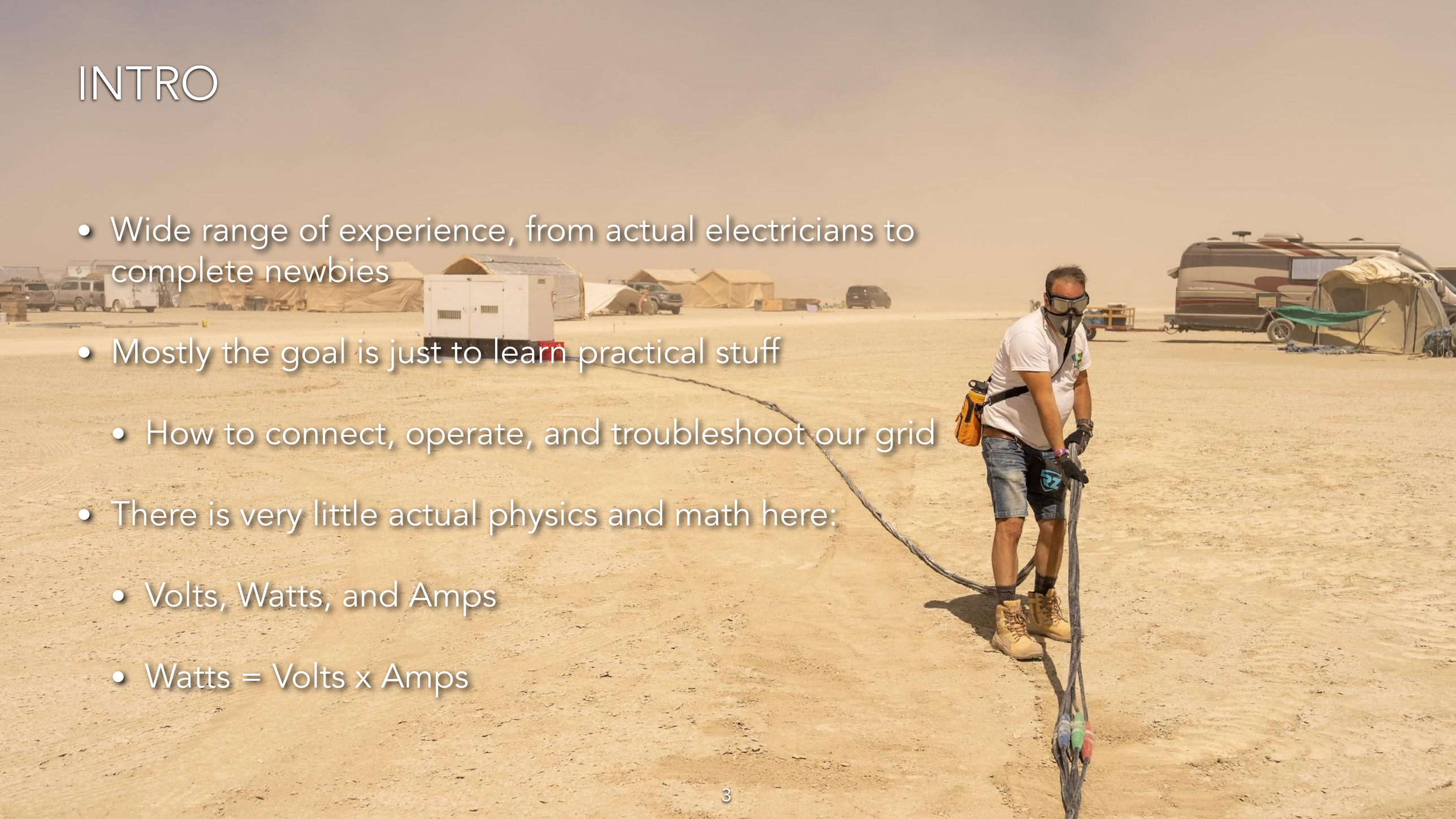
TURTLE HUB ELECTRIC GRID TRAINING

INTRO

- This is theory
- Practical training on-playa (Thursday of build week)
- Ask questions! No rush!
- Still confused? Write down slide #

INTRO

- Wide range of experience, from actual electricians to complete newbies
- Mostly the goal is just to learn practical stuff
  - How to connect, operate, and troubleshoot our grid
- There is very little actual physics and math here:
  - Volts, Watts, and Amps
  - Watts = Volts x Amps



WHAT'S THIS?

GENERATOR

- Closed frame
- 120V
- 2200 Watts
- (Available up to about 5000 watts)

WHAT'S THIS?

GENERATOR

- Open frame
- 120V
- 13,000 Watts

FOOD FORT BACKUP

WHAT'S THIS?

