Understanding Irrigation Electrical Safety for NRCS Employees

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- *Part 1: Why are we concerned?*
  - *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 (A separate webinar)
  - 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.

Electrical Hazard Data

- Electrical hazards are responsible for over 300 deaths & 4000 workplace injuries each year.
- While such hazards are not the leading cause of on-the-job injuries and accidents, they are disproportionately fatal and costly. (Source: Electrical Safety Foundation International, esfi.org)
- If you are not already, it's time to become familiar with codes, regulations and standards, including OSHA, NFPA 70E and the NEC.
- Safety awareness and how to recognize electrical hazards should be a way of life for every employer & employee.

Do Water & Electricity Mix Well?

What About Irrigation Systems?

Irrigation Safety

- Just because an irrigation system and related equipment works doesn’t necessarily mean it is safe or will fail in a safe manner.
- To ensure safety during operation, maintenance, inspection and testing of systems, employees must be aware of the potential hazards they might be exposed to and understand safe work practices necessary around these systems.

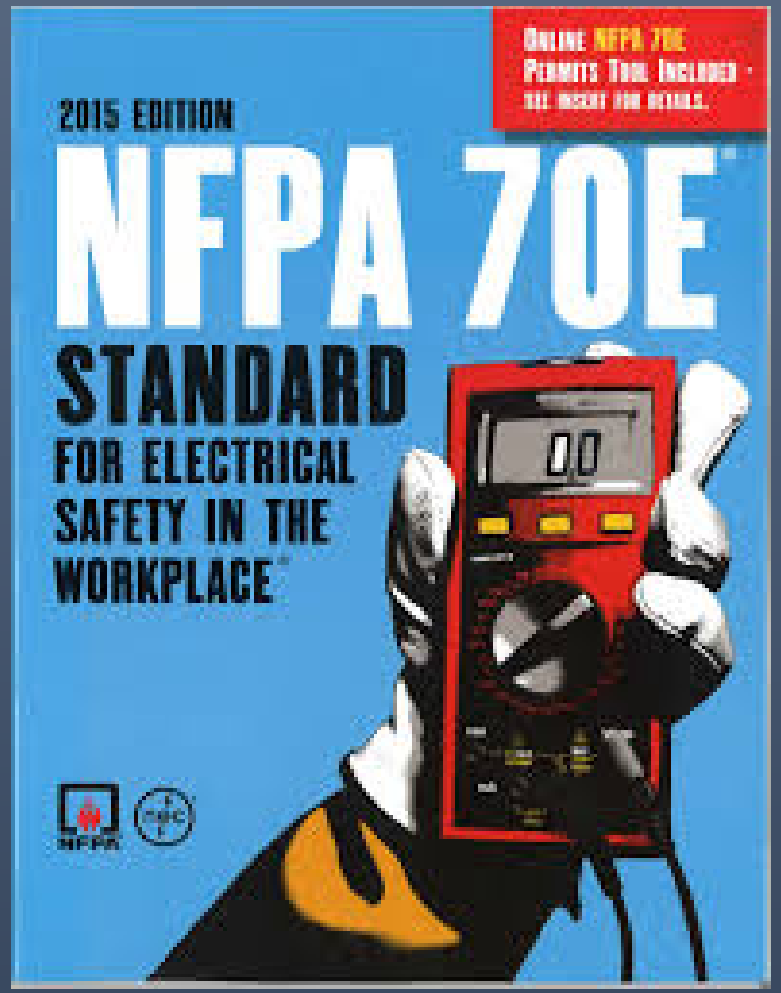
Who Makes the Rules?

OSHA® Occupational Safety and Health Administration

- The Federal group given responsibility and authority over workplace safety by congress.
- OSHA rules require that employers provide adequate protection to safeguard workers from injury caused by electrical hazards.
- The OSHA requirements in 29 CFR 1910 – and the National Electrical Code (NEC) – point to NFPA 70E as the accepted means of;
  - Assessing hazards
  - Determining personal protective equipment (PPE)
  - Implementing personal protective practices (PPP)
  - Providing warning labels
- Failure to comply with these requirements can result in significant fines for employers levied by OSHA.

What is NFPA 70E?
Standard for Electrical Safety in the Workplace

- National Fire Protection Association (NFPA) Standard 70E.
- Defines work practices for protecting workers from a electrical hazards during installation, inspection, operation, maintenance and demolition of electric conductors and equipment.
- Specifies safe work practices for employees who may not be directly working on electrical equipment but who are performing work that might expose them to electrical hazards.
- OSHA defines the general rules….NFPA 70E tells you how to meet the OSHA rules.



