



**Inverter / Charger Installation**  
**Operation and Maintenance**  
**Trouble Shooting**



# Operation and Maintenance

Once the system is **PROPERLY** installed, the maintenance of the system, while critically important, is not difficult. To be PROPERLY installed, the following criteria need to be met:

- SW equipment is solidly mounted on a wall with working space in front of it and to the sides.
- There is proper ventilation space to the left and to the right of the SW equipment.
- The area in front of the SW equipment is reserved as work space and not storage space. Operators should be able to walk up to the inverter equipment and work on it without climbing over equipment (or batteries).
- The AC IN 1 and AC IN 2 feeds go through disconnect switches prior to entering the SW.
- The AC OUT feed goes first to a disconnect switch and then to a dedicated circuit breaker panel to feed the loads.
- All AC In and OUT wiring is properly sized, and protected with circuit breakers.



# Operation and Maintenance

- The batteries are properly installed on a rack with adequate spacing to allow for inspection and filling of electrolyte, and for cleaning.
- All series connecting cables are tight and clean and of the right size conductor.
- The paralleling cables go to a common landing block.
- The home run battery cables go to a fuse and then to a DC rated circuit breaker before landing on the SW Equipment.
- The load wiring is run professionally, from the dedicated circuit breaker panel to the individual loads, with any outlets clearly marked with their specific purpose.
- The operator will need to know from the designer what the daily routine functions need to be. These functions will vary from site to site, depending on the quality (or the existence) of the incoming grid power.



# Operations Situations

- Two examples of situations that would entail different operations are:
- ***Grid power quality **is sufficient** to run the lab equipment, but has infrequent dips and/or complete brown-outs:***
- ***Grid power quality during the day is **NOT good enough** to run the lab, but is good enough to charge the batteries in the evening and through the night.***



