Electricity

For Onsite Wastewater Systems

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Electricity

- *Learning objectives*
  - *Basic electric current*
  - *Voltages*
  - *Wire sizing*
  - *How to calculate cost of electrical usage*
  - *Wiring in a basic panel*

Electricity

Basic Electric Current

- *It is estimated that over 75% of the service calls for onsite systems are related to an electrical problem*

- *A good understanding of basic electricity is a very important assets to have if your are an onsite contractor*

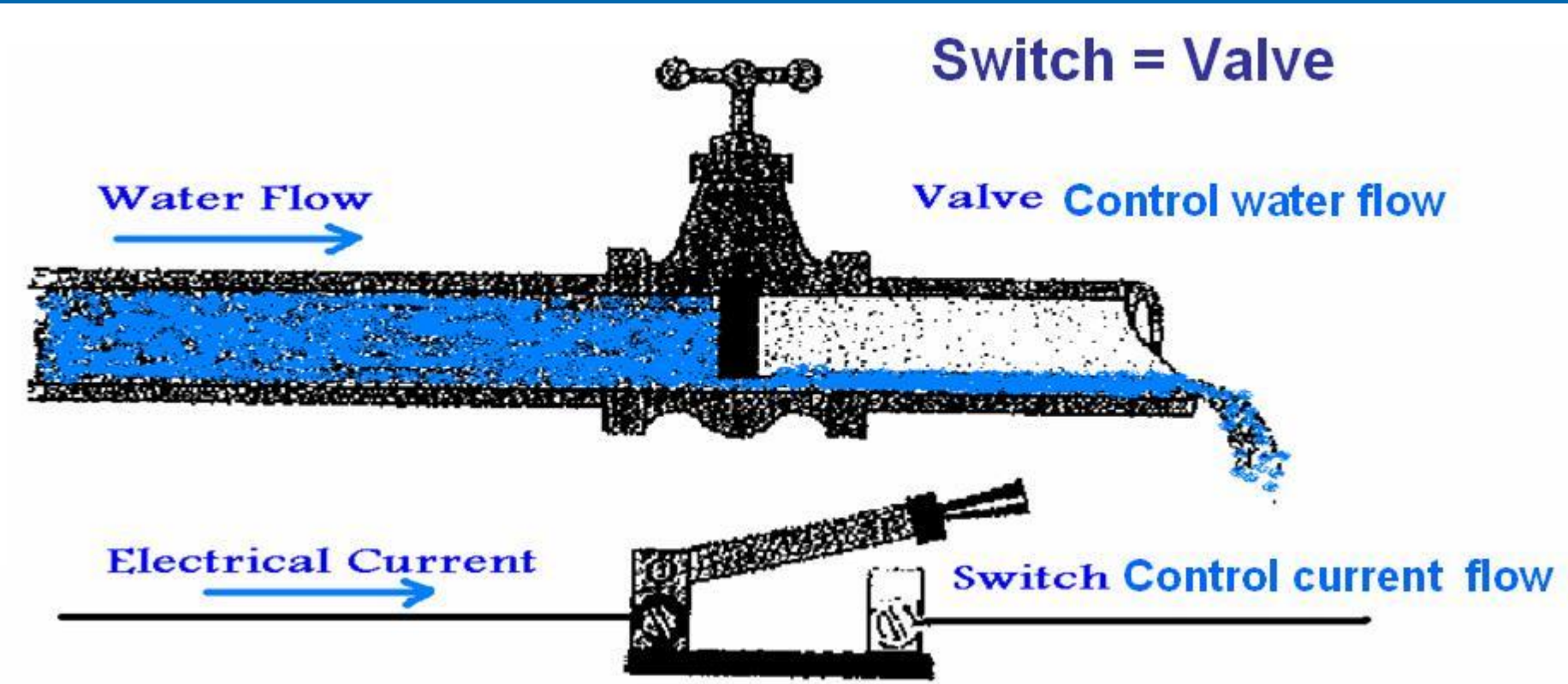
Electricity
Basic Electric Current

- *The 4 most basic elements of electricity*
  - *Volts*
  - *Amps*
  - *Ohms*
  - *Watts*

Electricity

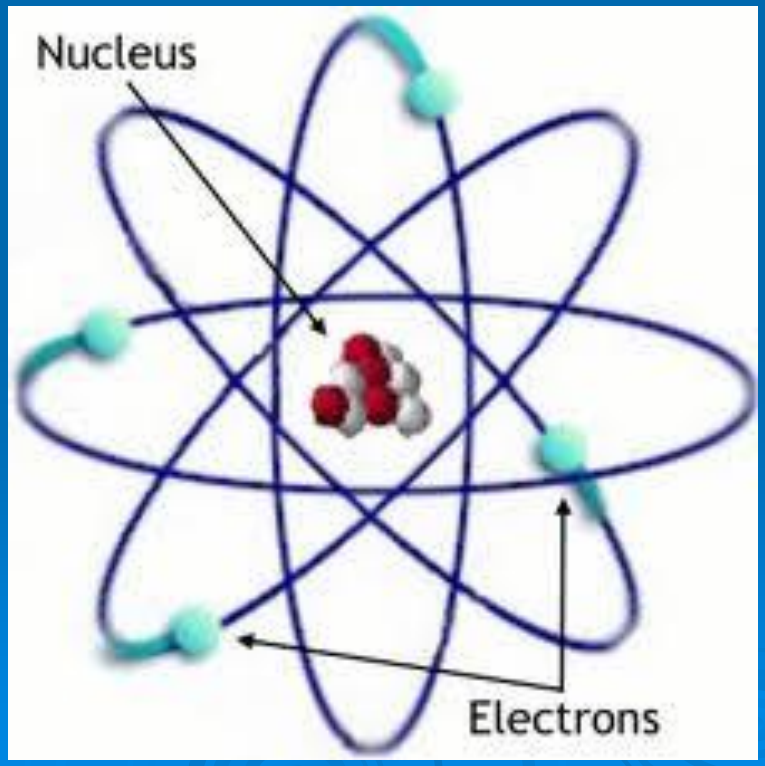
Basic Electric Current

Electrons in a wire are like water in a pipe



Electricity
Basic Electric Current

- *Volts*
  - *The smallest part of electricity is the electron*



Electricity
Basic Electric Current

- *Volts*
  - *Electrons have no problem moving through wires or conductors…….BUT*
  - *The all have a negative charge…..They are all pushing against each other*
  - *All the electrons pushing against each other creates a pressure we call volts*

