

An aerial photograph of a center pivot irrigation system. The system consists of a central pivot point with a concrete pad and a motor, from which a long metal arm extends outwards, supported by a series of truss-like structures. The arm is positioned over a large, green agricultural field. The text "Safety Around Irrigation Systems" is overlaid in large white letters at the top of the image.

# Safety Around Irrigation Systems

(PART – 2)

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# Irrigation Hazard

## Electrical Contacts

- Electrical safety concerns related to irrigation systems are important because:
  - Pumps and other equipment operate in a wet or damp environment increasing the chance of equipment failure if parts become wet.
  - Personnel working around this equipment are often wet or damp so their susceptibility to electric shock is greater.
  - Many of these systems may not have had proper maintenance performed on them over the years.

# **Irrigation Hazard**

## **Electrical Contact Accidents**

- Faulty Equipment & Wiring Installations & Maintenance.
- Unsafe Work Practices
  - Failure to turn off power before working on system.
- Lightning
- Overhead Power Lines
  - Irrigation Pipe, Standing on Systems, Spraying Water on Overhead Lines.

# Do Water & Electricity Mix?

- They can.....if proper safety precautions are followed.
  - Proper Equipment Selection
  - Proper Installation Methods
  - Proper Maintenance Practices
  - Use of Safe Work Practices



# Electrical Safety Goal

- Don't let any part of your body be a path for electricity to flow through you.

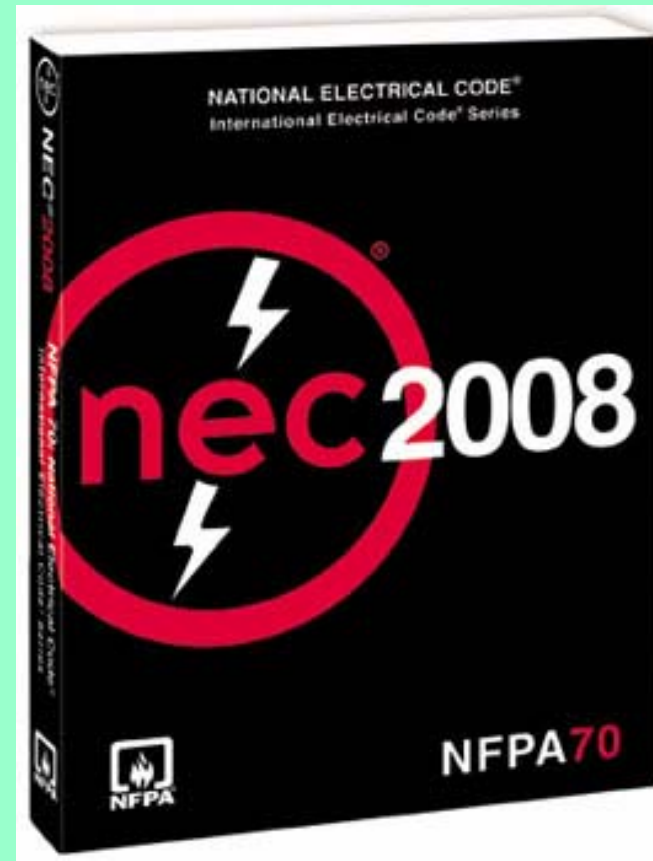


# Electrical Wiring Standards

- Many pumping systems and water distribution systems are electrically powered and many irrigation accidents are the result of electrical contacts or not turning off the power.
- Irrigation Systems should be wired to at least the requirements of the National Electrical Code (NEC).

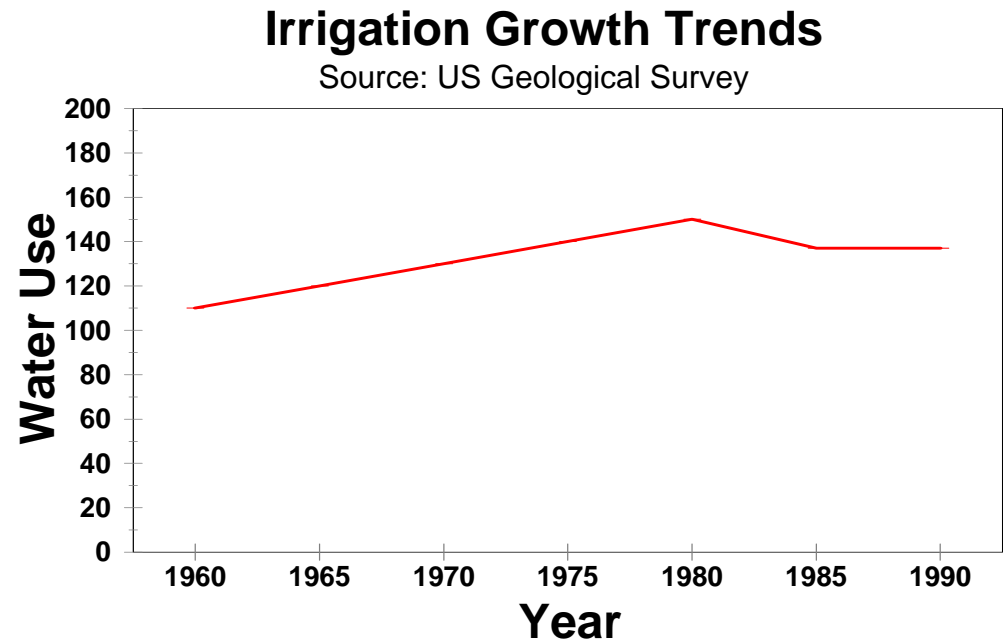
# National Electrical Code (NEC)

- The consensus safety standard of the electrical industry:
  - how to install a safe electrical system to electrical utilization equipment of most any kind.
  - A minimum standard... dictates wiring & equipment necessary to be safe, not to work well.