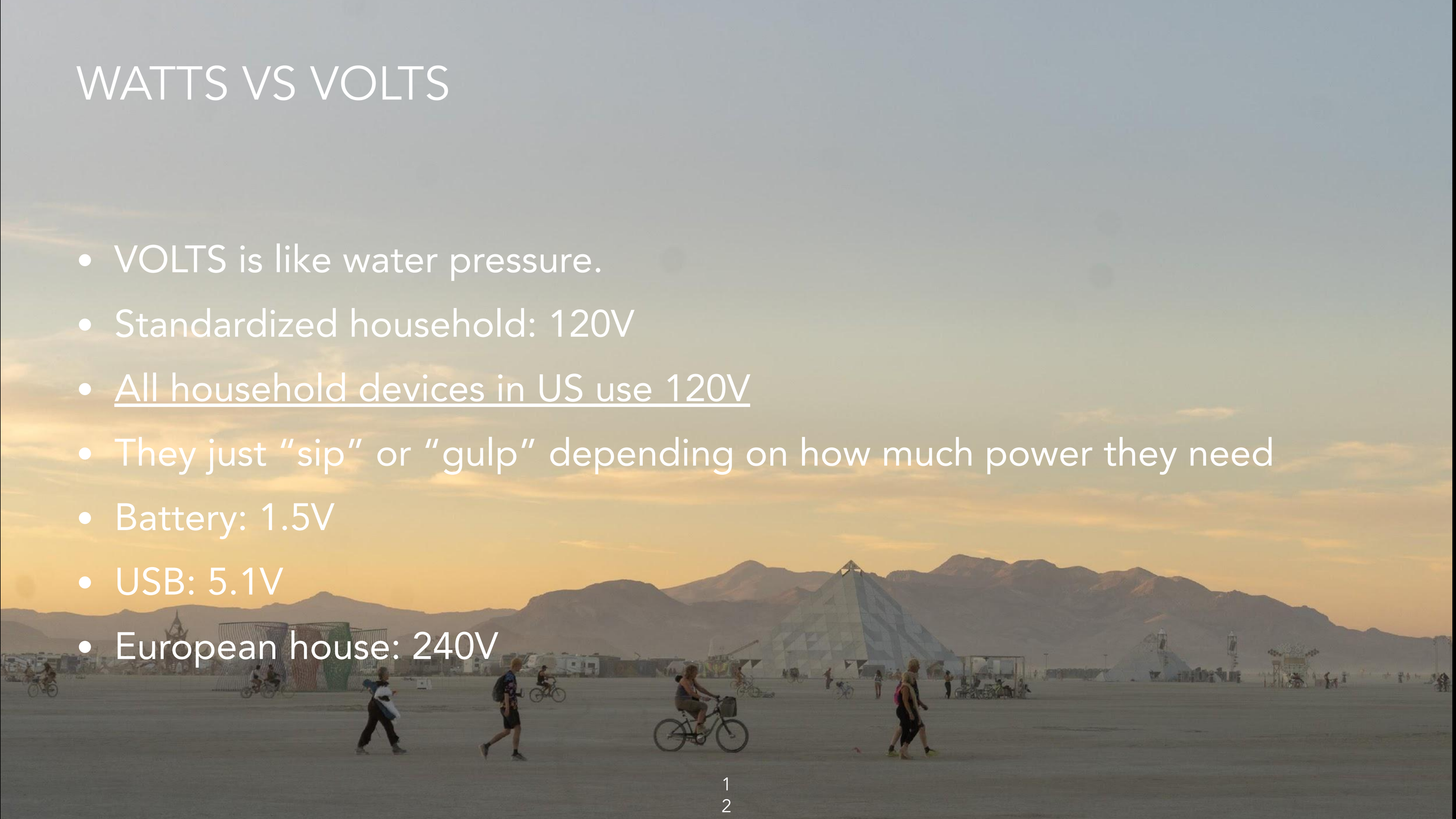
GENERATOR

- Three Phase (we'll get back to that…)
- 120 - 240 - 480 Volt
- 56,000 Watts
  - (available up to about 500,000)

What’s all this about Volts and Watts?

WATTS VS VOLTS

- VOLTS is like water pressure.
- Standardized household: 120V
- All household devices in US use 120V
- They just “sip” or “gulp” depending on how much power they need
- Battery: 1.5V
- USB: 5.1V
- European house: 240V



WATTS VS VOLTS

- WATTS: measures power.
  - “Gallons per minute”
  - Single LED: 0.02 watts
  - Household light: 2 - 10 watts
  - Refrigerator: ~300 watts
  - One horse: 746 watts
  - Window AC: 1000-1500
  - Our sound system: 1000
  - Hair dryer: 1500
  - RV: 4000

HOW MANY WATTS?

- Most things say on them!

Add up all the watts that your things need to determine how big a generator you get!

WHAT IS THE DIFFERENCE BETWEEN THESE?

16awg
10
amps
$20

12awg
15
amps
$50

6awg
50
amps
$500

2awg
200
amps
$1500

WIRE GAUGE

- The thicker the wire, the more current it can carry (measured in amps)
- Thinness is measured in awg. The higher the thinner.

SO WHAT ARE AMPS?

- AMPs = WATTs ÷ VOLTs
- WATTs = ?
- WATTs = AMPs x VOLTs
- Determines wire size. Thicker wire carries more amps.
- Household wiring, outlets, and breakers can handle 15 or 20 AMPS

WHAT IS THE DIFFERENCE BETWEEN THESE?