OSHA Electrical Hazard Recognition
Know Your Electrical Hazards

- https://www.osha.gov/SLTC/electrical/hazards.html
- It's about protecting workers from the hazards arising from the use of electricity including;
- Electric Shock
  - Electrocution, Burns, Shock/Startle/Falls
- Surprise Equipment Startup
  - Entanglements & Loss of limbs
- Fire/Ignition
- Arc Flash/Blast
- IT IS MANDATORY UNDER OSHA RULES & REGULATIONS!

Who is Responsible for Electrical Safety?

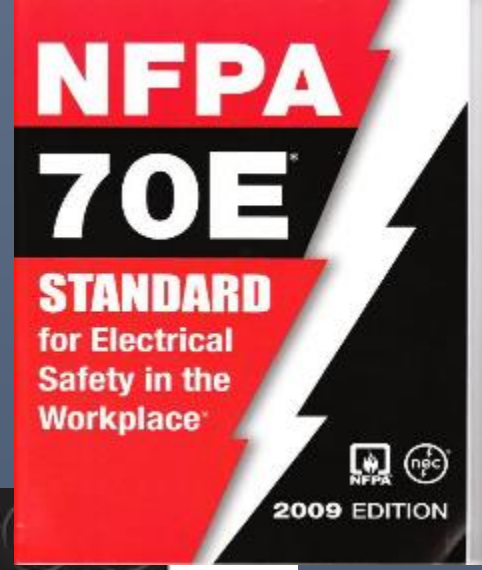
- The “Employer/Owner” is responsible for:
  - OSHA requirements
  - Electrical Safety Programs
  - Safety Policies and Procedures
  - Safety Training
- The “Employer/Owner” is inherently responsible for:
  - Employees on site
  - Contractors and others on their site
- The “Employee/Contractor/Other” is responsible for:
  - Implementing the employers safety procedures
  - Using personal protective equipment (PPE) and Practices (PPP)

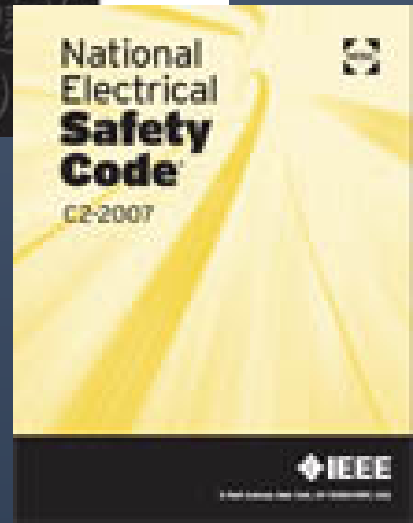
NFPA 70E Electrical Safety Philosophy

- To be safe, employees must:
  - Be generally familiar with the equipment they are working on or near.
  - Be qualified to work on or near the equipment or if unqualified know the safe clearance distance.
  - Know the hazards of the equipment they are working on or near.
  - Know what safety measures are needed (PPE and PPP) for the equipment they are working on or near.
- OSHA requires that employers train their workers proactively.

How Many Electrical Codes?

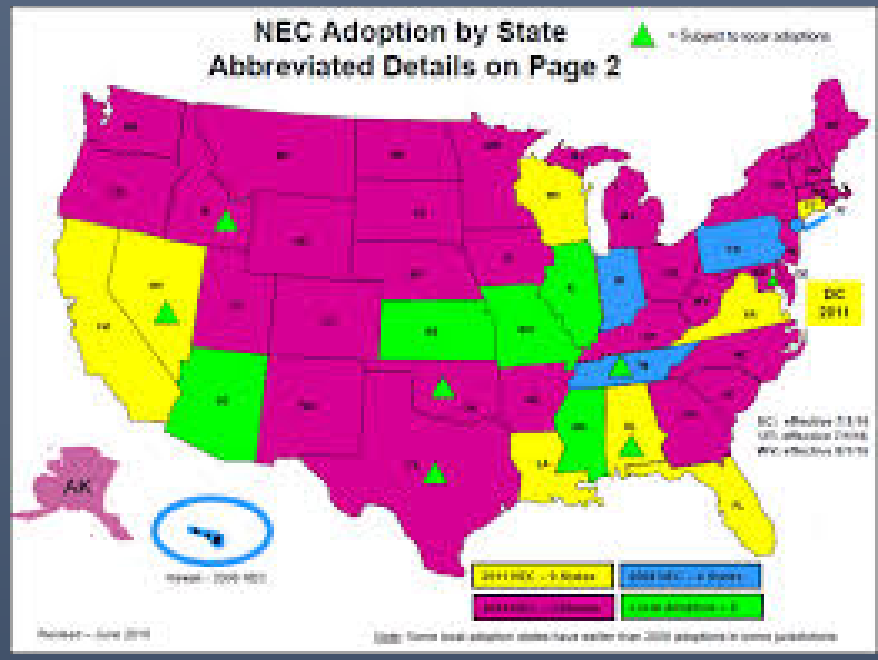
- NFPA 70: National Electrical Code (NEC)
  - Covers the safe design and installation of electrical equipment and components.
- NFPA 70E: Standards for Electrical Safety in the Workplace
  - Covers safe work practices to meet OSHA rules around equipment.
- IEEE C2: National Electrical Safety Code (NESC)
  - Covers the safe design and installation by the electrical utility.