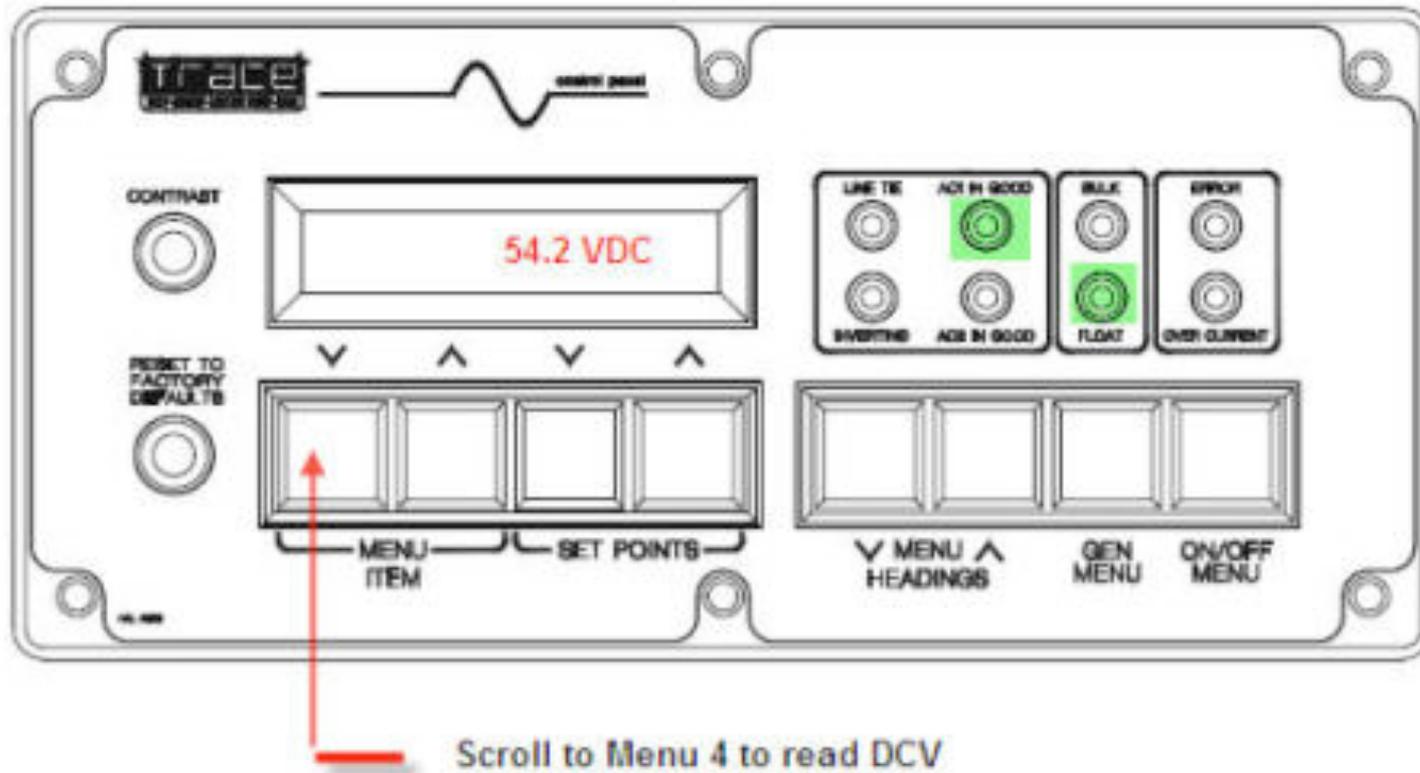
# Daily Log

The daily responsibilities of the operator will be checking all parts of the system, including the LED indicators, to be sure that everything appears to be working normally, and to maintain the **daily log**.

It is suggested that every day, **at the beginning of the shift, and at the end of the shift**, the operator records the DC Voltage of the batteries, along with the state of the inverter equipment as read by the LED lights. This information should be kept in a binder and transmitted to the engineering group on a periodic basis.



# Logging the System Status

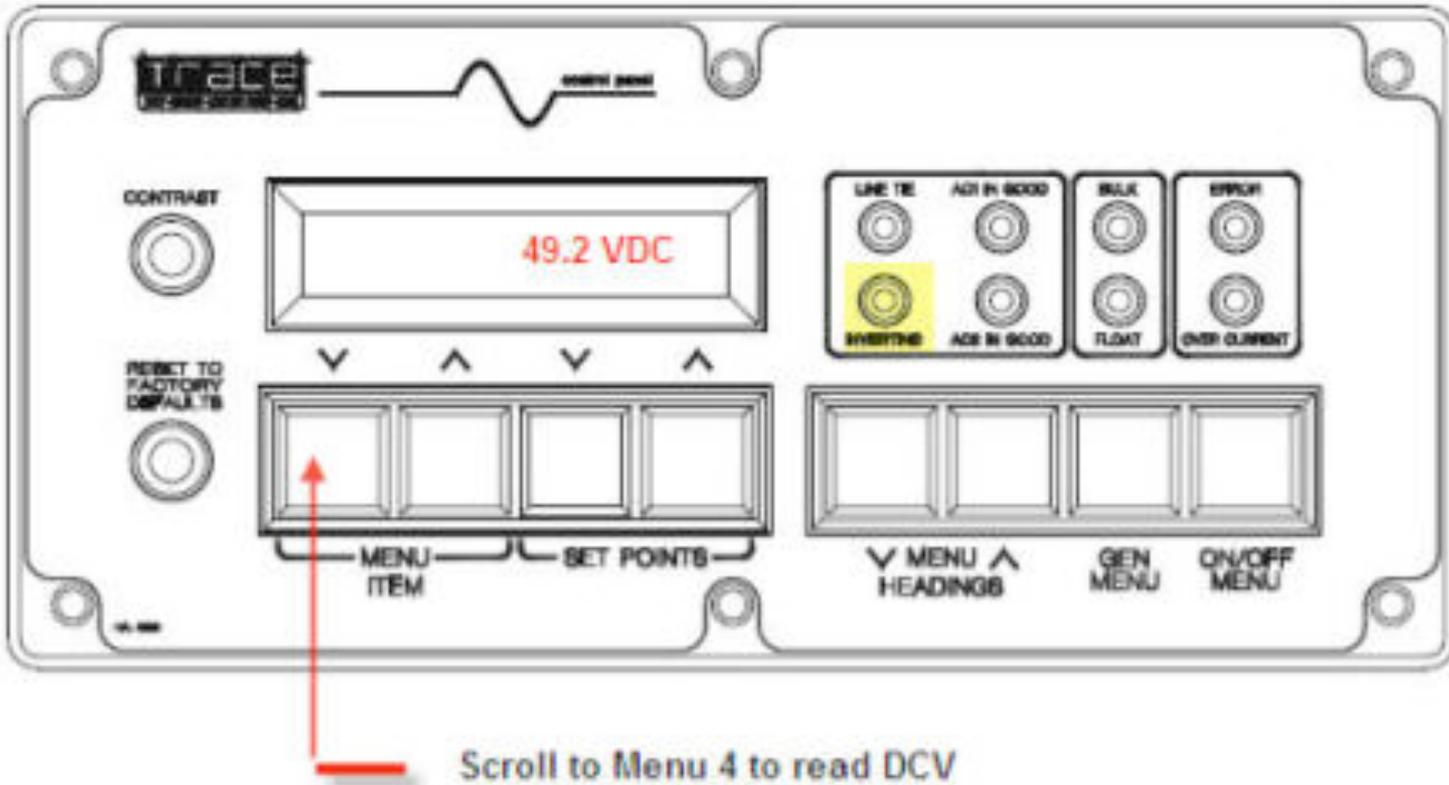


# Logging the System Status

- In this case, the **AC1 IN light is green**, meaning the inverter is connected to the grid.
- The **Float indicator is green**, meaning that the system is float charging the batteries, which means it has already completed the bulk charge cycle. The voltage is a reasonable level for a system that is float charging the batteries.
- The record in the log would show the **voltage and that AC1 IN is connected and the system is in Float charge.**