16awg
10
amps
$20

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2awg
200
amps
$1500

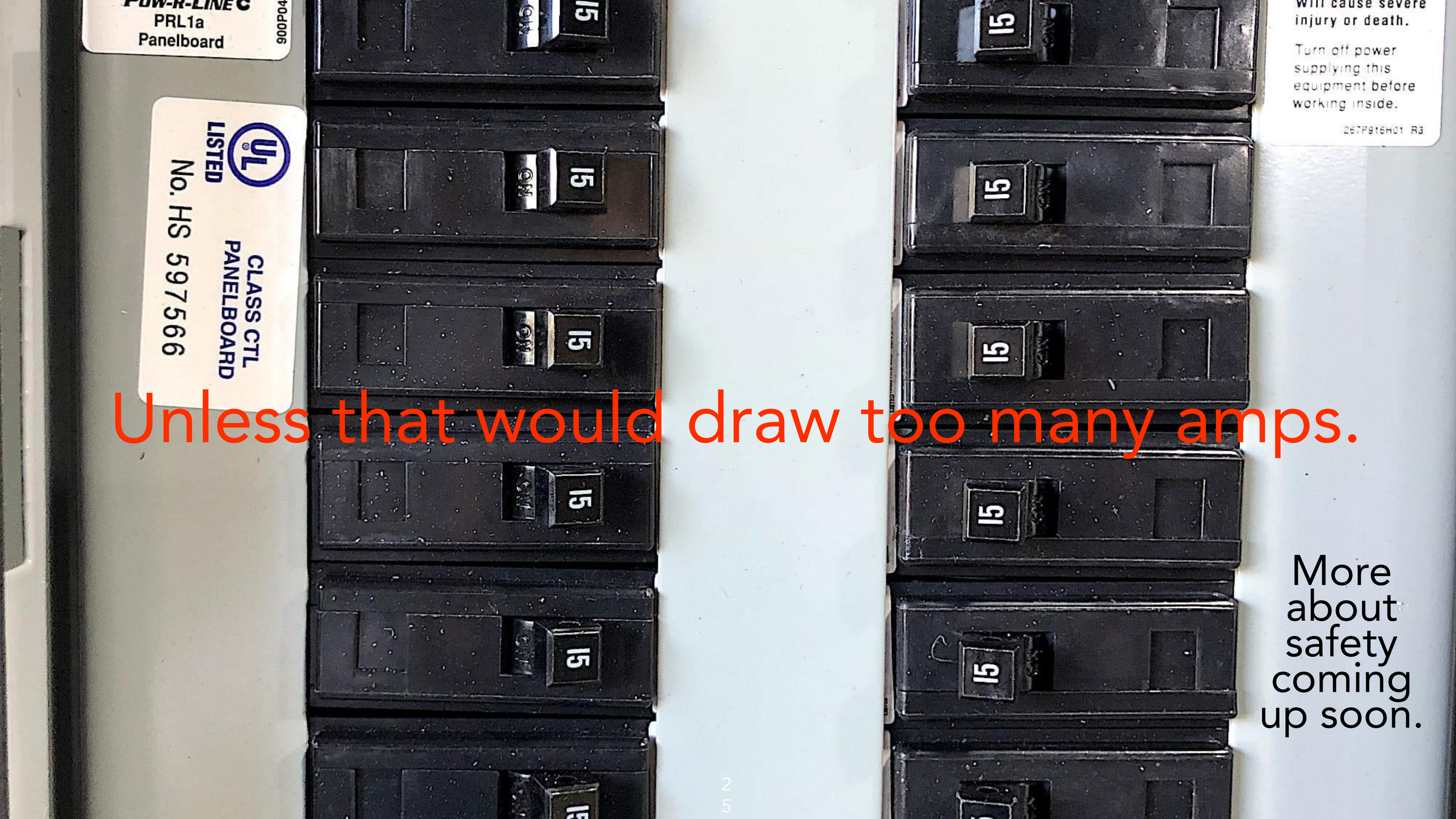
What does a BREAKER protect?

A BREAKER protects WIRES

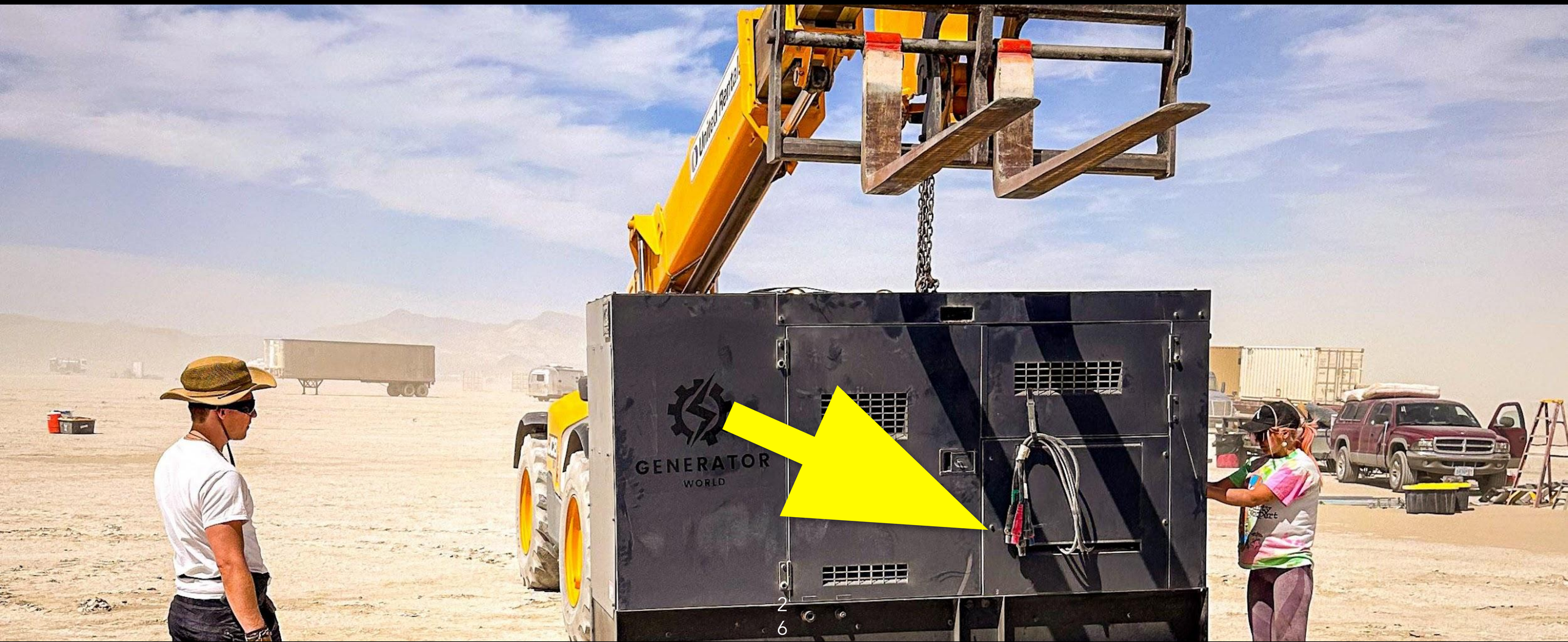
POW-R-LINE C
PRL1a
Panelboard
900P04006
LISTED
CLASS CTL
PANELBOARD
No. HS 597566
Will cause severe injury or death.
Turn off power supplying this equipment before working inside.
267P816H01 R3
A BREAKER protects downstream WIRES