# 1970's to Early 1980's

- Large growth in irrigation installations.
  - Significant increase in electrical accidents and electrocutions on irrigation systems (pumps & irrigation machines)
  - Electrical grounding of machines found to be horribly inadequate.
  - Development of ASABE Standards S362.2 and S397.2 and addition of Article 675, “Irrigation Machines” in National Electrical Code.



# **NEC Electrical Requirements**

## **Article 675 - Irrigation Machines**

- **Pumps & Irrigation Machines**
  - Must have disconnect switches
  - Must use equipment & enclosures suitable for the conditions (wet, dirty, corrosive, etc.)
  - Must protect wires from physical damage or use “jacketed” irrigation cable
  - Must have circuit and equipment grounding.

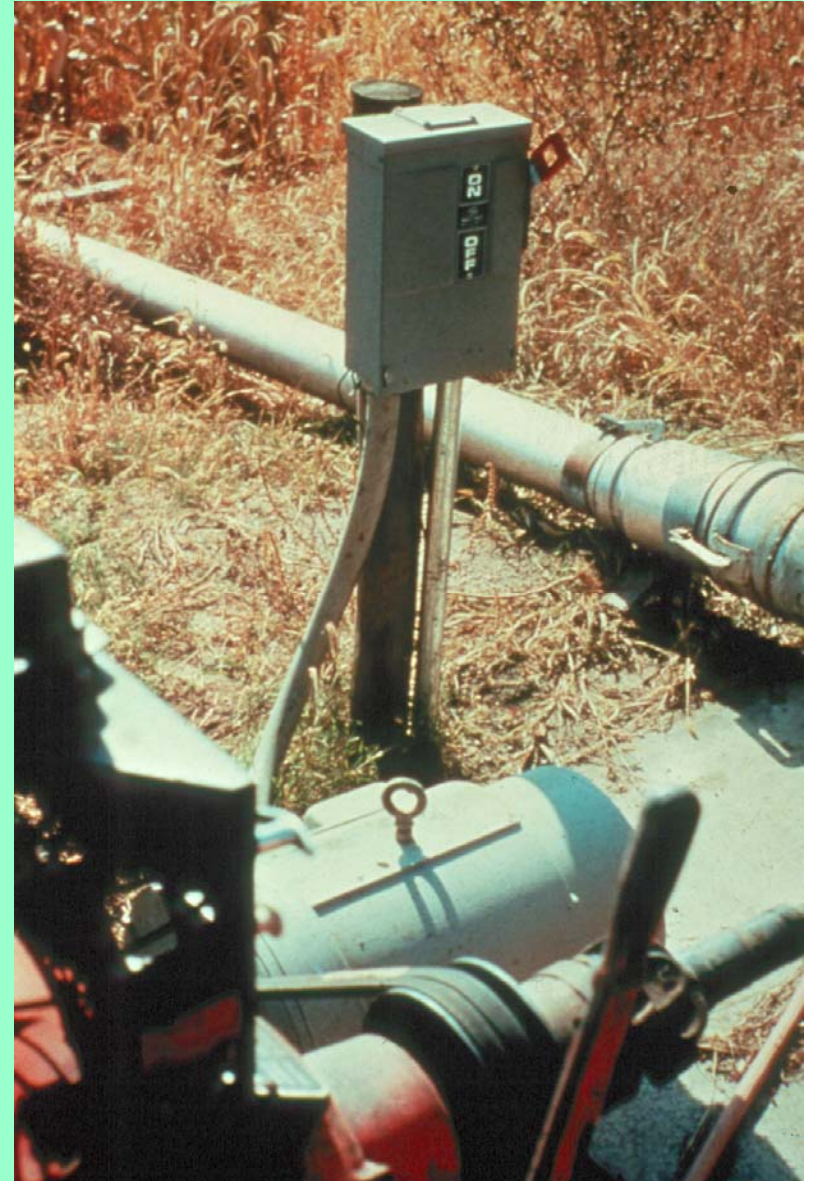
# Equipment & Installation Problems

- Common unsafe equipment selection, installation & maintenance problems include:
  - No Electrical Disconnect(s) to Turn Off Power
  - Improper Equipment or Installation
  - Improper Electrical Grounding
  - Faulty insulation on wires and power cords



# 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 that turns off the electrical power to the equipment.
  - Provides a convenient location to shut off the power for safe maintenance and repair of the equipment.



# 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 should not be supplied from the load side of the pump disconnect through the pump disconnect switch.