# Logging the System Status



# Logging the System Status

- In the above control panel configuration, it is seen that **neither AC1 nor AC2 is supplying power to the inverter.** This means either (a) there is no grid power or generator power, (b) there is power but it is turned off – possibly intentionally, possibly not, or (c) there is grid power but the grid usage timer has told the system not to use it.
- Since there is no power coming in, the system is neither float nor bulk charging and the loads are being powered by the batteries. The voltage will be lower than the fully charged battery voltage since there is no charging going on, and 49.2 VDC is a reasonable and healthy voltage to see at this point.



# Logging the System Status

It is preferable to make these log entries just before starting the day's work in the lab, and just after ending the day's work.

This will give a good idea as to how the system is operating in general.



# Battery Maintenance

Keeping the batteries working is the key to keeping the system working.

Suggestions for maintaining battery life are as follows:

- Do not allow the batteries to become discharged more than 50%.
- Maintain the liquid level on the batteries.
- Keep the batteries clean.
- Perform an equalizing charge when necessary



# Preventing Discharge

To keep from discharging a battery too much, it is critical to:

- (a) ensure that only the designed loads are connected to the system, and
- (b) the system is being charged regularly as designed.



# Load Management to Prevent Battery Discharge

- The battery system should be designed so that the batteries are **never discharged more than 50%..**
- The job of the operator is to assure that **only the equipment on the design sheet** is plugged into the system, and this equipment is only used for the number of hours that the designer indicates. Therefore it is important that this list of loads and hours/day be **posted on the site**, in prominent view of the operator and lab technicians.
- A system designed to supply 4,000 watt hours a day simply will not have a chance if it is being asked to supply 8,000 watt hours a day.



# Battery Charging

The designer would have determined what the charging cycle is.

Normally, the batteries will either be in constant float (with a decent grid system) **or** used during the day and expected to be charged back up at night.

Either way, the operator needs to be sure that the charging is taking place. If the loads are correct, but the charging is not happening, again, the batteries will not last long at all.