Electricity

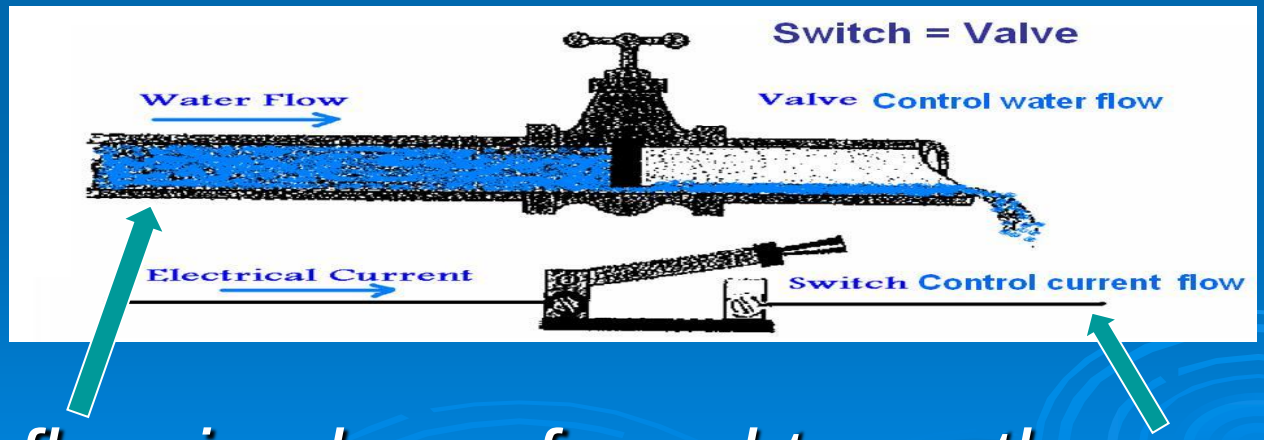
Basic Electric Current

- *This is like water in a pipe*
  - *The supply line to the fixtures in your house carries water under a certain amount of pressure*
  - *With water we measure this pressure in PSI or pounds per square inch*
  - *In electricity this pressure is measured in volts*

Electricity
Basic Electric Current

- *Amperage*

- *If a volt is the pressure of electricity, then an amp is the flow of electricity*



- *The flow is also referred to as the current*

Electricity

Basic Electric Current

- *But what exactly is amperage?*
- *Amperage is the number of electrons flowing past a point in a given amount of time*
- *Doesn't this sound like the flow of water in a pipe??……. Gallons Per Minute(GPM)*

Electricity
Basic Electric Current

- *With a valve we can shut off the flow of water ……The valve is just like a switch*

- *With a switch we can shut off the flow of electrons*

Electricity

Basic Electric Current

- *Increasing the size of a pipe will allow more gallons per minute past a certain point*
- *Same with electricity*
- *Increasing the size of a wire will allow more electrons past a certain point*

BUT

- *Use a smaller wire and you restrict the flow of electrons and lower the voltage to the pump*

Resistance

Electricity

Basic Electric Current

Resistance

- *In electricity this resistance is measured in <u>ohms</u>*
- *Simple….the more ohms you have the less amps you get*

Electricity

Basic Electric Current

Volt

Defined – The unit of measurement of electrical pressure

The real world ?

- *Low voltage*
- *High voltage*
- *No voltage*
- *Wrong voltage*

Electricity

Basic Electric Current

Amp

Defined – Unit of measurement of the rate of electrical current flow in a conductor

The real world ?

How hard the is motor working

Overloading a circuit

Electricity

Basic Electric Current

ohms

Defined – Unit of measurement of a conductors ability to resist current flow

The real world ?

Continuity

Heat

Holding back these electrons is difficult……..and HOT

Electricity

Basic Electric Current

What about

Watts

Electricity
Basic Electric Current

- *A watt is a unit of work done over time*

More watts…More work

Less watts…Less work

Electricity

Basic Electric Current

Watts….In the real world

It is the "price per gallon" of electricity

Electricity

Basic Electric Current

- *A watt is the standard measure of how much electricity is used*
- *A kilowatt is simply 1,000 watts (kilo = 1,000)*
- *A kilowatt hour (kWh) is a kilowatt used for one hour*

Electricity

Basic Electric Current

How much is this system going to cost me to operate??

- *Most motors will not say how many watts they use but they do show the amperage they draw on the nameplate*
- *Voltage x amperage = watts*

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Basic Electric Current

- *The motor is 115 volt that draws 4 amps…115 x 4 = 460 watts*
- *Multiply the watts times hours used and divide that by 1,000 (We pay by the kilowatt hour)*
- *The motor runs 30 minutes on and 30 off for a total of 360 hours per month*

Electricity
Basic Electric Current

- *Now multiplying the watts (460) times the hours used in a month (360)*
- *460 x 360 = 165,600 watts (not kilowatts)*
- *165,600 / 1,000 = 165.6 kilowatt hours*

Electricity

Basic Electric Current

- *KCP&L charges .08 / kilowatt hour*
- *165.6 x .08 = $13.25 per month*
- *Is this a lot ??*

Electricity

Basic Electric Current

- *An 18 Cu Ft frostless refrigerator uses about 615 watts and run an average of 325 hours per month*
- *325 x 615 = 199,875 watt hours per mo*
- *199,875 / 1,000 = 199.875 (200) Kwh*
- *200 x $0.08 = $16.00 per month*