NEC Adoption as State Law

- The first tenant of electrical safety is to understand the NEC covers the safe installation of wiring and equipment.
- Not all states adopt the NEC as state statute and/or require licensed electricians do the electrical work.
  - Leave it up to local political subdivisions (county, city, etc)
- Some states have additional requirements beyond the NEC in their state code.
- Some states specifically exempt agriculture from compliance with the NEC.
- Almost all irrigation and related equipment manuals will indicate equipment needs to be installed to meet the NEC and any additional state or local requirements.



Purple- Adopt 2014 NEC Statewide
Yellow-Adopt 2011 NEC Statewide
Blue-Adopt 2008 NEC Statewide
Green-Up to County or City

Unsafe Work Practices

- Installation of the safest and best maintained electrical system can still result in electrical accidents if unsafe work practices are used by personnel performing repair, maintenance or testing of the system.

OSHA inspects for NFPA 70E Compliance

- OSHA can enforce NFPA 70E in one of three ways.
- 1) The OSHAct General Duty Clause 5(a)(1)
- 2) 1910.132(d)
  - Employer is required to perform a hazard assessment to determine personal protective equipment required. Employer shall provide, employee shall use, personal protective equipment that is appropriate for the job or task, and specific parts of the body to be protected.
- 3) 1910.335(a)(1)
  - (a) Use of protective equipment
  - (1) Employees working in areas where there are potential electrical hazards shall be provided with, and shall use, electrical protective equipment that is appropriate for the specific parts of the body to be protected and for work to be performed.

What About the OSHA Ag Exemption?

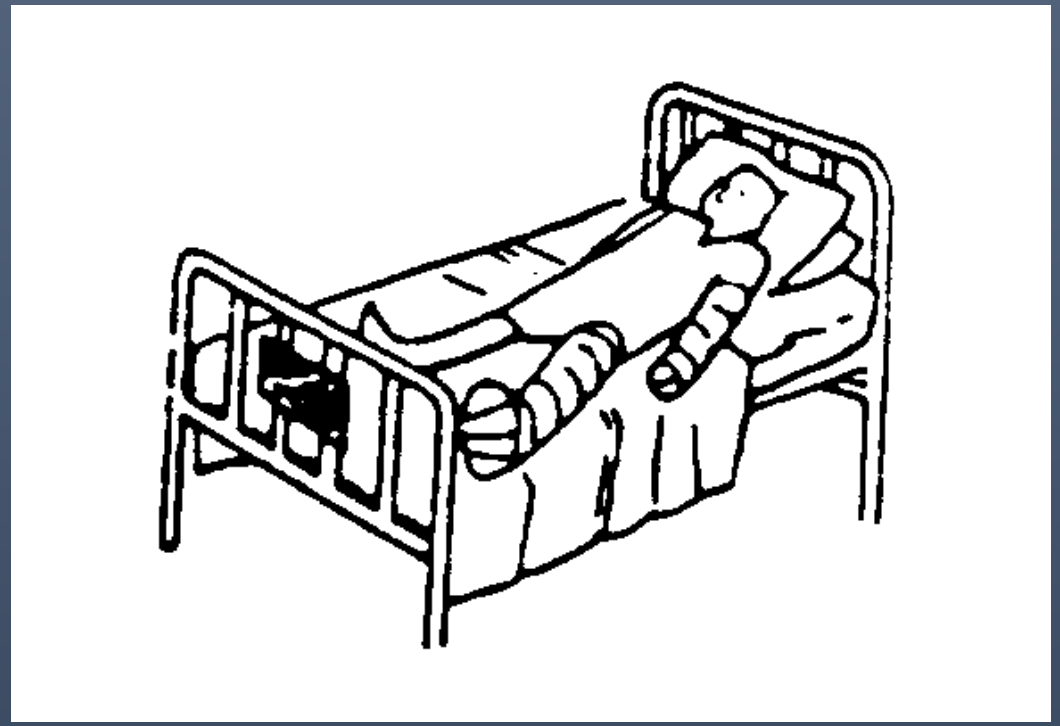
- OSHA Enforcement Guidance for Small Farming Operations.
- The Appropriations Act exempts small farming operations from enforcement of all rules, regulations, standards or orders under the Occupational Safety and Health Act.
- A farming operation is **exempt** from **all** OSHA activities if it:
  - Employs 10 or fewer employees currently and at all times during the last 12 months; and
  - Has not had an active temporary labor camp during the proceeding 12 months.
- Note: Family members of farm employers are not counted when determining the number of employees.
- So it doesn't directly apply to many Ag Operations you might be involved in.
- WHAT? So safety in agriculture isn't important (Well, remember some states exempt agriculture from the NEC……..