POW-R-LINE C
PRL1a
Panelboard
900P04006
UL LISTED
CLASS CTL PANELBOARD
No. HS 597566
Will cause severe injury or death.
Turn off power supplying this equipment before working inside.
267P816H01 R3
It keeps them from burning up from too many AMPS

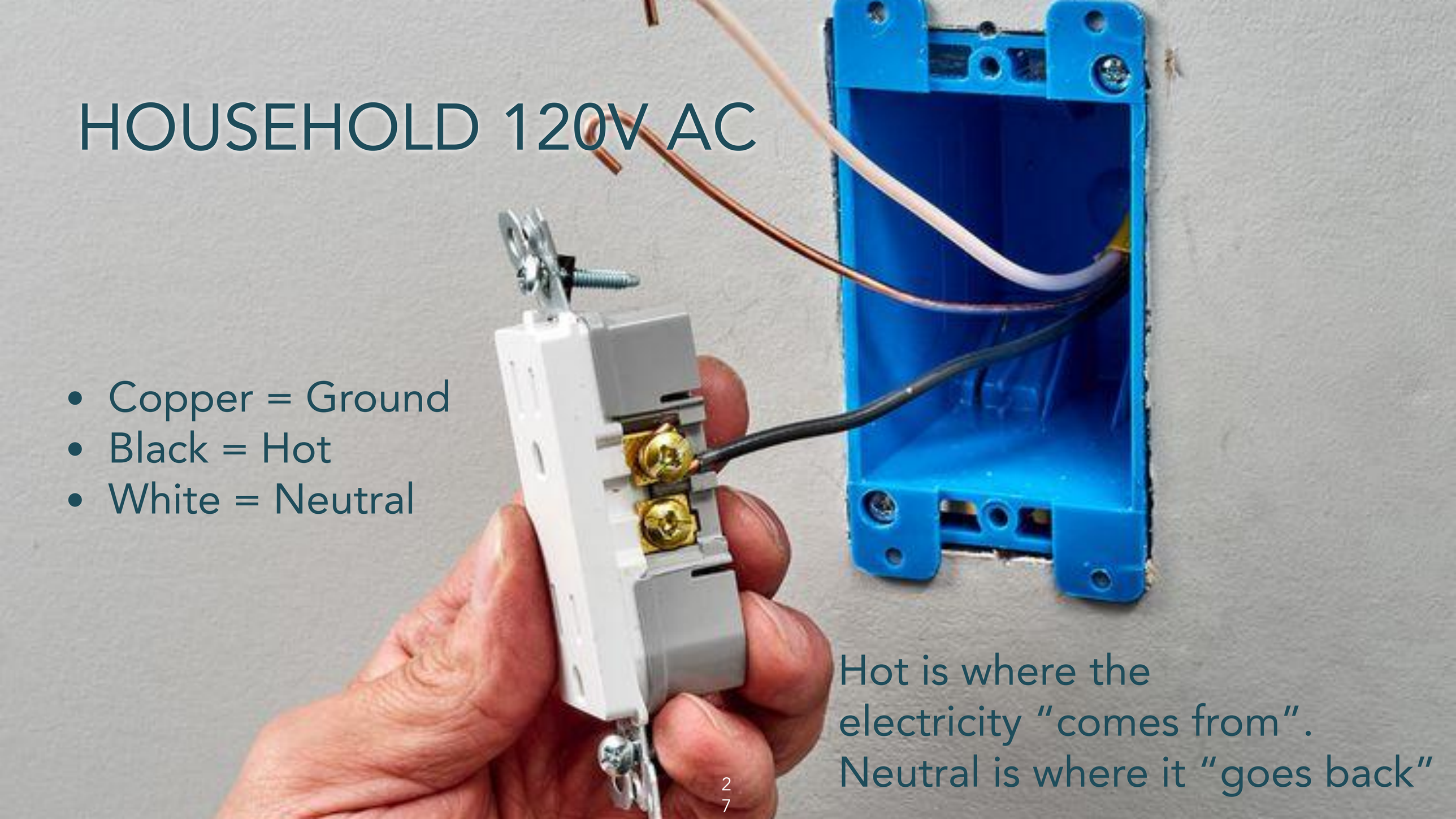
It does not care if someone is getting shocked.