Electricity
Voltages

- Voltage choices
  - 115 Single phase
  - 230 Single phase
  - 208 Three phase

Electricity

Voltages

- *115 Volts*
  - *The most common voltage around the house*

Electricity

Voltages

- *115 Volts*
  - *A 115 volt circuit would commonly have 3 wires, or leads as referred to by electricians*
    - *Black lead – referred to as the hot*
    - *White lead – referred to as the neutral*
    - *Copper lead – referred to as the ground*
  - *Each one of the leads with the exception of the ground would be enclosed in insulation*

Electricity

Voltages

- *115 Volts*
  - *The three leads with 2 insulated and 1 bare would then be enclosed in a non conductive insulation that we commonly call “romex”*
  - *Romex is a brand name for a type of plastic insulated wire*
  - *The formal name is “non-metalic sheath” or NM*

Electricity

Voltages

- *115 Volts*
  - *Most new homes are wired with NM wire where it is not exposed to mechanical damage, excessive heat or moisture*
  - *In damp places (buried wiring to a lift station) you will need special wire called UF for underground feeder*

Electricity

Voltages

- *UF wire is designed to be buried directly into the earth with no conduit..However there is a major problem with all plastic wire*
  - *Landscape lighting*
  - *Sprinkler wiring*
  - *Trees and shrubs*
  - *Roto-tilling*

Electricity

Voltages

- *Most building codes suggests that all UF wire be buried to a depth of 18 inches*
- *Best practice would be to run it in conduit*
  - *What is another advantage of conduit??*

Electricity

Voltages

- *230 Volts*
  - *This is the voltage around the house that would power things such as air conditioner, clothes dryer and oven*

Electricity

Voltages

- *230 Volts*

So what is the big deal with 115 and 230 ? It seems confusing that pumps / motors can run on either voltage.

If 115 is so common why would I ever want to use 230 volts ?

Electricity

Voltages

- *When you use a 230 volt pump the amp draw is ½ that of the 115 volt pump with comparable curves*
- *This means the power wire can be twice as long with equal line loss as the 115*

Electricity

- *115 volt single phase*
- *230 volt single phase*
- *208 volt three phase*

If you are working on a commercial job be sure you know if the voltage is 230 or 208

Electricity

- *115 volt single phase*
- *230 volt single phase*
- *208 volt three phase*

If you are working on a commercial job be sure you know if the voltage is 230 or 208

We spec wire size for a Maximum 5% voltage drop

Electrical

- *Most pump manufactures sell 115 & 230 volt pumps close to the same cost*
- *Is there a good reason to consider 230 over 115*

Maude did you know that 230 volt pumps use less electricity?

She's ***'busted'***

Electrical

- *You purchase electricity by how many watts you use*
- *Volts x amps = watts*
- *A 115 volt pump at 10 amps uses 1,150 watts*
- *230 volt pumps run on ½ the amps*
- *A 230 volt pump at 5 amps uses 1,150 watts*

So is there a good reason to use a 230 volt pump??

YES !

And it should be in your troubleshooting toolbox

Electrical

115 volt pump at 10 amps 250' from power source #12 wire

8.74% Voltage drop

230 volt pump at 5 amps 250' from power source #12 wire

2.18% Voltage drop

Measure voltage at the pump to confirm

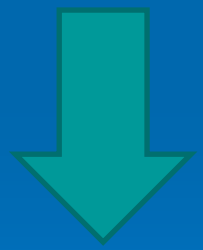
Electrical

- *Wrong voltage*
  - *Measure voltage at source and at the pump*
  - *Wire size*
  - *Distance*

Electrical

Wire size makes a difference

Refer to a wire sizing chart



115 volt using #12 wire

Wire length one way>	50	75	100	125	150	175	200	250	300	350	400	450
Amps												
1	0.17%	0.26%	0.35%	0.44%	0.52%	0.61%	0.7[illegible]%	0.87%	1.05%	1.22%	1.40%	1.57%
2	0.35%	0.52%	0.70%	0.87%	1.05%	1.22%	1.4[illegible]%	1.75%	2.10%	2.45%	2.80%	3.15%
3	0.52%	0.79%	1.05%	1.31%	1.57%	1.84%	2.1[illegible]%	2.62%	3.15%	3.67%	4.19%	4.72%
4	0.70%	1.05%	1.40%	1.75%	2.10%	2.45%	2.8[illegible]%	3.50%	4.19%	4.89%	5.59%	6.29%
5	0.87%	1.31%	1.75%	2.18%	2.62%	3.06%	3.5[illegible]%	4.37%	5.24%	6.12%	6.99%	7.87%
6	1.05%	1.57%	2.10%	2.62%	3.15%	3.67%	4.1[illegible]%	5.24%	6.29%	7.34%	8.39%	9.44%
7	1.22%	1.84%	2.45%	3.06%	3.67%	4.28%	4.8[illegible]%	6.12%	7.34%	8.56%	9.79%	11.01%
8	1.40%	2.10%	2.80%	3.50%	4.19%	4.89%	5.5[illegible]%	6.99%	8.39%	9.79%	11.19%	12.58%
9	1.57%	2.36%	3.15%	3.93%	4.72%	5.51%	6.2[illegible]%	7.87%	9.44%	11.01%	12.58%	14.16%
10	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	6.99%	8.74%	10.49%	12.23%	13.98%	15.73%
11	1.92%	2.88%	3.85%	4.81%	5.77%	6.73%	7.69%	9.61%	11.54%	13.46%	15.38%	17.30%
12	2.10%	3.15%	4.19%	5.24%	6.29%	7.34%	8.39%	10.49%	12.58%	14.68%	16.78%	18.88%
13	2.27%	3.41%	4.54%	5.68%	6.82%	7.95%	9.09%	11.36%	13.63%	15.91%	18.18%	20.45%
14	2.45%	3.67%	4.89%	6.12%	7.34%	8.56%	9.79%	12.23%	14.68%	17.13%	19.58%	22.02%
15	2.62%	3.93%	5.24%	6.55%	7.87%	9.18%	10.49%	13.11%	15.73%	18.35%	20.97%	23.60%
16	2.80%	4.19%	5.59%	6.99%	8.39%	9.79%	11.19%	13.98%	16.78%	19.58%	22.37%	25.17%

