Wire you shocked?

Electrical safety in the Brewery

Protect equipment? Or people?

Russell A. McCrimmon, O.H.S.T.

BREWERY SAFETY CONSULTING

This presentation is dedicated to

Content

- Begin with the basics of injury and damage
- How we prevent injury
- How we prevent damage
- Equipment selection
- Safety by design

- The most basic concepts
- to more advanced knowledge

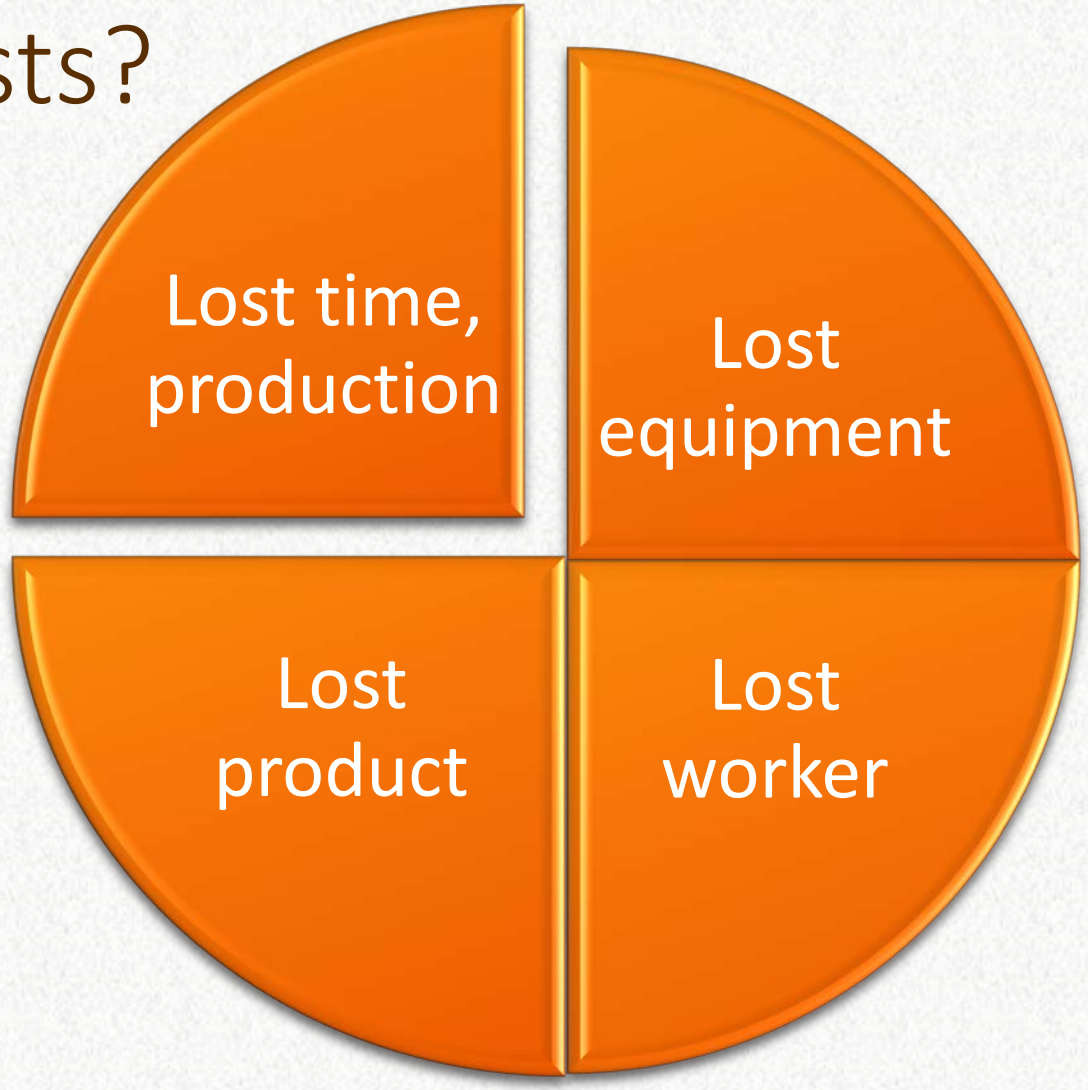
To protect equipment?
Or to protect people?

OSHA to BA Safety member:

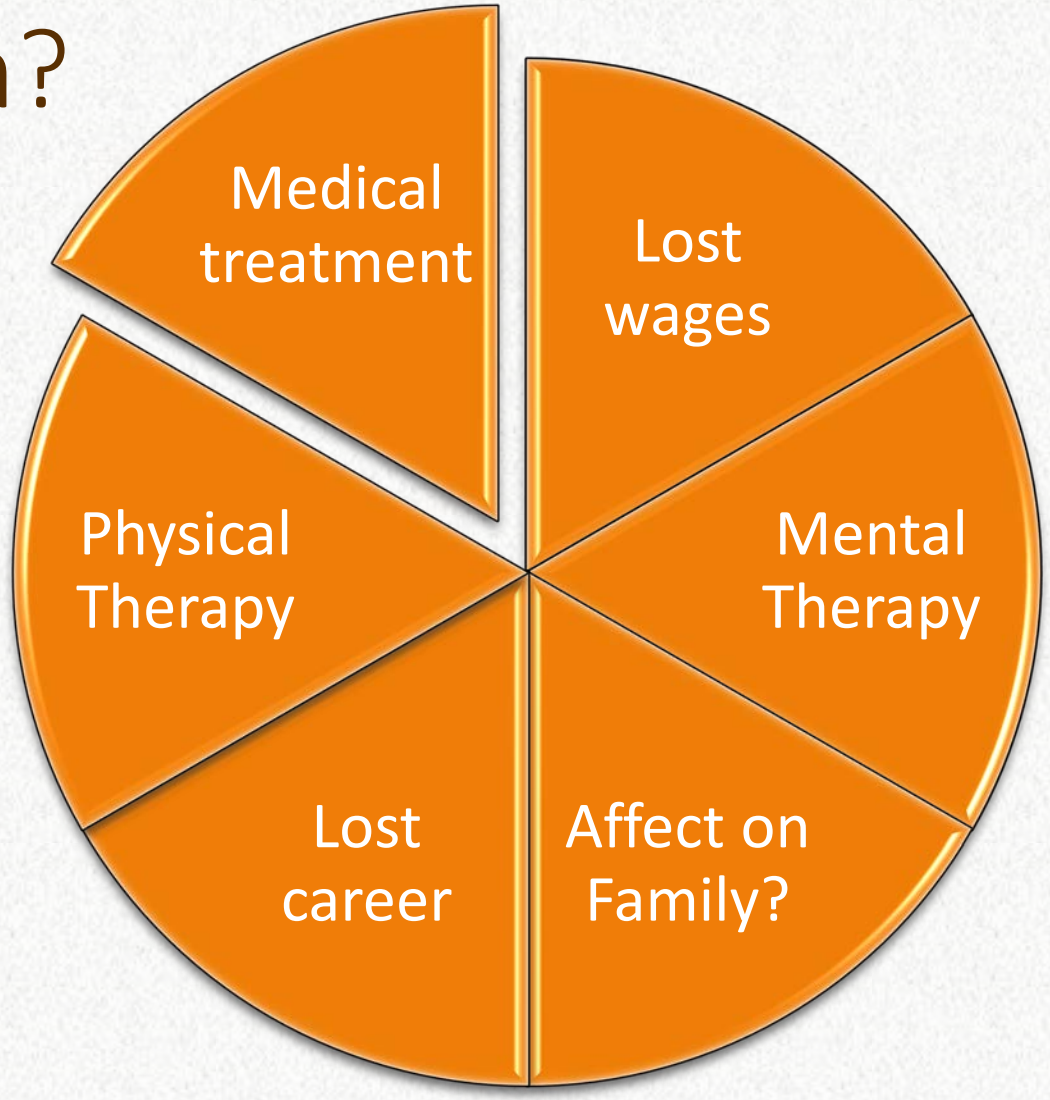
OSHA can lock your doors, just as quickly as TTB

Cost of injuries

Business costs?



To the Person?



The extent to which the employer pays the direct costs depends on the nature of the employer's workers' compensation insurance policy. The employer always pays the indirect costs.

Estimated Average cost

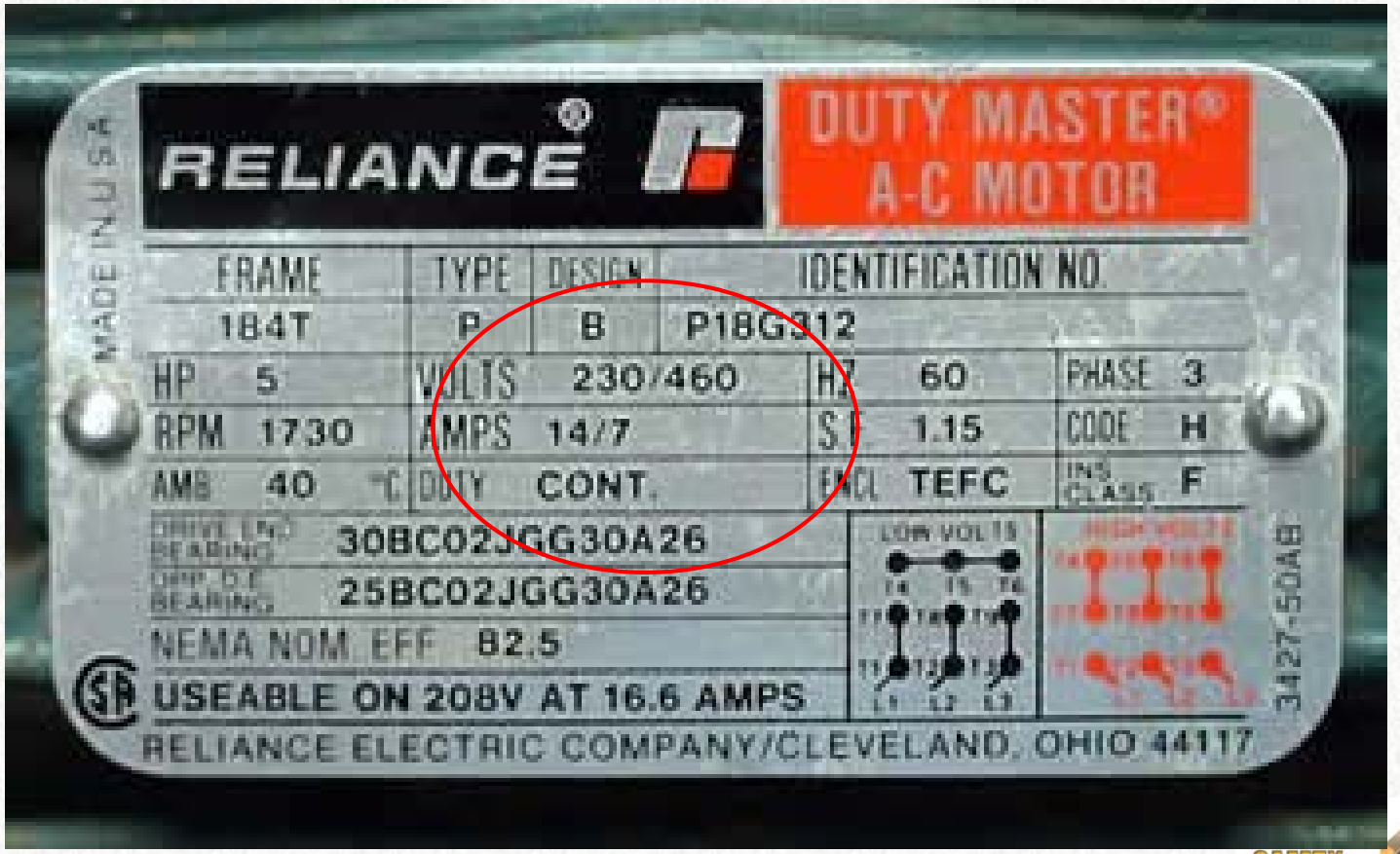
- Employer’s direct costs depend on workers' comp “co-pay”.
- Employer always pays the indirect costs.
- Additional sales based on 20% profit margin
- “I’ll use my personal insurance coverage”??