# Battery Charging

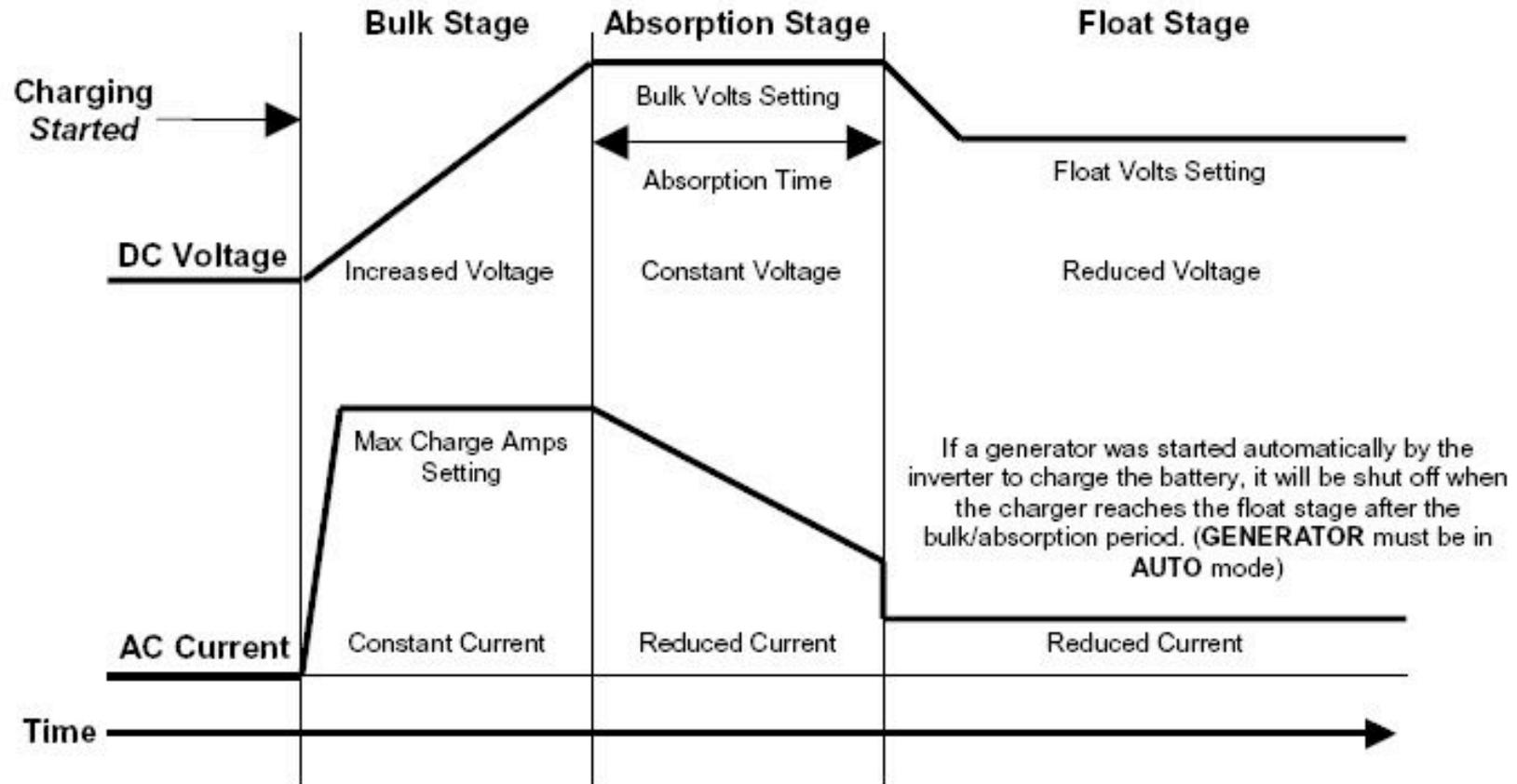
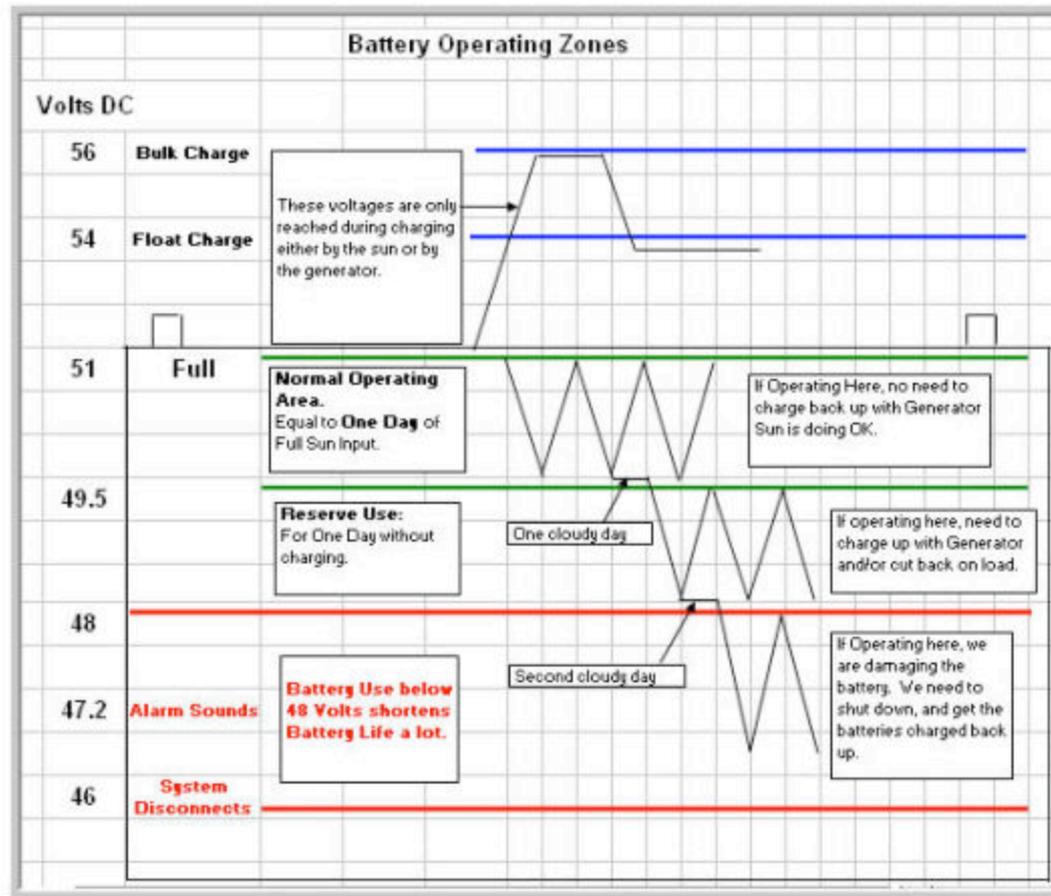


Figure 21, Three-Stage Battery Charging

# Battery Charging



# Maintain Electrolyte Level

- In most cases, Haitian facilities use the Trojan T-105 battery. This is a lead-acid, liquid filled battery. When it charges, water evaporates from the cells. When the water level gets down to the level of the top of the plates in the battery, air is able to reach the plates and this is detrimental.
- The batteries are constructed so there is a reservoir above the plates, but this must be checked frequently, and the cells topped off.