Where Can I Get A Copy?

- Where can I read NFPA 70E without having to buy a copy?
  - Purchased at bookstores.
  - Can be purchased on the NFPA web site at: **www.nfpa.org**.
  - NFPA has a copy that can be read online at no charge.
  - You need to register with NFPA before you can get access to the online version.

Human Response to Electricity

- How much voltage does it take to kill a person?
- It's not the volts that get you….It's the AMPS!!!!!!
- Human Response
  - Perception (feel it)
  - Let-Go (can't let go)
  - Burns (physical damage)
  - Fibrillation (electrocution)
- The Severity of Shock is affected by three primary factors
    - amount of current flowing through the body
    - path of the current through the body
    - length of time the body is in the circuit



Electric Shock

- Electricity travels in closed circuits
  - shock occurs when the body becomes part of the electrical circuit
  - (1) short circuit
  - (2) ground fault
  - (3) metallic part of enclosure becomes energized
- Current flow causes the damage
- Severity of injury caused by amount of current
- Less severe when nerve centers and vital organs not involved

Human Response to Current

- Perception Level
- Level humans can start to perceive that the electricity is there (feel it).
  - 0.001 amp or 1 milliamp.
  - Tingling sensation
  - Have you ever seen someone put a 9 volt battery on their tongue?
- Let Go Level
- Level where you start to lose control of your muscles (can’t let go).
  - 0.015 amp or 15 milliamps.
  - Electrons over-ride signals from your brain through your nervous system.

Electrical Burns

- Level where the heat starts to burn human skin internal tissues/organs and bone.
  - 0.05 amp or 50 milliamps.
  - Characterized by entry & exit wounds with burning on the inside of the body.
- Most common type of workplace electrical shocks result in burns at some level
  - Three types of electrical burns
    - Heat from the current flowing through the body
    - Heat from the electrical arc
    - Heat from the fire ball and exploding shrapnel of an arc flash/blast

Electrocution/Fibrillation

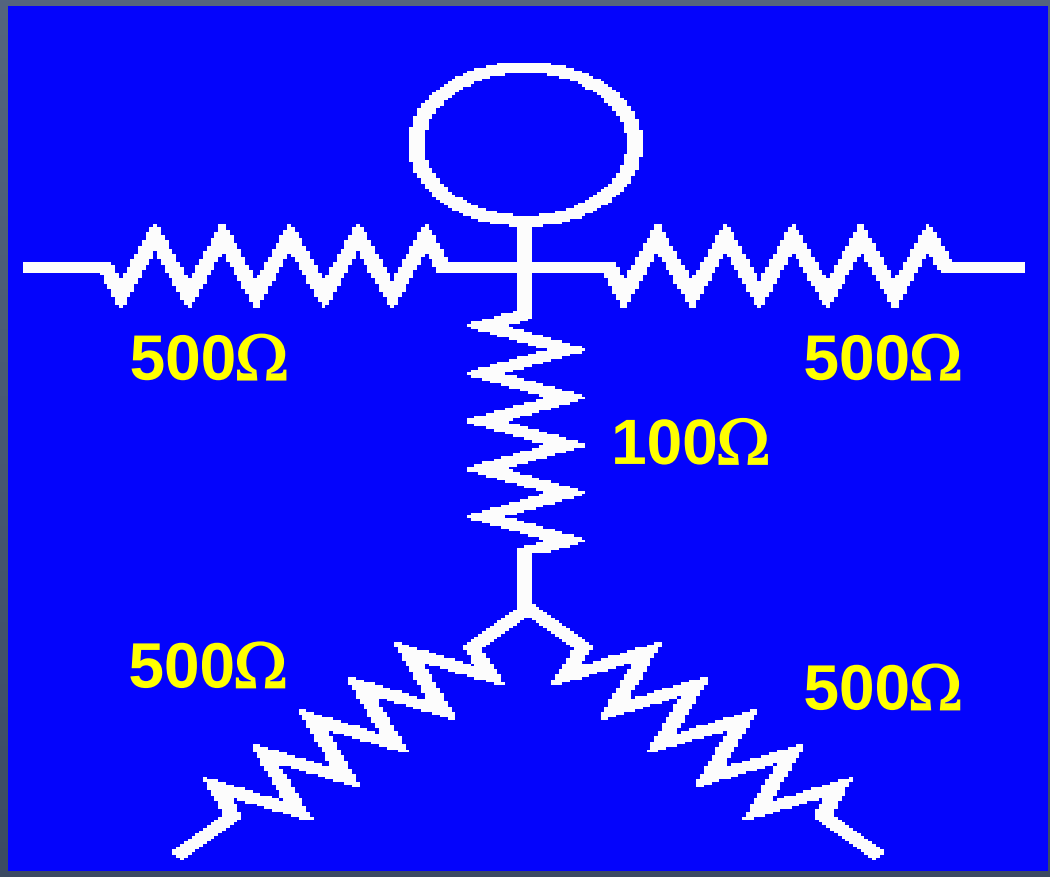
- Level where your heart can go into fibrillation.
  - 0.1 amp or 100 milliamps.
  - If CPR is not performed or if the heart was damaged badly, death may result.
- Contraction of the chest muscles, Paralysis of nerve centers, Ventricular fibrillation; Suspension of heart rhythm, Hemorrhages and destruction of tissue, nerves and muscles
- CPR is the key in an electrical contact where the heart has gone into fibrillation.