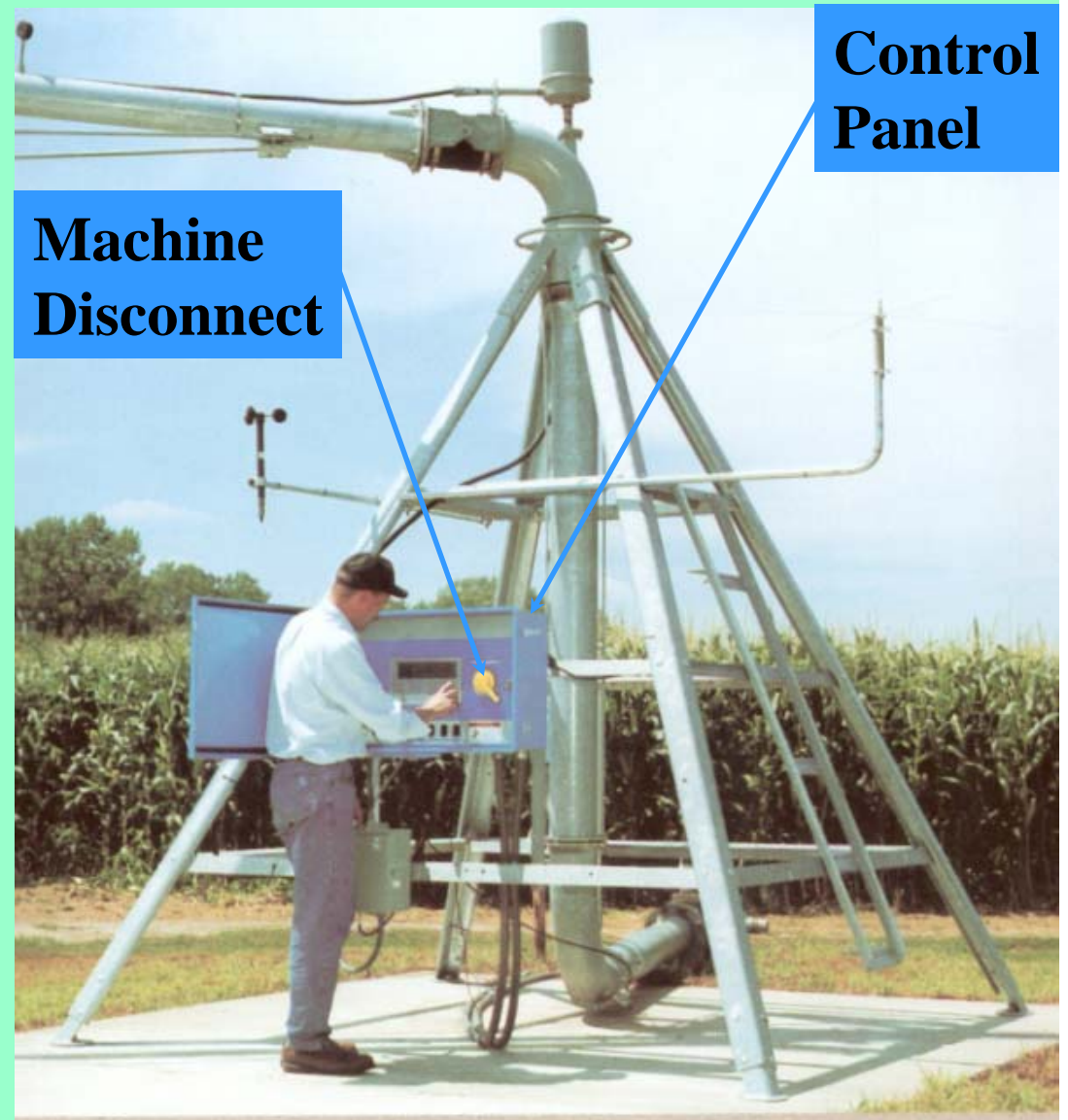
**Pump Disconnect Switch**

**Pump Motor**



# Irrigation Machine Disconnect

- Irrigation machines require 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.



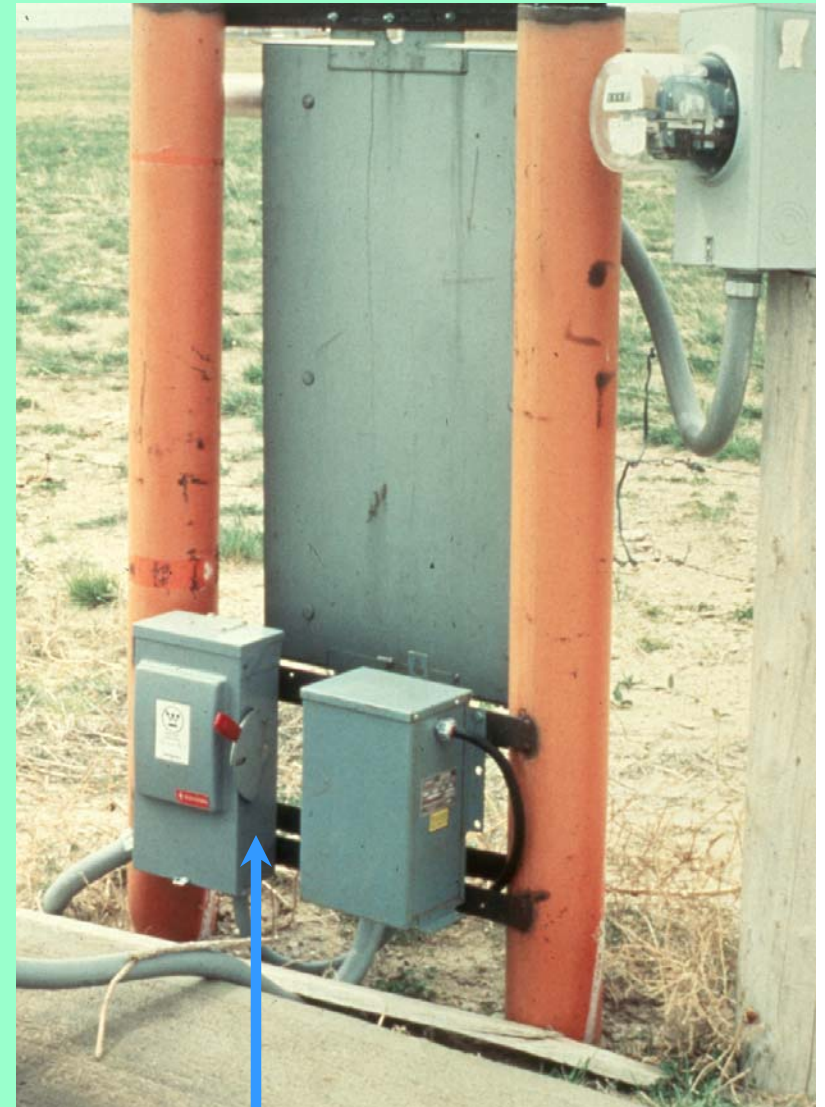
# Machine Disconnect Switch

- Most Manufacturers provide this as part of the control panel on the irrigation machine.
- Allows power to be turned off to the entire machine from one location.
- Allows the power to be “locked” off for maintenance & repair.