POW-R-LINE C
PRL1a
Panelboard
900P04006
UL LISTED
CLASS CTL PANELBOARD
No. HS 597566
Will cause severe injury or death.
Turn off power supplying this equipment before working inside.
267P816H01 R3
Unless that would draw too many amps.
More about safety coming up soon.

WHY ARE THERE FIVE WIRES COMING OUT OF THIS?



HOUSEHOLD 120V AC



- Copper = Ground
- Black = Hot
- White = Neutral

Hot is where the electricity “comes from”.
Neutral is where it “goes back”

THREE PHASE POWER

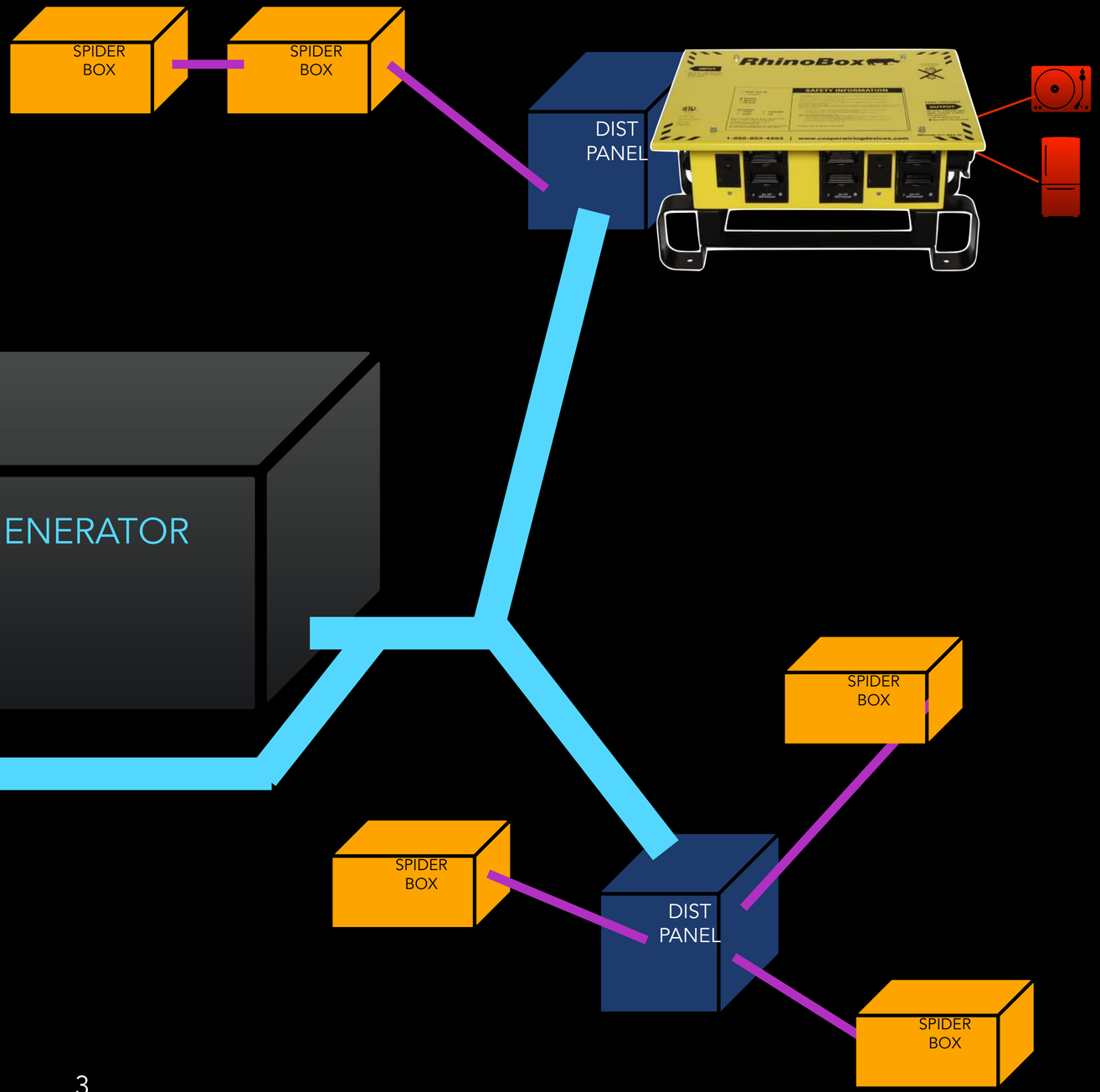
- Green = Ground
- Black,
  Red,
  and Blue = Hot
- White = Neutral

THREE PHASE POWER

- Black + white = 120V
- Red + white = 120V
- Blue + white = 120 V
- Any two hots = 208 V

THREE TIMES THE FUN!