How Safe is 120 Volts?

- What would happen if you walked up and put a finger from each hand into each side of a 120 volt outlet?
  - (How much current would flow?)
- Pathway is hand to hand through your chest.
- Could also be hand to earth through your feet.

Human Resistance

- Human Resistance Varies
- Skin condition is a big factor
  - Dry vs wet?
  - Thick/Calloused vs soft?
  - Nicks, scrapes, cuts?
- Best Case = 10,000 ohms
  - Dry, no nicks, scrapes or cuts, thick skin
- Worst Case = 1,000 ohms
  - Wet, nicks, cuts and scrapes, thin skin

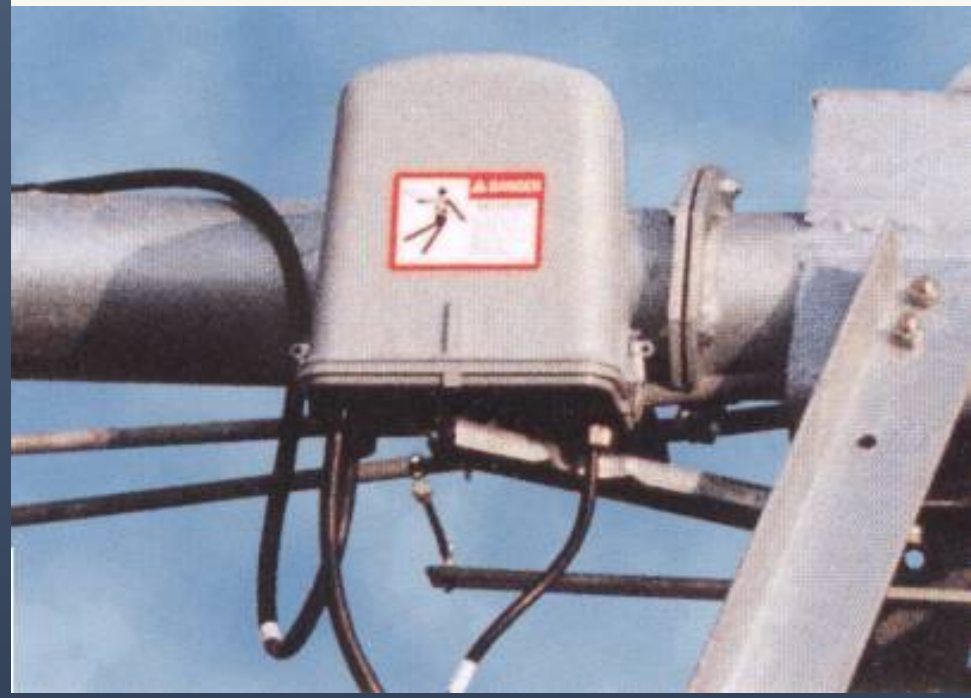


Ohm's Law

- Best Case Condition
  - I = 120 volts/10,000 ohms
  - I = 0.012 amps
  - Slightly below the Let-Go level.
- Worst Case Condition
  - I = 120 volts/1,000 ohms
  - I = 0.12 amps
  - Above the electrocution level.
- 480 Volt Irrigation System?
  - I = 480 volts/1,000 ohms
  - I = 0.480 amps (4 times the 120 volt level)
- What was the overriding condition that resulted in what happened?
  - How good or poor a conductor you were when you made contact…

