FORM FOLLOWS FUNCTION

Power System Design for High Lattitudes and Wiring Best Practices

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What Drives System Design?

- Project Requirements and Constraints:
- How much power/energy?
- AC? DC? Both?
- Autonomous or grid-tied?
- Summer only or year-round?
- Portability/set-up time?
- Data/communications requirements?
- Logistics considerations
- Budget/resources
- Timeline

What Drives System Design?

- Environmental Factors/Resources:
- Solar resource?
- Wind resource?
- Fuel generator only?
- RTG – maybe someday….
- Hybrid design?
- Energy storage requirement based on calculations including de-rating factors. Can be many sources, e.g., battery + fuel.

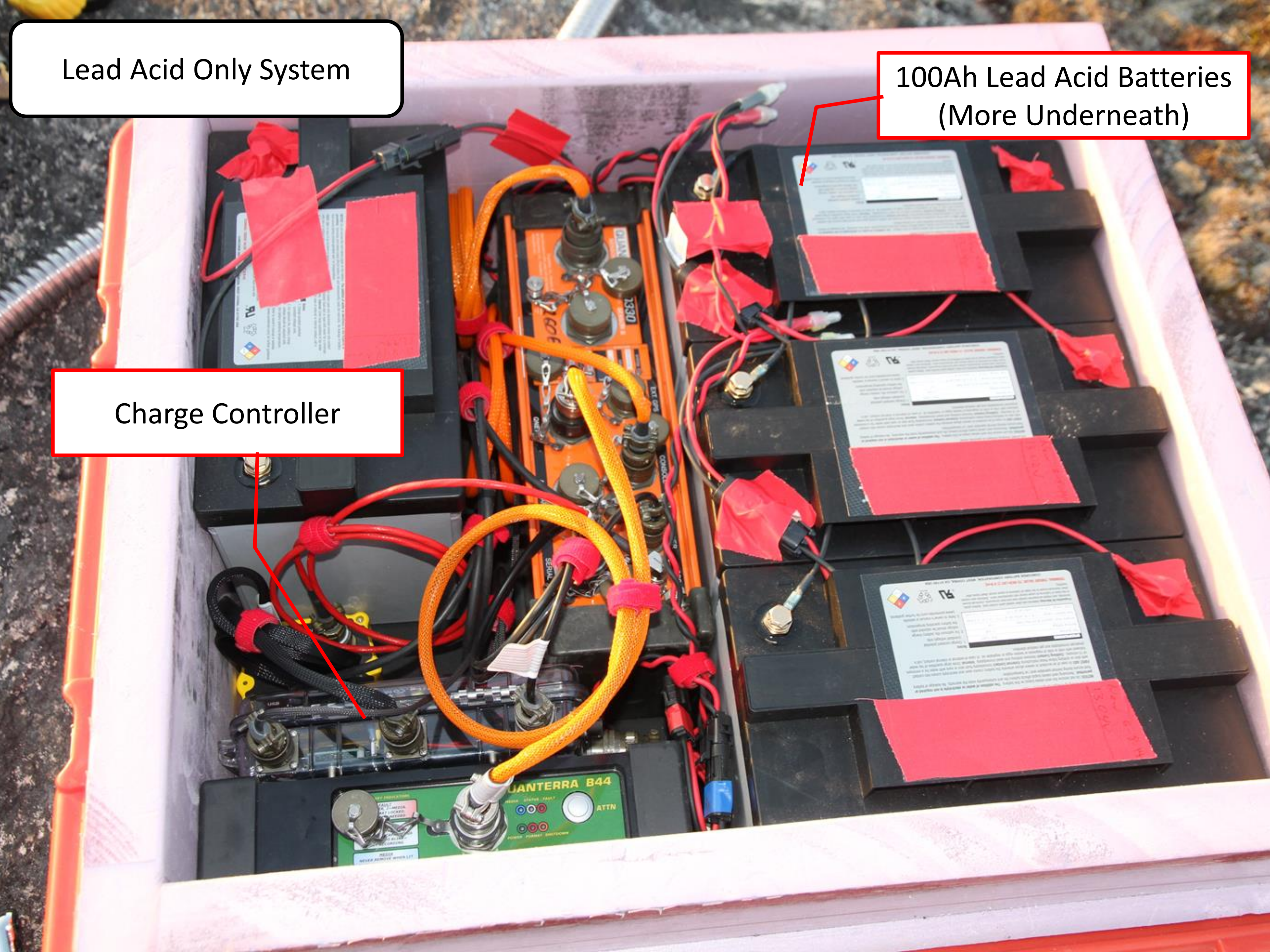
Example: IRIS/PASSCAL

- Power/Data/Communications for Seismic Stations in Antarctica.

