inspection to determine if there is any damage

Irrigation System Maintenance

- The second link the irrigation safety chain involves maintaining properly installed systems in good shape.
- Many irrigation systems are poorly maintained and fall into states of disrepair.
- Many systems have been modified or repaired using sub-standard equipment.
- Example:
  - Unprotected conductors/connections exposed to water and people
  - No equipment grounding conductor
  - Improper cord/plug connection
  - Unprotected motor exposed to moisture
  - Motor not attached to solid base/anchor

Damaged Electrical Power Cords

- Areas to look for include:
  - Cords run unprotected on top of the ground exposing them to damage.
  - Obvious physical damage to the outside of the cord.
  - Areas of damage where the conductors inside the insulation are exposed.
  - Areas that have been covered with electrical tape or similar materials.
  - Indoor extension cords with thin outer coverings that were not meant to be used outdoors and subjected to physical damage.

Unprotected Cords Exposed to Damage

Damaged Electrical Power Cords

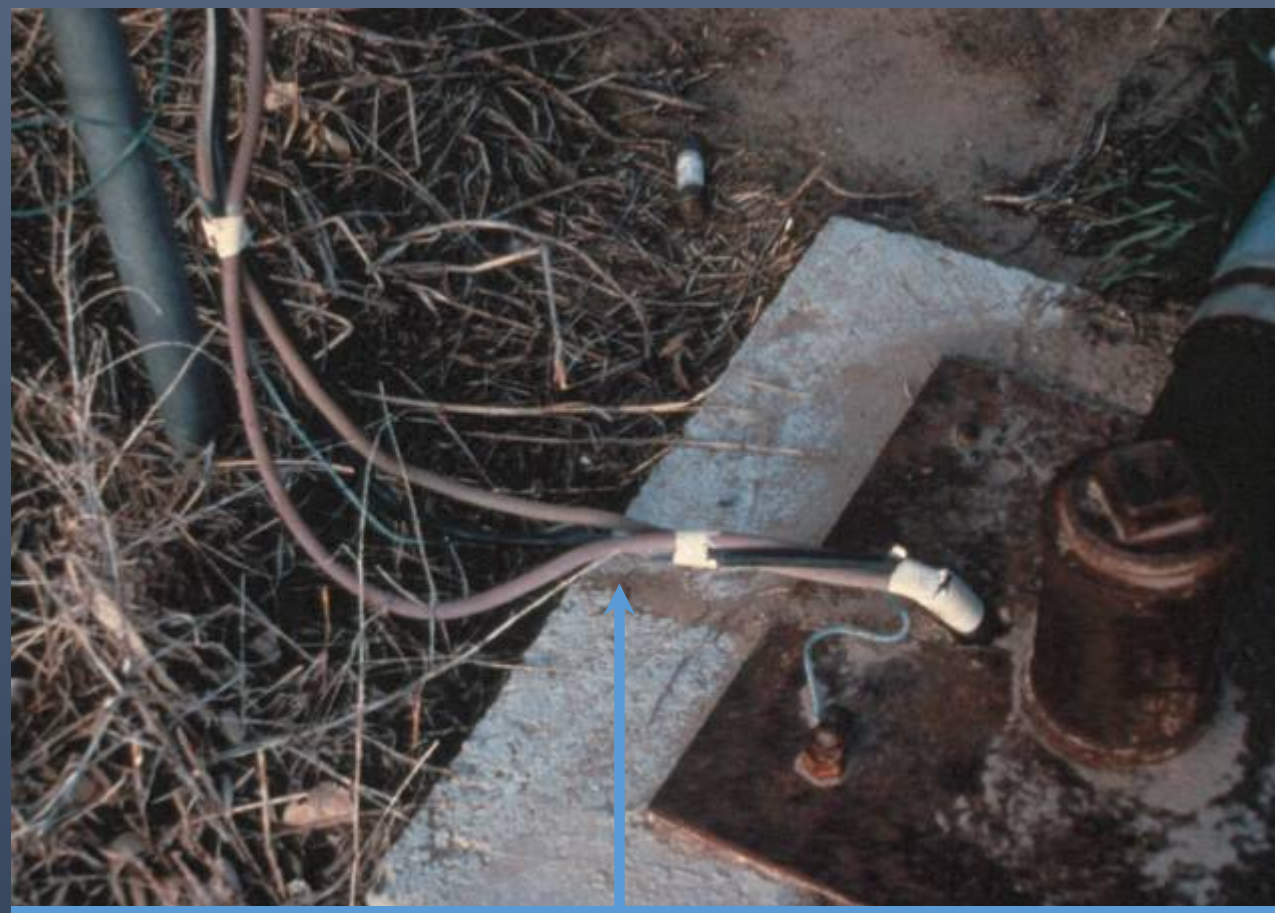
- Contrary to popular opinion……Electrical tape is **NOT** meant to fix extension or power cords with gouges or cuts exposing bare wire.
- Electrical tape does have many useful purposes in concealed wiring….but it is not meant for exposed wiring, especially in wet areas.
  - It’s not rated as an insulating material.
  - It’s not watertight.

Taped Power Cord

Power Cord Insulation

- When power cord or conductor insulation is damaged, the result can be energization of equipment from the bare electrical conductors being contacted or coming in contact with humans, water puddles, or damp soil.
- What can you identify as potential concerns from visual inspection of this installation?
  - Are the electrical conductors protected from damage?
  - What might tape around wires mean?
  - Do the electrical conductors go through a proper clamp for the purpose where they disappear or is that a sharp unprotected metal edge?

Would your mother allow you to wire things like this at her house



Unprotected individual power conductors subject to damage.

Electrical Power Cords On Equipment

- Power cords on irrigation systems are exposed and subjected to the elements and in some cases physical damage so their insulation is more prone to damage than that of cables inside conduit or buried underground.
- Be alert for damaged areas of power cords exposing the conductors.
- Another frequent problem is lack of proper cord connectors supporting the cord where it goes into motors and other enclosures.
  - Sharp metal edges of the entrance points can damage the conductor insulation.

Cord Damage With Tape Coming Off

Broken/Separated/Corroded Electrical Conduit

- Sharp metal edges on broken or separated electrical conduit can cut conductor insulation and cause electrical shorts to the metal conduit energizing any metal equipment or structure connected to it.
- If the system was not wired properly and was relying on the metallic conduit for the equipment grounding conductor, the break in the conduit would render the equipment grounding useless.

Damaged Conductors with Tape

Broken Conduit Joint

Broken/Separated/Corroded Electrical Conduit

- Look for metallic conduit that has deteriorated, broken or pulled apart at joints exposing the electrical wires inside to the sharp metal edges and possibly cutting into them.
- Sometimes when new pumps or machines are installed there is a lack of attention paid to the condition of the ancillary electrical infrastructure, panels and control boxes.