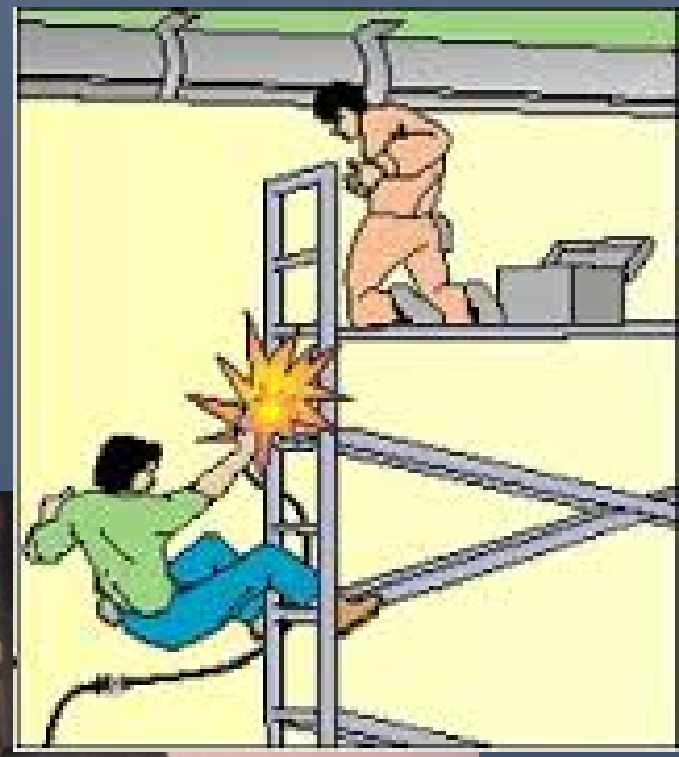
Electrical Hazard - Electrical Contact

- The NEC and irrigation standards require manufacturers to place warning signs on electrical enclosures containing live electrical parts and potentially hazardous voltages to alert personnel performing inspection, repair & maintenance to the potential hazard.
- The electrical voltage to most irrigation machines will be 240 or 480 volts three phase.
- What can 240 or 480 volts do to the human body if you are wet and have thin skin with nicks, scrapes or cuts?
  - Your margin for error with 240 and 480 volts is much smaller than for 120 volts.



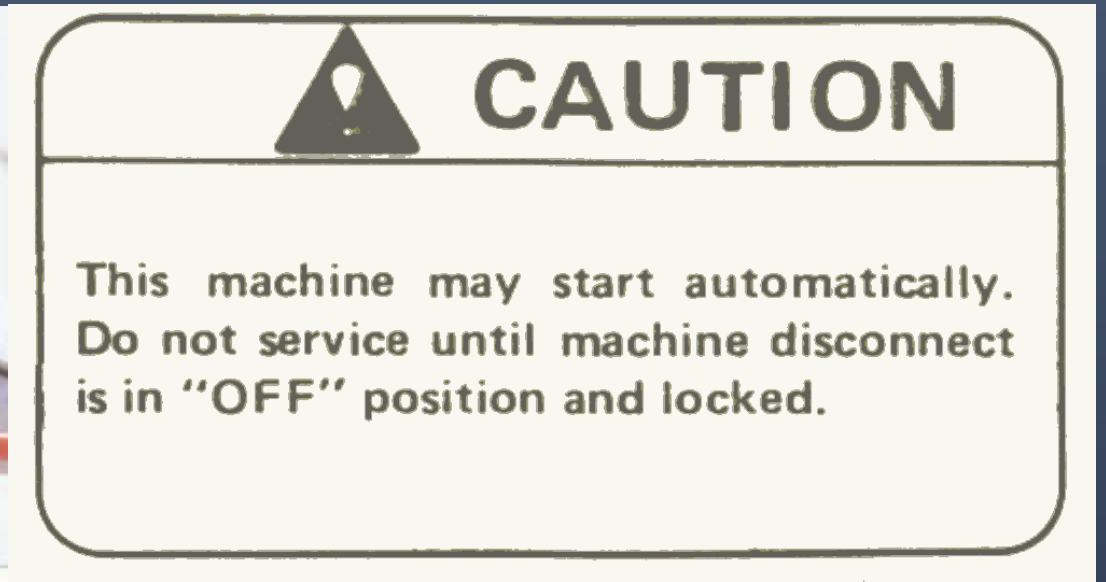
Electrical Hazard: Surprise Shocks/Reactions

- Startle Voltages
  - May not electrocute you or burn you but still cause a dangerous/hazardous condition.
  - You are surprised by the shock and fall off the ladder, scaffolding, lift, etc.
  - The electricity didn’t hurt you but the fall did!
- How good a conductor are you on a metal ladder against a metal irrigation machine on wet dirt?