**ONLY USE DISTILLED WATER. DO NOT USE REGULAR WATER, AND DO NOT ADD ACID.**



# Maintain Electrolyte Level

- Many people add acid solution that can be found in automotive stores. **Don't do this.** When the batteries are charging, and liquid is escaping, it is only the water that is escaping – not the acid. So, if acid is added, the specific gravity is changed (and therefore the entire chemical reaction) of the battery. Again, only add distilled water.
- The liquid level on the batteries should be checked **AT LEAST once/week.** They may not need filling every week, but it is important to check them every week.
- The operator should record in the log:
  - (a) when the batteries were checked for electrolyte level, and
  - (b) whether or not distilled water was added, and if so how many liters.

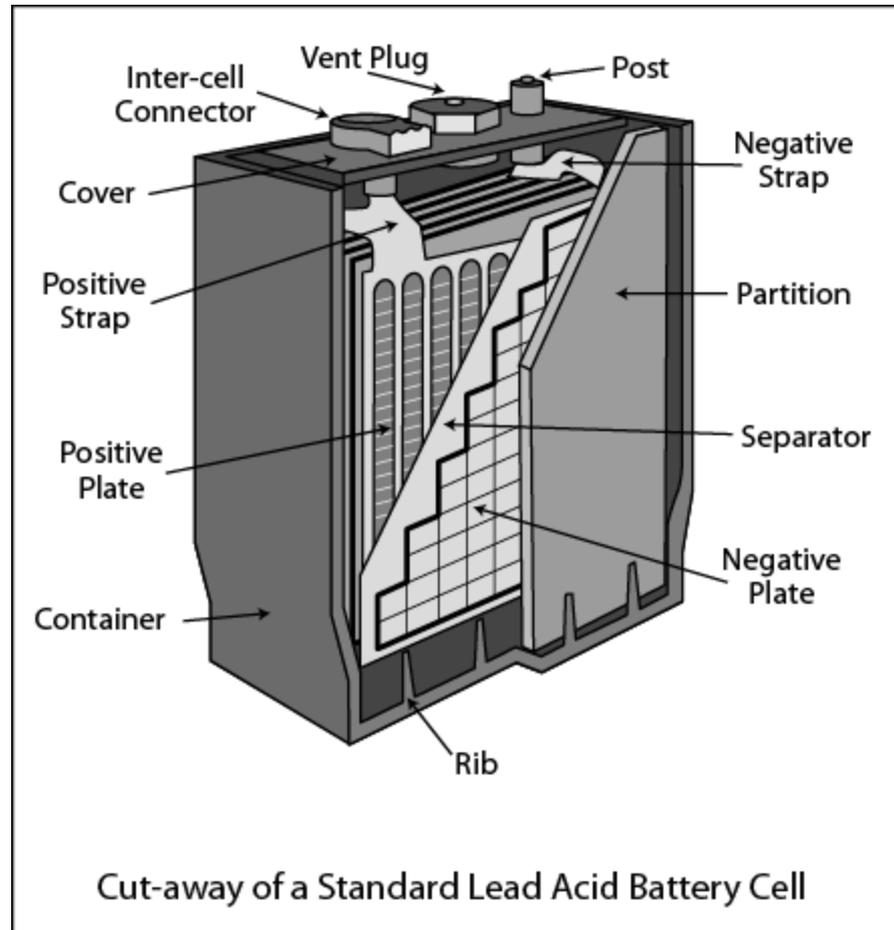


# Keep Batteries Clean

- The batteries should be cleaned **at least once every week**. They should be cleaned more often if they are excessively dirty at the weekly cleanings.
- With dust and moisture on the batteries, current paths can set up between the terminals causing tracking, corrosion, and quicker discharge. **Clean batteries last longer.**



# Battery Cut-Away



*Courtesy of SEI*

# Equalizing the Battery (liquid filled ONLY)

- **Equalization** is a process where the batteries are given an extra high voltage charge for a couple of hours. This is generally done once/month. During normal use, chemicals build up on the plates, and this high charge “boils” the batteries, knocking the chemicals down to the bottom of the battery.
- Because of this “boiling” effect, more liquid will be lost during the equalization. The batteries should be assured to have sufficient electrolyte before the equalization charge, and then they will need to be topped off following the equalization cycle. **(with distilled water only.)**
- The equalization charge is started under **menu item 2** on the control panel. Please refer to the Owner’s Manual for additional information on the equalization process.
- For additional information on Battery Maintenance, please refer to the Trojan brochure – “Deep Cycle Battery Maintenance.”