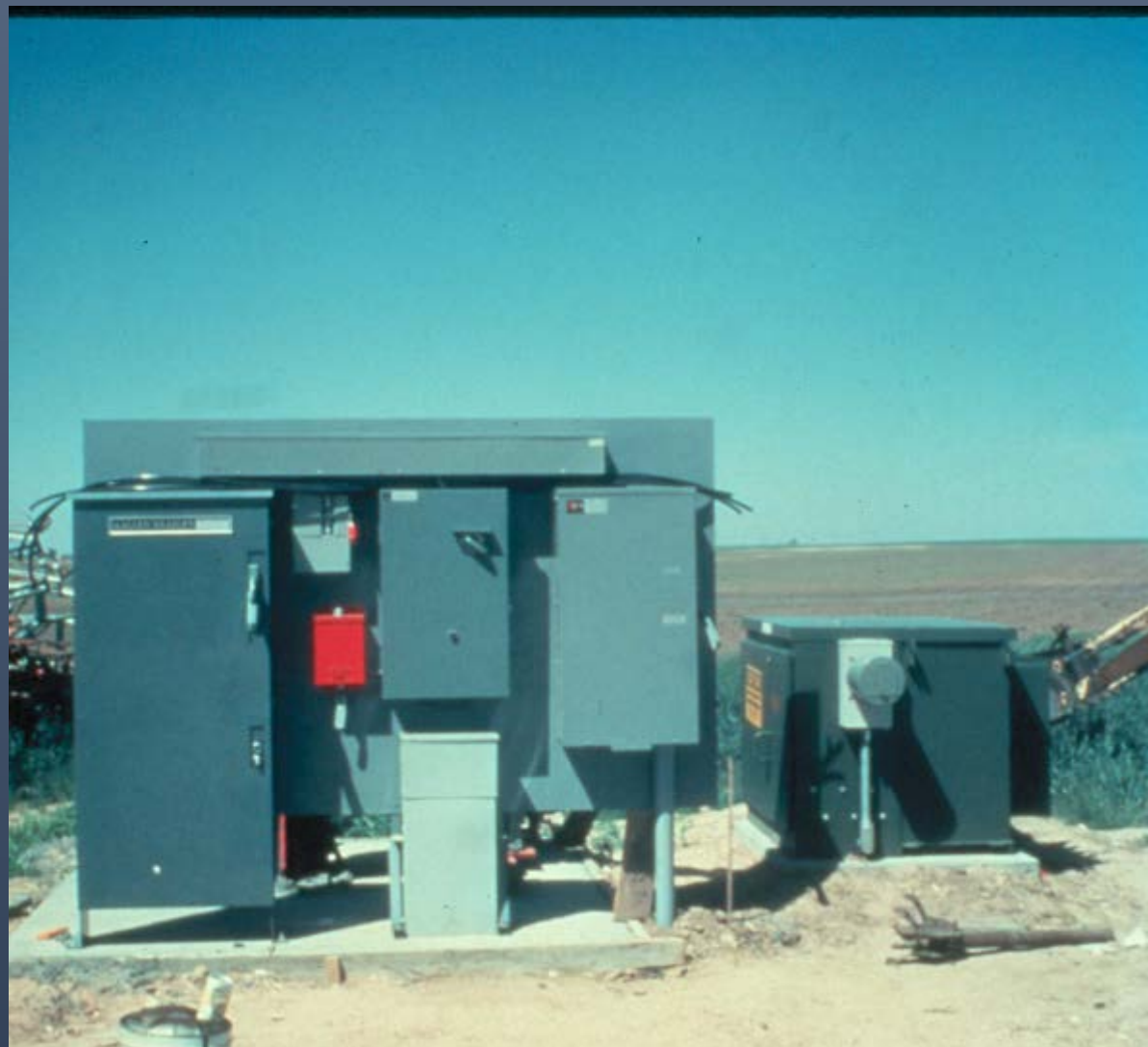
Old Corroded & Broken Conduit

Electrical Disconnects

- Electrically powered irrigation pumps and irrigation machines are both required to have an electrical disconnect switch within sight of and within 50 feet of the equipment it operates that turns off the electrical power to the equipment.
- Provides a convenient location to shut off the power for safe inspection, maintenance and repair of the equipment.

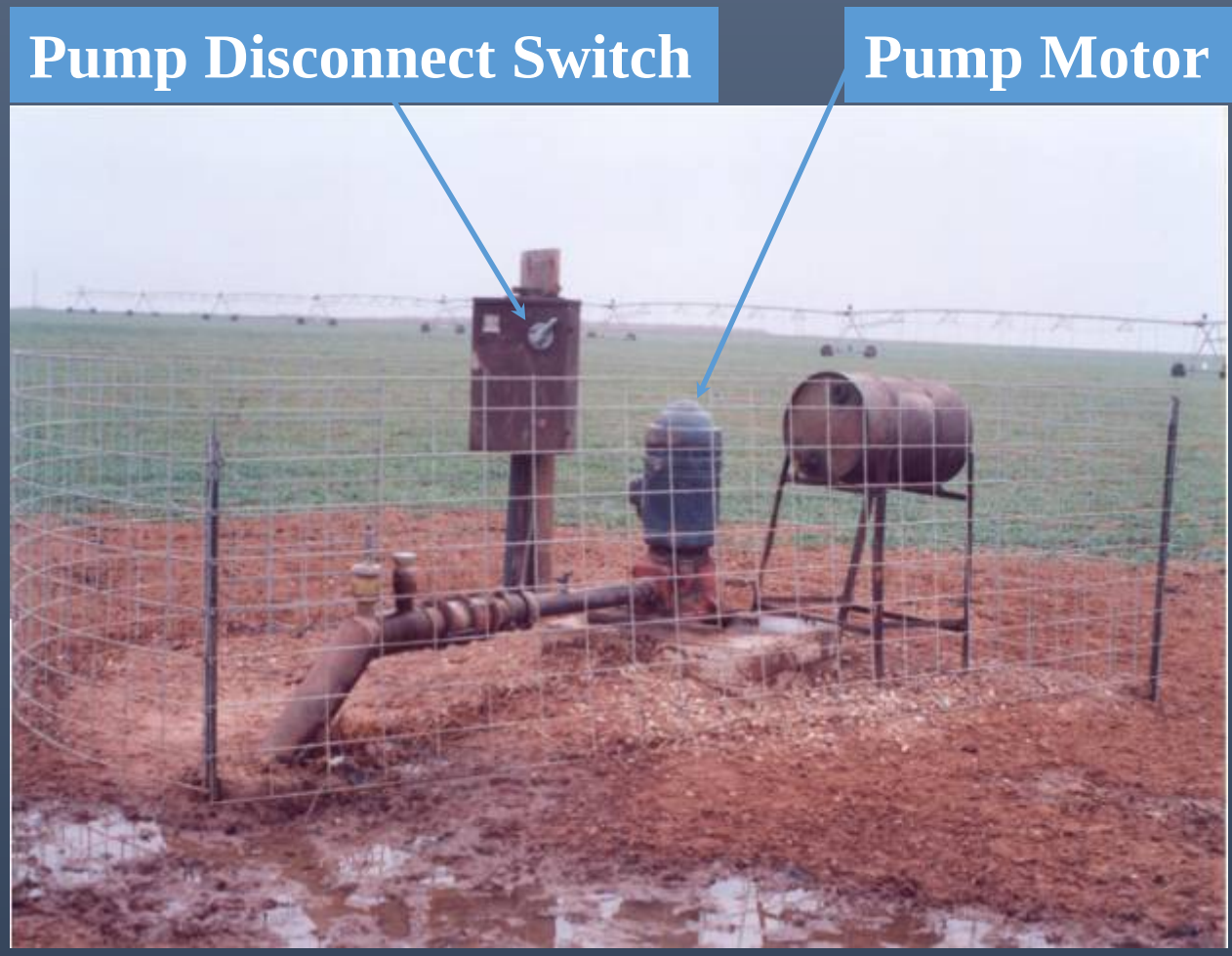
Locate the Electrical Disconnects

- Always identify the electrical disconnects for the equipment you are going to do inspection, maintenance or repair on.
  - Look for labeling/evaluate layout of system.
  - The NEC requires the disconnect switches to be labeled for the equipment they operate
  - How often do you suppose that happens in ag irrigation systems?
  - Depends on the inspection requirements.
  - Sometimes they have “come off”
  - Ask the Land-Owner/Manager if you are unsure.



