Upgrading Electrical Systems on Older Yachts

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You are about to try and take a drink from a firehose!!

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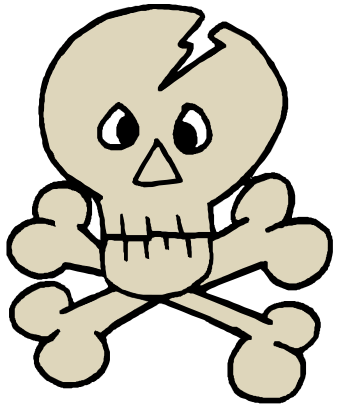
- This presentation will not make you into a competent marine electrician
- JTB Marine Corporation and the presenter assume no responsibility for the use of any of the materials, calculations or methods described in this presentation.



Introduction:
Who is Charlie Johnson?

- Mechanical Engineer
- Retired Naval Engineer: Submarine Maintenance and Repair
- 100 Ton Master
- ABYC Certified Marine Electrician
- Amateur Radio Operator: Advanced License
- Live aboard a 53’ Gulfstar Trawler; ten years
- Extensive cruising experience; three years “Down Island mon” in the Eastern Caribbean
- All round nice guy……..

Upgrading Electrical Systems on Older Trawlers: Overview

- This can be a daunting task
- Where to start?
- Many man-hours
- Many boat bucks
- In the end, you may not be happy with the final result
- What to do?

Upgrading Electrical Systems on Older Trawlers: Overview

- Look at how we got here
- Survey the wiring, the power distribution panels, and the switches and circuit protection devices
- Find all of the “sneakers”, circuits that have been added and are sourced from any available B+ circuit
- Plan what we want to accomplish…include the ability to expand

How did we get here?

We will use the m/y SPARKY, a 1978 vintage single engine trawler as our example. SPARKY was delivered with the following electrical configuration:

m/y SPARKY Electrical Equipment

- Three Group 27 batteries rated at 90 amp-hr each
  - One starting, two house
- 1-2-Both-Off switch
- One 55 amp Motorola, internally regulated, alternator
- Engine starting system
- 12 VDC navigational and cabin lights
- Knotmeter
- Depth sounder
- VHF radio
- Electric bilge pump

m/y SPARKY Electrical Equipment

DEVICE	QTY	AMPS/DEVICE	HRS/DAY	TOTAL AH
Cabin lights	3	1.5	3	13.5
Navigational lights	3	1.5	12	54
VHF radio transmit	1	5	0.5	2.5
VHF radio receive/standby	1	0.5	23.5	11.75
Depthsounder	1	0.2	24	4.8
Knotmeter	1	0.2	24	4.8
Deck light	1	4	1	4
			Total:	95.35

m/y SPARKY Electrical Equipment

- Pretty well balanced
  - 90 amp-hour available following the 50% discharge rule
  - 95 amp-hour demand
- The 55 amp alternator would do ok in recharging…it would take a fair amount of engine operation
- Not optimized for extended living on the hook

m/y SPARKY Electrical Equipment

Over the years, owners have added the following 12 VDC equipment:

- Lights
- Fans
- GPS
- Auto pilot
- Radar
- Pressure water
- 12 VDC refrigerator

The Electrical Load Grows…

DEVICE	QTY	AMPS/DEVICE	HRS/DAY	TOTAL AH
Cabin lights	4	1.5	3	18
Navigational lights	3	1.5	12	54
Anchor light	1	1	8	8
VHF radio transmit	1	5	0.5	3
VHF radio receive/standby	1	0.5	23.5	12
Depthsounder	1	0.2	24	5
Knotmeter	1	0.2	24	5
Deck light	1	4	1	4
Norcold DE-461	1	5	18	90
Potable water pump	1	5	0.3	2
Stereo	1	1	10	10
Radar	1	5	8	40
Autopilot	1	6	10	60
			Total:	309

You Now Own SPARKY and The Electrical Load Keeps Growing…

- Chartplotter
- Marine single sideband radio
- Laptop computer
- 12 VDC watermaker
- Shower sump pump
- More fans
- Icemaker

You Now Own SPARKY and The Electrical Load Keeps Growing…

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Stereo	1	1	10	10
Radar	1	5	8	40
Autopilot	1	6	10	60
Watermaker	1	15	4	60
Marine SSB	1	20	0.5	10
Icemaker	1	5	12	60
More fans	6	0.5	24	72
Chartplotter	1	0.6	24	14
			Total:	508

The Electrical Load Grows…and So Does the Frustration!

WOW!!

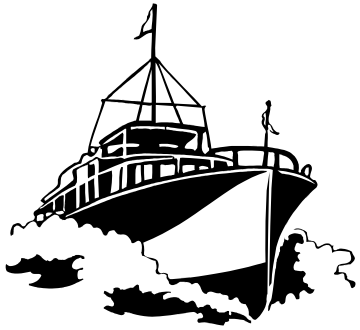
ARE WE IN TROUBLE ?