# Switches/Controls

- Should be mounted at a height to prevent the need for kneeling or climbing.
- 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
    - Water Pump
    - Injection Pump



**Switch Mounted Too Low**

# Electrical Enclosures/Boxes

- 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.
  - Weatherproof or watertight equipment enclosures and boxes for all irrigation systems.
  - Look for holes and openings that allow rodents and/or water and other foreign materials to enter and accumulate in panels and other enclosures.

# Electrical Enclosures

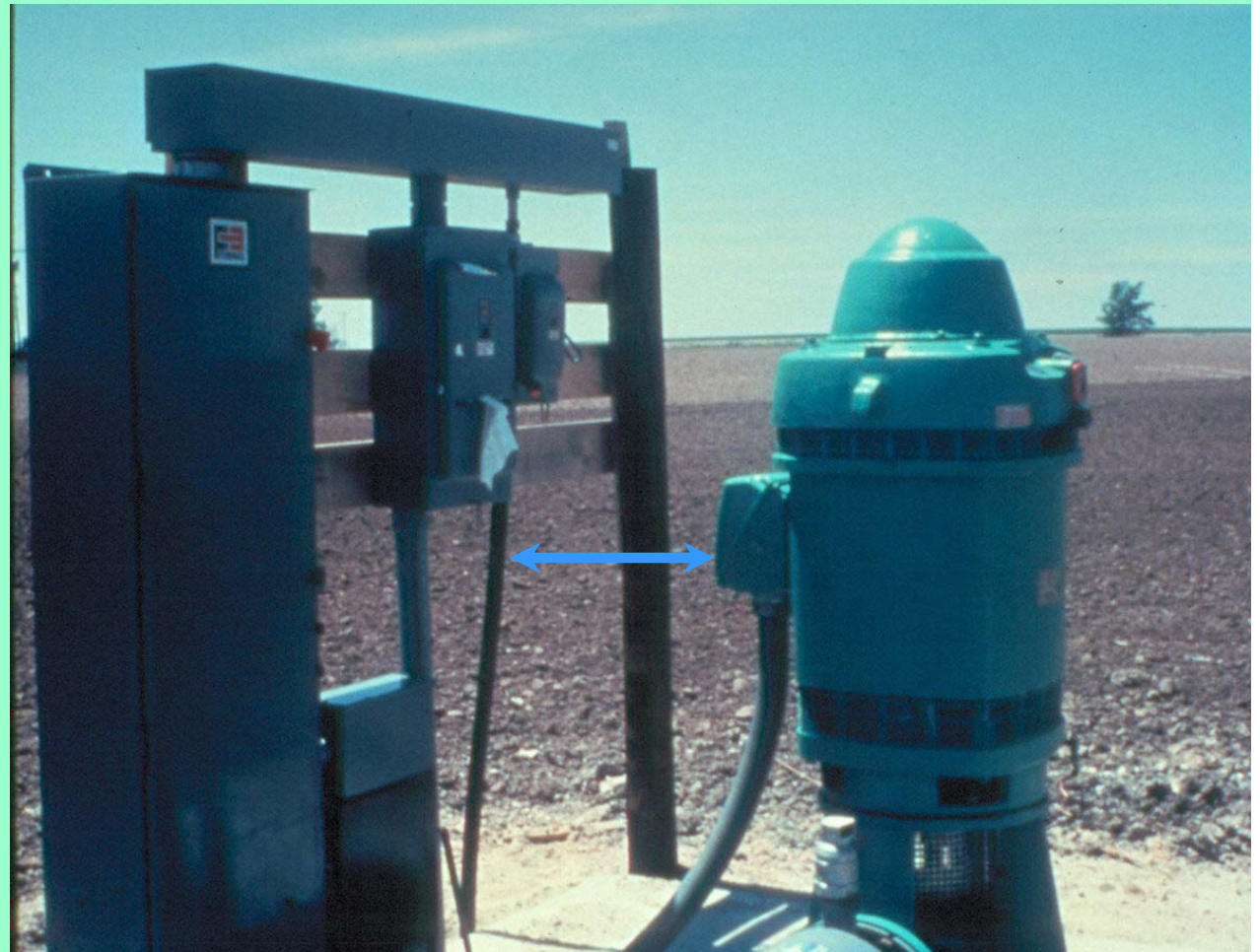
- All electrical enclosures should be suitable for the environmental conditions they are exposed.
- Generally requires “weather-proof” or “water-proof” enclosures.
- Should not have openings that allow water, dirt or rodents.



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

# Inadequate Working Space Around Equipment

- All electrical equipment is required to have specific clear “working space” around it depending on location and voltage.
  - Allows people performing adjustment, repair or maintenance and inspection to do it safely.