DISTRIBUTION



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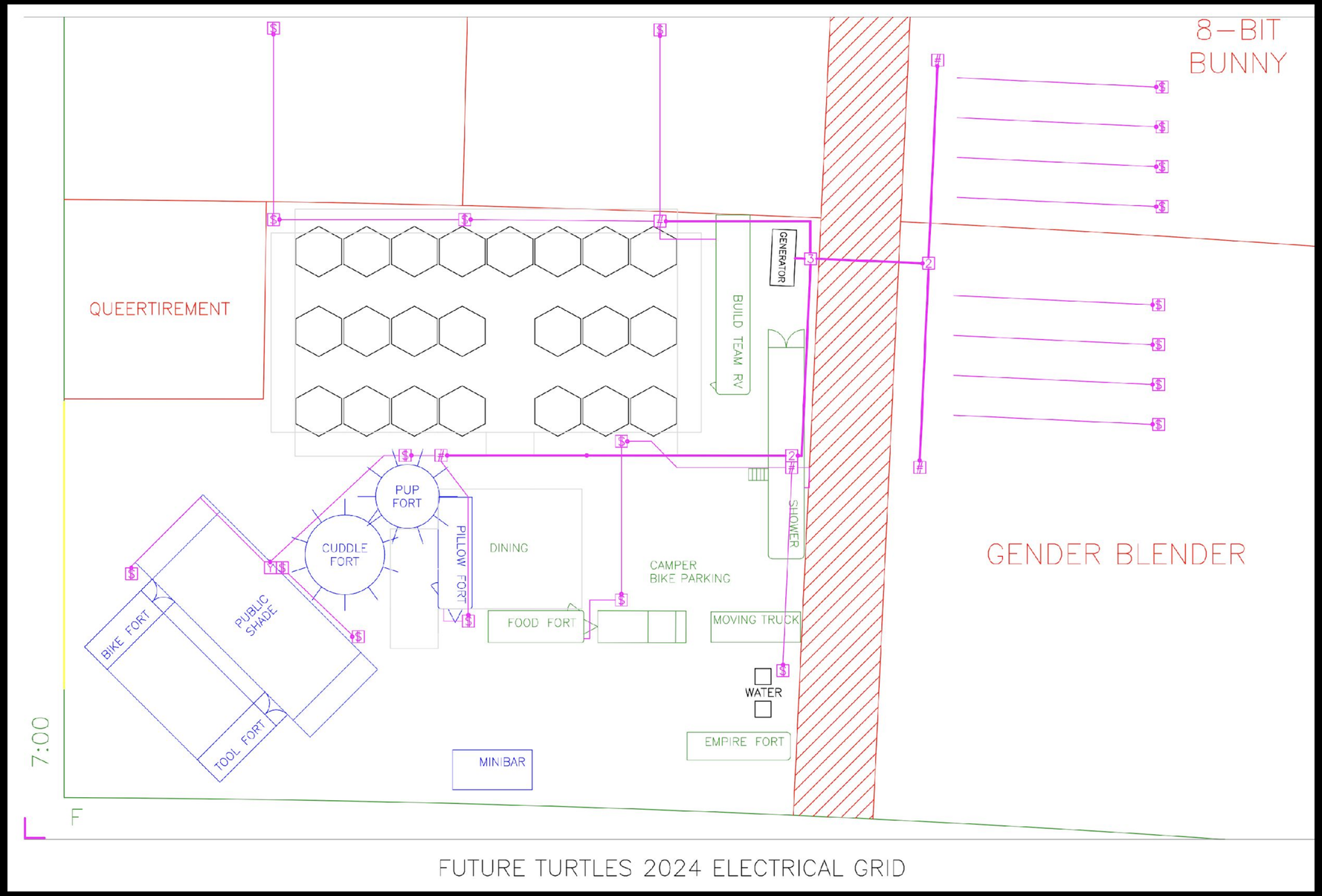