Common methods to combat excessive demand

- Dock talk…
- Add additional batteries
  - Go to 8D's
  - Use gel batteries
  - Put in bigger wire
- Install a wind generator
- Install solar panels
- Etc., etc., etc…….

The Frustration Continues…

And you find yourself running from power plug to power plug…



…thirsting for **POWER!!**

Common problems when "Upgrading'

- The alternator isn't giving a full charge…the anchor light is out by dawn's early light…get a bigger one
- The original ferroresonant charger doesn't seem to be cutting it…maybe install a bigger one

The Electrical Load Grows…and So Does the Frustration!

The System Approach

- The Energy Equation:

Energy In = Energy Out Plus Inefficiencies

The System Approach

- The Energy Equation Restated:

Sources of energy = Users of energy plus inefficiencies

The System Approach

- How is the boat going to be used?
  - Day running
  - Weekending
  - ICW/Great Loop
  - Extended time on the hook
- Honestly assessing the usage pattern is key

The Budget

- Be brutally honest...do not hedge your numbers!!
- The goal is to arrive at the realistic amount of power that your battery bank is going to have to produce to supply all of your electrical loads.

The Budget

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Survey the Components in the Existing System: The Panel

- Start here because this is where everything electrical on your boat starts!
- Condition of and type of “bus bars”
- Condition of and type of circuit breakers or fuses
- Panel meters
- Reverse polarity indicators
- Labeling/identification

Survey the Components in the Existing System: The Wire

- Type 2 or Type 3?
- Boat Cable or SAE?
- Untinned?
- Romex?
- Solid?
- What is the overall condition?
- Protected from chafe?

Survey the Components in the Existing System: The Charger

- Charger technology has improved incredibly over the last five years
- A good three stage charger is worth its weight in gold
- Ferroresonant chargers make excellent dinghy moorings…they heat more batteries than they charge

Survey the Components in the Existing System: House Bank

- Most batteries do not die…they are MURDERED!!!
- Pound for pound and dollar for dollar a flooded, true deep cycle, battery is the most economical
- Gel batteries and absorbed glass mat batteries are the choice when batteries must be placed where access is limited

The Upgrading Plan: Behind The Power Panel

- Replace overloaded bus bars
- Replace cobbled together bus bars made from terminal strips
- Add power posts where required
- Establish the “boat ground” bus
- Eliminate the “sneakers” behind the panel and get them on a circuit protection device (CPD)
- Start identifying and labeling B+ AND B- wires
- Start a schematic

The Upgrading Plan: Power Panel

- Is the panel with its circuit breakers, meters, etc. worth saving?
- Is there room for additional breakers?
- Is there room for a sub-panel?
- Work with panel manufacturers
- Circuit protection devices protect the wire…not the component

The Upgrading Plan: Power Panel

- Are the circuit breakers standard?
- Every single load on the boat MUST have its conductor protected by a properly sized CPD
- See the references for discussions on how to size CPDs and where they are to positioned

The Upgrading Plan: The Wiring

- What if your existing wiring is not up to standards?
  - Has it been serviceable?
  - Have there been any problems?
  - Is it protected from chafe throughout its entire run?
- If the wiring has been satisfactory, don't automatically start full rip-out

The Upgrading Plan: The Wiring

- Biggest, non-catastrophic, problem will be labeling and identification
- Consider terminating the old wire at power posts and terminal blocks behind the power panel and at the equipment
- Run Type 3 Boat Cable of the appropriate size from the power posts and terminal blocks to the component

The Upgrading Plan: The Wiring

- Use only tinned Boat Cable
  - BC5W2
    - Insulation rated for 105°C dry
    - Insulation rated for 75° C wet
  - UL 1426
  - Type 3
- Do not use SAE Boat Cable…It has 12% less cross sectional area

The Upgrading Plan: The Charger

- Install a three stage charger
- Ensure that the output from the charger is properly protected with CPD
  - Many chargers internally protected
- Multi bank capability