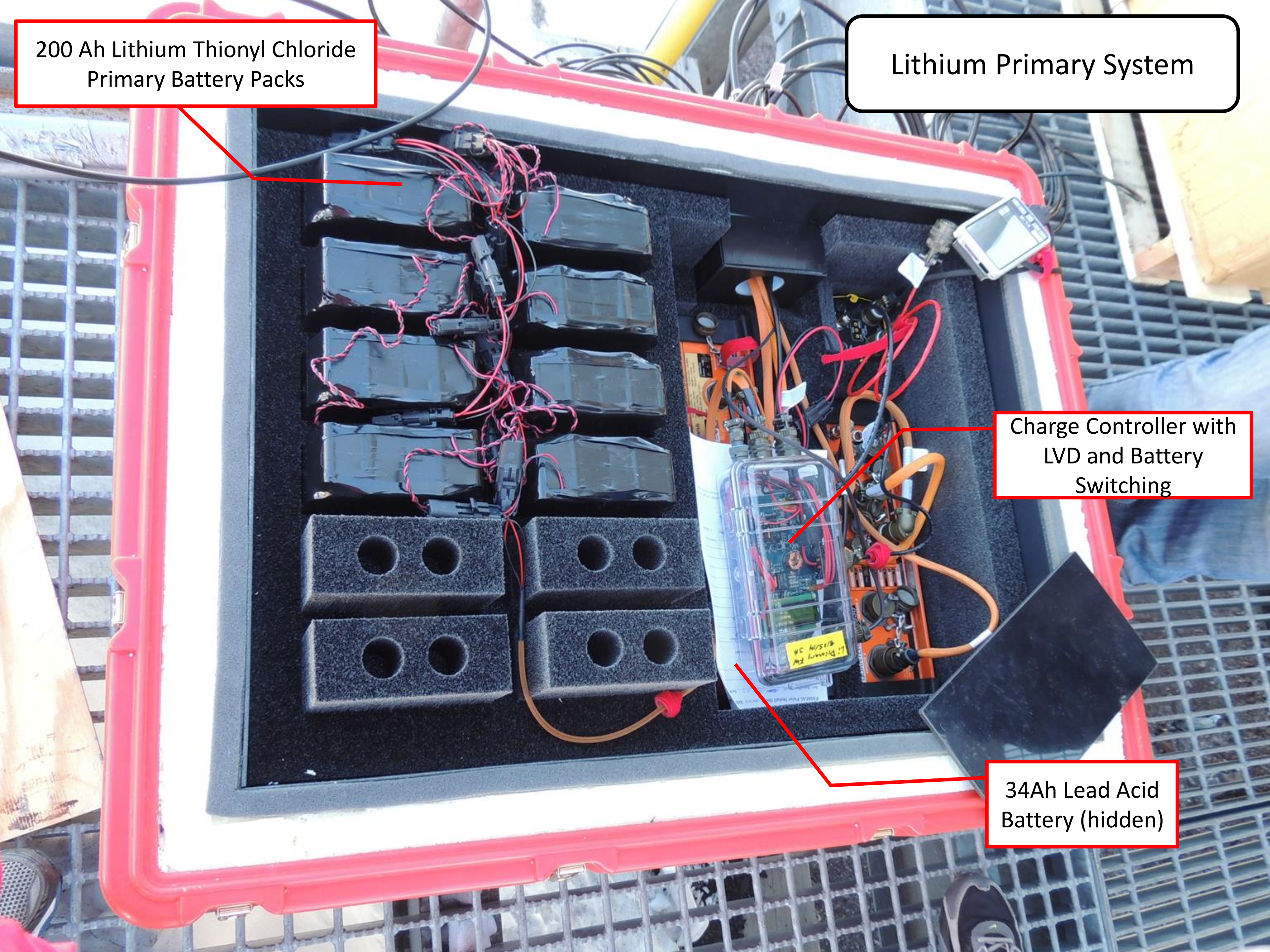
- Major focus on minimizing energy consumption; 1.6 Watt average load

- Different battery technologies are used for different environmental conditions.