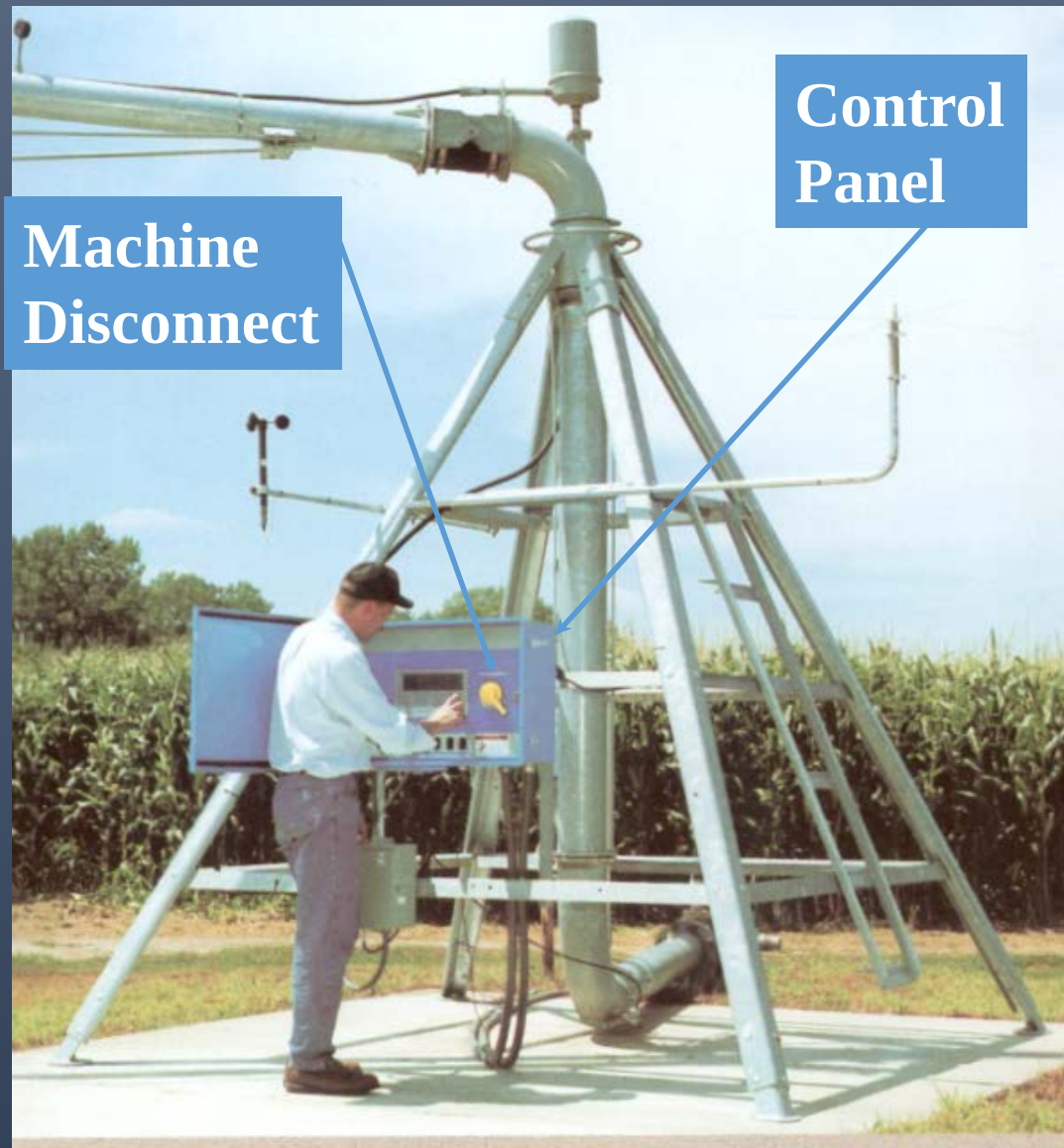
Pumping System Disconnect

- The disconnect switch for the pump should only control the pump motor.
- Equipment such as irrigation machines or fertilizer or chemical injectors and other ancillary equipment should not be supplied from the load side of the pump disconnect through the pump disconnect switch.
- They should be supplied from ahead of the pump disconnect switch if they are in close proximity to each other.
- Similar to any other motor, the NEC requires the disconnecting switch be within sight of and within 50 feet of the motor.



Irrigation Machine Disconnect

- The NEC requires irrigation machines to have a disconnect switch with overcurrent protection (fuses) capable of being locked in the open position at the point of connection of electric power to the machine.
- The irrigation machine disconnect in a center pivot will typically be inside the main control panel.
- There could be an optional disconnect switch within 50 feet of the control panel to shut power off to the control panel for inspection, maintenance and repair.



Machine Disconnect Switch

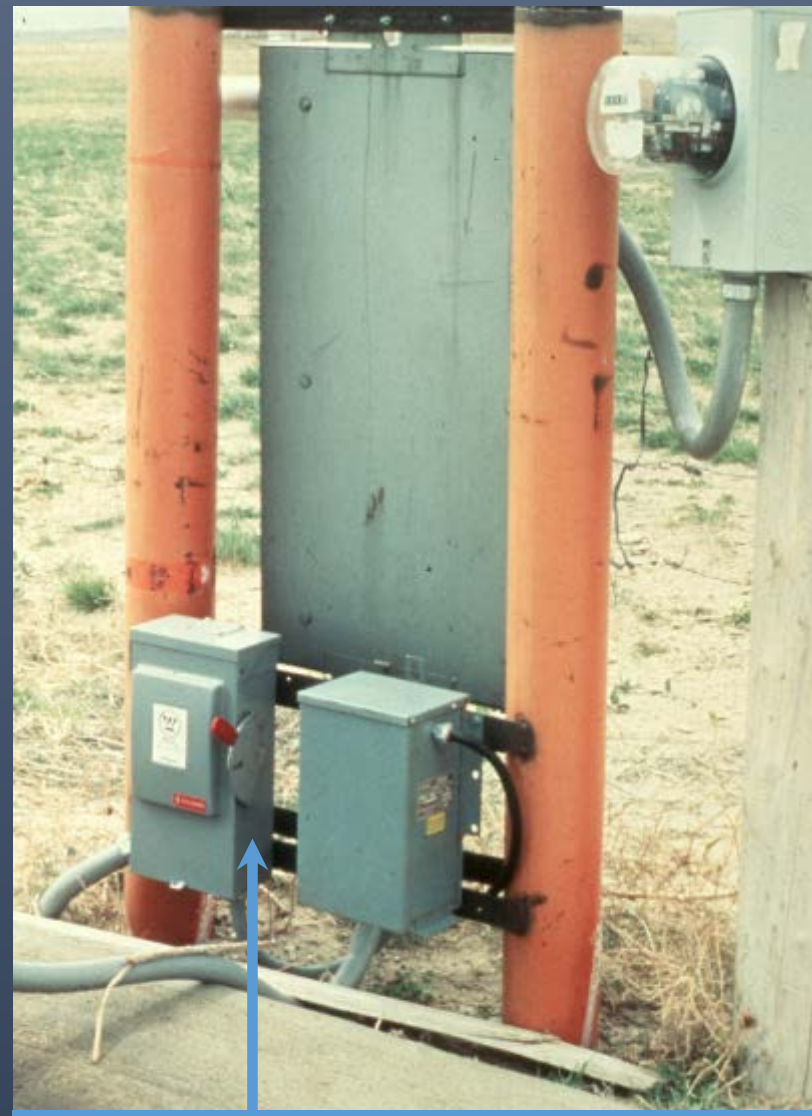
- Allows power to be turned off safely to the entire machine from one location.
- Allows the power to be “locked” off for maintenance & repair.
- Does it also de-energize the pump(s)?
  - Not necessarily……..although it could be set up that way.

Irrigation Machine Control Panel

Disconnect Switch

Switches/Controls

- Should be mounted at a height to prevent the need for kneeling or climbing to operate the switch/controls.
- NEC rules dictate the handles for disconnects must not be higher than 6.5 feet or lower than 3 feet.
- All switches must be permanently labeled for their function and use.
  - Examples:
    - Pivot/Sprinkler System
    - Water Pump
    - Injection Pump
    - Booster Pump
    - Etc.



Switch Mounted Too Low

Inadequate Working Space

- The NEC requires equipment have adequate working space for people to work on it.
  - Mounting height is important.
  - You should never have to bend over, kneel or lay on your back, side or stomach to operate a switch, or other control device.

Door will not open far enough to allow someone to safely replace fuses.