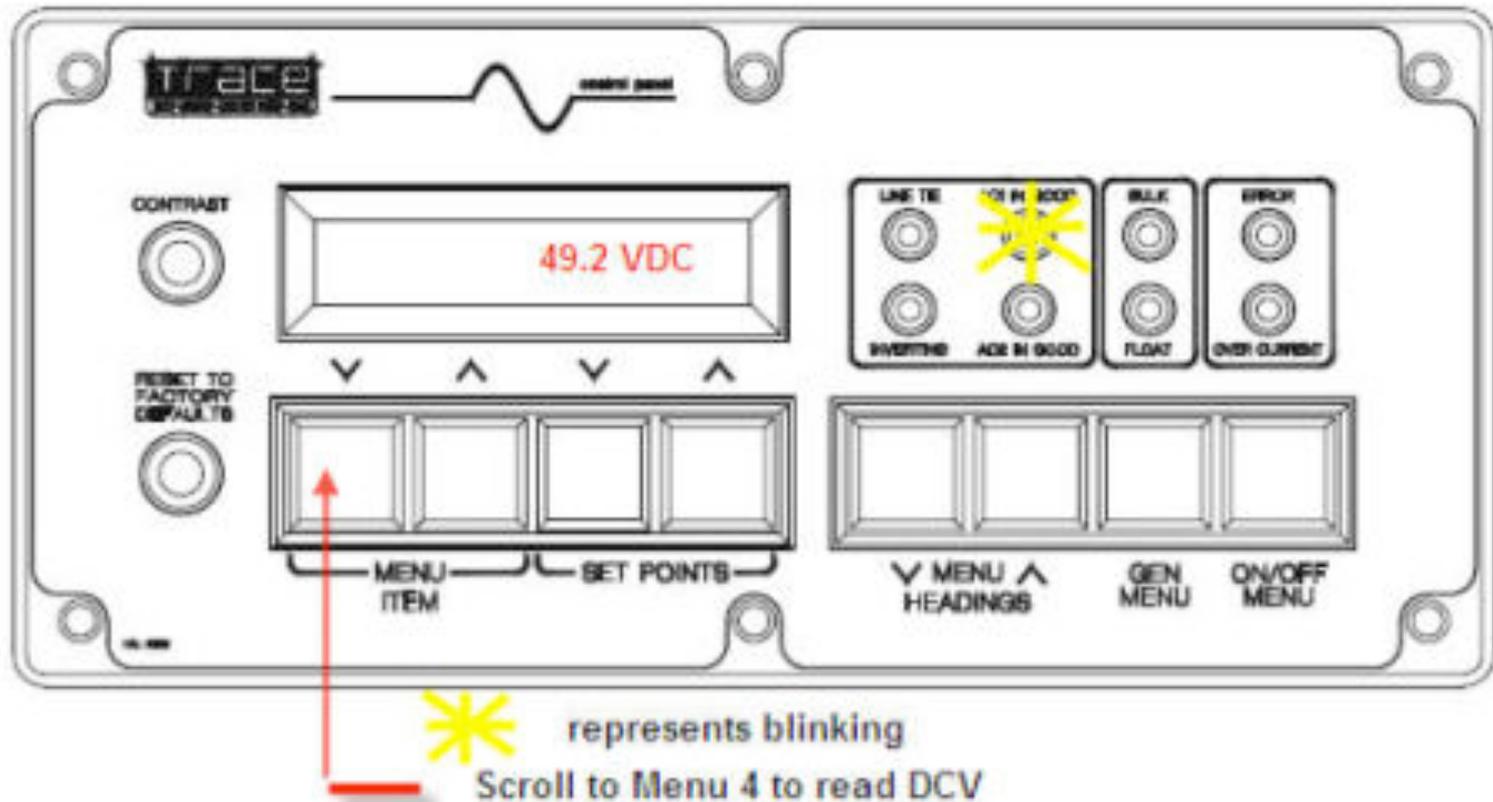


# Troubleshooting

- In many areas of Haiti, there were problems with low voltages. The SW equipment default “voltage window” is from a low of 108VAC to a high of 132 VAC. **So, when the voltage dips below 108, the system disconnects.**
- If the system disconnects, then the loads are being powered by the batteries, and **no charging takes place.** If the grid power is below 108V almost all of the time, then the batteries never get charged.
- We witnessed this on several occasions.



# System Disconnects on low Voltage (or Frequency)



# Troubleshooting

- The blinking light on AC1 IN means that the system sees voltage present at AC 1 IN (from the grid), and is trying to synchronize with this voltage. If either the voltage or the frequency is out of range, the system can not connect.
- Frequently, a cycle is observed, where the blinking light occurs for a while, and then goes solid, indicating that the system saw acceptable voltage and frequency and connects to the grid. Then, shortly after, the system disconnects from AC 1 IN and goes back into the invert mode. Then, a blinking light is observed again, indicating that the SW is trying to connect to the grid.
- What could cause this?