- For polar plateau sites where weight and reliability in extreme cold are major design drivers, a small, solar re-chargeable lead acid battery is used during the summer, then the system switches over to lithium primary cells for the winter months.
- At other locations, conventional deep cycle lead acid batteries are a more cost effective alternative.


Lead Acid Only System
100Ah Lead Acid Batteries
(More Underneath)
Charge Controller

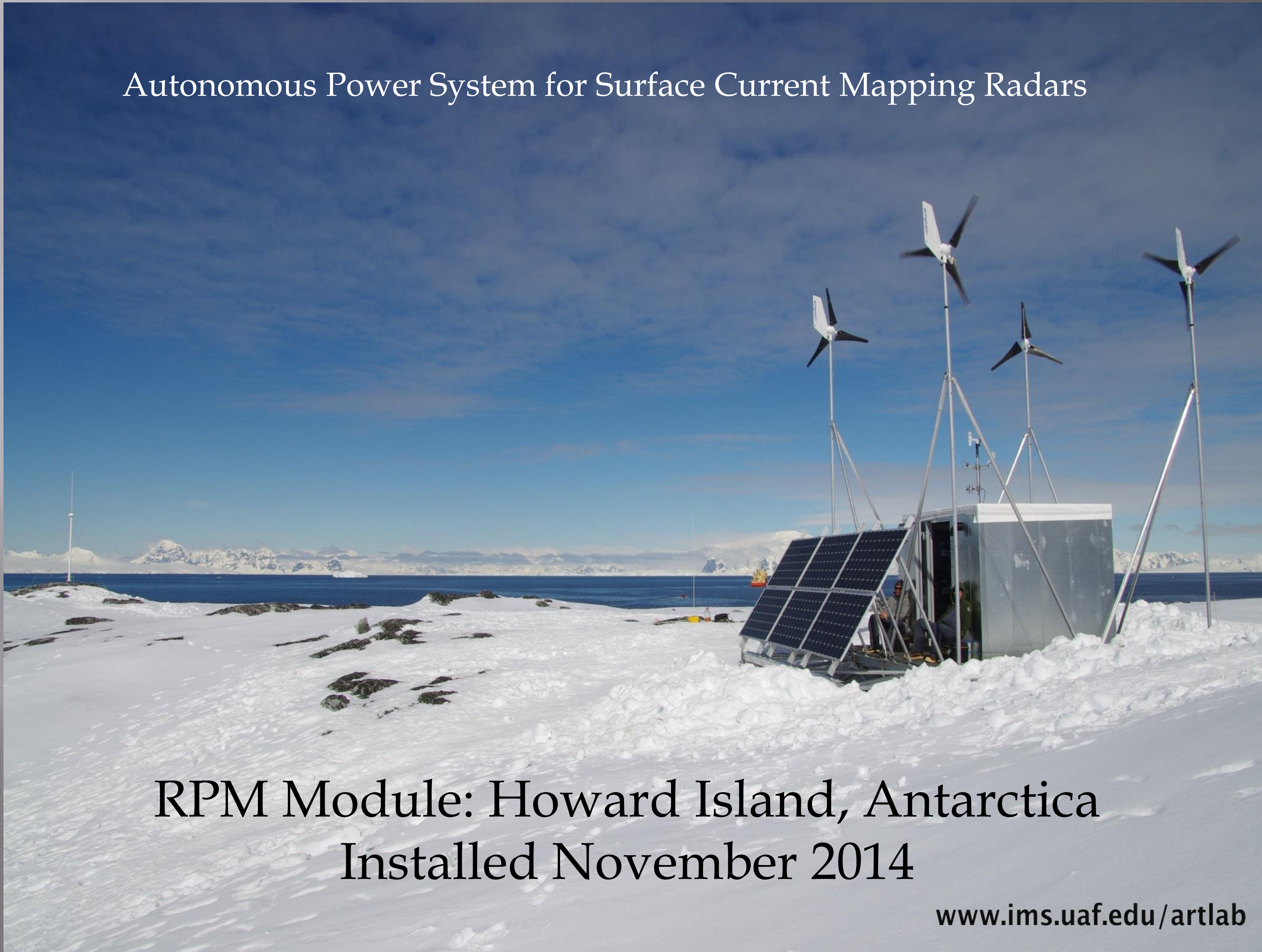
Lithium Primary System



Example: UNAVCO

- Power/Data/Communications GPS stations in Antarctica and Greenland