Electrical Enclosures

- Electrical enclosures and boxes are used to guard operators from live electrical parts (electrical connections, switching mechanisms, etc) in the pump control panel, irrigation machine control panel, and other related electrical devices.
  - Irrigation generally requires “weather-proof” or “water-proof” enclosures.
  - Look for holes and openings that allow rodents and/or water and other foreign materials to enter and accumulate in panels and other enclosures.
  - Should not have openings that allow water, dirt or rodents.
  - Should be solidly mounted to a physical structure for protection
  - Proper connectors/terminations should be used to protect the conductors from the sharp metal edges where they go in and out of the enclosure.

Weather-proof switch and enclosure
Note: Openings are unsealed and it is not installed at the required height or mounted to a permanent structure.

Irrigation Machine Circuit/System Grounding

- Grounding
  - A grounding conductor and ground rod used for no other purpose than for machine grounding shall be used.
- All irrigation machines whether permanently installed or portable should have a copper ground wire run from the control panel to an 8 foot ground rod installed in the soil.
  - Primary purpose is lightning protection for the system.
  - It should run directly along the structure and not be wrapped as pictured.

Tingles

- If you suspect an electrical short or other problem due to a “tingle”…..
  - Do not touch the machine again.
  - Contact the owner or manager and inform them of the incident and suggest they have a competent electrician check the system for any problems.
  - Document the date, time and location of both the shock and the communications to the owner or manager, etc.

NEC Article 120 Establishing an Electrically Safe Work Condition

- 120.2 Work On or Near Deenergized Electrical Conductors or Circuit Parts That Have Lockout/Tagout Devices Applied.
- (A) General. All electrical circuit conductors and circuit parts shall be considered energized until the source(s) of energy is (are) removed, at which time they shall be considered de-energized.
- Electrical conductors and circuit parts that have been disconnected, but not under lockout/tagout, tested, and grounded (where appropriate) shall not be considered to be in an electrically safe work condition, and safe work practices appropriate for the circuit voltage and energy level shall be used.
- Each employer shall identify, document, and implement lockout/tagout procedures to safeguard employees from exposure to electrical hazards while they are working on or near de-energized electrical conductors or circuit parts that are likely to result in injury from inadvertent or accidental contact or equipment failure.
- Lockout/tagout requirements shall apply to all equipment including temporary equipment and portable equipment.

Personal Protective Practice: Lockout/Tagout

- Personal Protection Practice required by OSHA and explained in NFPA 70E.
  - Always remove and disable the energy source from equipment before performing inspection, repair or maintenance.
  - Means of ensuring electrical and other energy is off and others cannot turn it back on accidentally.
  - Most basic safety work practice after visual inspection of area.
- Lock and tag the energy source off so conductors are de-energized and equipment can't come back on un-expectedly.
  - Other people might notice the system is "off" and think they are being helpful in turning it back on.
  - Applies to all sources of "energy"….not just electricity.

Lockout/Tagout Procedures

- Analyze the equipment to determine where the energy system disconnect switch(es) are that will remove all energy from the system.
- A qualified person shuts down the system (turns power off) to remove the energy.
- All people involved apply their own padlock to the controls or switch to indicate who is working on the system and it cannot be turned back on until everyone has finished their work.
- Tags can be used in some instances under certain conditions in complex operations or if a lockable disconnect is not provided. (better than nothing)
- Only the person applying the lock/tag may remove it under normal conditions. (You are the only one that can remove your lock!)

Lockout/Tagout (LOTO)

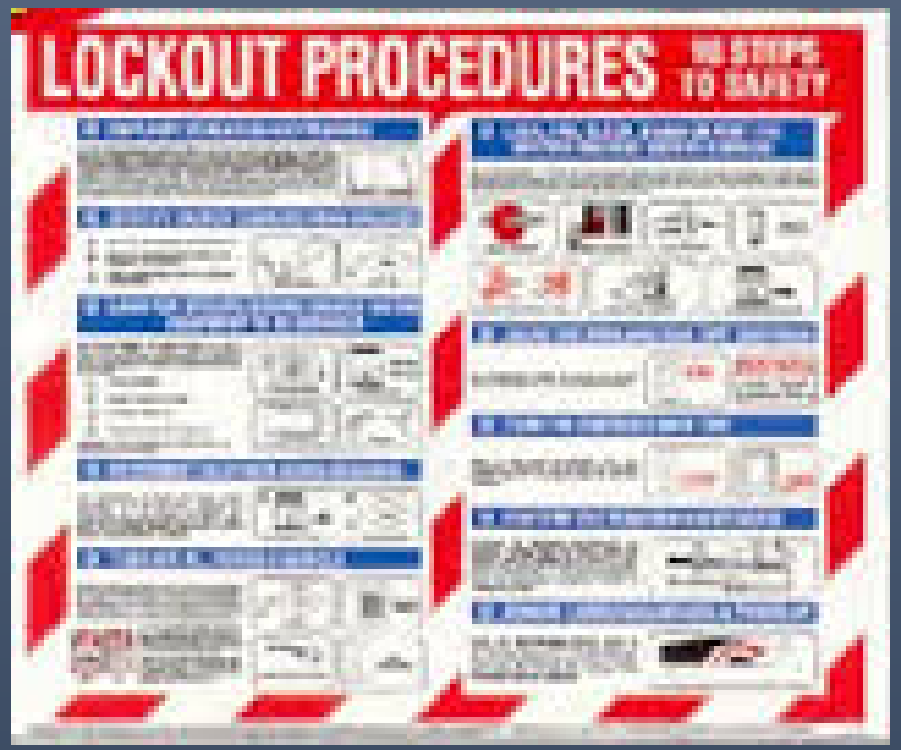
- Your lock AND tag is the best way to ensure your safety.
  - Your lock prevents others from re-energizing the system…you are the only one with the key/combination to your lock or authorized to remove your lock unless certain conditions (spelled out in the LOTO policy) have taken place.
  - Your tag identifies you, the date you placed it and what you are doing.
  - Multiple locks and tags identify all the individuals involved in the work and operation of the system.
- Tags Only
  - If adding a locking mechanism creates a higher danger than simply using a tag…..allowances can be made (within the written LOTO policy) to allow for use of only a tag.
  - Everyone onsite must be understand the policies and rules and abide by them.

OSHA Lockout/Tagout Principles

- Individual Control (No tag or lock)
  - Device is under exclusive control of the individual performing service and never left unattended.
  - You are the only one there and you can always see the disconnect switch and it is always within your arms reach.
- Simple LOTO
  - Straightforward set of conditions may involve multiple people on the same site, there is generally one device to disconnect power (may be multiple energy sources), for a short time/only one shift, etc.
  - You are not the only one on site and the switch is outside your arms reach at any time you are on the site with other people.
- Complex LOTO
  - Involves multiple employees from multiple companies, multiple machines, multiple energy sources or multiple shifts and shift changes.
  - Irrigation system AND pump, Owner or employers and You, Electric irrigation system and diesel pumping plant drive, etc.