Injury Type	Direct Cost	Indirect Cost	Total Cost	Additional Sale (Indirect)	Additional Sale (Total)
Electric Shock	$ 93,858	$ 103,243	$ 197,101	$ 516,219	$ 985,504
Burn	$ 40,188	$ 44,206	$ 84,394	$ 221,034	$ 421,970

fundamentals

- I=E/r
- I = current, is the flowing electricity
- E= volts, force that pushes
- r = resistance trying to hold it back
- W= watts of power
- combination of volts and current gives watts
- 745.7 W = 1 Hp

Look at your pump motor: higher voltage, uses lower amperage



SAFETY CONSULTING

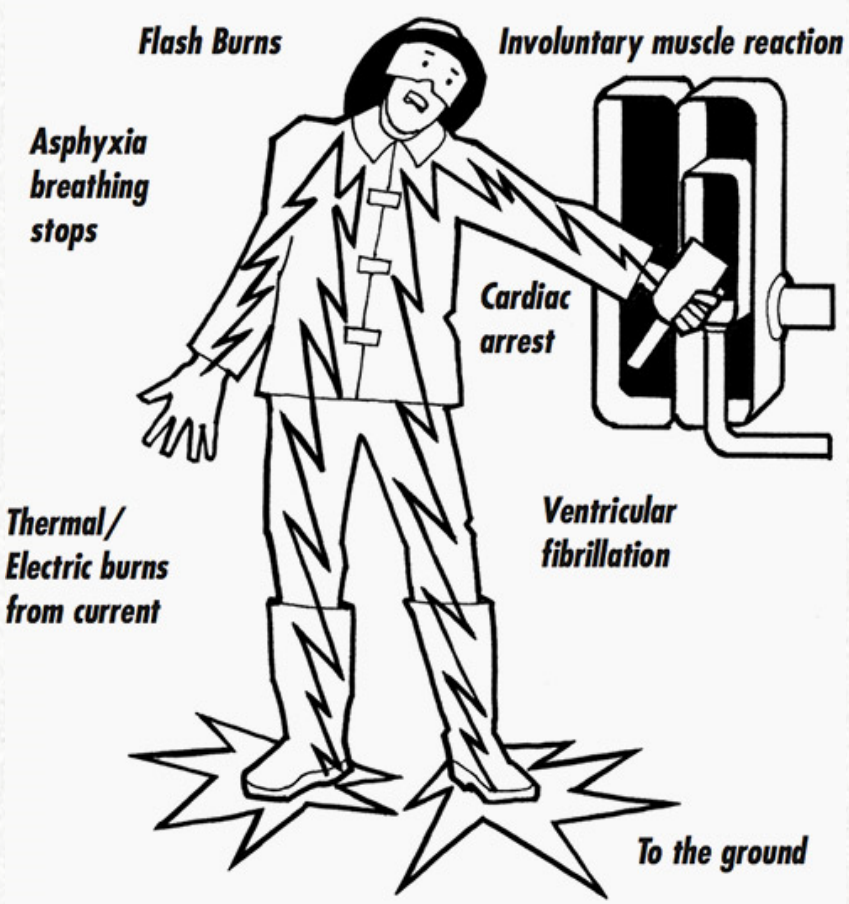
Does a **SHOCK** damage human cells?

When do I feel a shock?

- When am I in danger?
- Low level electricity causes injury
- Maximum safe voltage only 10V
- Physical affects from **milli**-amps.

CURRENT A/C 60HZ	PHYSIOLOGICAL PHENOMENA	FEELING OR LETHAL INCIDENCE
< 1mA	None	Imperceptible
1mA	Perception threshold	
2-10mA	Sensation of shock	Not painful, muscle control maintained
5mA		Ground Fault Circuit Interrupter Operates
10-20mA	Paralysis Threshold of Arms	Cannot release hand grip, victim may be thrown clear
20-50mA	Respiratory Paralysis	Breathing Stoppage (frequently fatal)
50-100mA	Fibrillation Threshold (0.5%)	Heart action discoordinated (probably fatal)
100-200mA	Fibrillation Threshold (99.5%)	
>200mA	Tissue Burning	Non fatal unless vital organs are burned

Electrical safety



- Amps are from Voltage and Resistance
- Body resistance can be 500 ohms.
- 1000 ohms is realistic for wet, intact skin.
- Broken skin has less resistance
- Voltage breaks down skin cells.
- Lowers resistance.

Quoting: OSHA Letter Of Interpretation 9/4/2015

- Current causes injury, not voltage.
- Current passing through depends on resistance.
- Resistance of the body can be as low as 500 ohms.
- 60 volts through 500 ohms is 120 milliamperes; enough for serious injury.
- Documented serious injuries are proof that below 50V is dangerous.
- Auto mechanics: 12-volt at 24 milli-amps.

Power of electricity

Hire an industrial or commercial electrician

By The Numbers

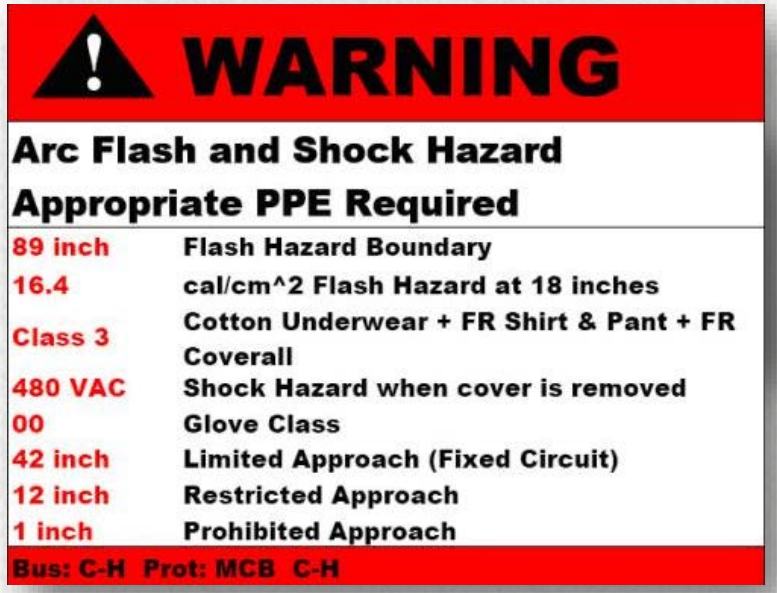
How Often	Number	Effect
United States Annual Average	4,000	Non-Disabling electrical contact injuries
United States Annual Average	3,600	Disabling electrical contact injuries
Every Day	1	Person is electrocuted in the workplace
Electrocutions are	4th	Leading cause of traumatic occupational fatalities
Each year	+2,000	Workers are sent to burn centers with electrical burns

- "Switch" doesn't kill power in circuit
- Shut off power at breaker
- **1** electrocution per day
- **6** electrical burns per day
- **2 of 3** are worker error
- Arc Flash is not "shock"

NFPA 70e HOST AND CONTRACT EMPLOYERS' RESPONSIBILITIES

- **110.3(A)** Host employer **communicates hazards to contractor**
- Include info the contractor needs to assess safety
- **110.3(B)** Contractor trains employees on electrical safety
- Communicates **hazards identified by the host**
- Contractor must report to host, any new hazards
- **110.3(C)** "…shall be **documented meeting** between host and contractor."

NFPA 70e HOST AND CONTRACT EMPLOYERS' RESPONSIBILITIES



- Electrical schematic drawings
- Questionable, faulty circuits
- Circuit Voltage and amperage
- Proper labels that Identify

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That means

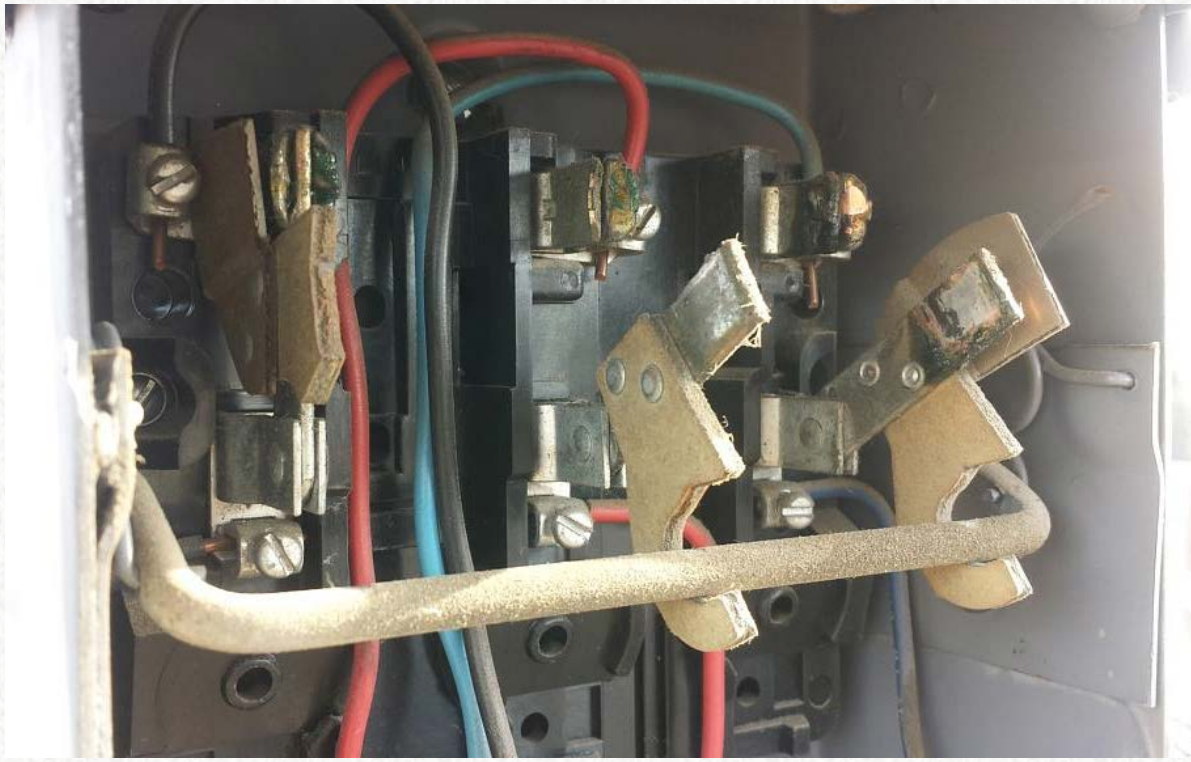
I AM RESPONSIBLE

for my electrician

going home in one piece

Electrical safety NFPA 70e Rev 2015

- Do you see the problem here?
- Only a **properly protected** electrician should touch this
- This will **kill**
- By arc
- Or by direct shock