- About a 5 Watt average load year-round; 120 Wh/day, 840 Wh/wk, 43.68 kWh/year.
- Even with a lot of energy storage, active generation becomes more essential.
- Systems are exceptionally well adapted to the project requirements and environmental drivers.
- Variations in design between super windy rock sites and polar plateau sites

Autonomous Power System for Surface Current Mapping Radars



RPM Module: Howard Island, Antarctica
Installed November 2014

www.ims.uaf.edu/artlab

10kWh/day load with very plug and play design
Collaboration between UAF and Remote Power Systems

Example: Deegan

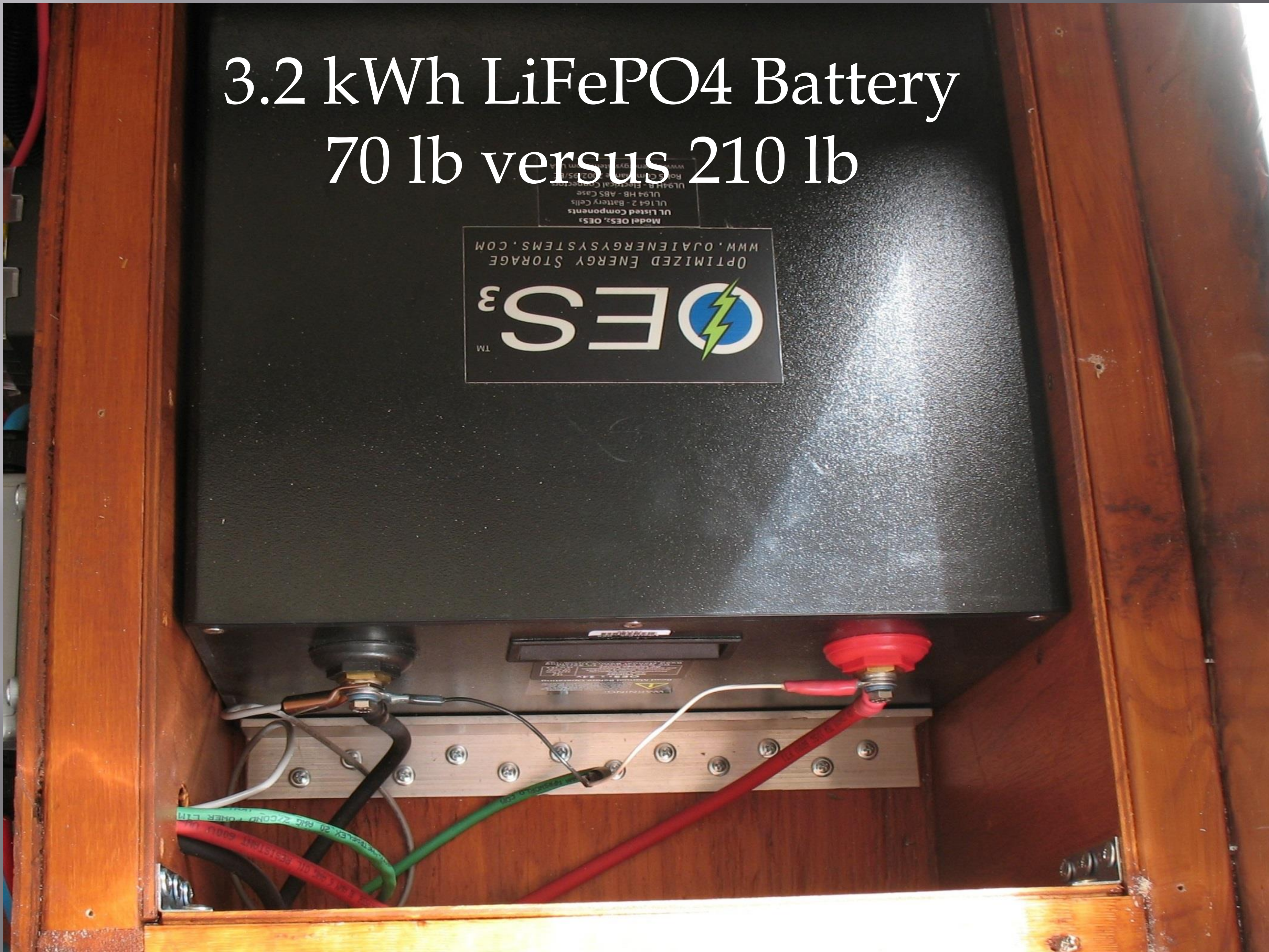
Deegan contd.