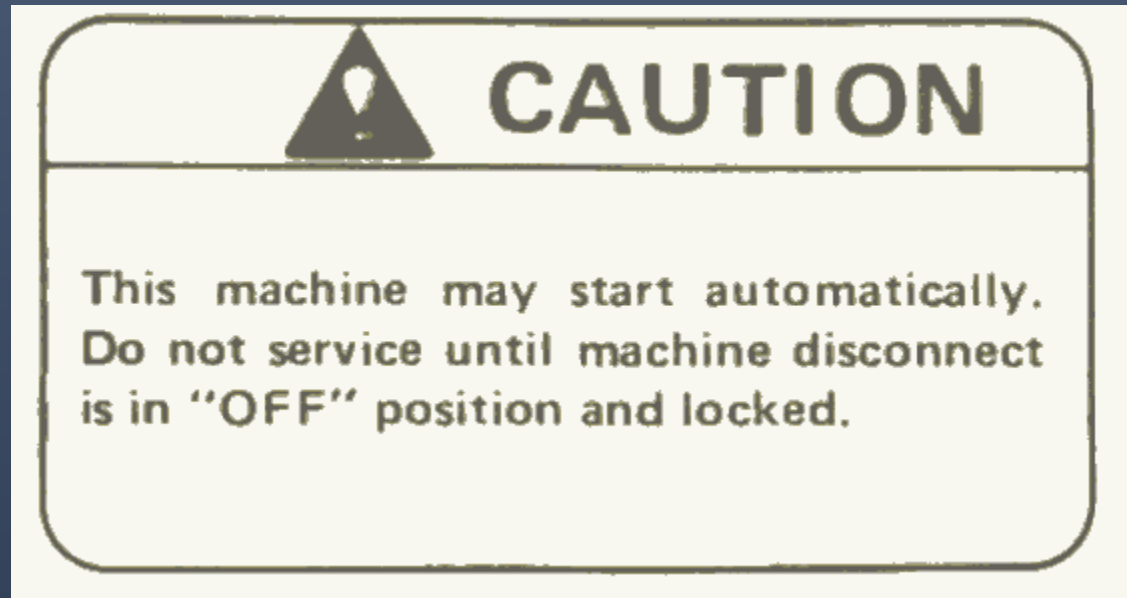
Complex Procedures

- Requires a written plan of execution that identifies a person in charge.
- Multiple locks (one for each person) or comparable mechanism.
- Methods to account for personnel when they are not on site. (leave for parts, etc.)
- How many Ag Producers have a written LOTO plan?
  - Remember the Ag Exemption?



Always De-energize Equipment

- Removing the source of energy removes concerns for:
- Electrical shocks
- Unplanned equipment startups while people are inspecting or working on the equipment.
- Accidental or un-expected sudden starting of irrigation related electrical equipment is a major contributor to irrigation accidents.
  - You MUST de-energize equipment prior to physical inspection or working on equipment in order to do it safely.
  - Lockout/Tagout procedures should be followed.



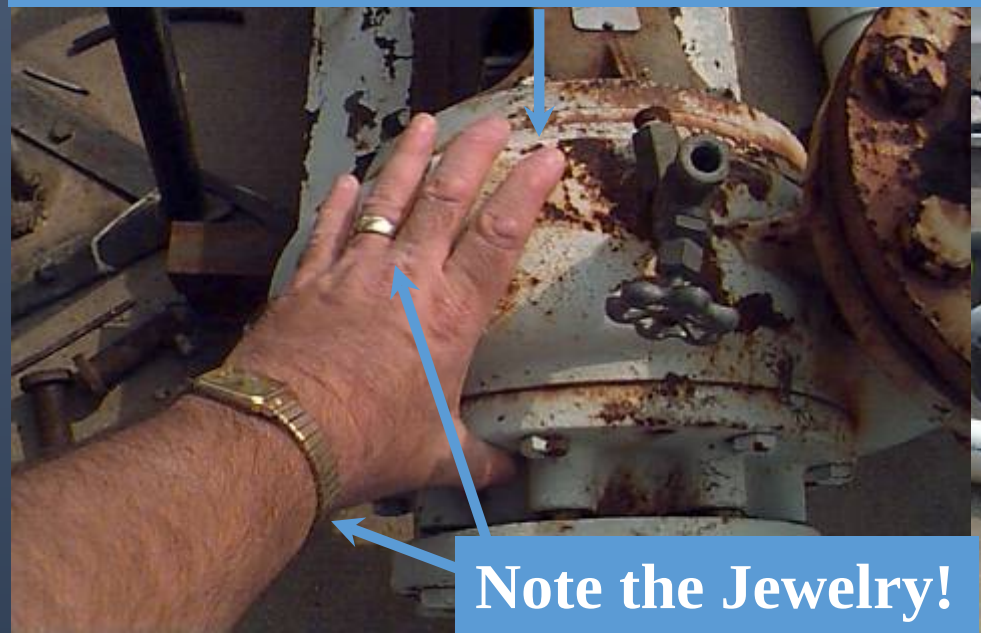
Question?

- Which disconnects (pump or irrigation machine) should be shut off while performing inspection, maintenance or repair on an irrigation system?
- **Answer:**
- Both the pump AND irrigation machine disconnects should be shut off…….the pump and irrigation machine may be electrically connected through metal piping, water in the pipes or puddles on the ground.
- Shutting both the pump(s) AND irrigation machine(s) off ensures the entire interconnected system is de-energized.

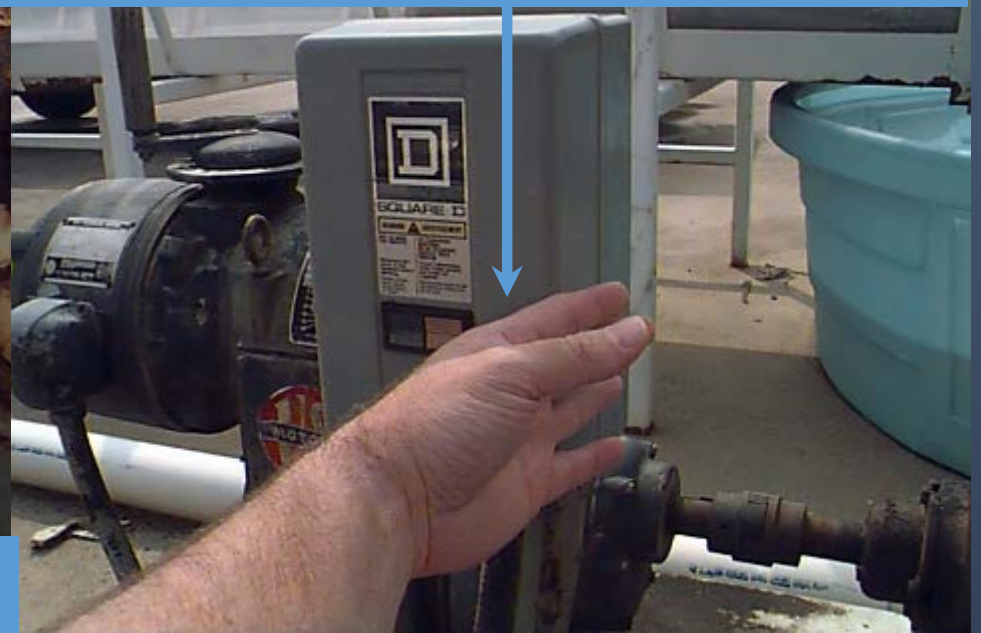
Back-Hand the System

- Make it a practice to always lightly brush the BACK of your hand against any irrigation system metal structure or enclosure before grasping with your palm.
- Grasping an energized metal structure member will cause your hand to clamp around it.

Don't test this way!



Do Test This Way.



Electrical Hazard - Entanglements

- OSHA does not require driveshaft covers on center pivot irrigation machines.
  - Slow rotation speed.
  - Per OSHA, the operator is supposed to disconnect the power prior to any maintenance or repair work on the system. (LOCKOUT/TAGOUT)
  - Most manufacturer's install them to prevent crop wrappage.
  - Older machines may not have them.
  - Never attempt to remove vegetation or other foreign materials from equipment that has not had LOTO applied.
- Question: What is our safety concern then?
  - Ag Exemption to OSHA Lockout/Tagout
  - Entanglement deaths and loss of limbs have happened from people trying to "beat the clock".