**Should be at least 30” of clear working space**

# 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.



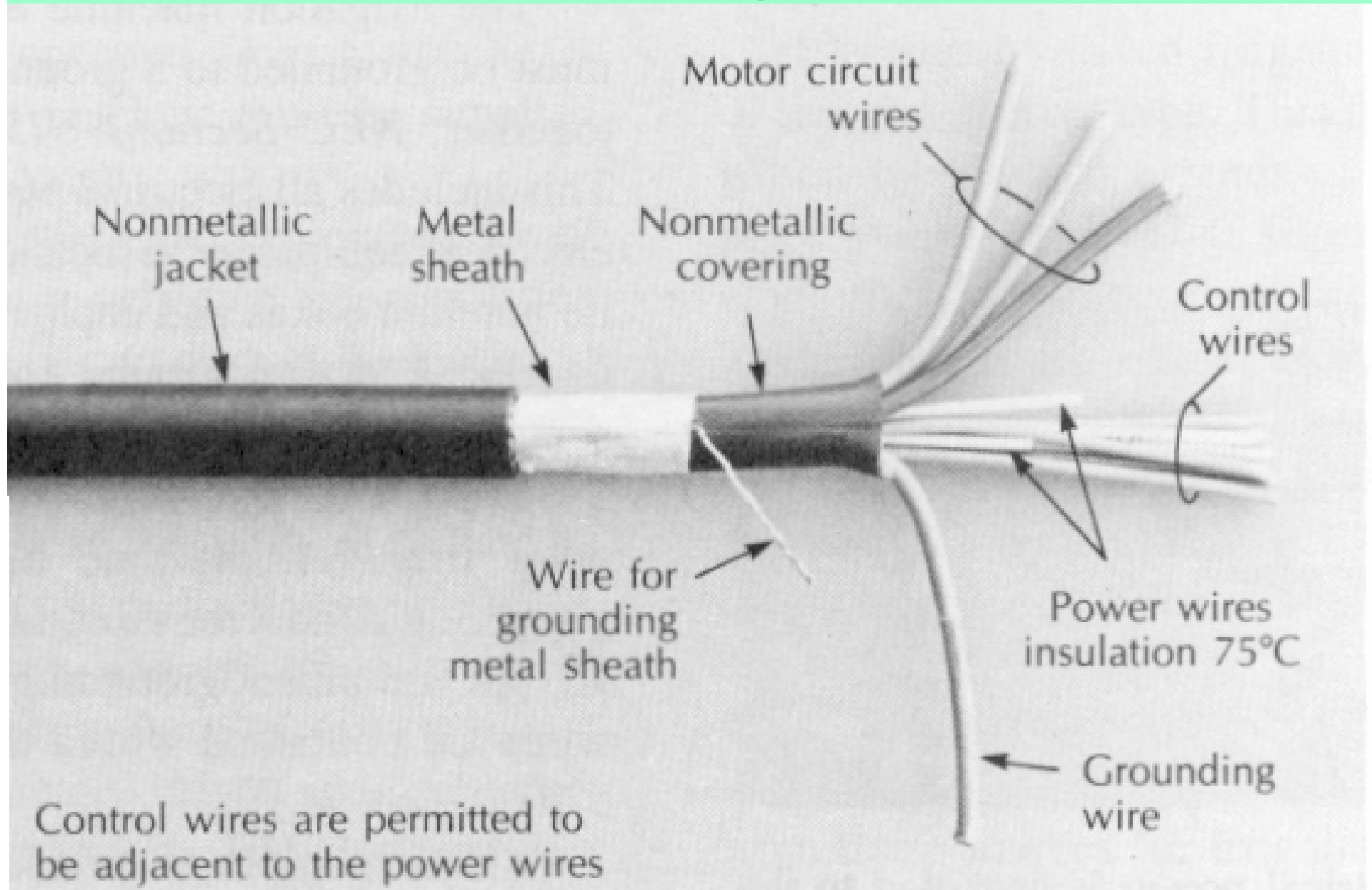
**Door will not open far enough to allow someone to safely replace fuses.**

# Irrigation Machines

- Conductors
  - All electrical conductors **SHALL** be within an enclosure, a raceway (conduit), or a jacketed cable.
  - Most systems use a heavy duty jacketed “irrigation cable” which has more protection than an “extension cord”



# “Jacketed” Irrigation Cable



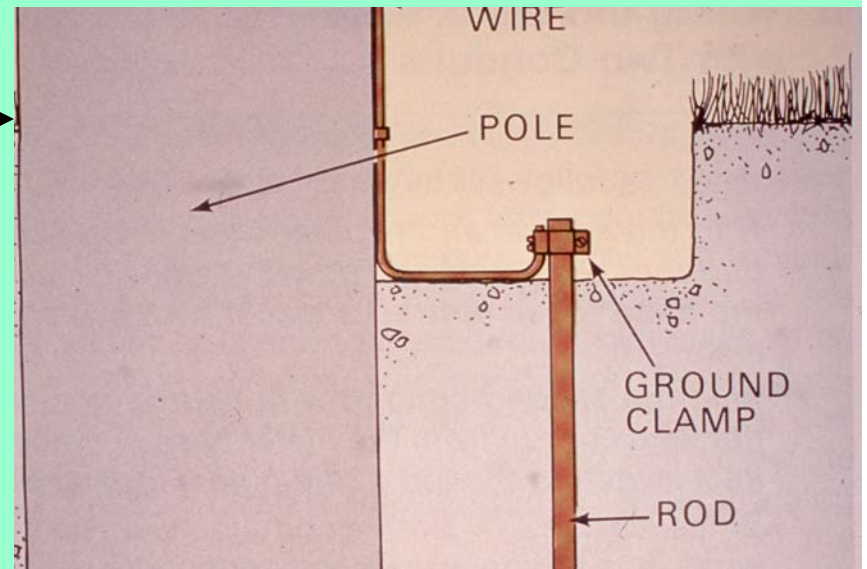
# Electrical Grounding

- Grounding is a “secondary” measure of protecting employees and operators from electrical shock when insulation and guarding fail.
- Grounding is the process of connecting the electrical circuit and/or equipment to the earth (soil).
- There are two types of “Grounds” which is confusing.....Circuit/System Grounding and Equipment Grounding.

# Electrical Grounding

- **Circuit/System Grounding** →

- Intentionally connecting a current carrying wire in the electrical system to earth (soil).
- Protects the electrical wire and equipment from lightning.