- Autonomous operation of SONAR, computer and peripherals
- Summer only in North Slope Alaska
- Will be moved 9X per season by R44 helo
- Quick set-up/take down essential
- Power : 80W > 120W = 100W average load
- 2.4kWh/day energy budget
- Modest $ budget
- Power system and science data archived locally
- No communications or remote telemetry

Deegan contd.

Deegan contd.

3.2 kWh LiFePO4 Battery
70 lb versus 210 lb

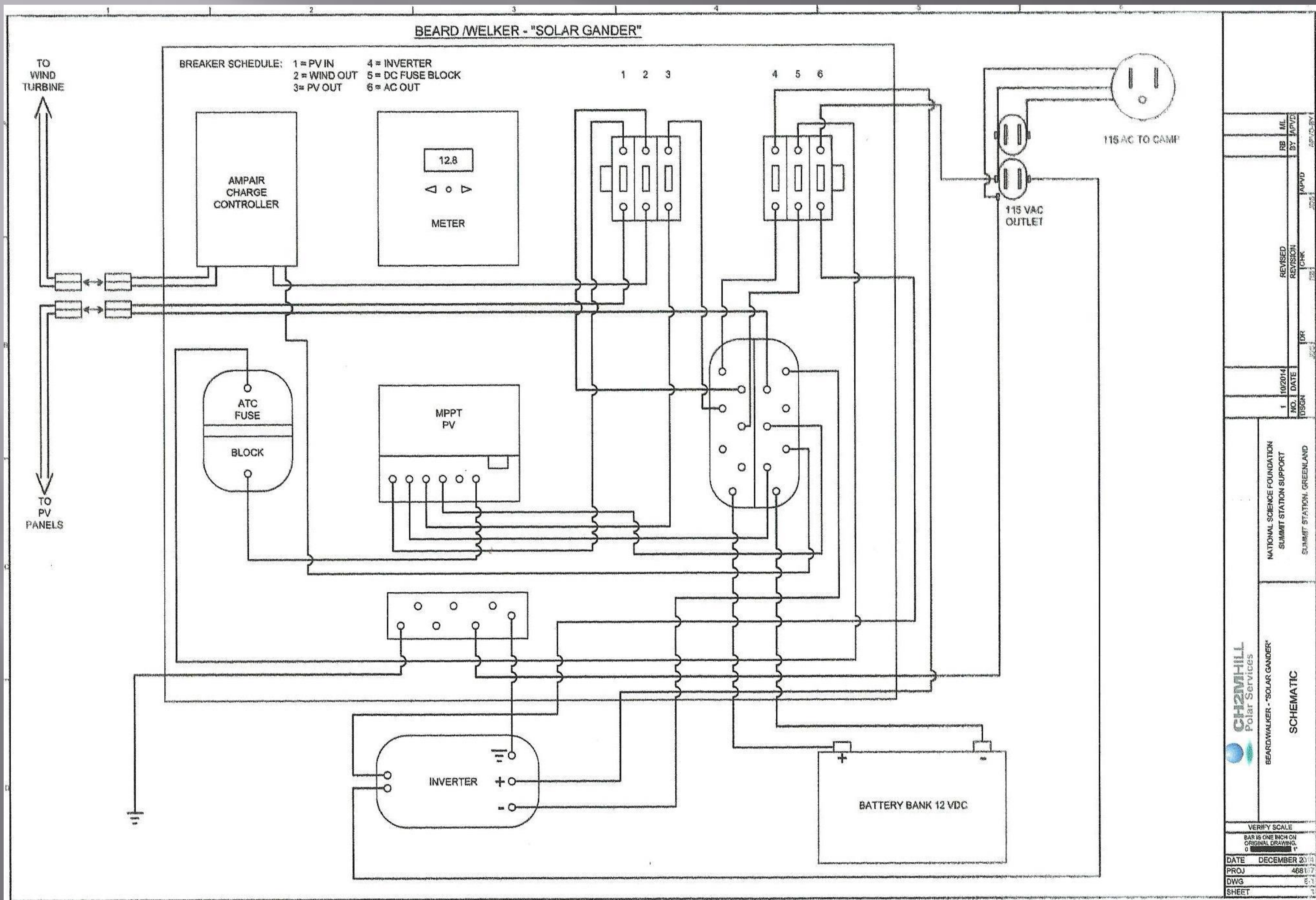



APRS WT 14 Wind Turbine
Tool-less installation
Excellent power /weight

Test the System Before Deployment!!!

Disclaimer: Although every effort has been made to optimize this design to fulfill the project requirements, it has not yet been subjected to the final test – deep field use. Feedback from the researchers will be used to refine subsequent iterations.

Document, Document, Document!



Electrical Wiring Best Practices

- Mentoring Program: Be a Mentor or Find a Mentor
  - Save yourself a lot of time and grief and learn what others have done successfully.
  - Institutional knowledge
  - Colleagues, peers, training, workshops
- Understand Ohm’s Law Calculations
- Tap Into Available Resources
  - National Electrical Code (NEC)
  - Online resources
  - Publications; books, magazines
- Never stop learning because you will never know it all and technology doesn’t stand still.

Wiring Best Practices contd.