Upgrading Plan: Inverter/Charger

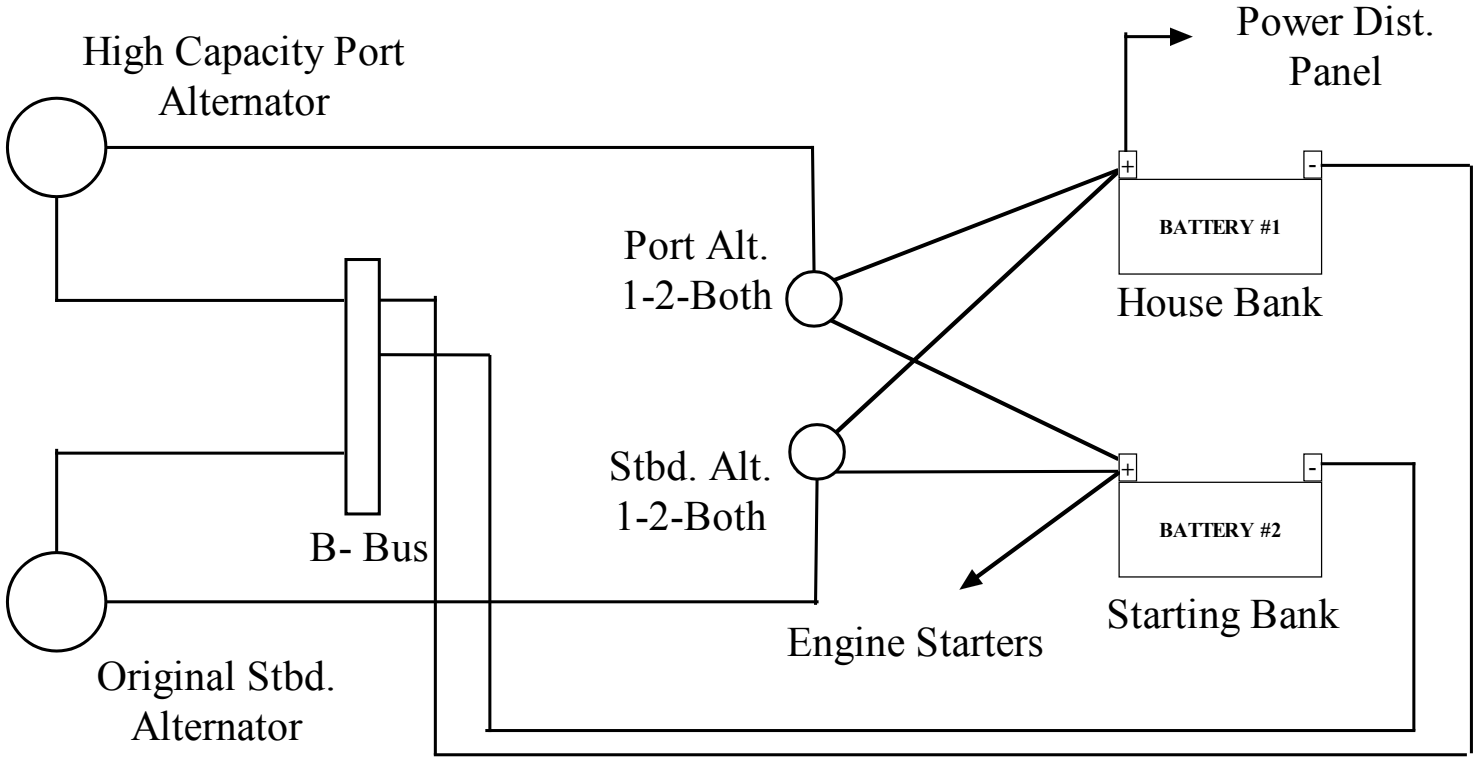
- Significant self-sufficient cruising; consider inverter/charger
  - 2.5 kw inverter/charger has 130 amp charger
  - Can charge a flooded battery bank at about 10% of the bank's capacity

    Example: 1320 amp-hr total bank capacity can be charged at a max of 132 amps

Upgrading Plan: The Alternator

- Consider installing a high capacity, externally regulated alternator
- If twin engine, possibly only install one high capacity alternator
  - Single belt can drive a 100 amp hot rated alternator…any larger go to multiple belts
  - Rule of thumb: It takes 1 hp per 25 amps of alternator capacity.

Upgrading Plan: The Alternator



Schematic for Controlling Alternator Output

Upgrading Plan: The Starting Bank

Evolving from the 1-2-Both-Off switch:

- Battery isolators
  - Trouble free
  - 0.6 VDC voltage drop
- Battery combiners
  - Solenoids
  - Early models were problematic
- Echo charging
  - Inverter/chargers have built in
  - Can buy off shelf model

Summary

- Assessed how the boat was going to be utilized
- Computed an honest energy budget
- Designed an electrical storage and replenishment system to support
  - Remember the energy equation

Summary

- Surveyed wiring and the power distribution panels
  - Salvaged what makes sense to salvage
  - Ensure that every single conductor is protected with an appropriate CPD
  - Replaced power panel if warranted…added a sub-panel if possible

Summary

- Eliminated “sneakers”
- Replaced the overloaded and inadequate bus bars and pseudo bus bars behind the power panel
- Established the boat ground
  - Eliminated ground loops and a myriad of other B- related problems

Summary

- Labeled ALL wires; both B+ and B-
- Drew a basic schematic
- Upgraded at least one alternator
- Installed a three stage battery charger to replace the old battery heater

Summary

- Now you are living within your energy budget…

And you are the conquering hero!!

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Installing Inverter/Charger Systems

- References
  - ABYC Standards and Technical Information Reports for Small Craft
  - Boatowner's Mechanical and Electrical Manual; 2nd Ed.; Nigel Calder
  - Powerboater's Guide to Electrical Systems; Ed Sherman
  - Blue Sea Systems; http://www.bluesea.com/
  - Xantrex; http://www.xantrex.com/

Any Questions