Shock and Arc magnified by water and dust

- **Helps electricity travel** across easier
- Minerals and dust in water are more conductive
- Dust in **air or on exposed** circuits
- More impure, more conductive

Prevention vs. protection

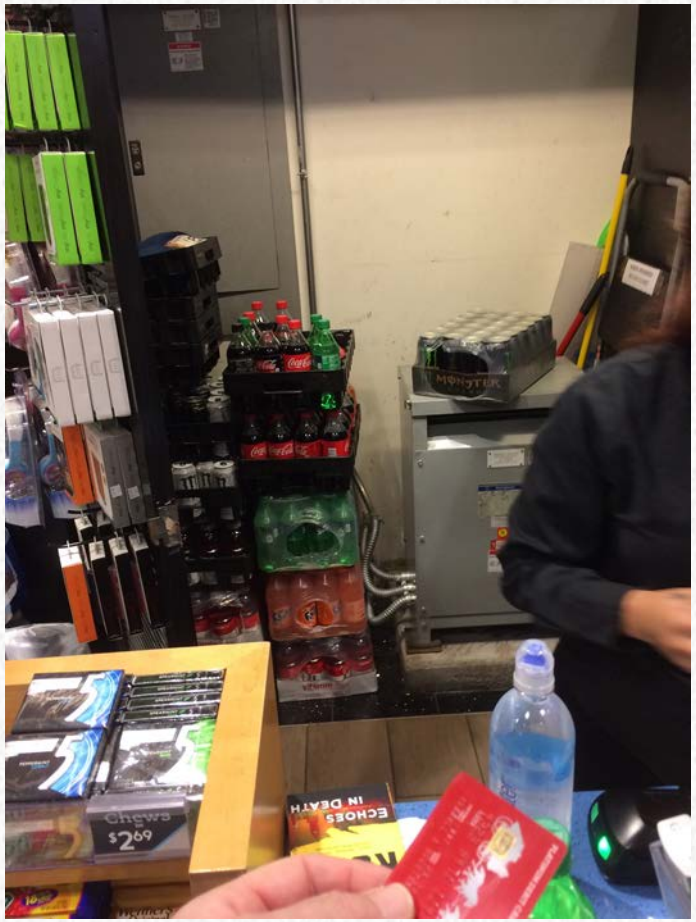
Codes, Regulations, Basic good electrical practice

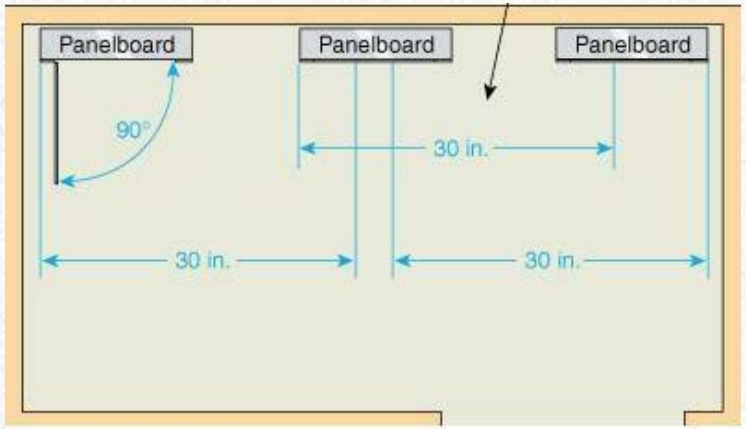
- National Electrical Code
- NFPA
- ANSI
- ASTM
- Factory Mutual
- CE
- Underwriter's Laboratory
- Am Society of Safety Engineers
- OSHA Subpart S Electrical
- NFPA 70
- NFPA 70e
- UL listings

Electrical 1910.303 to 1910.399

- No openings in boxes or covers
- Use it as it’s engineered
- Rated for necessary amps
- Switches vs. Disconnects
- Equipment access in emergency
- No cords through doors, openings, walls, etc.

Keep access clear for emergency shut off





1910.307 Hazardous locations

- Electrical equipment in dust environments
- Includes lights, motors, cords…
- Includes exit signs, emergency lights, etc.

Fast Fact:

Dust build-up on equipment causes it to OVERHEAT,

and can ignite the surrounding atmosphere.

Class II equipment must resist this “dust blanket”.

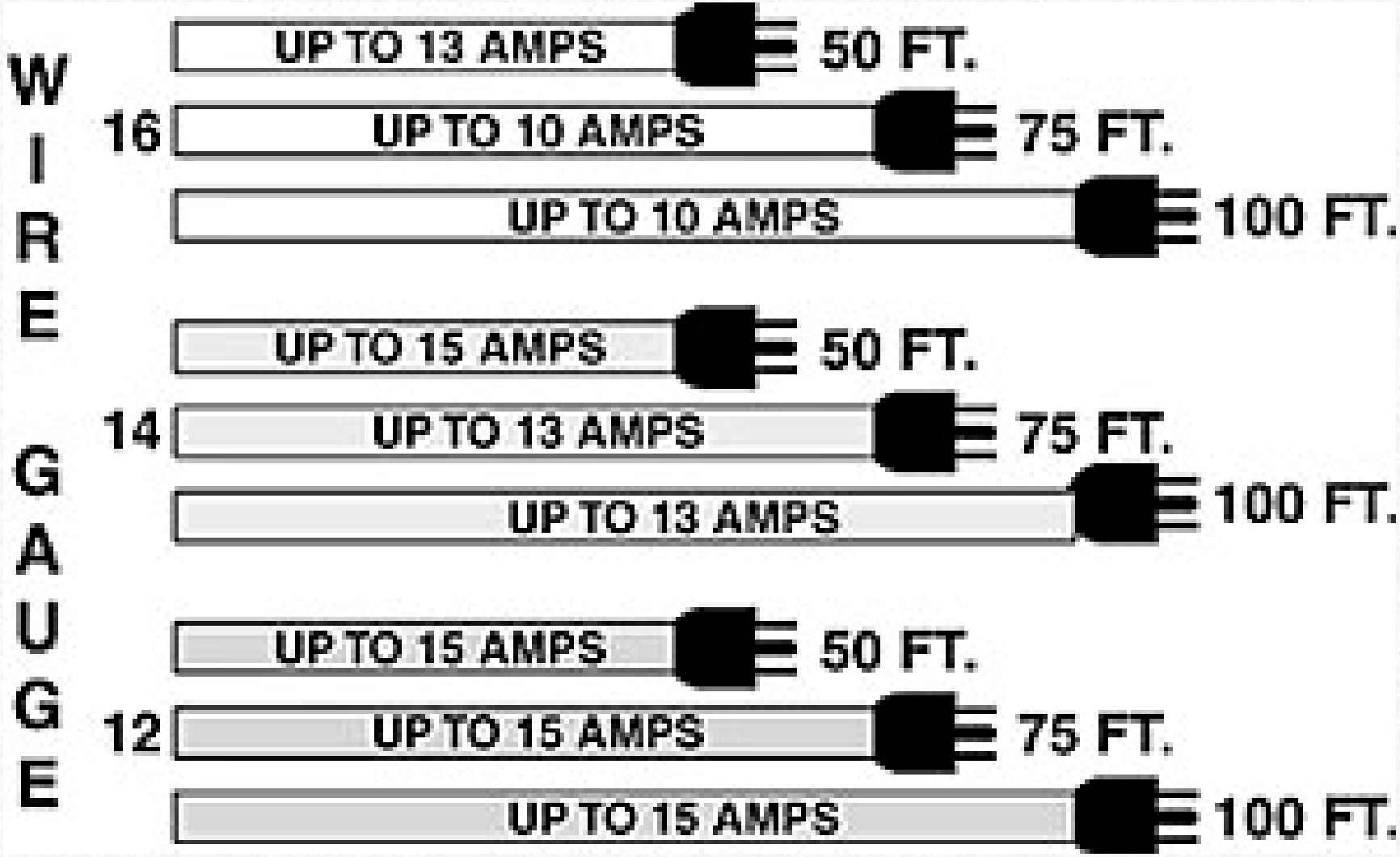
- Correct equipment for the job
- Ground all cords and equipment
- Cords almost as good as new
- Inspect it, if it can be damaged
- Water will puddle in these strain reliefs

Current and cords

Selecting extension cords

- Protective jacket over insulated conductors
- The gray cord design shown is illegal
- Read instructions for proper use and power capacity.
- Select cords rated for your current
- Thick, round, big gauge, high amp cords

Longer cord lower amp capacity



W: Suitable for outdoors (wet)

Read cord's jacket:

S- general use

W- suitable for outdoors

J- 300 V insulation; without a J is 600 V

P- parallel wiring, used indoors

O- oil-resistant cord

T- vinyl thermoplastic jacket

E- thermoplastic elastomer rubber jacket

- SJTW

On this cord, SJTW indicates the jacket type and AWG 18/3 indicates the gauge rating.

Tips To Remember

- **Never use extension cords.**
- Extension cords are **fire and safety** risks.
- Use Outdoor-Rated, Wet location Cords
- Wet cords are moisture-resistant.
- Larger gauge wires for larger equipment.
- Indoor cords are for living rooms.

Stop using a warm or hot cord

- Don’t connect multiple cords.
- Never tape, staple, nail up cords
- Don't bend or coil cords in use.
- Keep cords out from under feet

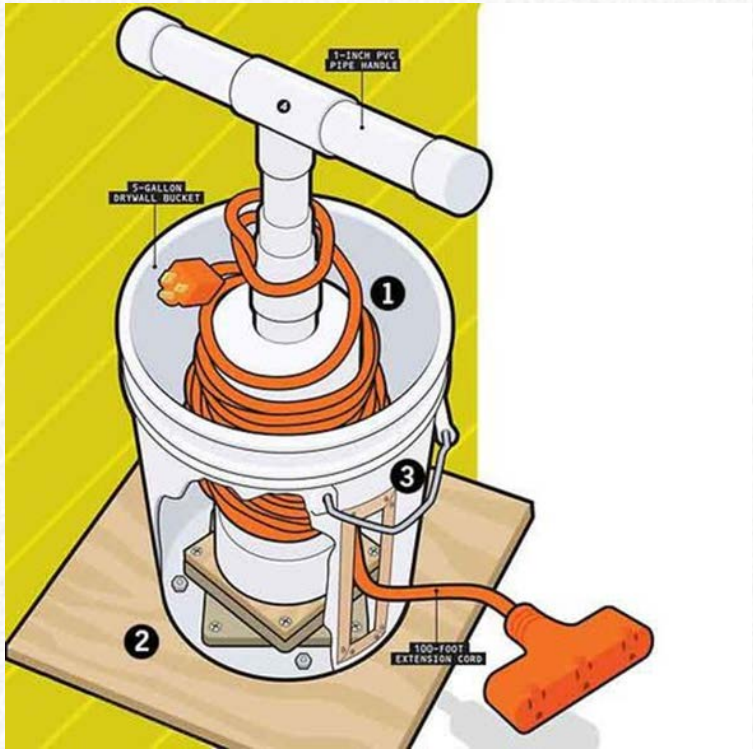
- These magnify heat gain
- Heat damages materials
- Increase damage, increase danger

Cord plug safety

- Outlet and cover plate get hot
- Plug ends gets hot at outlet box
- Both plugs get hot
- Entire cord gets hotter