230 volt using #12 wire

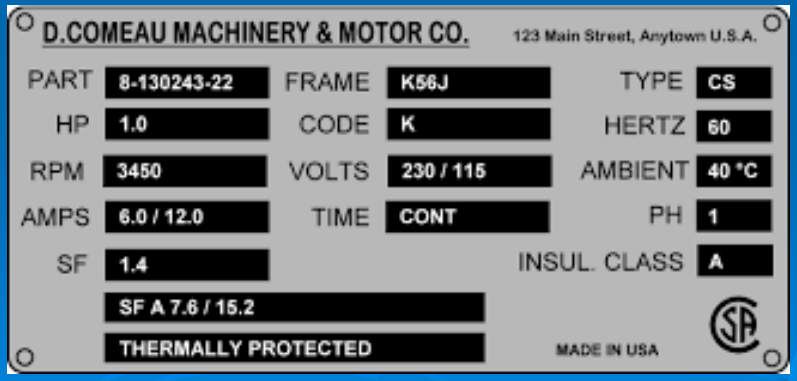
Wire length one way>	50	75	100	125	150	175	200	250	300	350	400	450
Amps												
1	0.09%	0.13%	0.17%	0.22%	0.26%	0.31%	0.35%	0.44%	0.52%	0.61%	0.70%	0.79%
2	0.17%	0.26%	0.35%	0.44%	0.52%	0.61%	0.70%	0.87%	1.05%	1.22%	1.40%	1.57%
3	0.26%	0.39%	0.52%	0.66%	0.79%	0.92%	1.05%	1.31%	1.57%	1.84%	2.10%	2.36%
4	0.35%	0.52%	0.70%	0.87%	1.05%	1.22%	1.40%	1.75%	2.10%	2.45%	2.80%	3.15%
5	0.44%	0.66%	0.87%	1.09%	1.31%	1.53%	1.75%	2.18%	2.62%	3.06%	3.50%	3.93%
6	0.52%	0.79%	1.05%	1.31%	1.57%	1.84%	2.10%	2.62%	3.15%	3.67%	4.19%	4.72%
7	0.61%	0.92%	1.22%	1.53%	1.84%	2.14%	2.45%	3.06%	3.67%	4.28%	4.89%	5.51%
8	0.70%	1.05%	1.40%	1.75%	2.10%	2.45%	2.80%	3.50%	4.19%	4.89%	5.59%	6.29%
9	0.79%	1.18%	1.57%	1.97%	2.36%	2.75%	3.15%	3.93%	4.72%	5.51%	6.29%	7.08%
10	0.87%	1.31%	1.75%	2.18%	2.62%	3.06%	3.50%	4.37%	5.24%	6.12%	6.99%	7.87%
11	0.96%	1.44%	1.92%	2.40%	2.88%	3.36%	3.85%	4.81%	5.77%	6.73%	7.69%	8.65%
12	1.05%	1.57%	2.10%	2.62%	3.15%	3.67%	4.19%	5.24%	6.29%	7.34%	8.39%	9.44%
13	1.14%	1.70%	2.27%	2.84%	3.41%	3.98%	4.54%	5.68%	6.82%	7.95%	9.09%	10.22%
14	1.22%	1.84%	2.45%	3.06%	3.67%	4.28%	4.89%	6.12%	7.34%	8.56%	9.79%	11.01%
15	1.31%	1.97%	2.62%	3.28%	3.93%	4.59%	5.24%	6.55%	7.87%	9.18%	10.49%	11.80%
16	1.40%	2.10%	2.80%	3.50%	4.19%	4.89%	5.59%	6.99%	8.39%	9.79%	11.19%	12.58%

Electrical

- *Power supply wire damaged*
  - *Measure resistance with ohm meter*

Electrical

- *Wrong amperage*
  - *Check the nameplate to confirm the run amps*
  - *Check the amp draw with your amprobe*



Electr

- *Is the breaker engaged*
  - *Did the homeowner turn the breaker off*
  - *Did the last service technician forget to turn it on*
  - *Did something in the circuit trip the breaker*

Electricity

Voltages

- *Let's say we have a 115 volt pump that draws 9 amps*
- *Let's also say we are installing this pump 175 feet from the main control panel using 12 / 2 UF wire (The most common used)*
- *See any problems?*
- *This is the worst kind of failure…A "soft" failure*

Electricity

Voltages

- *Now take a look at the same installation using a 230 volt pump*
- *See how the 115 volt pump requires you to step up to #10 wire to prevent line loss or low voltage*
- *But using a 230 volt pump is well within the range of #12 wire*

Electricity

Voltages

The mysterious

3 phase

208 Volts

What do you do ??