Machine with telescoping driveline covers

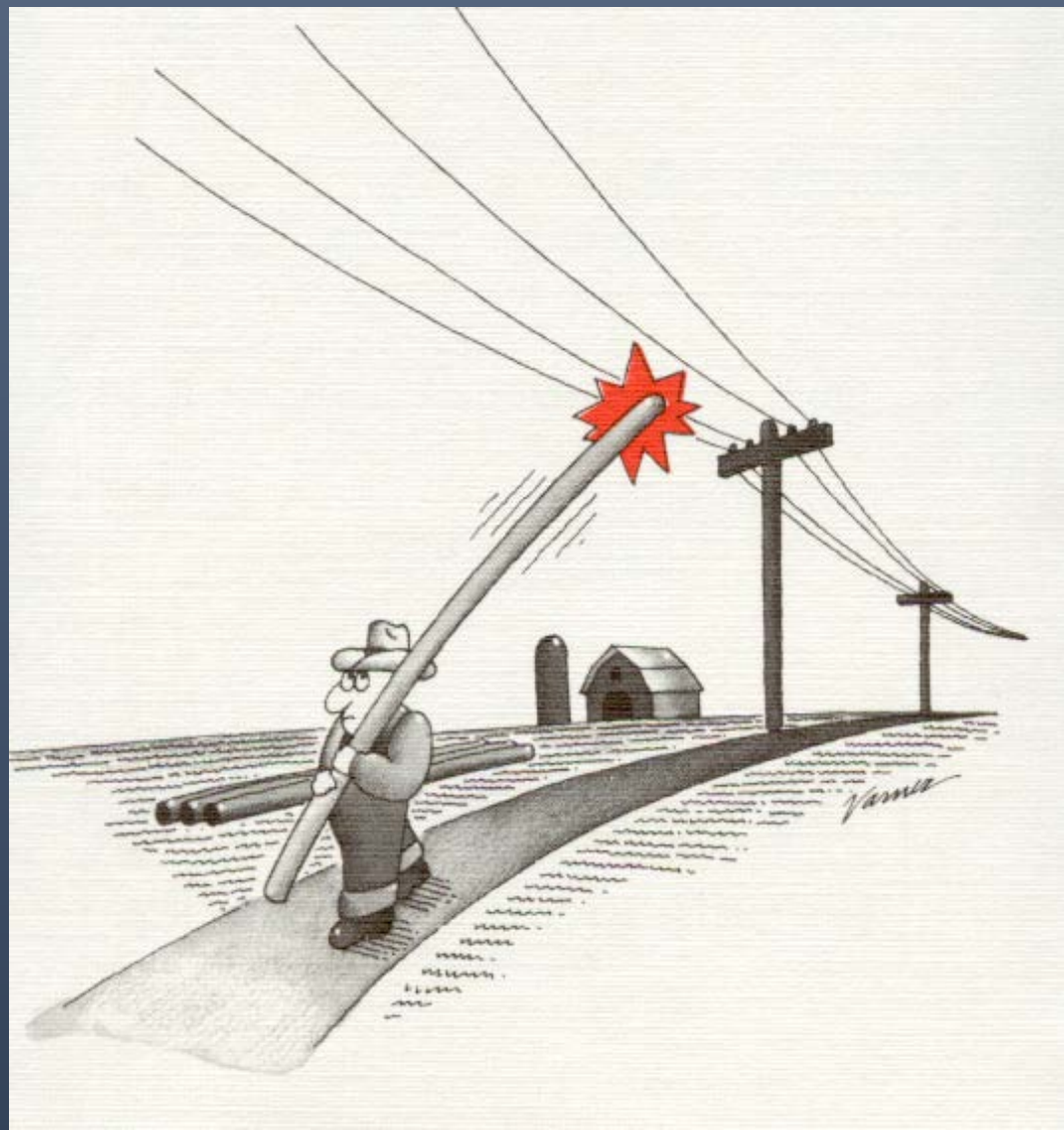
Other PPP for Electrical Hazards - Lightning

- Take a quarter mile system (or more) of metal pipe, mount it on electrically driven wheels, connect a water pumping system to it and the ground….
- You have a very effective lighting rod.
- Stay away from self-propelled irrigation machines during storms.
- Large metal irrigation structures of all types make good paths to ground/soil and they tend to be large lightning “receptors” due to their height in the fields

Graphic courtesy University of Nebraska Cooperative Extension Service

Other PPP: Electrical Hazard - Overhead Power Lines

- Irrigation concerns with overhead power lines include:
  - Lifting aluminum irrigation pipe into overhead power lines.
  - Standing on irrigation systems while performing maintenance near overhead power lines.
  - Well drilling trucks/booms drilling wells close to overhead power lines.
- Be aware of your surroundings and the location(s) of overhead power lines on the property.



Electrical Hazard
Spraying Water on Power Lines

- Don’t touch irrigation systems while they are spraying water on power lines.
  - Alert the system owner and/or the power company.
  - Distance, stream size, water conductivity and voltage ALL effect the amount of current carried when an irrigation system sprays a power line.
- Under certain conditions mentioned above the electricity from the power lines can travel through the stream back down to the metal system making all its metal parts inherently dangerous.

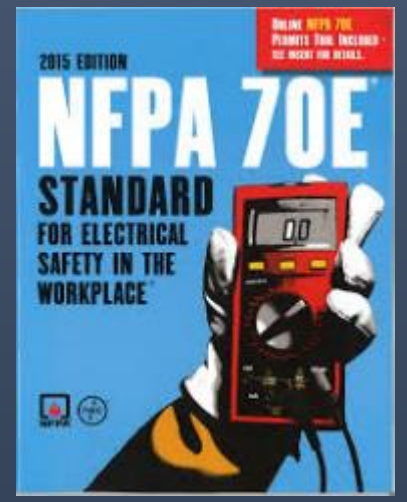
End gun spraying power lines & transformers

History of Arc Flash

- Prior to 1980 we assumed electric shock was the major electrical safety risk.
- 1982: “The Other Electrical Hazard: Electric Arc Blast Burns”, Dr. Ralph Lee
  - As many as 80% of electrical injuries result from arc flash rather than from shock.
  - Industry awareness of the hazard began to grow
- In 1990 OSHA updated their electrical rules to recognize the need for arc-flash safety.
- A few years later, NFPA 70E was revised to include the calculations necessary to establish arc flash protection boundaries, PPP and PPE.
- 2010’s: NEC rules refer to arc flash ratings and arc flash reductions as well as PPP and PPE.

Why are People Talking About Arc Flash

- It is relatively new (1990?)
- OK…it is finally being enforced..
- Frequent code and standards changes
- OSHA Compliance
- Code Compliance
  - NEC Article 110
    - Definitions
  - NEC Article 240.87
    - Arc Flash Reduction
  - NFPA 70E
    - Electrical Safety in the Workplace



ELECTRICAL SAFETY
Article 110 of NFPA 70E

- 110.4 Multiemployer Relationships
- (B) Outside Personnel (Contractors, etc). Whenever outside servicing personnel are to be engaged in activities covered by the scope and application of this standard, the on-site employer and the outside employer(s) shall inform each other of existing hazards, personal protective equipment/clothing requirements, safe work practice procedures and emergency/evacuation procedures applicable to the work to be performed.
- This coordination shall include a meeting and documentation.

So What is Arc Flash Safety?

- Owner/employer must conduct an arc flash safety study to identify the type of Hazard Category (and PPE) for employees to perform their job safely.
- The arc flash analysis determines the amount of worst case energy available should an arc flash occur.
- The study information is used to determine values that need to be on the arc flash label
  - Arc flash boundary distance
  - Type of PPE that is required to work within that boundary
- NFPA 70E requires that the following types of electrical equipment in locations other than dwellings be marked with an arc flash warning label:
  - Equipment operating at above 240 volts to ground
  - Switches and disconnect panels (pump & irrigation machine)
  - Control panels (pump and irrigation machine)
  - General enclosures
  - Motor control centers (pump and irrigation machine)
  - In addition, some employers are labeling electrical equipment, that are not included in the above list but may require that live work be done.

NFPA 70E-Using Labels & Signs for Electrical Safety

- Labels and signs are required by OSHA in general to warn about hazards.
- NFPA 70E requires the use of labels to warn about arc flash hazards.
- Labels and signs can also;
  - Provide safety procedures
  - Remind staff about required permits
  - Remind about LOTO procedures
  - Provide maintenance information
  - Communicate other information at the location where it is needed.

Arc Flash Label Location

- Where must arc flash labels be located?
- The NEC requires that labels must be located so that they are clearly visible to personnel before beginning maintenance or inspection.
- In other words, workers must be able to see and read the label before they are exposed to an arc flash hazard.
- This includes workers who might not be involved in working on the equipment, but are just passing through the area.
- Labels must be large enough to be legible at distances of up to several yards, depending on the severity of the hazard.