- **Equipment Grounding** →

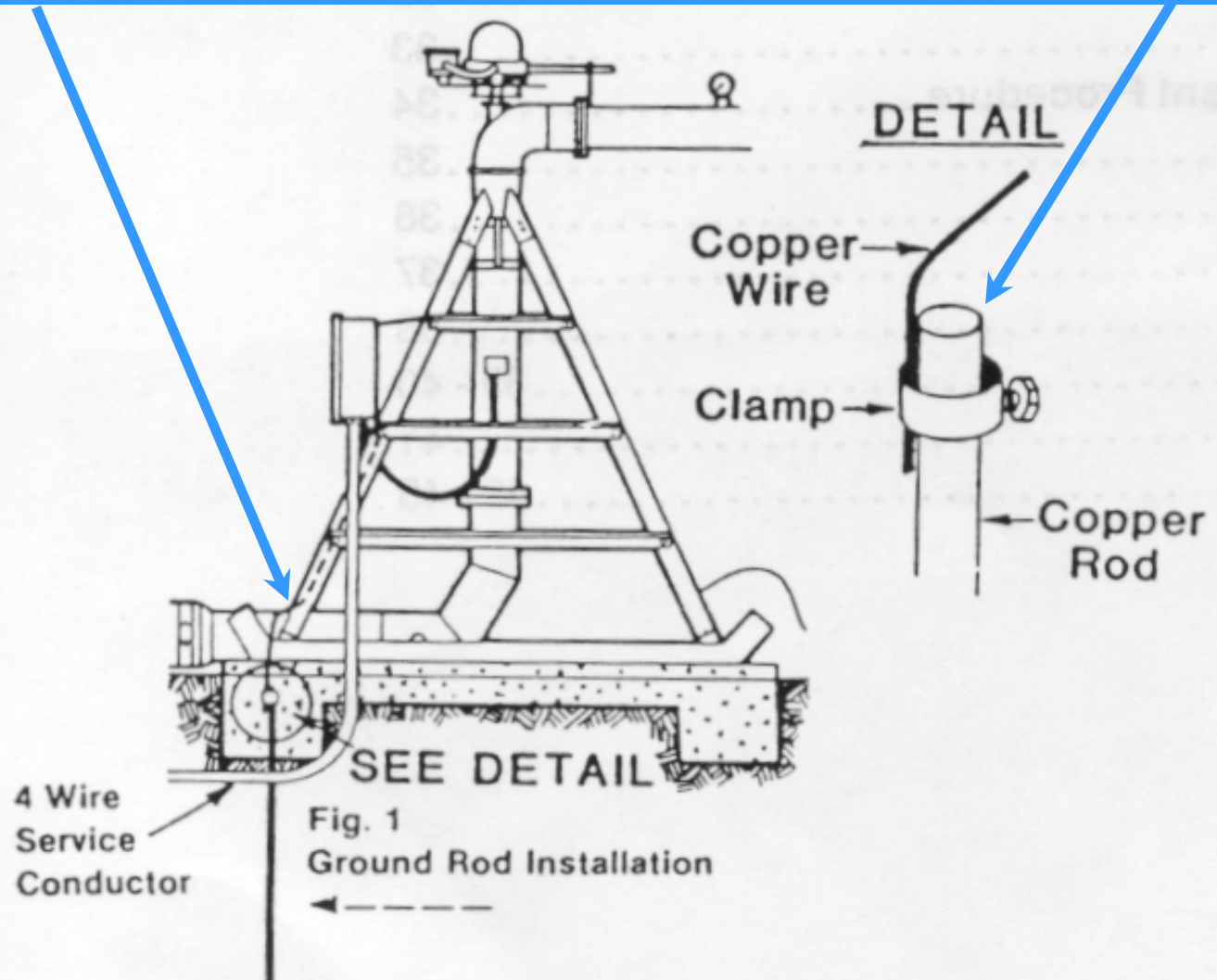
- Intentionally connecting the metal cases/enclosures of electrical equipment to earth (soil).
- Reduces hazards to persons from wiring or equipment short circuits.



# Irrigation Machine Circuit/System Grounding

- Grounding
  - A grounding conductor and ground rod used for no other purpose than for machine grounding shall be used.
  - Provides lightning protection.

## Irrigation Machine Ground Wire & Rod



# Circuit/System Grounding

- 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 wrap as pictured.