Hot cords

- Current heats cords
- Inductive coupling magnifies heat



Caring for extension cords

- Unplug unused cords.
- Pull on the plug — not the cord.
- Cords are temporary; add more outlets
- Avoid touching equipment or breakers when wet

Caring for extension cords

- Unplug from outlet first, then tool
- Power arcs across the connection

Relocatable power tap

Overloaded electric outlet strip

- Not designed for excess amp draw
- Cannot be permanently mounted
- Must disconnect daily

Grounding versus GFCI

Grounds are path of least resistance

- Dissipate voltage and current if malfunctions
- Test for resistance less than 25 ohms
- Electricity uses path of least resistance

To reduce:

- Electric shock
- Equipment damage
- Time lost during repair
- Cost

Ground and **O**ver **C**urrent **P**rotection

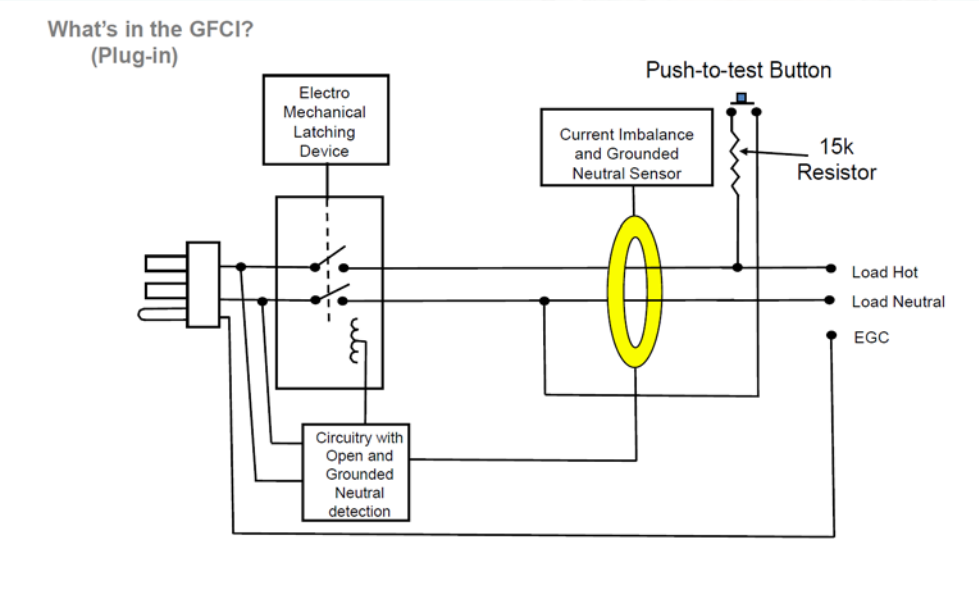
OCP, breakers

- 10 amp circuit
- 15 amp
- 25 amp
- 50 amp
- Require ground

GFCI

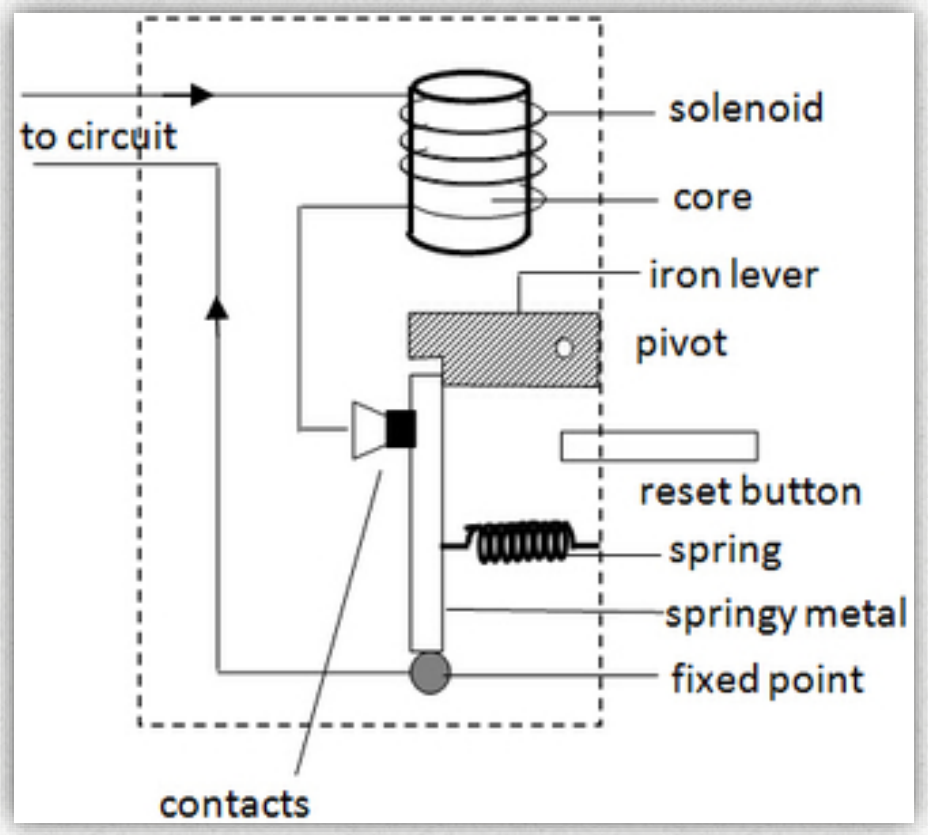
- 4-6 milli-amps
- Less than 40 milliseconds
- Don’t require ground

Ground Fault Circuit Interrupters vs. OCP
Both are switches



- GFCI trip 4-6 mA and 1/40 second

OverCurrent Protection Trips when?



Current Level

- Breakers eliminate or minimize damage
- Outbound current is compared to return current
- Measures the **difference in current**
- GFCI protects from electrocution by paralysis

Current Magnitudes

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DC Current	Physiological Phenomena
0-4 mA	Perception Threshold
4-15 mA	Surprise
15-80 mA	Reflex Action
80-160 mA	Muscular Inhibition
160-300 mA	Respiratory Failure
>300 mA	Usually Fatal

Misconception

- I won't get a shock
- Oh yes, I will!

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GFCI

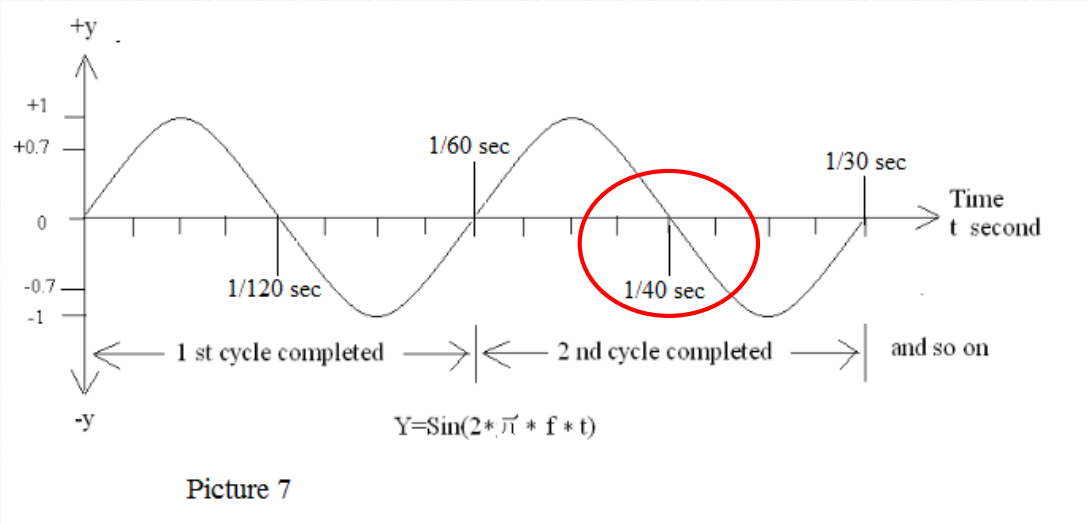
Portable GFCI outlets, plugs into any outlets.
Must say is “waterproof”.