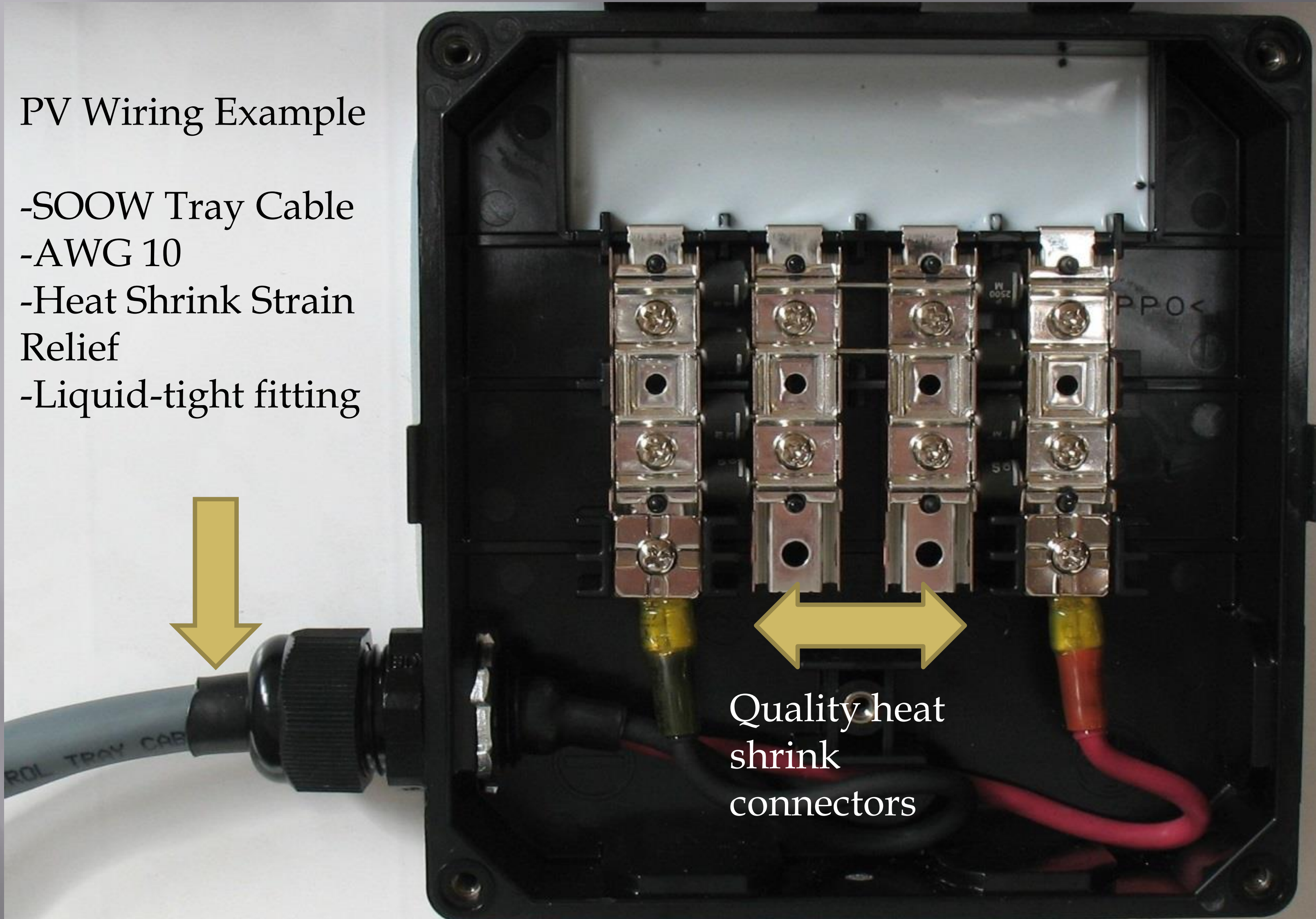
- Use the Correct Wire for the Job
  - Understand Insulation/Conductor Designations; USE-2, SOOW, XHHW, etc.
  - Voltage rating must exceed anticipated maximum voltage for the circuit.
  - Size conductors for voltage drop as well as ampacity.
- Use the right type and quality of connector and install them with the correct tool
- If making soldered connections, strain relief near connection is critical
- Generally do not tin a conductor that will be used in a mechanical connection

Wiring Best Practices contd.

- Use ferrules, particularly with fine-strand wire
- Secure conductors to prevent excessive movement
- Protect wire from mechanical damage
  - Use conductors with outer sheathing when possible
  - Flexible conduit
  - Cable tray
  - Split loom
  - Heat shrink
  - Mining cable (MC) for long outside runs (e.g., Tundra Grid)