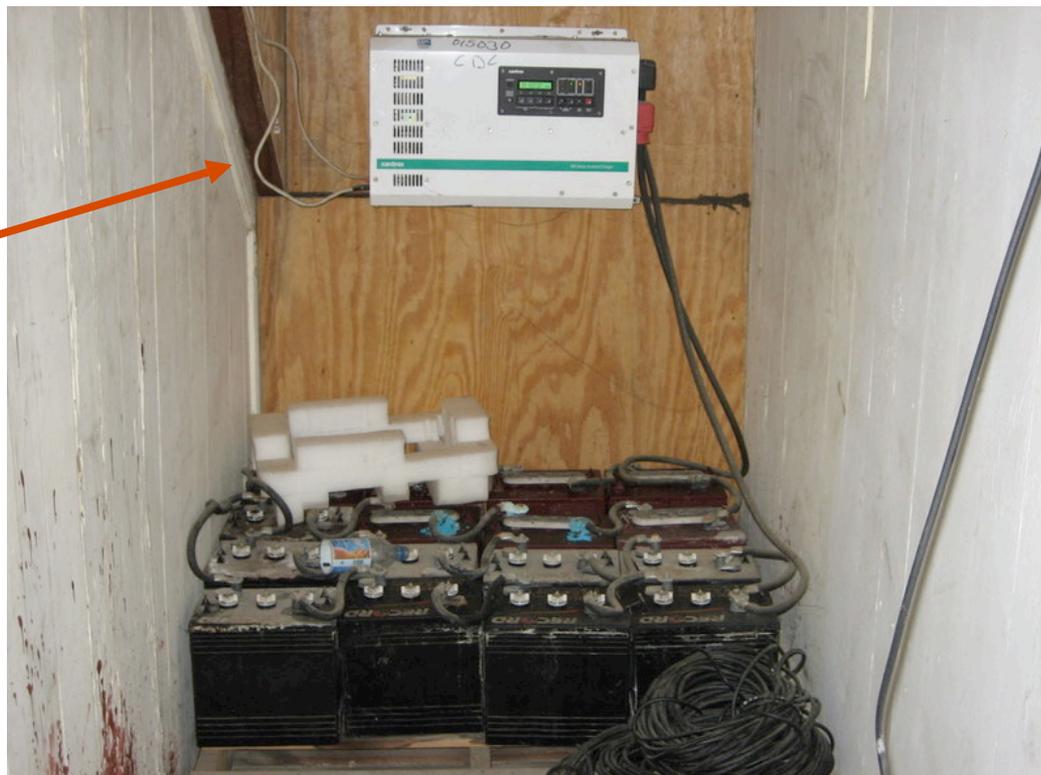
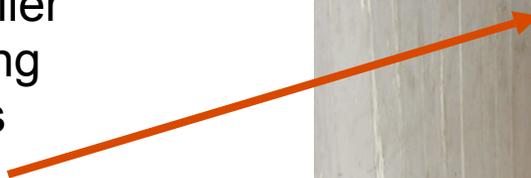
# Troubleshooting

- It could be that the grid is fluctuating in and out of the acceptable voltage window.
- It could also be that the very act of attempting to connect to the grid **CAUSES** the voltage to drop.



# Troubleshooting

2.5 mm<sup>2</sup> or smaller  
conductor feeding  
the AC IN of this  
inverter.



What Happens?

# Effect of too small AC IN Wire

120VAC 2.5 mm<sup>2</sup> conductor under little or no load 110VAC  
Wire rated maybe 25 amps for 100 feet

Inverter “sees” VAC > 108V and connects.

After connecting, it charges the battery at 30 amps and powers the loads.

120VAC 2.5 mm<sup>2</sup> conductor over loaded and too long Less than  
(can become very hot and be a fire hazard) 100V

Inverter now “sees” VAC < 108V and disconnects,

And then “sees” VAC > 108V and restarts cycle.