National Electrical Code and **OSHA**

Require GFCI in all **wet area** circuits

Both Inside and Outdoors

Documented monthly tests



Picture 7

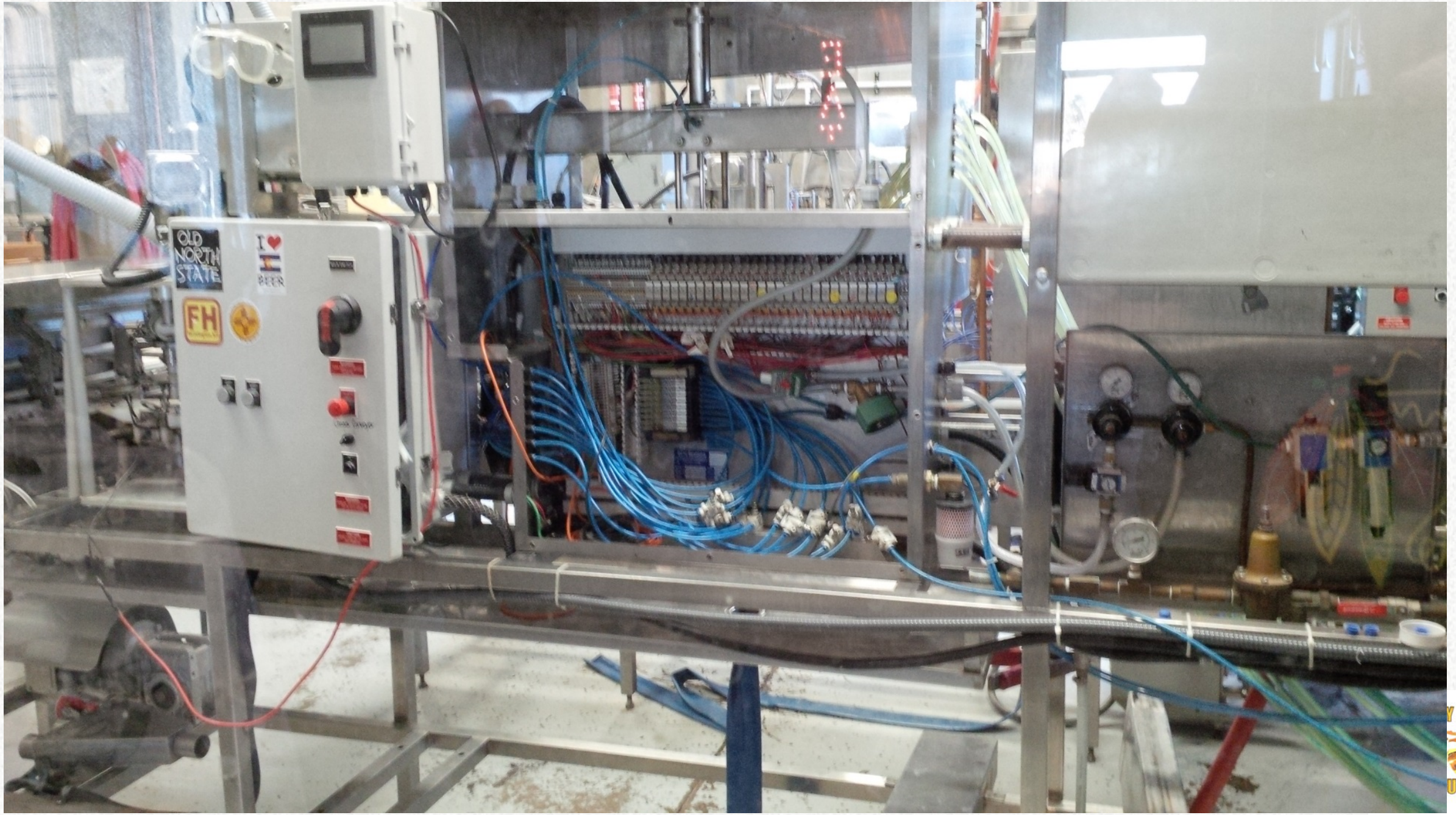
GFCI trip 4-6 mA and 1/40 second

Safe Work Practices

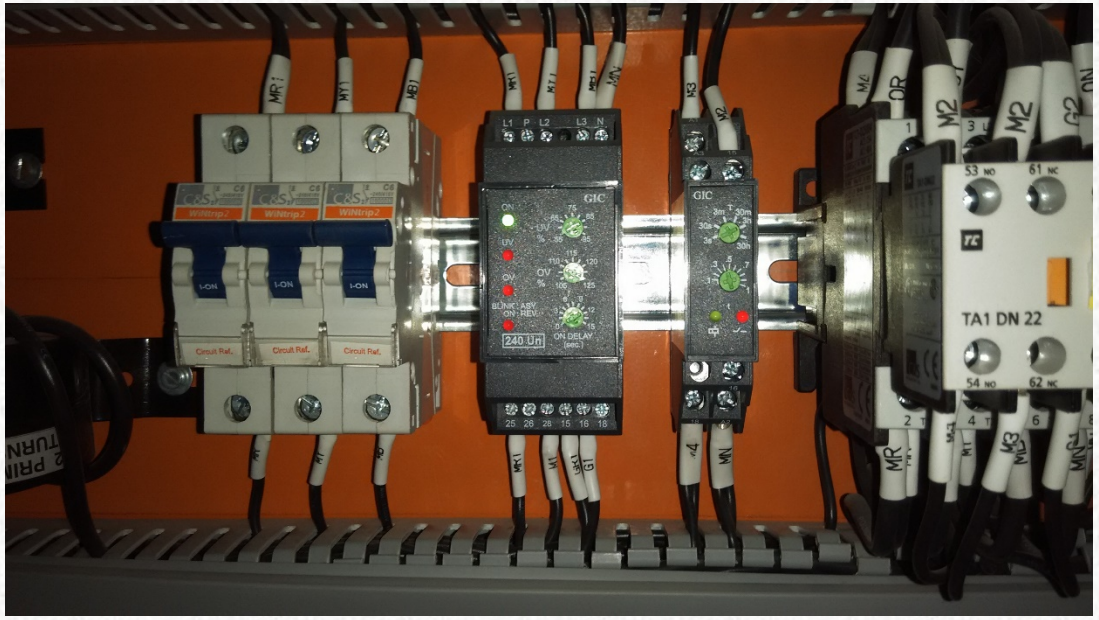
- May be free!
- Teach every person
- Never assume they know
- Best Management Practices

Safe work practices

- Close panels
- Clean dust out of panels
- Minimize extension cords
- Squeegee floors
- Reduce water
- Dust off electrical equipment

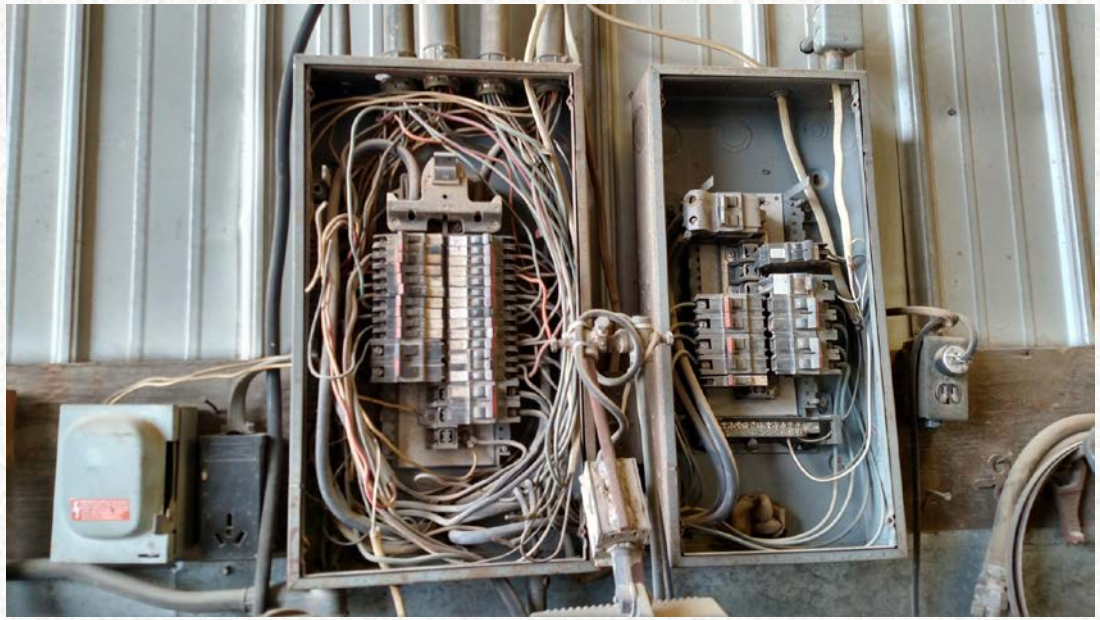

OLD NORTH STATE
I ♥ BEER
FH

Poor design of adjustments



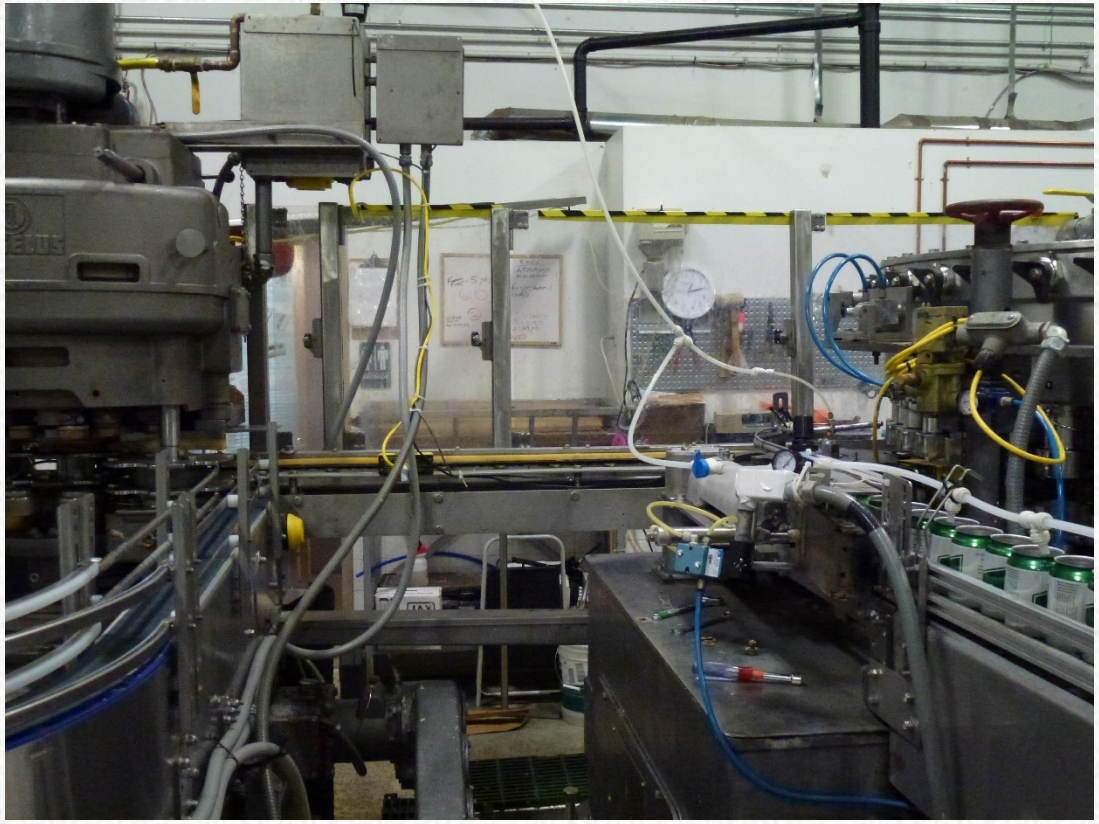
Electrical maintenance

- Clean dust out of breaker panels
- Friend had 2 dust fires in breaker panels
- Procedure to check and clean regularly
- Shut off power to the panel



Safe practices for less than a couple bucks

- Machine guards limit travel of splash.
- De-energize all electrical
- Verify it’s de-energized
- Lockout
- Always assume power is turned on:
- Chris was told it was de-energized
  - BELIEVED, so didn’t verify
  - THEN IT zapped HIM
  - SHOCKING!