Do Labels Ensure Safety?

- Of course not….labels don’t ensure safety….compliance with PPE and PPP can help better ensure safety.
- The source of electrical power affects the hazard level and equipment must be assessed in the situation it will be used.
- NFPA 70E requires that at least one of the following must be included on the label:
  - Available incident energy and corresponding working distance
  - The highest hazard or risk category (NFPA 70E Table 130.7(C)(15)(a) and Table 130.7(C)(16) for the description of the PPE.
  - The minimum arc rating of required clothing
  - The minimum required level of PPE

Why Don’t Manufacturers Put Arc Flash Labels on Equipment?

- Arc flash labels must provide information that is specific to the electrical equipment, installation and environment.
  - Typically they must be printed after equipment is installed based on site specific information.
- NFPA 70E required arc flash labels can be very generic though.
  - Many safety consultants and training companies have libraries of custom made arc flash labels that can be used to satisfy most general conditions.
  - This limits the number of “special labels” needed.

Wait…Don’t We Work De-energized

- Do you think that because you only do de-energized work, no arc flash consideration is necessary?
- The process of de-energizing the energy to the pump and/or irrigation system is itself energized work.
- When someone performs lockout/tagout they are required to adhere to arc flash safety
- For that short window of time when the equipment is being de-energized and locked out, arc flash protection must be ensured.

Arc Flash Mitigation Goal

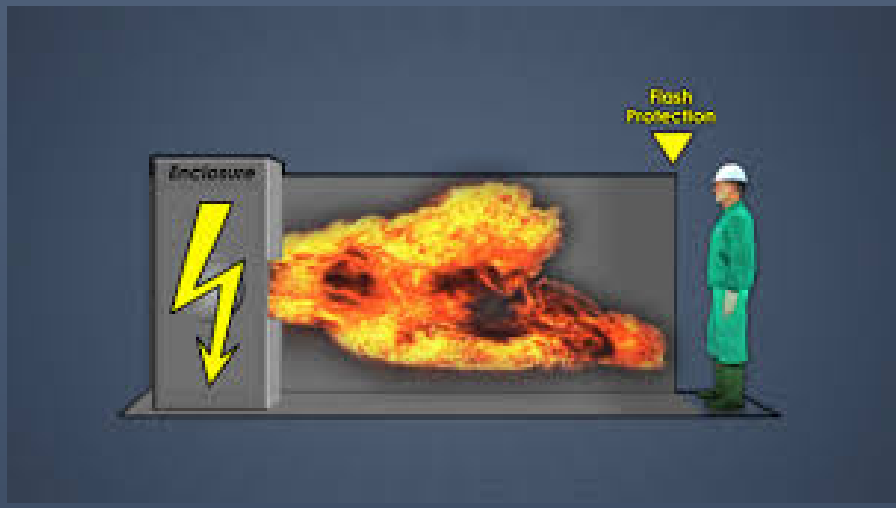
- Reduce the arc flash energy (and PPE) to a level that permits normal tasks to be performed on equipment safely.
- Arc flash mitigation strategies can be attained by:
  - Reducing arc flash energy levels by reconfiguring equipment to a level where routine tasks can be performed without specialized PPE.
  - Locating the worker such that they are not subject to harm.
  - Example: remote operation of electrical switches and disconnects through lower voltage relays and contacts.

Qualified vs Unqualified

- What's the difference between a qualified and unqualified worker?
  - NFPA 70E states that a qualified person is someone who has skills and knowledge related to the construction and operation of electrical equipment and installations and has received safety training to recognize and avoid the hazards involved.
- Is a journeyman electrician a qualified person?
  - Maybe…..maybe not.
  - A journeyman is proficient at doing low voltage electrical work may not have the training and skills required to recognize and avoid electrical hazards of medium or high voltage electrical work.
- This highlights the major difference between a qualified and unqualified person.
- A qualified person must not only have the necessary work skills, they must be trained and have the ability to recognize and respond appropriately to any hazards present from the equipment.

How About Assisting?

- If someone is assisting a qualified worker who is inside the arc flash boundary, but the assistant is outside of the boundary, must the assistant be using arc flash PPE?
  - If the assistant is outside the arc flash boundary no arc flash protection is required by NFPA 70E.
  - If the assistant is outside of the restricted approach boundary, then shock protection PPE is not required by NFPA 70E.
- However, it is still a good work practice for the assistant to use appropriate PPE.
  - Example: You may be asked to hand something to the worker within the arc flash boundary and this could make a circuit resulting in a shock hazard.



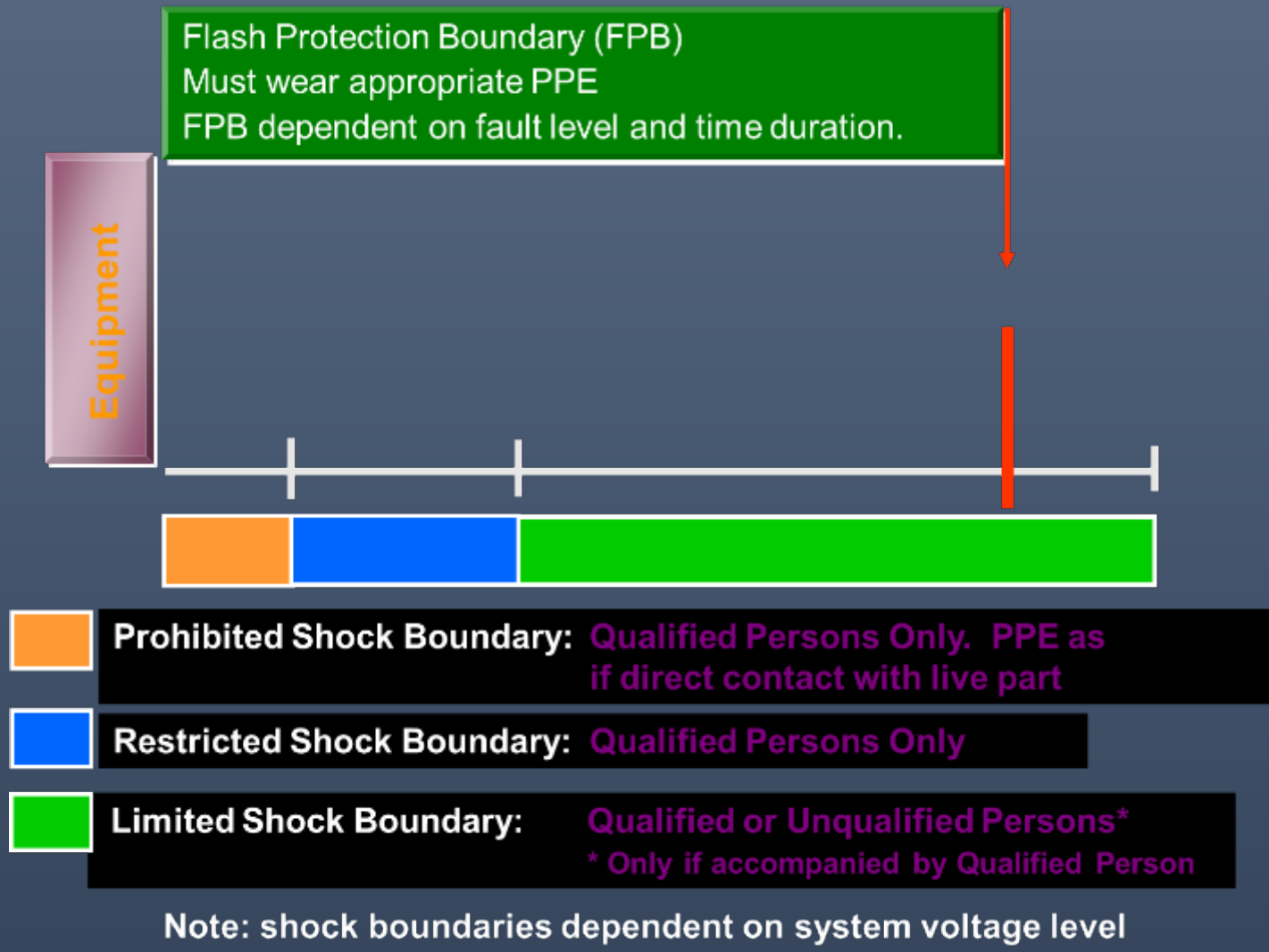
Approach Boundaries – Live Parts

- Limited approach boundary
  - A shock protection boundary to be crossed by only qualified persons (at a distance from a live part) which is not to be crossed by unqualified persons unless escorted by a qualified person.
- Restricted approach boundary
  - A shock protection boundary to be crossed only by qualified persons (at a distance from a live part) which, due to its proximity to a shock hazard, requires the use of shock protection techniques and equipment when crossed.
- Prohibited approach boundary
  - A shock protection boundary to be crossed only by qualified persons (at a distance from a live part) which, when crossed by a body part or object shall require the same protection as if direct contact is made with a live part.