Electrical Hazard - Entanglement

- Industry standards (NEC and Irrigation Industry) require manufacturers to provide safety signs on motors/equipment that could start automatically to alert personnel performing repair & maintenance to the potential hazard and to shut off power before working on the system.
- Shutting off the power to the system before inspection, maintenance or repair is called Lockout/Tagout. (more later)



Electrical Hazard – Fires/Combustion/Explosions

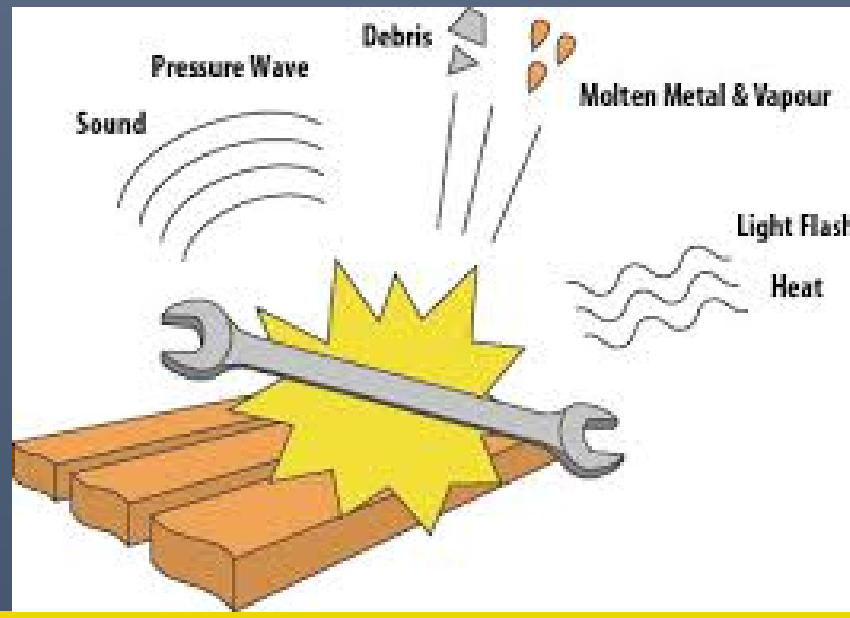
- Sparks/arcs from electrical shorts in the power drive unit and the irrigation system can ignite fuels or any gas and oil accumulations from leaking storage systems, fuel lines or improper storage containers.
- Be alert to fuel leaks from storage tanks, cans and fuel lines.
  - Gasoline, natural gas and propane all ignite from 2 to 15 percent vapor concentration.
  - Be careful around un-marked storage containers because there is a high probability they do not contain what their label indicates.
- Shutting the electrical supply off for inspection, maintenance and repair eliminates the source of the spark/arc to cause the combustion.

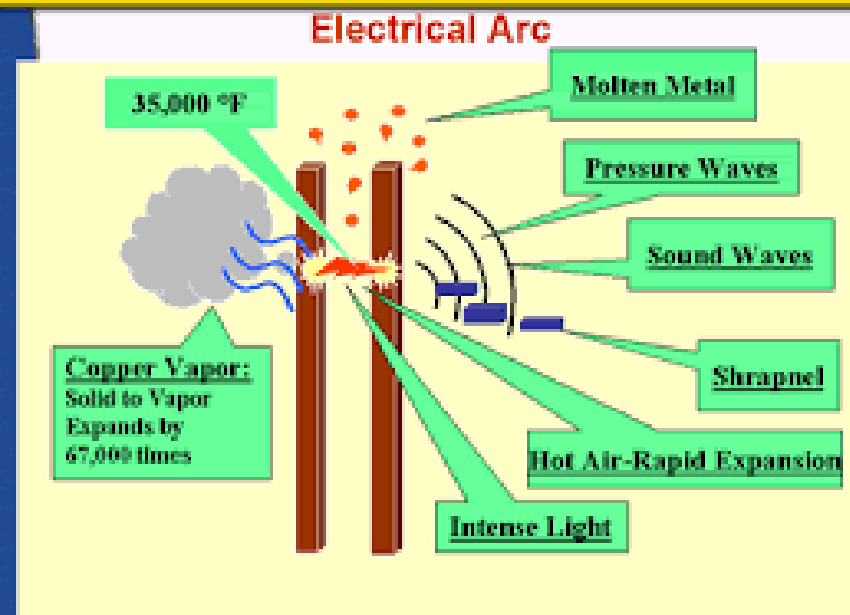
Fuel Storage Tank

Oil and lubricant storage.
Are most systems this clean???