**Ground Wire**

**Ground Rod**



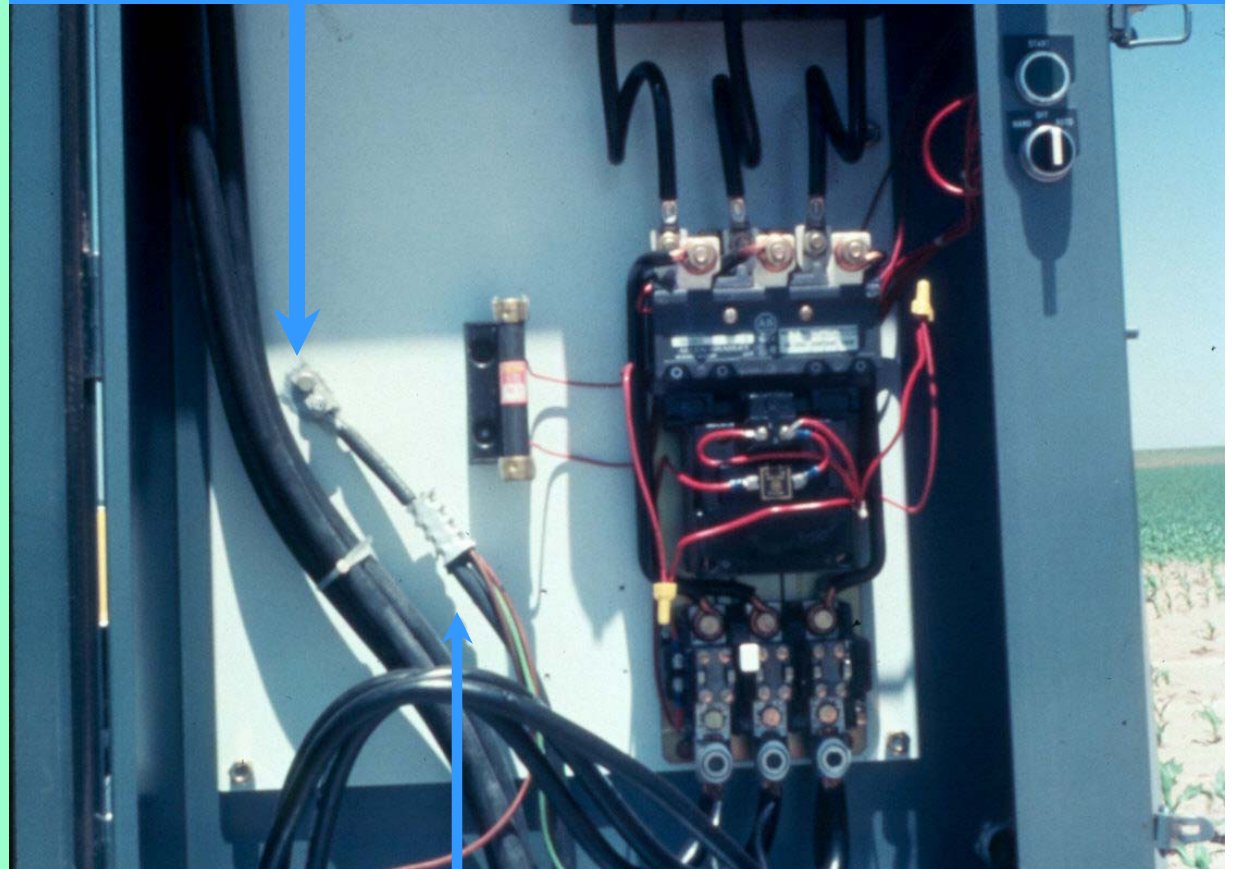
# Pump & Irrigation Machine Equipment Grounding

- Both the pump and irrigation machine are also required to have appropriate “equipment grounding”.
  - Generally a bare copper or green insulated wire run from the electrical service to the metal frame of the pump motor and irrigation machine.
  - Similar function to the 3rd prong or “safety” wire on a standard 120 volt outlet.
- Difficult to determine without opening electrical enclosures and inspecting.

# Equipment Grounding

- Equipment grounding allows the system to fail in a safe manner and blow the fuses to shut the power off if the pump or irrigation system has a short circuit.
- It is not necessary to make the system operate...only fail in a safe manner.

## Equipment Grounding Conductor & Connection in Pump Panel

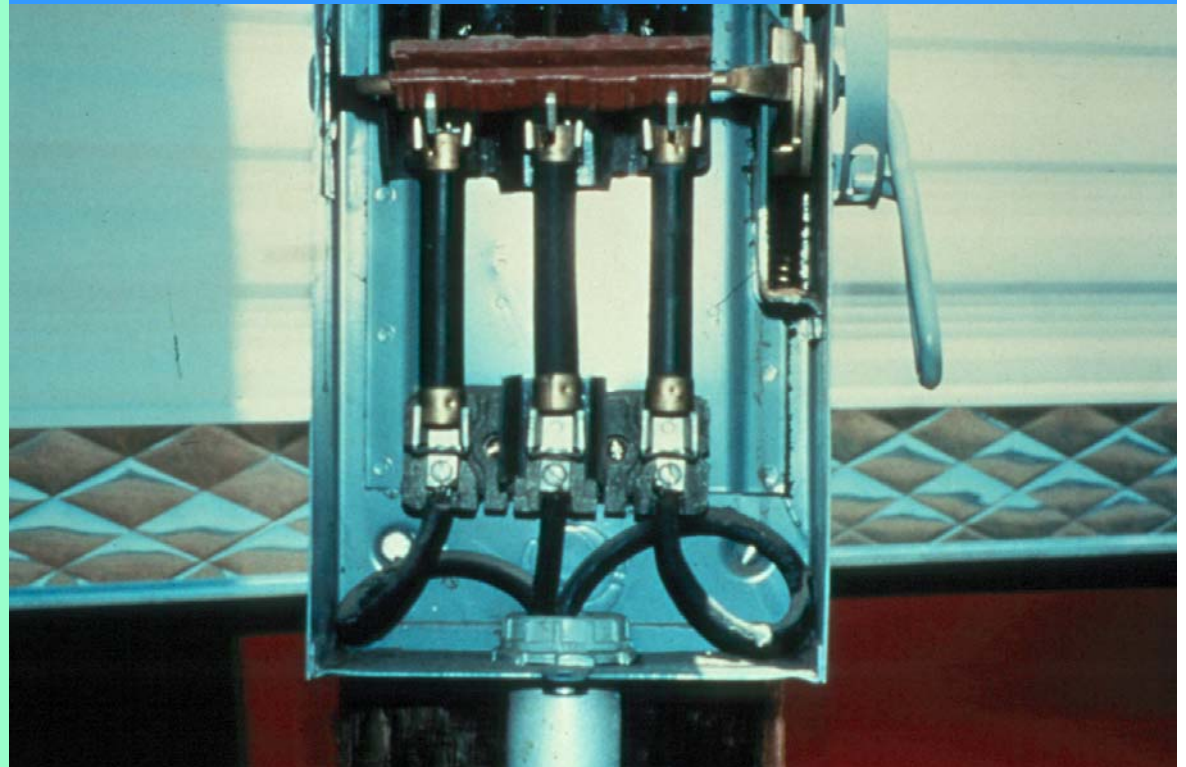


**Equipment grounding conductor runs to metal frame of pump motor.**

# No Equipment Ground??

- Without equipment grounding wires, the circuit will probably not be de-energized due to a short circuit in the equipment.
- The metal frame of the irrigation pump or the irrigation machine will become energized.
- Anyone touching it and wet ground is subject to electrocution.