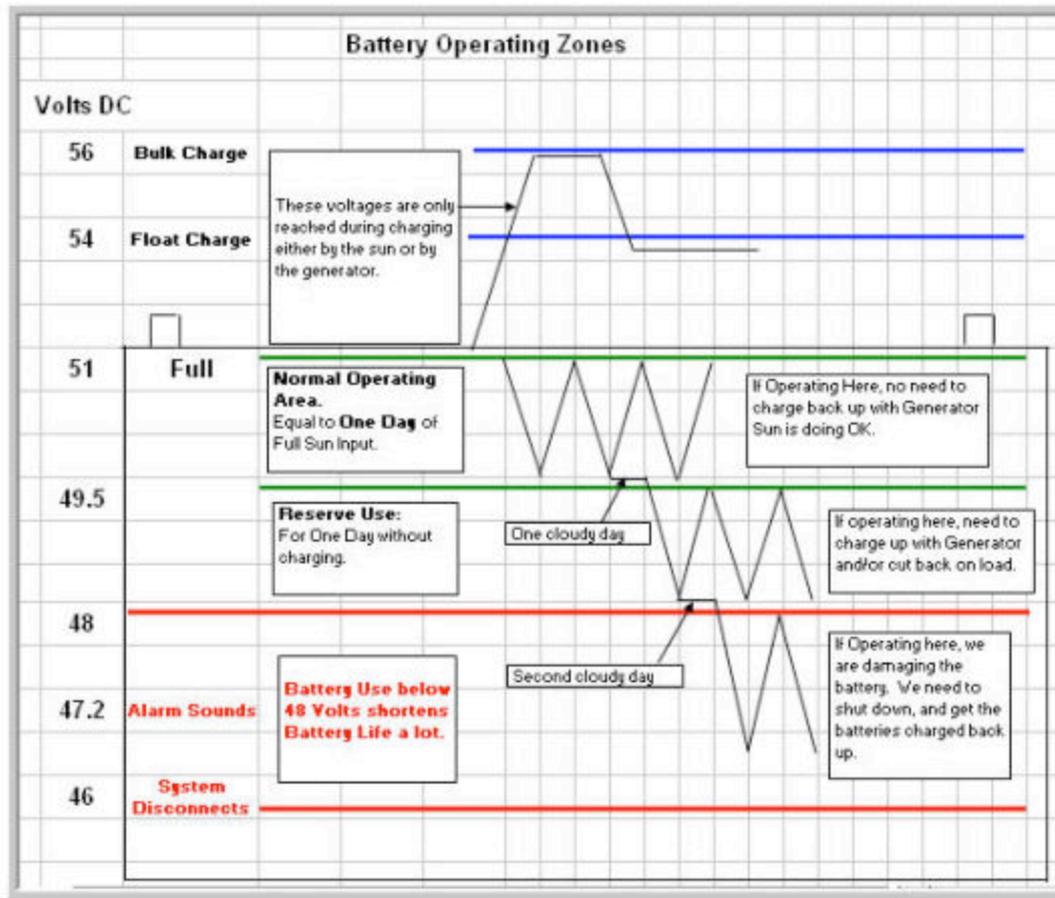
# Troubleshooting

What is the proper correction to this problem?

(should we widen the voltage window to accept the voltage drop?)



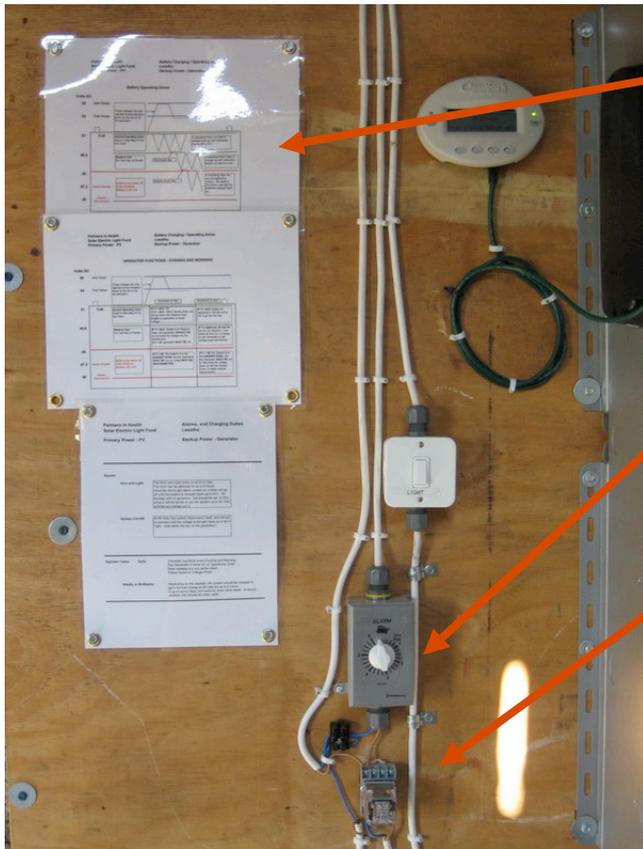
# Load Management and Alarms



# Load Management and Alarms

- Discuss various voltage points.
- Discuss addition and operation of an alarm that warns when the voltage is getting low.

# Alarm Wiring



Operator Instructions should be clearly posted.

Timer can silence the Alarm

Relay turns on the horn and light from a low voltage indication with the inverter / charger