What is an Arc Flash/Blast?

- An arc flash is an electrical explosion….
  - This happens when an electrical fault in a power system creates an electrical arc.
- An arc flash is best described as a short circuit through air to conductive items or ground via a flash, ionizing the air to form a superheated plasma. (Really, really, really, really, really HOT!)
- Why the concern?
  - Temperature of the arc can approach 35,000 degrees F.
  - Metals expand, melt, explode, etc.
  - Personnel can be burned, thrown by the blast force, hit by shrapnel, blinded by light, deafened by the shockwave or asphyxiated by toxic gas
  - All in less than 0.2 seconds in most instances.





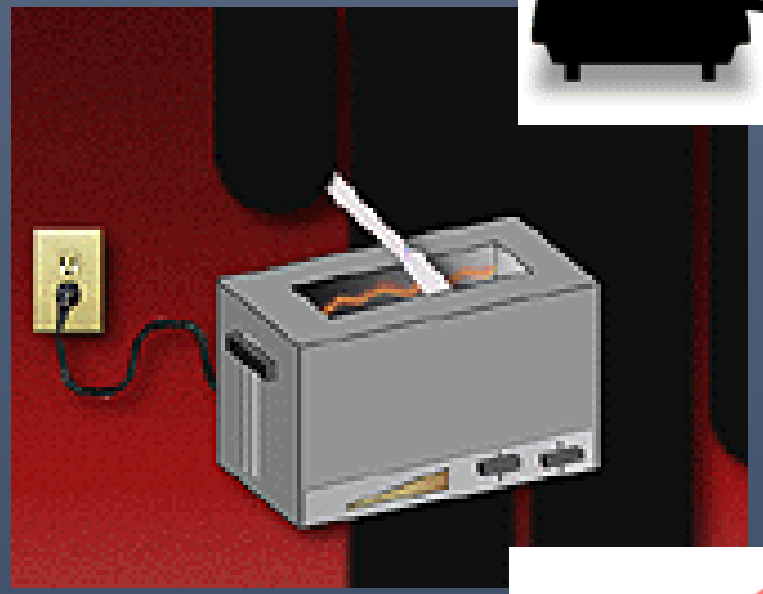
Electrical Hazard – Arc Flash/Blast

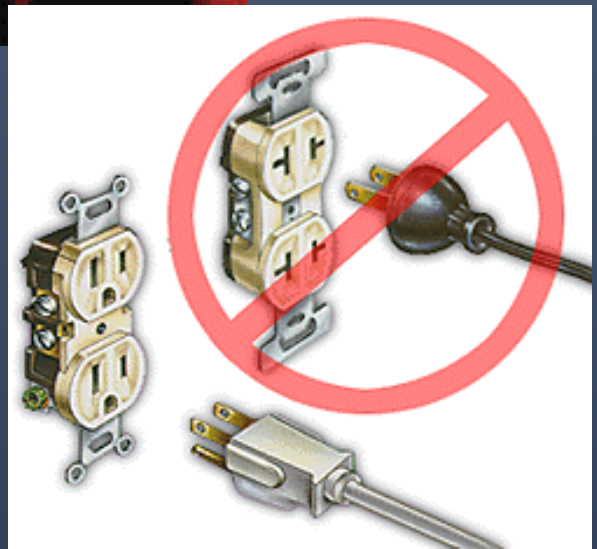
- OSHA and NFPA 70E have specific arc flash hazard safety requirements. (More on this later)
- Arc flash warning labels
- Equipment must be de-energized for inspection, maintenance and repair. (Lockout/Tagout)
  - How to turn equipment off and protect from arc flash
- If the equipment must be live;
  - Approach/boundary distances for certain unqualified employees
  - Personal protective equipment (PPE)
  - Personal protective practices (PPP)

You will not be working on/near equipment that generally requires This level of PPP and PPE.

What Protects Us?

- Insulation
  - Insulation can fail.
- Common Sense????
  - (I Don’t Think So)
- Grounding
  - Backup for when insulation fails.
- Personal Protective Practices
  - Lockout/Tagout
- Personal Protective Equipment





Irrigation System Equipment Understanding

- Type of Energy Supply (electric, diesel, nat gas, propane, etc)
- The Power Drive Unit
  - Electric Motor
  - Fossil Fuel Engine
  - How does the drive unit connect to the energy supply?
- The Irrigation System
  - Multiple types from flood to center pivot to traveling sprinklers.
  - Electric motors
  - Electric control systems
  - Ancillary equipment (booster pumps)
  - How does the irrigation system connect to the energy supply and power drive unit?

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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