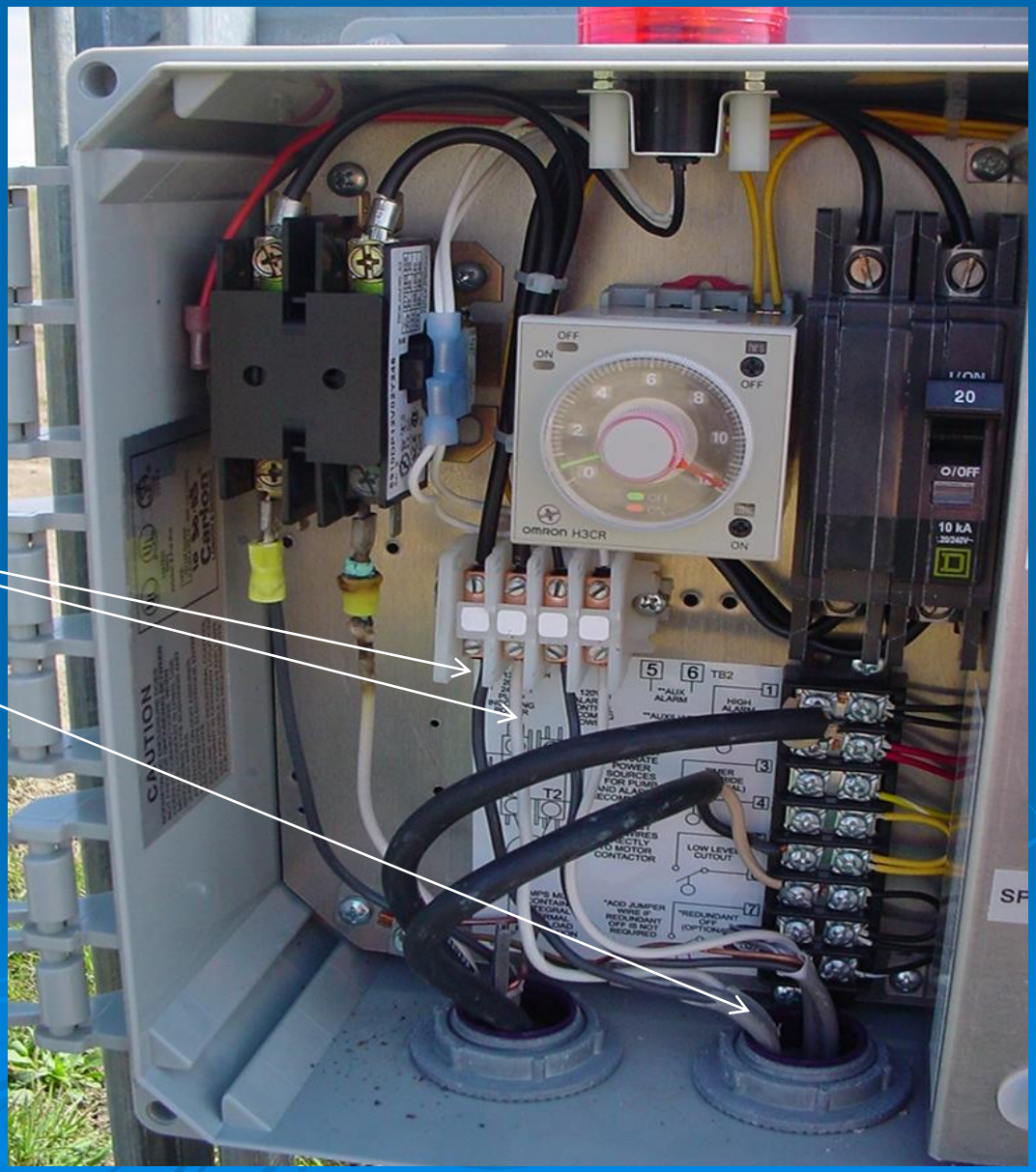
Go Fishing !!!