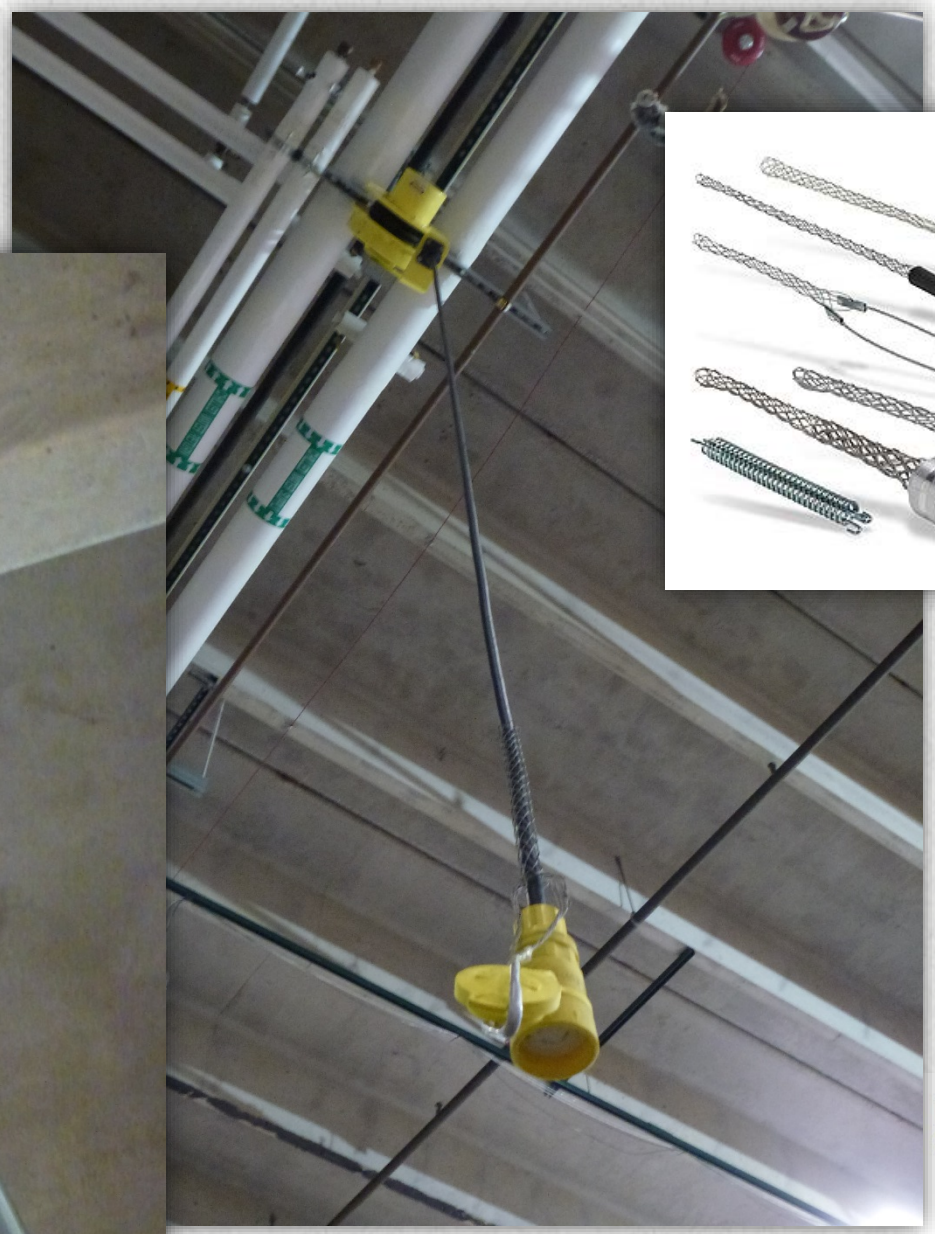


Safety by design

Adding outlets

Hard wired or plug-in

Support entire cord with cable to plug end

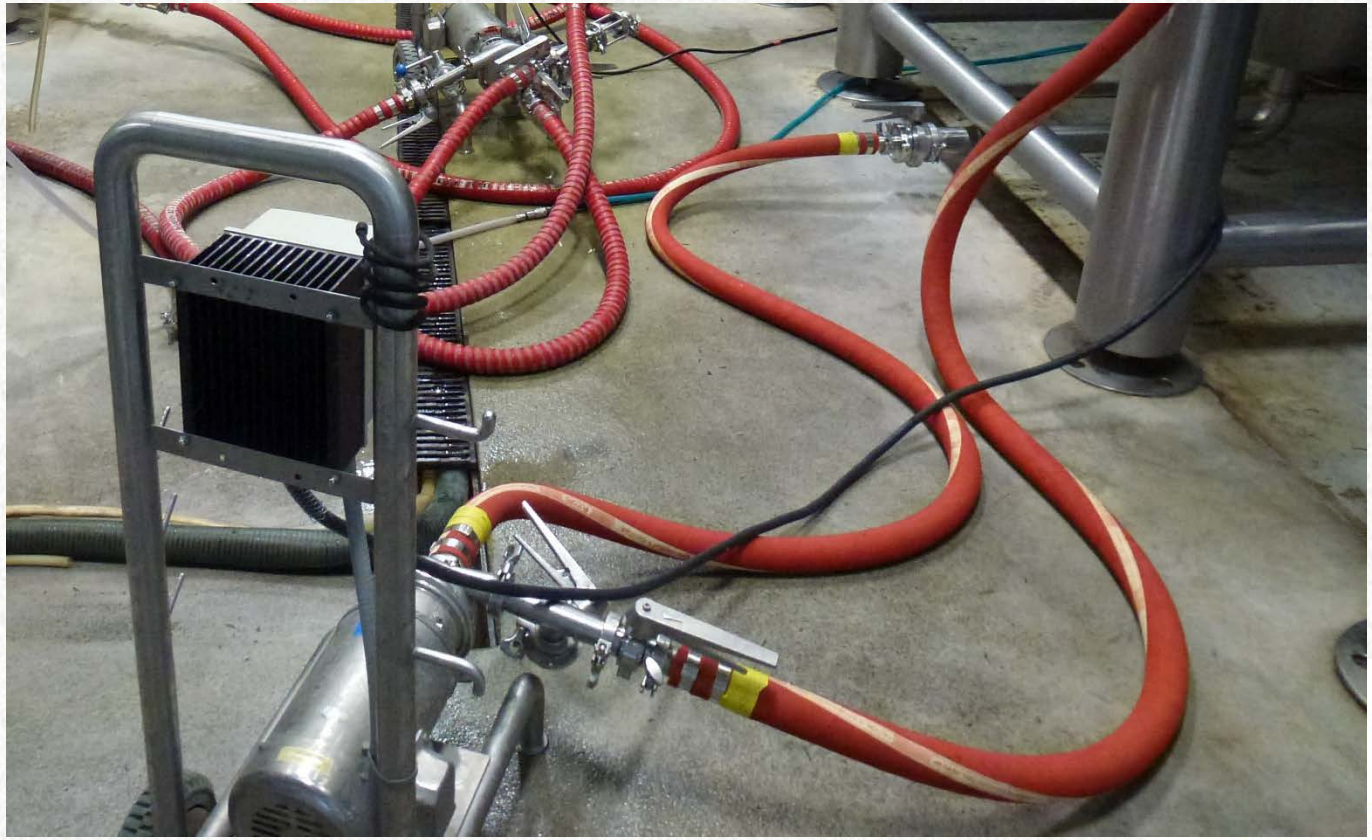


Avoid use of extension cord

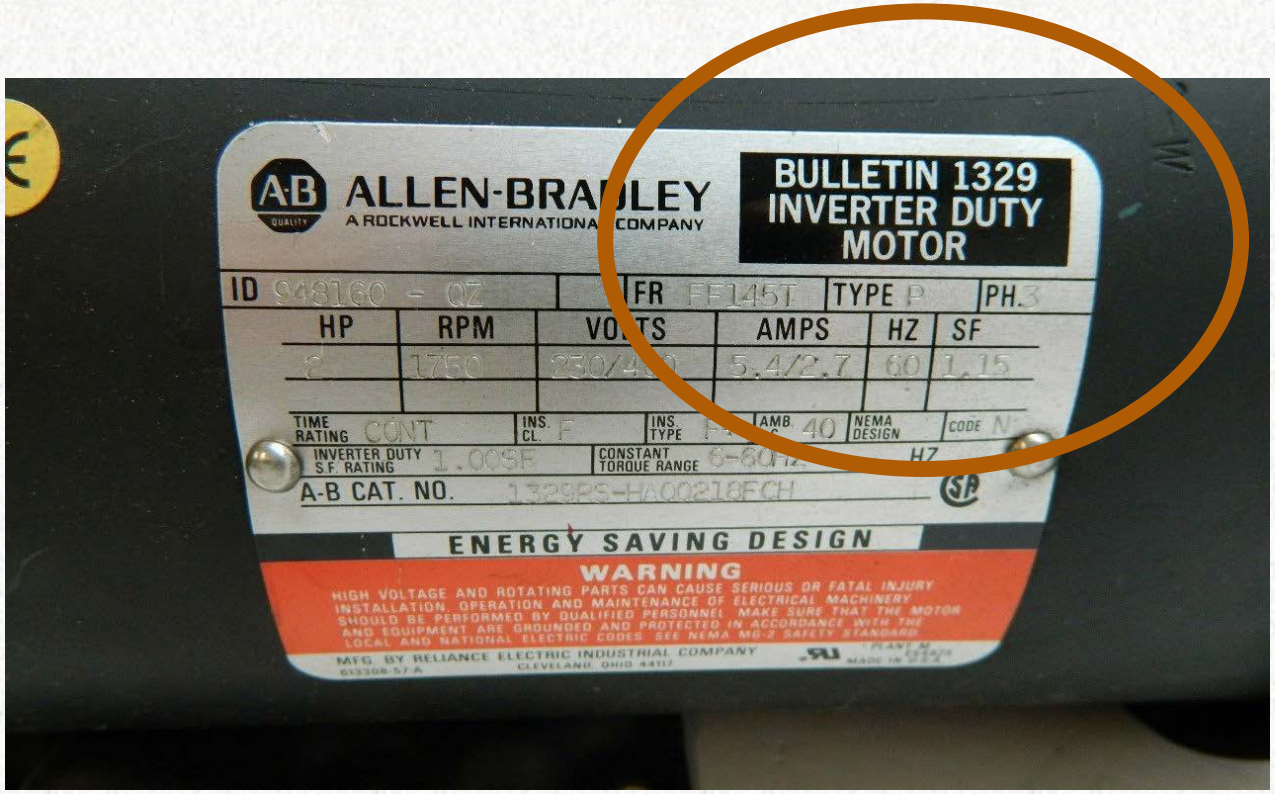
- Short cord with waterproof plug

(this one plugs into the hanging cord)

- Long cord out of wet area



Correct motor on transfer pump?



Inverter Duty Motor

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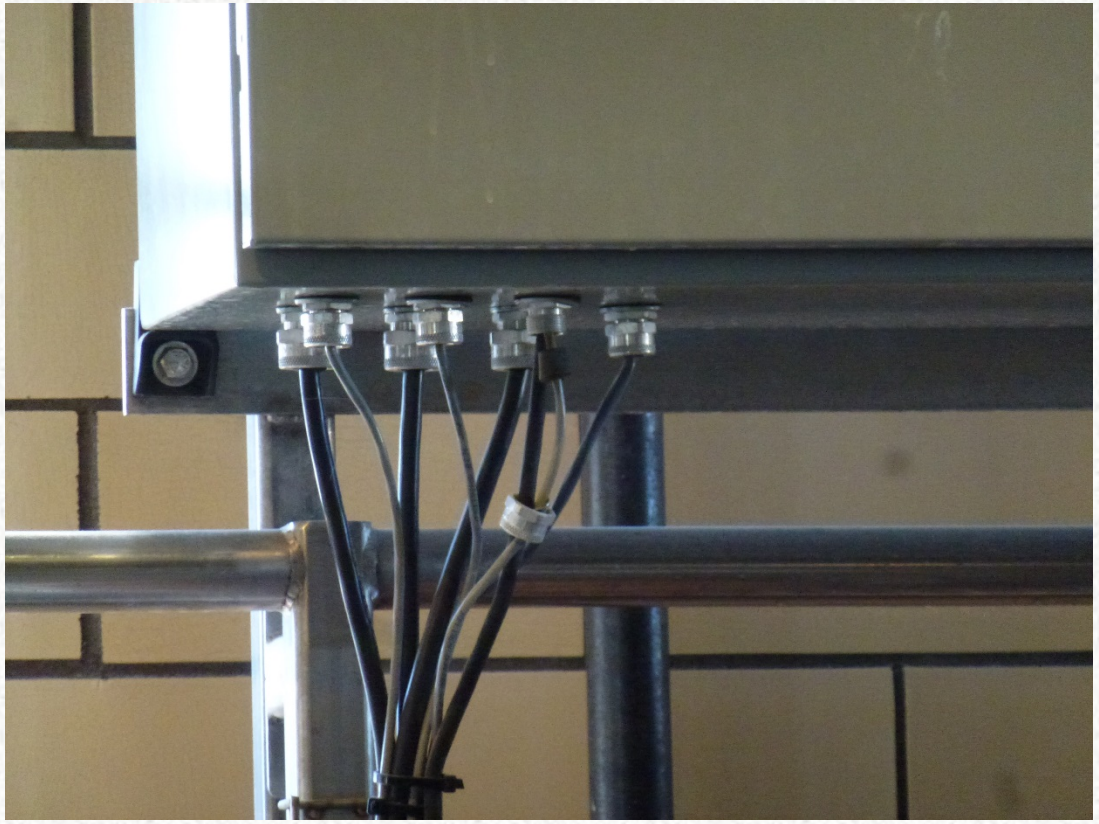
- Dust?