FUTURE TURTLES 2024 ELECTRICAL GRID

DISTRIBUTION

SPIDER BOX

SPIDER BOX

DIST PANEL

SPIDER BOX

SPIDER BOX

SPIDER BOX

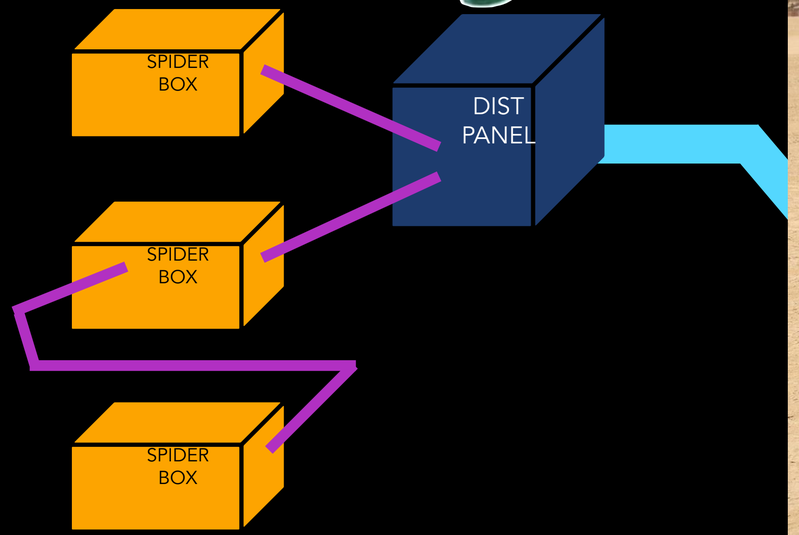
SPIDER BOX

SPIDER BOX

DIST PANEL

SPIDER BOX

5 WIRE BANDED CABLE



DISTRIBUTION PANEL

50 AMP CABLES

4 CONDUCTORS
ONLY CARRY 2 of 3 LEGS

SPIDER BOX
SPIDER BOX
DIST PANEL
SPIDER BOX
SPIDER BOX
DIST PANEL
SPIDER BOX
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SPIDER BOX
SPIDER BOX
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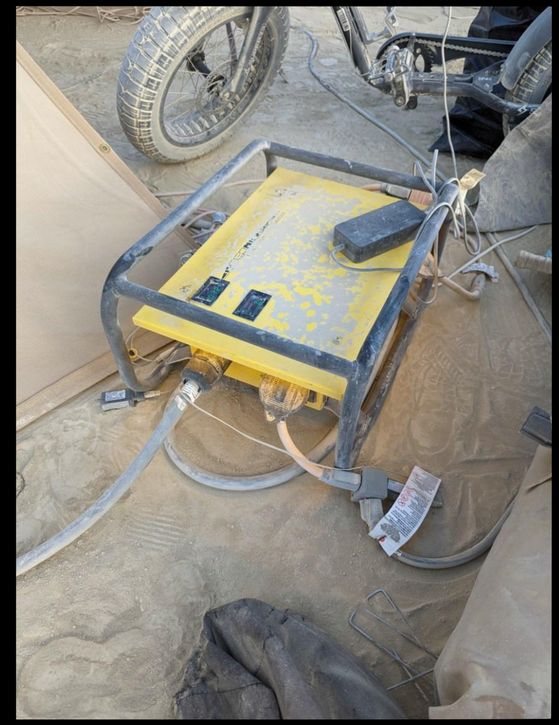
SPIDER BOX


INPUT
RhinoBox
SAFETY INFORMATION
FEED THROUGH
OUTPUT
1-866-853-4293 | www.cooperwiringdevices.com

GFCI SWITCH
1.5 HP
ON
RESET
TEST
OFF

WHAT KEEPS US SAFE?



- Breakers
  - Protects the wires downstream from heat/fire
    - Short Protection
      - What is a short? Why are shorts so bad?
    - Overload Protection
- GFCIs
  - Measure return current. Not enough? Someone is being electrocuted
- Keeping shit out of water

OH NO! SOME BREAKER FLIPPED!

- Instantly re-flips?
  - Short!
- Reflips after a minute?
  - Overload!
- Main breaker at the generator?
  - Turn off ALL distros, flip generator on, then bring up one distro at a time.
- Breaker at a distro?
  - Turn off all branches (power to spider boxes), flip distro on, then bring up one spider box at a time
- Breaker at a spider box?
  - Turn off all breakers on the spider box, turn on spider box, then turn on breakers one at a time

MYSTERY!

- Everything was running fine.
- We turn off the generator to check the oil.
- Ten minutes later, we turn it on again.
- The main breaker on the generator flips right off

ANYTHING WITH A MOTOR

STARTUP POWER CAN BE MANY TIMES MORE THAN RUNNING POWER

(AC, PUMP, MOTOR, FRIDGE)

COMMON PLAYA PROBLEMS

- Generator is not tuned to 120, or too much voltage drop at the ends of the network
- GFCI itself is faulty
- Overload because of heavy load (AC, heater, motor, stove, fridge)
  - Sometimes this is a fan or motor clogged with playa dust

MEASUREMENT AND TEST TOOLS

- outlet tester
- multimeter - for volts only

MEASUREMENT AND TEST TOOLS

- clamp meter
  - works on banded cables
  - doesn't work on 50A or extension cords (why not)?
  - but there is a tool to make it work on a regular outlet
- generator SOMETIMES has meters built in
- distribution panels SOMETIMES have meters built-in

SAFETY

- Wear boots with rubber soles
- You may think you know the path of least resistance, but electricity always knows!

SAFETY

- Don’t let your knees touch the ground

SAFETY

- Use sockitboxes for all outdoor connections (plug into extension cord, power outlet, etc)

SAFETY

- “Anti Murder Screwdriver”
- When you’ve got the generator turned off for maintenance, put a screwdriver through the lock latch of the control panel.
- If you see that screwdriver there, do not turn on the generator and murder your fellow electrician.

HIGH CURRENT -> ARC DANGER

ARCING

ESPECIALLY banded cable or 50 amp cables! Jeez!