Nominal System Voltage Range Phase to Phase	Flash Protection Boundary	Limited Approach Boundary		Restricted Approach Boundary	Prohibited Approach Boundary
		Exposed Movable Conductor	Exposed Fixed Circuit Part	Includes Standard Inadv'tent Movement Adder	Includes Reduced Inadv'tent Movement Adder
	Energized Part to Employee - Distance in Feet-inches				
300 V or less	3'-0"	10'-0"	3'-6"	Avoid Contact	
over 300V, not over 750V	3'-0"	10'-0"	3'-6"	1'-0"	0'-1"
over 750V, not over 2kV	4'-0"	10'-0"	4'-0"	2'-0"	0'-3"
over 2kV, not over 15kV	16'-0"	10'-0"	5'-0"	2'-2"	0'-7"
over 15Kv, not over 36kV	19'-0"	10'-0"	6'-0"	2'-7"	0'-10"
over 36kV, not over 48.3kV	*	10'-0"	8'-0"	2'-10"	1'-5"
over 48.3kV, not over 72.5kV	*	10'-0"	8'-0"	3'-3"	2'-1"
over 72.5kV, not over 121kV	*	10'-0"	8'-0"	3'-2"	2'-8"
over 138kV, not over 145kV	*	10'-8"	10'-0"	3'-7"	3'-1"
over 161kV, not over 169kV	*	11'-0"	11'-8"	4'-0"	3'-6"
over 230kV, not over 242kV	*	13'-0"	13'-0"	5'-3"	4'-9"
over 345kV, not over 362kV	*	15'-4"	15'-4"	8'-6"	8'-0"
over 500kV, not over 550kV	*	19'-0"	19'-0"	11'-3"	10'-9"
over 765kV, not over 800kV	*	23'-9"	23'-9"	14'-11"	14'-5"

Rule of Thumb Arc Flash Protection Boundary

- Below 600 volt systems = Stay at least 4 feet away from energized parts.
  - More conservative than actual calculations but applies in all conditions
- Above 600 volt (called Medium Voltage Systems)
  - Must use tables in NFPA 70E to determine the flash protection boundary…..(or look at the arc flash label for info).

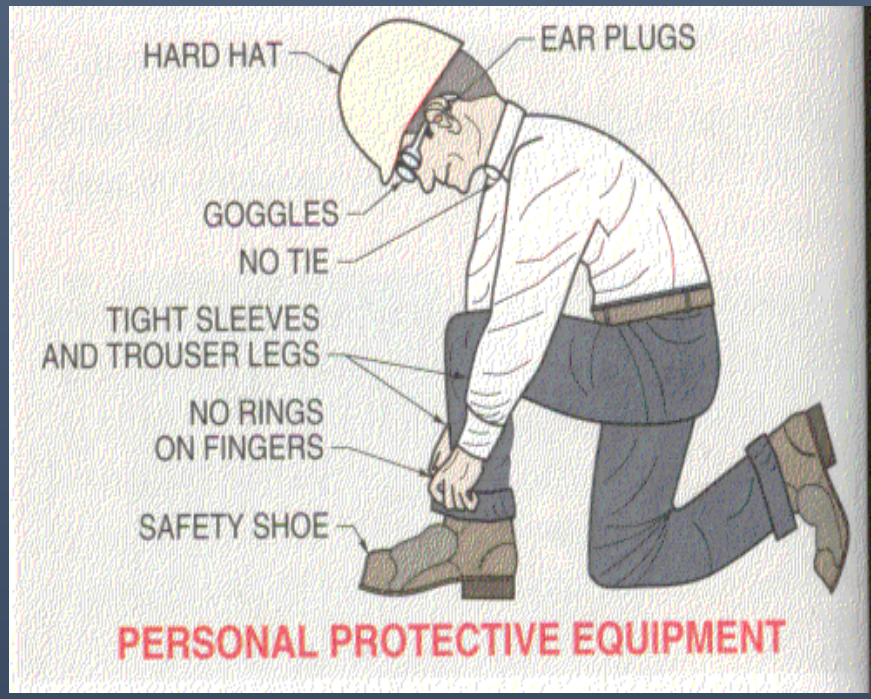


Preventing Electrical Hazards - PPE

- Proper foot protection (not tennis shoes)
    - Many tennis shoe soles are made from ground up steel belted radial tires and are conductive to some degree when they have worn.
- Electrical Hazard Rated Insulated work boots for shock protection are available – not mandatory
- Hard hat (insulated - nonconductive)
- Qualified employees must use rubber insulating gloves, hoods, sleeves, matting, and blankets if working on live equipment depending on the arc flash category of the equipment.

Clothing/Personal Protective Equipment

- Before leaving for the site consider the clothing & personal protective equipment needed?
  - Clothing - What's the weather like?
    - If it's hot, bring drinking water……don't rely on drinking water from the irrigation system.
  - Footwear - Boots…..Rubber or Leather?
  - Head Protection - Class 1 Hard Hat.
  - Hearing Protection – (Fossil Fuel Systems) Earplugs or Earmuffs.
  - Eye Protection - Are your glasses ANSI Z rated?, Safety Glasses, Do you need them?



Eliminate Problem Clothing & Jewelry/Accessories

- Conductive articles of jewelry and clothing (such as watchbands, bracelets, rings, key chains, necklaces, metalized aprons, cloth with conductive thread, metal headgear, or metal frame glasses) shall not be worn where they present an electrical contact hazard with exposed live parts.
- Eliminate and Secure:
  - Jewelry
  - Metal jewelry is electrically conductive and tends to concentrate an electrical burn at the site of the metal.
  - Long hair & Loose clothing (ties, scarves, etc.)
  - Long hair & loose clothing can easily become caught in rotating parts.

Electrical Head Protection

- Most ag owners and operators typically do not wear head protection when working on/around farm equipment.
- Falling objects are rarely ever encountered however, bumping your head on irrigation structures can be painful.
- If you are concerned about basic head protection from physical and electrical contacts a Class 1 head protective device (hard hat) is adequate for working around lower voltage (< 600 volts) equipment.

Electrical Safety PPE - Foot Protection

- Ag operations typically involve rough, un-even ground and frequently muddy conditions.
- Comfortable foot wear appropriate for wet, muddy conditions and un-even terrain is required.
- Leather is non-conductive when dry.
- What about tennis shoes?
  - Some athletic shoes are made with ground up (recycled) steel belted radial tire material in the sole…….They can be conductive.

Safety Communication is Important!

- Safety can be a very complex issue with lots of competing interests.
- Sometimes the most important safety messages get lost in the large volume of information you are given at a site.
- It is important to put all the information you are given in context.

The End

- Additional Material;
  - http://www.irrigation.org/uploadedFiles/Certification/CIC%20Standards,%20Codes,%20Regulations.pdf
  - http://digitalcommons.unl.edu/cgi/viewcontent.cgi?article=5576&context=extensionhist
  - NRCS-Safety Around Irrigation Systems Power Point

- Instructor Contact Information
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