You can sit all day and work on a panel like this one

Basic time dose control panel

Incoming power to the pump

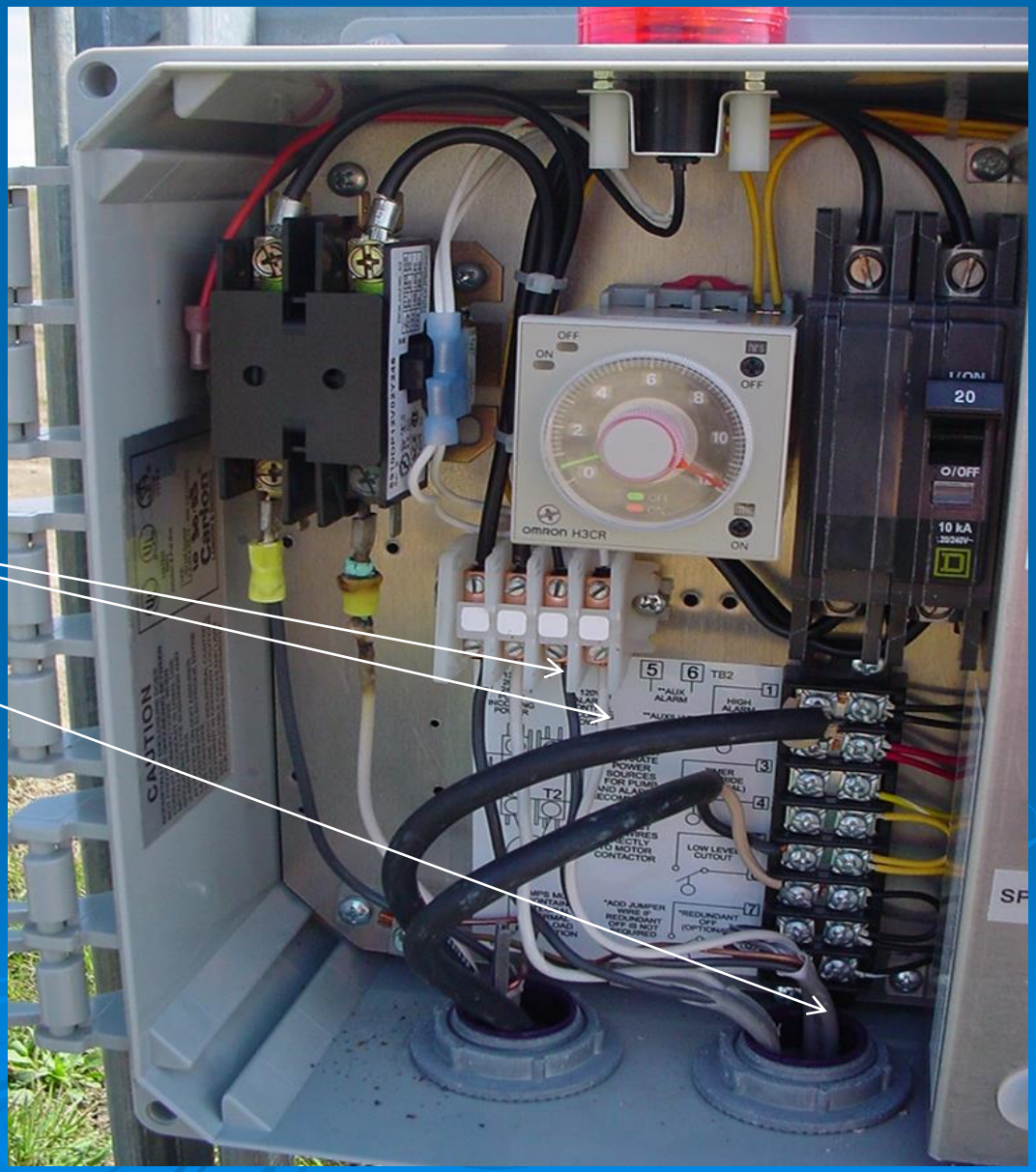
Usually 12/2 UF wire



Basic time dose control panel

Incoming power to the panel

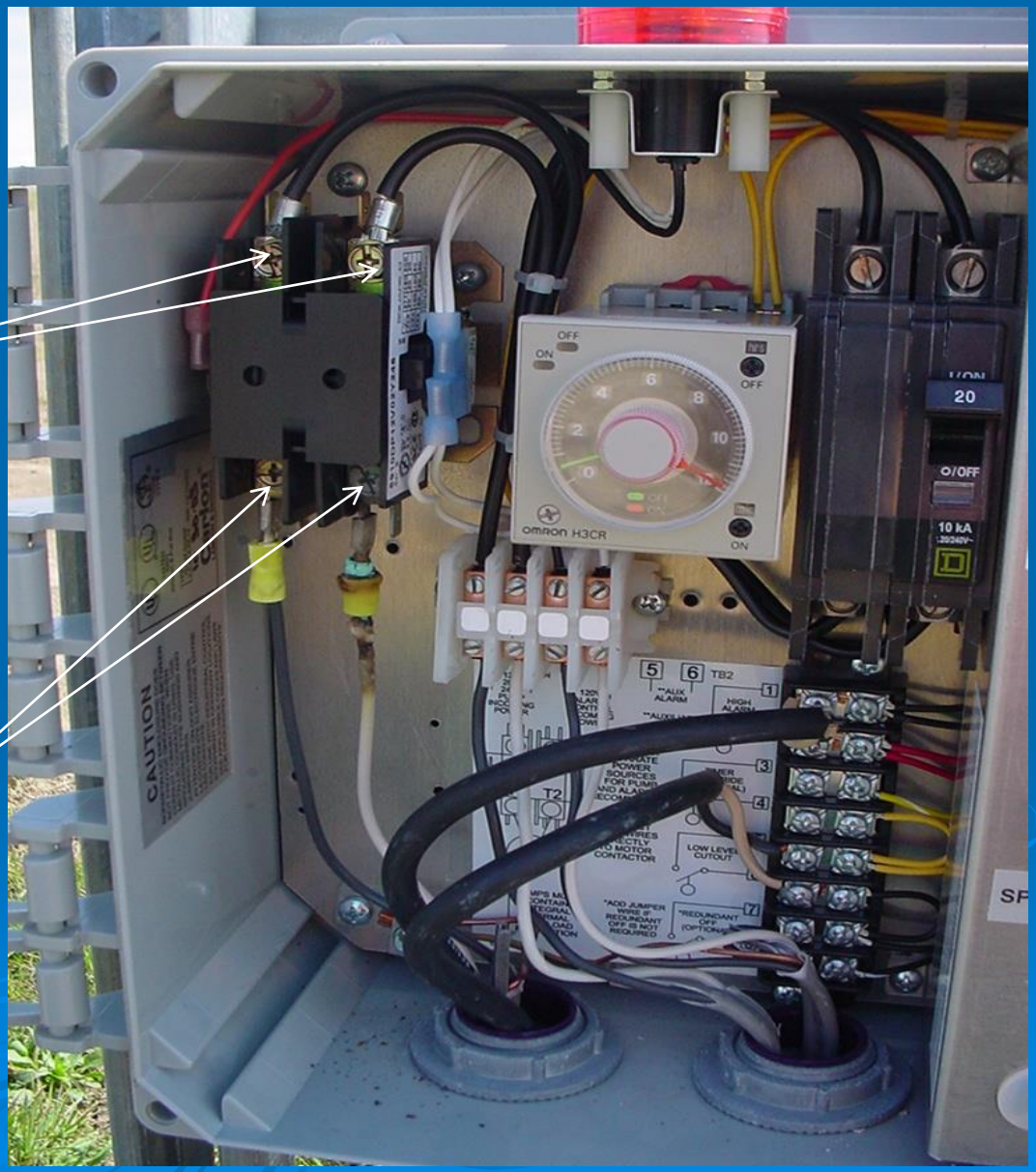
Usually a smaller gauge wire like 14/2 UF