**3 Phase circuit without equipment grounding conductor**



**3 Phase circuits should have 4 wires.**

# Improper Maintenance of Systems

- Common problems related to improper or poor maintenance of systems include:
  - Open Electrical Enclosures (boxes)
  - Broken or Damaged Electrical Conduit
  - Use of Damaged Electrical Power Cords
  - Improper Fuse Replacement

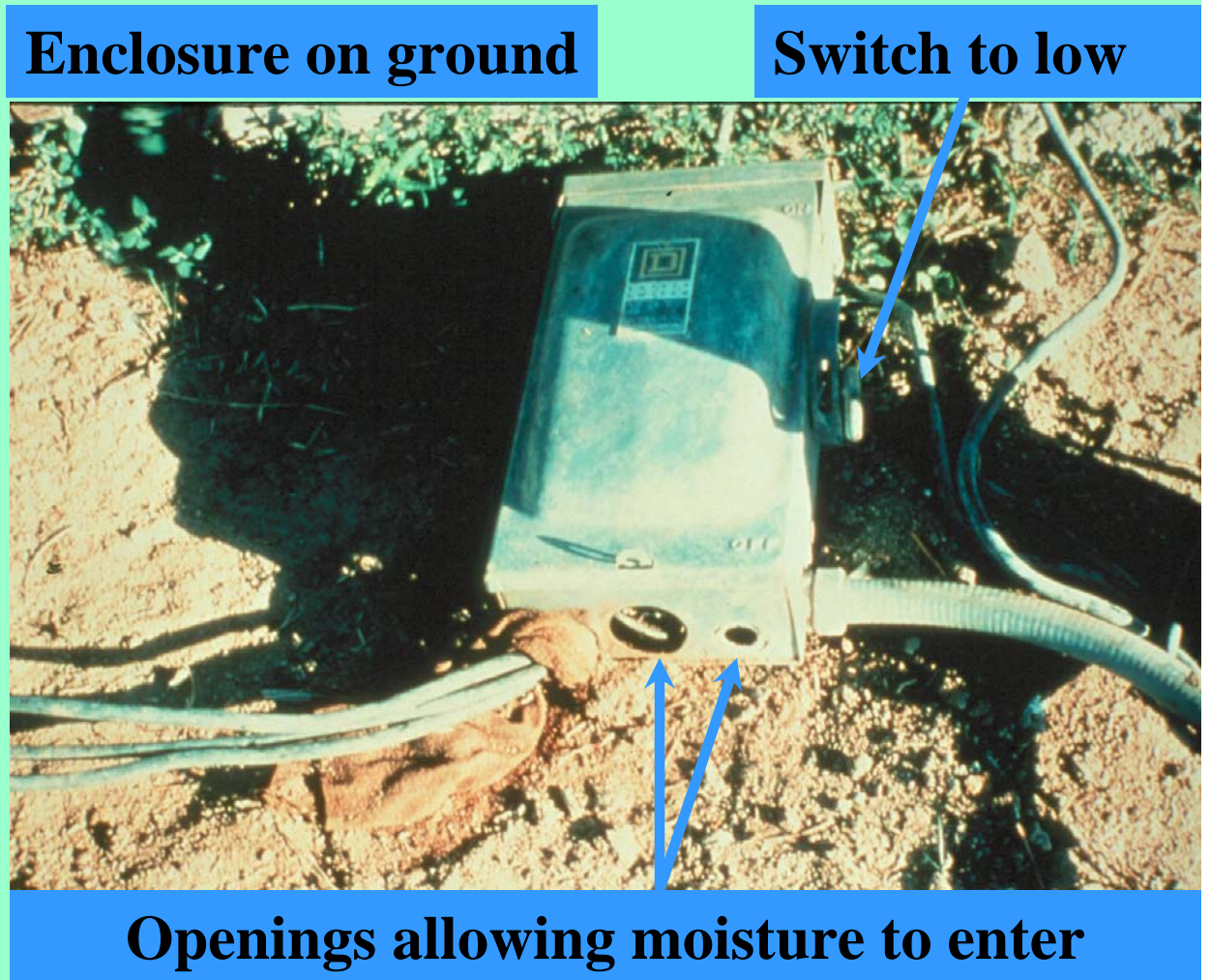
**No Equipment Grounding Wire to Motor**



**Open Connections & Motor Enclosure**

# Open Enclosures/Boxes

- When electrical enclosures and boxes are left open after repair or maintenance or holes are left unsealed, moisture, dirt, and other debris will accumulate inside the enclosure.
  - Can cause voltage to leak from the wires to the metal enclosures/boxes and energize the metallic enclosure.



# 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.

**Damaged Conductors with Tape**



**Broken Conduit Joint**

# Broken/Separated/Corroded Electrical Conduit

- Look for metallic conduit that has broken or pulled apart at joints exposing the electrical wires inside to the sharp metal edges and possibly cutting into them.



**Old Corroded & Broken Conduit**

# Electrical Power Cords

- 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.



**Cord Damage With Tape Coming Off**

# 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.



**Unprotected individual power conductors subject 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**

# Damaged Electrical Power Cords

- Areas to look for include:
  - Obvious physical damage to the outside of the cord.
  - Areas that have been covered with electrical tape.
  - 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