Don’t plug and unplug anything that is powered on

SAFETY

- Flip breakers off before plugging or unplugging anything more than household current
- Low loads can be plugged and unplugged while hot
- Motors, ACs, etc may spark
- 50 amp / 200 amp plugs are not designed to be safe to plug and unplug while hot

SAFETY

- Don’t be LoveBurn
- Don’t use household extension cords - only outdoor rated, 12awg or lower
- Don’t plug extension cords into extension cords (this is a camper problem usually)

SAFETY

- Assume the ground is wet. Look at everything you see with that in mind

SAFETY

- Don’t coil excess high amp cables
- That will make a magnet
- Make a figure 8 instead

THREE PHASE LOAD BALANCING

- Each distribution box splits up 3 legs into 2 legs per 50A circuit
- Each spider box takes splits up 2 legs among all outlets
- Measure load on each phase (in amps)
  - clamp meter
- Log that in a book
- Move load from highest leg to other legs until they are closer together
  - usually by moving a spider box from one outlet on the distribution panel to another outlet

DAILY GENERATOR MAINTENANCE

- Morning and evening:
  - Fuel level (turn off generator before running out of fuel!!!!)
  - Load balancing
- Morning only:
  - with generator off:
    - oil check
    - Coolant overflow tank, add water as needed
    - Remove air filter, bang out dust, replace if it has been a dusty day
  - Turn generator back on (ideally one distro at a time)
  - Blow radiator out with leaf blower or air compressor

"IT DOESN'T WORK" DIAGNOSES

- Is the generator on?
- Work your way back from the load
- Testing tools
- Multimeter
- Plug in diagnostic

WHERE DOES DIESEL FUEL COME FROM

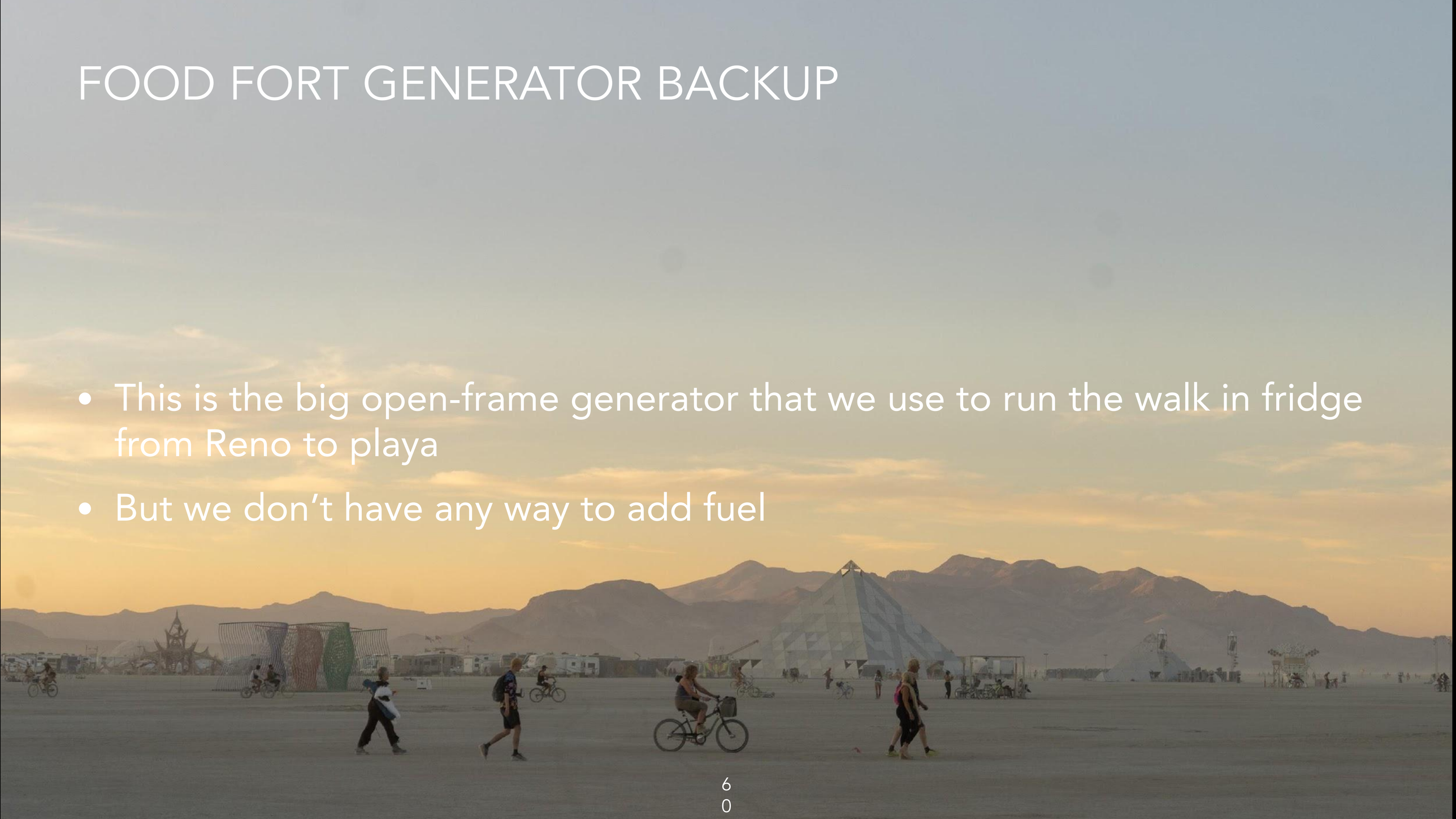
- BRC Petrol and other backup plans

OUR RV AS EMERGENCY BACKUP

- Mainly for health and safety. We can run lighting and maybe audio if we have a party, but no ACs
- Might keep reefer running
- Has a single 50 amp outlet in one of the bays
- RV generator would have to be running

FOOD FORT GENERATOR BACKUP

- This is the big open-frame generator that we use to run the walk in fridge from Reno to playa
- But we don’t have any way to add fuel



ON PLAYA

- Build team
- In-person training and certification
- Guidelines to your campers about permitted / non-permitted use and what to expect from the power system