- Dust?

Explosion proof vs water tight

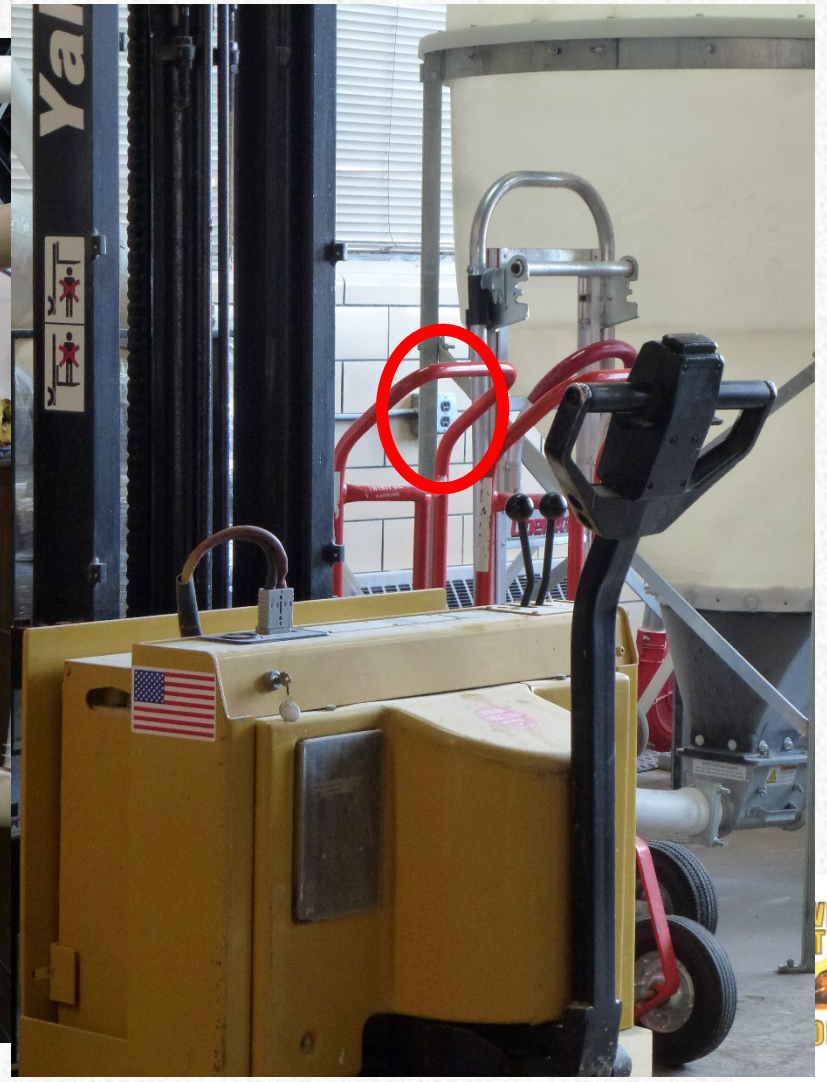



Danfoss
MADE IN DENMARK
Coil 018F7681
Type BT240CS
208-240V 60HZ 14W
230V 50HZ 16W
CE F1181

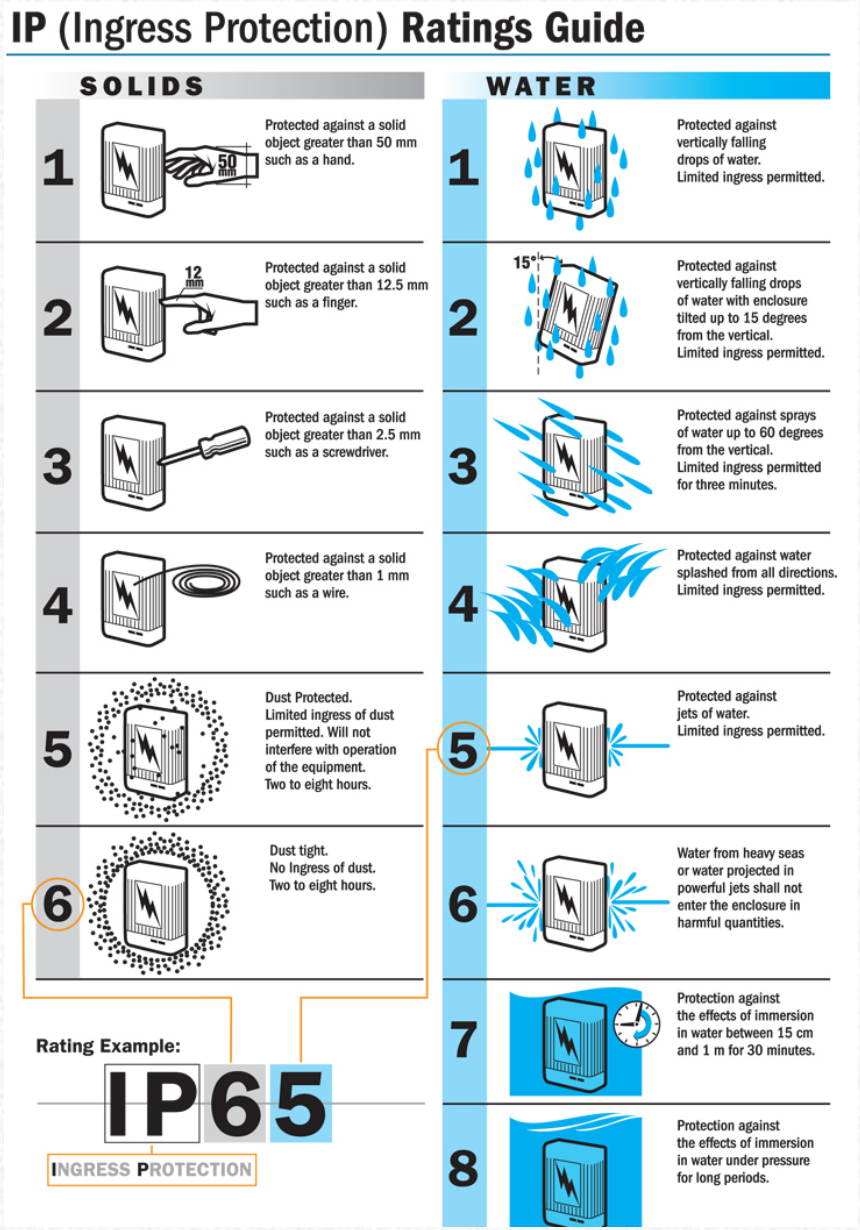
Emergency motor shut off

- Motor's power disconnect is "within sight of" the motor.
- OSHA says **this "within sight"** is less than 50 feet.
- Disconnect is "easy to reach"
- Clearly indicates (off) or (on)
- If mounted vertical, (off) is always down

Accessible disconnects and outlets



IP: Ingress Protection for sensors



- **6** is dust tight

- 2nd digit is **water ingress**:
- **IP65:** low pressure spray with limited ingress.
- **IP66:** strong jets with limited ingress.
- **IP67:** 30 min. immersion without ingress.
- **IP68:** submerge without water ingress.
- **IP69K:** high pressure, high temp wash-downs, as in food processing.

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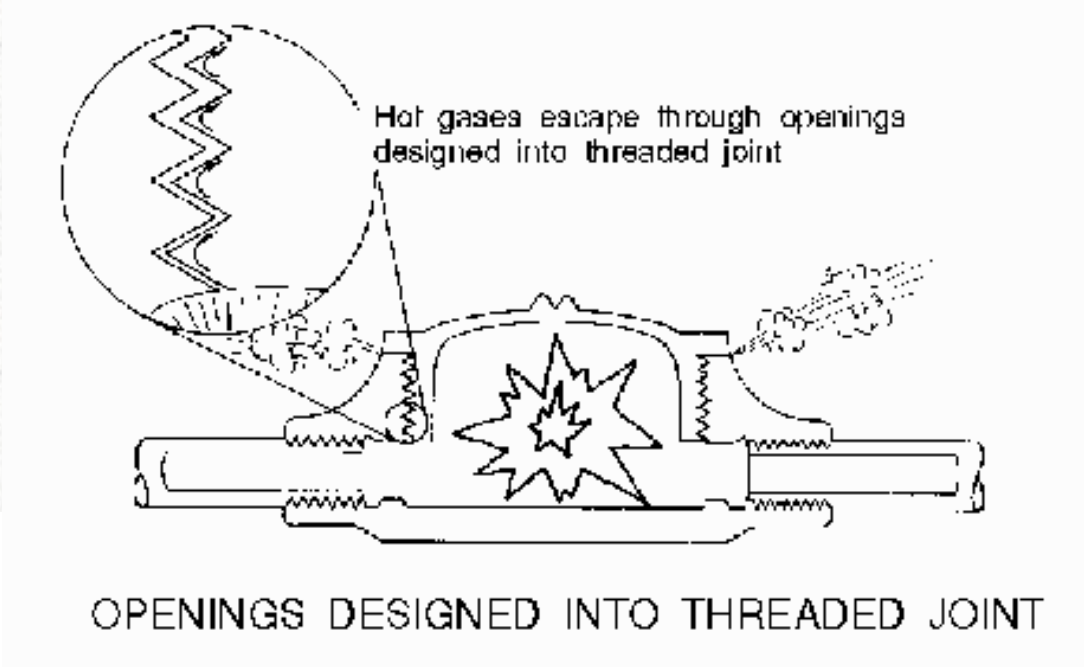
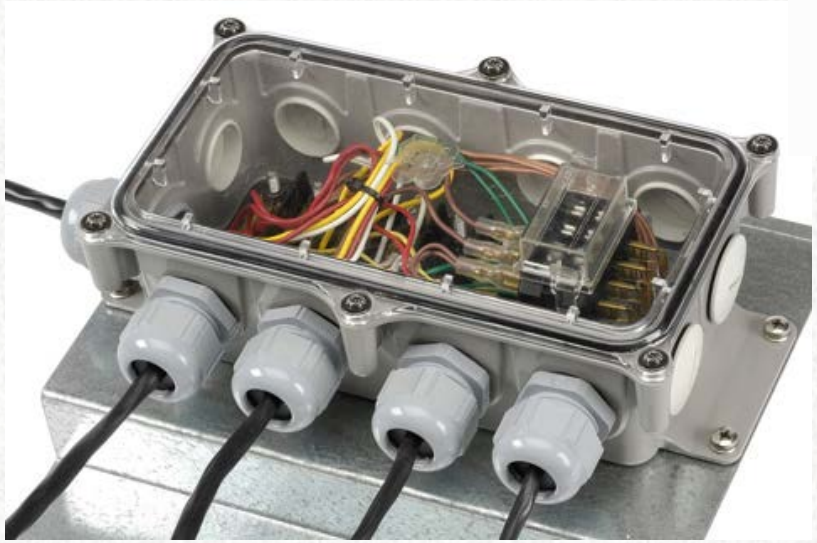
Water proof? versus explosion proof





Hazardous location

Hazardous Location Conditions:

Class II is the second type of hazardous location

“Sufficient quantities of combustible dust to be explosive or ignitable”

Class II locations for combustible dust, and then:

- Group G = grain dusts…

NEMA Enclosure ratings

Type of Enclosure

Provides a degree of protection against condition type

	1	2	4	4X	5	6	6P	12	12K	13
Access to hazardous parts	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Ingress of solid foreign objects (falling dirt)	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Ingress of water (dripping and light splashing)		✓	✓	✓	✓	✓	✓	✓	✓	✓
Ingress of solid foreign objects (circulating dust, lint, or fibers)			✓	✓		✓	✓	✓	✓	✓
Ingress of solid foreign objects (settling airborne dust, lint , or fibers)			✓	✓	✓	✓	✓	✓	✓	✓
Ingress of water (hose down and splashing)			✓	✓		✓	✓			
Oil and coolant seepage								✓	✓	✓
Oil or coolant spraying and splashing										✓
Corrosive agents				✓			✓			
Ingress of water (temporary submersion)							✓			
Ingress of water (prolonged submersion)							✓			

Enclosure Type		IEC						
		IP10	IP11	IP14	IP52	IP54	IP56	IP67
NEMA	1	●						
	2		●					
	3					●		
	3R			●				
	3S					●		
	4						●	
	4X						●	
	5				●			
	6							●
	6P							●
	12				●			
	12K				●			
	13					●		

Source: www.engineeringtoolbox.com/nema-iec-enclosure-standards-d_920.html

Note: Use this chart to convert NEMA to IP, but not IP to NEMA

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Wash down duty

- Wash down duty motors are not air-tight.
- Have condensate drain holes
- Holes breathe as they heat and cool
- If the drain holes are up, water runs in
- You can get shocked
- “…wash down isn’t wash down!” -Simmons

UL 508A

- Industrial control panels
- Spacing of components
- Calculates for heat created
- To minimize, dissipate component heat
- Limit potential for fire
- Increase life of components

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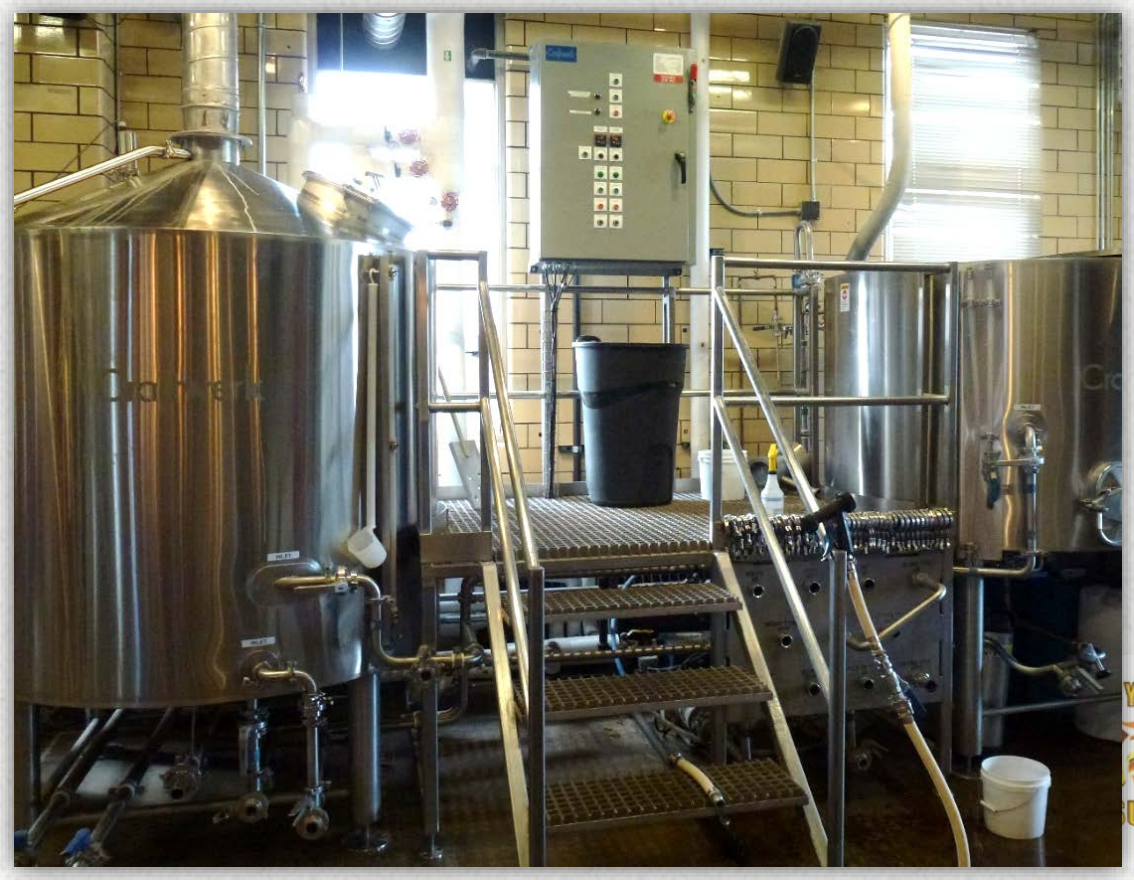
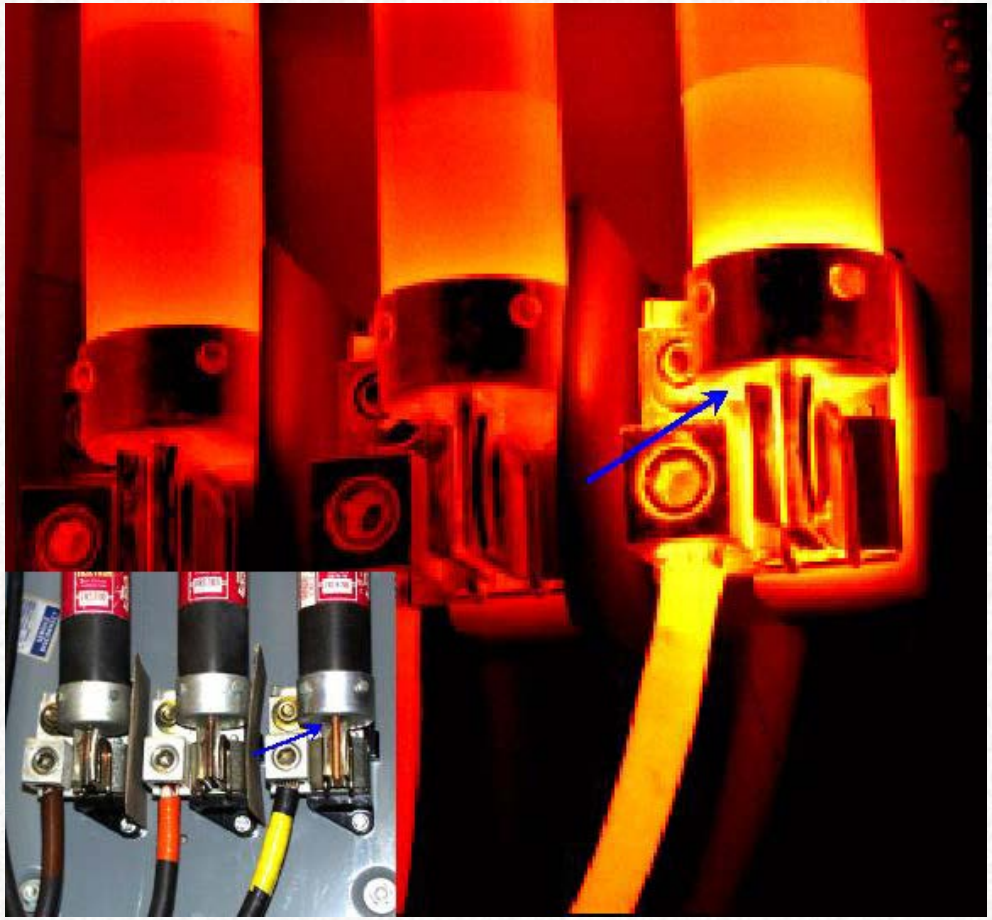
UL508A helps equipment last

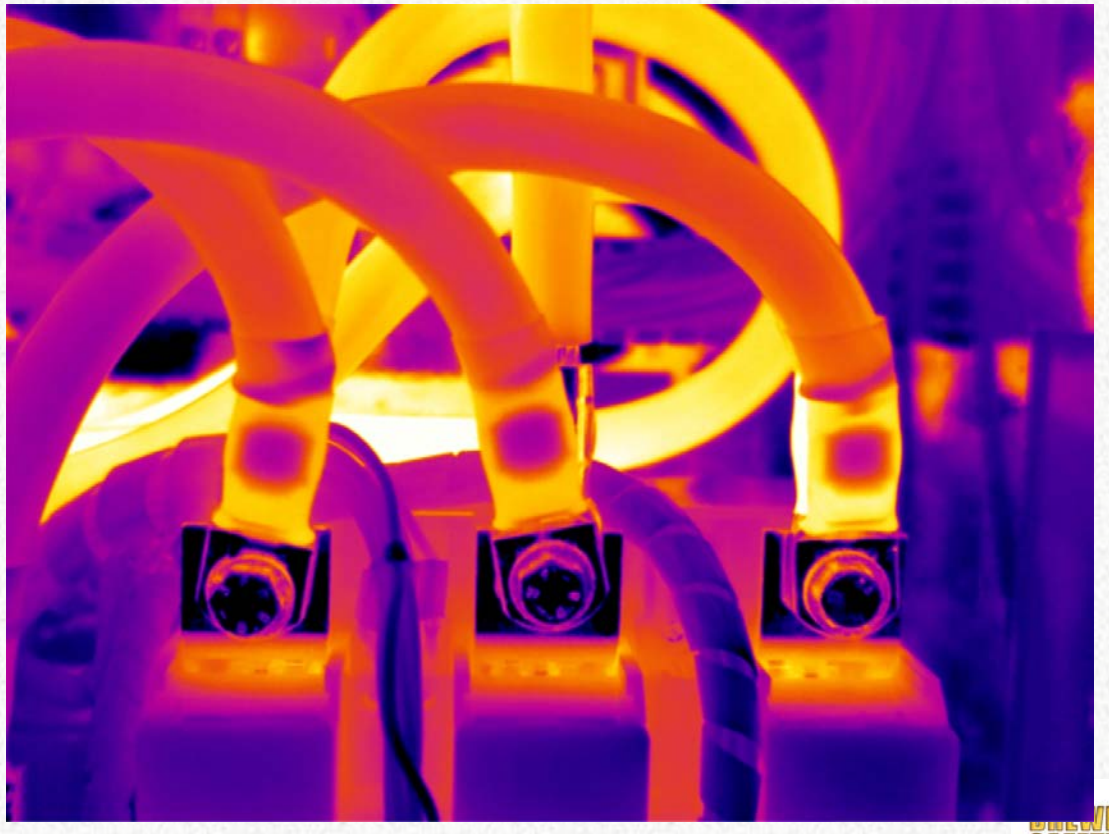
- Too small for heat and trips
- Has to run with door open

- Oversized so equipment is cool
- Runs without a hiccup



Hot Circuits and electrical maintenance





Flying lead impacting other wires

BREWERY SAFETY CONSULTING

Ask questions to:

Brewery.safety.consulting@gmail.com

BA Forum: attn Safety subcommittee

Thanks to:

- Dry Dock Brewing
- Station 26 Brewing
- Upslope Brewing
- Pagosa Brewing
- Sleeping Giant
- Ska Brewing
- OSHA 1910
- OSHA 1926
- Red Rocks CC OSHA Institute
- BA Safety Subcommittee team
- My wife