PV Wiring Example

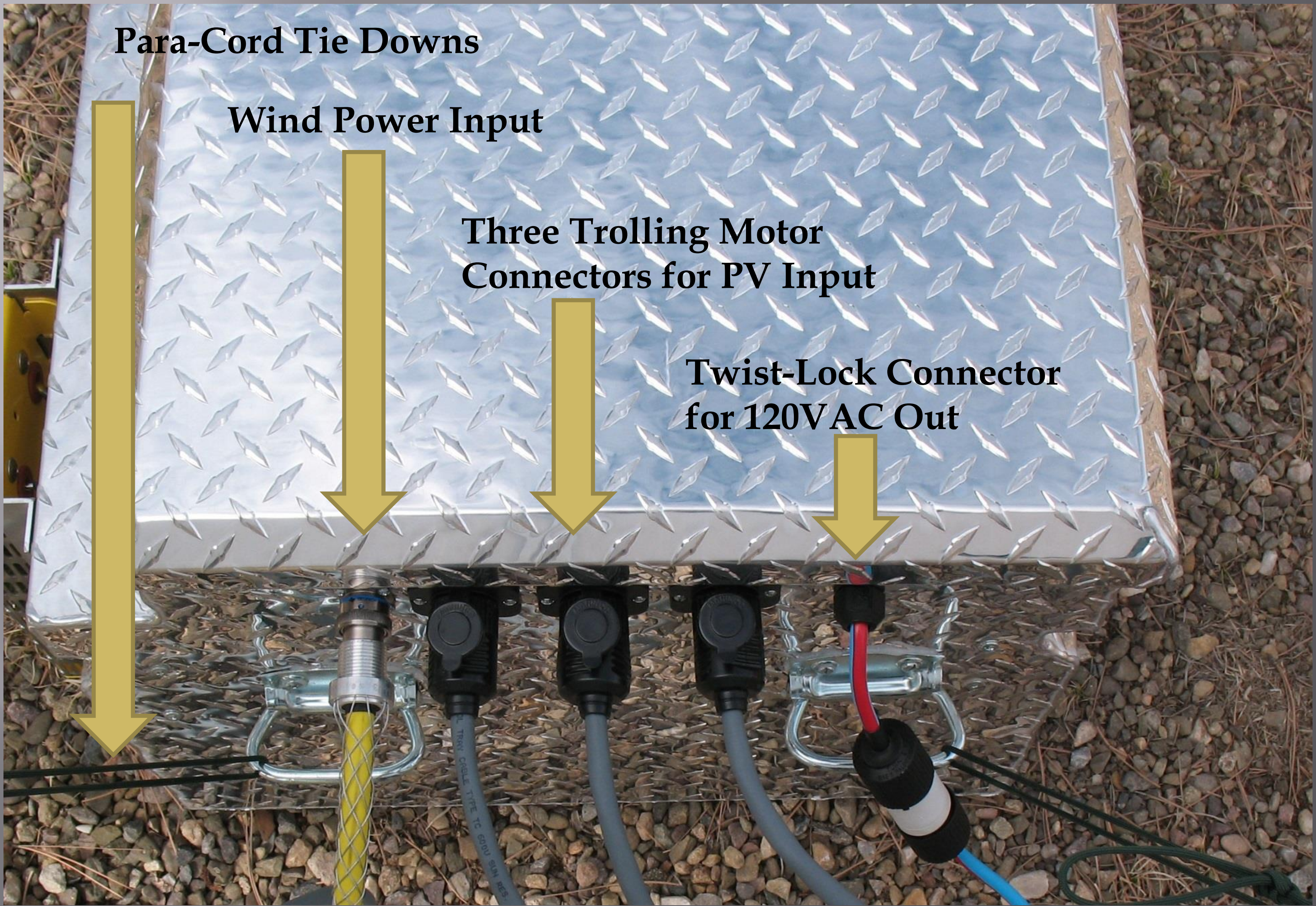
- -SOOW Tray Cable
- -AWG 10
- -Heat Shrink Strain Relief
- -Liquid-tight fitting



Many PV larger panels come with USE-2 cable and MC4, SMK or other connectors. This can be a good option for higher voltage series connections.


REMOTE METER
RM-1
25.41
MORNINGSTAR
CE
DC–
+
RUN
AC
10A
10A
10A
40A
20A
20A
10A
150VDC
GENASUN
INVERTER
ON
PWR ON
STANDBY

Strive for Plug & Play Connections



Careful Component Selection

- Rated for expected temperatures
- Rated for voltage
- High efficiency
- Conformal coated PC boards
- Strive to standardize components to the extent possible
- Unsolicited testimonial for Polar Wire Products
  - Arctic Ultra-Flex Power and Control Wire
  - Vendor for Marinco and Blue Sea marine products
- Anxious to see other folks favorite gizmos

Cursory Overview

- Many additional subjects that could be discussed if time permitted:
- Facility scale power systems
- Bonding and grounding
- Engine generators and fuel cells
- Energy storage systems
  - * Battery technologies
  - * Hydrogen
  - * Fossil fuels

Make your suggestions for PTC 2016!

Questions?
Additional Suggestions?

Let’s go workshop!