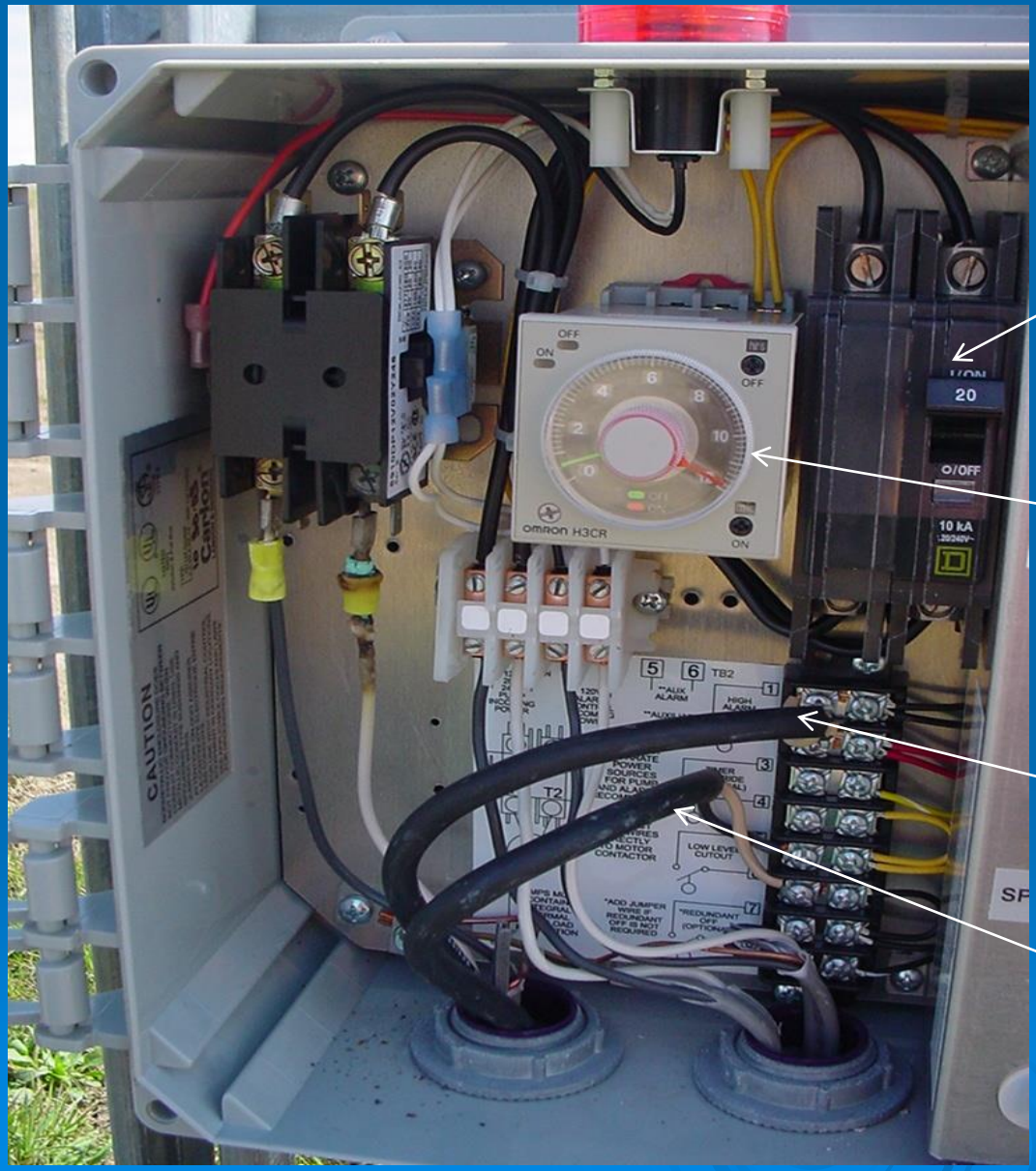
Basic time dose control panel

Pump power to the relay

Pump power from the relay to the pump



Basic time dose control panel

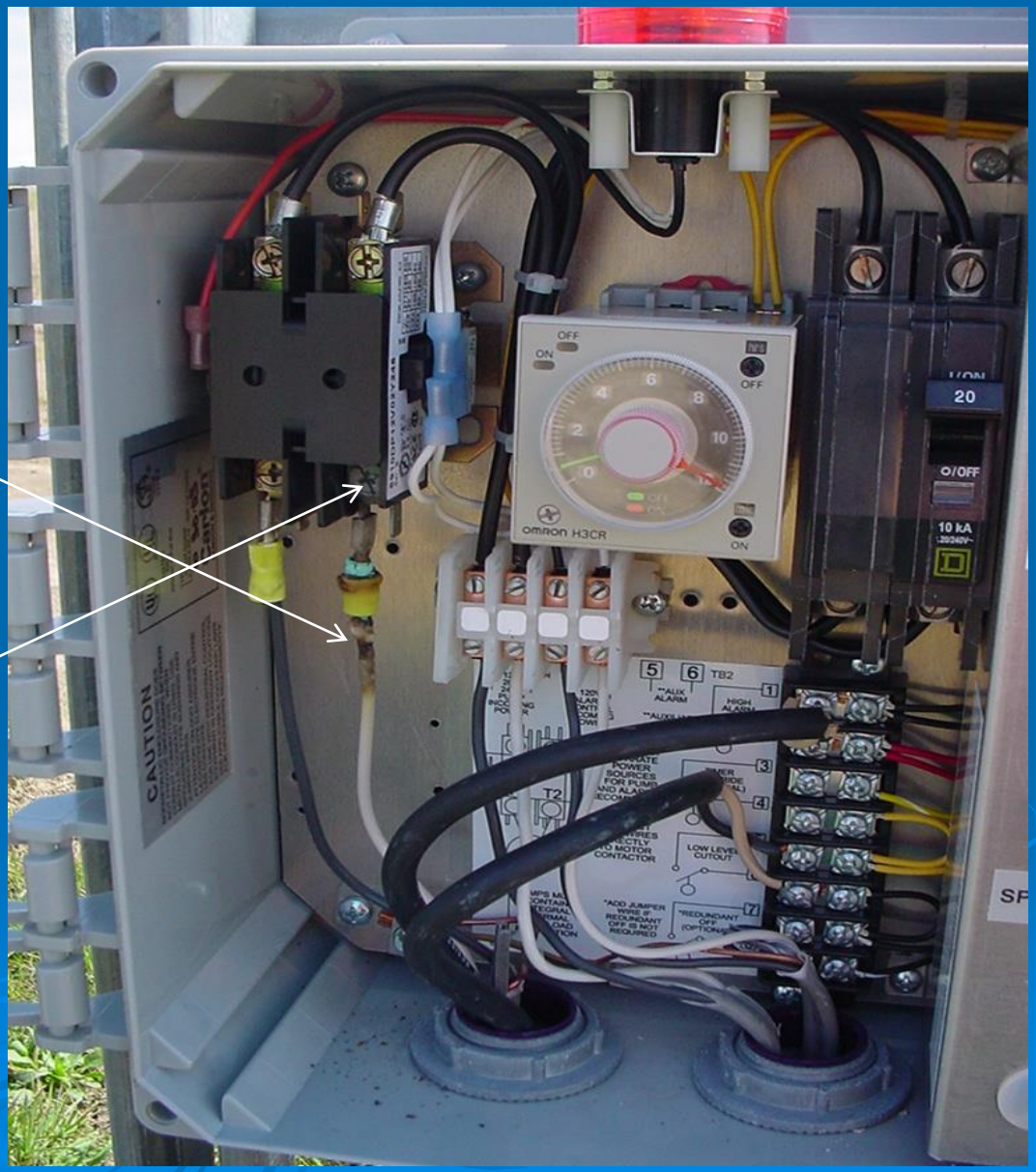


Basic time dose control panel

Did anybody notice this ?

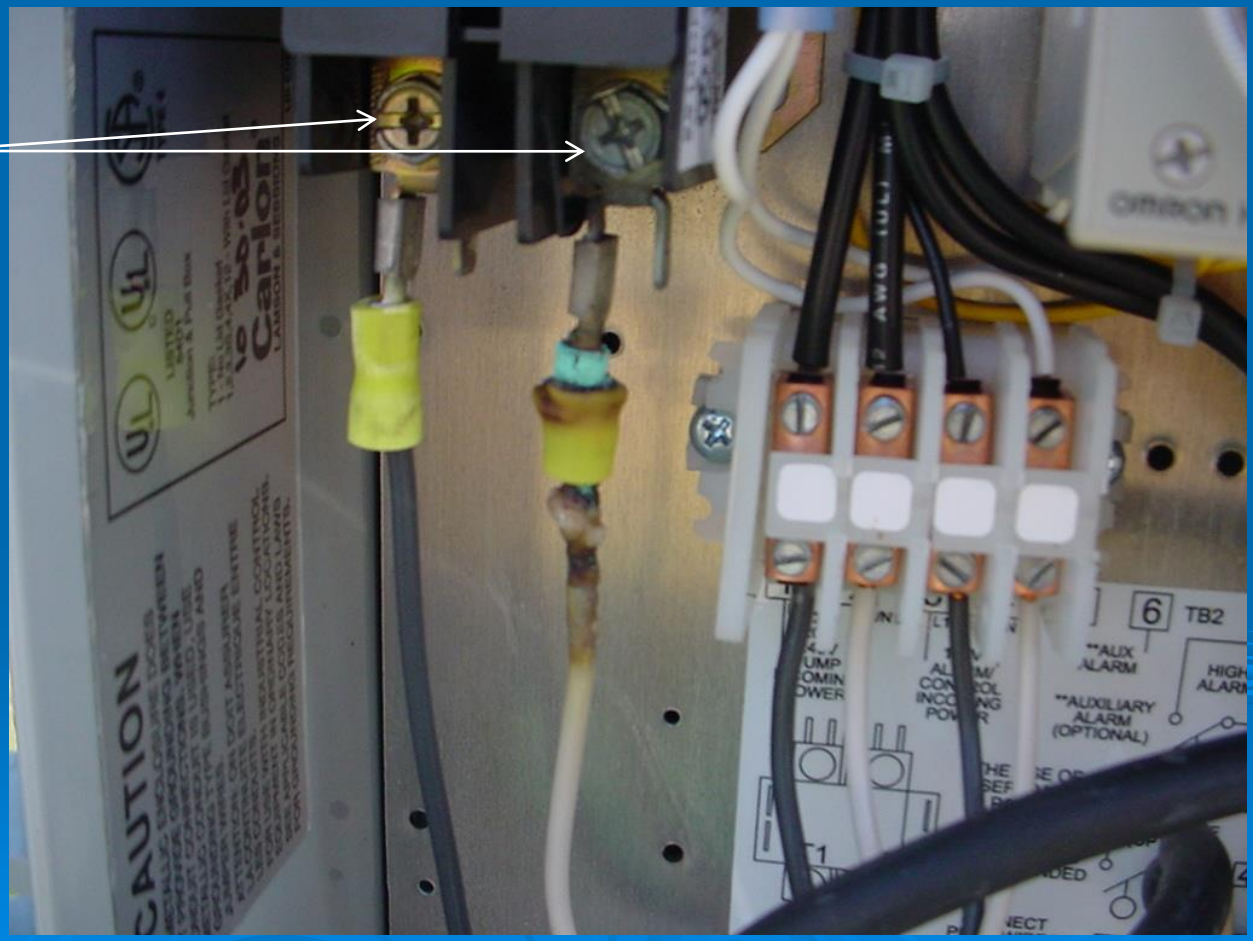
What could be the cause ?

Probably this



Basic time dose control panel

Notice the difference in the color of the brass lug screws ?



This is from the heat caused by the loose connection

Basic time dose control panel

Incoming power supply from house

Outgoing power to pump and float leads from tank

Take a look where these leads enter the tank

Panel mounted on sturdy unistrut extending along side the tank to a depth of 5 feet minimum

Note: All leads are in conduit attached to the panel with watertight hubs and penetrating the panel in the bottom maintaining the NEMA 4 rating

Basic time dose control panel

Power to pump and float leads maintaining good watertight connections from the panel to the tank

IMPORTANT: *Don't forget to seal the tank gasses from the panel*

Basic time dose control panel

Ready for backfill

Questions