UpgradingElectrical Systemson OlderYachts

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Youare aboutto tryand takea drinkfrom a firehose!!

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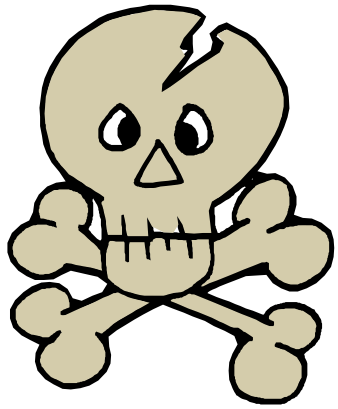
- This presentation will not make you into a competent marine electrician
- JTB Marine Corporation and the presenter assume no responsibility for the use of any of the materials, calculations or methods described in this presentation.



Introduction:
Whois CharlieJohnson?

- 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……..

UpgradingElectrical Systemson OlderTrawlers: Overview

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

UpgradingElectrical Systemson OlderTrawlers: Overview

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

Howdid weget here?

We will use the m/y SPARKY, a 1978 vintages ingle engine trawler as our example. SPARKY was deliveredwith the following electrical configuration:

m/y SPARKYElectrical 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 SPARKYElectrical 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 SPARKYElectrical Equipment

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

m/y SPARKYElectrical Equipment

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

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

TheElectrical LoadGrows …

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

YouNow OwnSPARKY andThe ElectricalLoad KeepsGrowing …

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

YouNow OwnSPARKY andThe ElectricalLoad KeepsGrowing …

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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

TheElectrical LoadGrows …and SoDoes theFrustration!

WOW!!

AREWE IN TROUBLE ?

Commonmethods tocombat excessivedemand

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

TheFrustration Continues…

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

…thirsting for **POWER!!**

Commonproblems when “Upgrading’

- The alternatorisn ’t giving a full charge…the anchor light is out by dawn’s early light…get a biggerone
- The original ferroresonant chargerdoesn ’t seem to be cutting it…maybe install a bigger one

TheElectrical LoadGrows …and SoDoes theFrustration!

TheSystem Approach

- The Energy Equation:

Energy In = Energy Out Plus Inefficiencies

TheSystem Approach

- The Energy EquationRestated:

Sources of energy = Users of energyplus inefficiencies

TheSystem Approach

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

TheBudget

- Be brutally honest...donot hedgeyour numbers!!
- The goal is to arrive at the realistic amount of power that your batterybank is going to have to produceto supply all of your electrical loads.

TheBudget

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Surveythe Componentsin the ExistingSystem: ThePanel

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

Surveythe Componentsin the ExistingSystem: TheWire

- Type 2 or Type 3?
- Boat Cable or SAE?
- Untinned?
- Romex?
- Solid?
- What is the overallcondition?
- Protectedfrom chafe?

Surveythe Componentsin the ExistingSystem: TheCharger

- Chargertechnology has improved incredibly over the last five years
- A good three stagec hargeris worth its weight in gold
- Ferroresonant chargersmake excellent dinghy moorings…they heat more batteriesthan they charge

Surveythe Componentsin the ExistingSystem: HouseBank

- Most batteriesdo not die…they are MURDERED!!!
- Pound for poundand dollarfor dollar a flooded,true deepc ycle, battery is the most economical
- Gel batteriesand absorbedglass mat batteriesare the choice when batteries must be placed where access is limited

TheUpgrading Plan: BehindThe PowerPanel

- 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

TheUpgrading Plan: PowerPanel

- Is the panelwith its circuit breakers, meters,etc. worths aving?
- Is thereroom for additionalbreakers?
- Is thereroom for a sub-panel?
- Work with panel manufacturers
- Circuit protectiondevices protectthe wire…not the component

TheUpgrading Plan: PowerPanel

- Are the circuit breakersstandard?
- Every single load on the boat MUST have its conductor protectedby a properlysized CPD
- See the referencesfor discussions on how to size CPDs and where they are to positioned

TheUpgrading Plan: TheWiring

- What if your existingwiring 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 automaticallys tartfull rip-out

TheUpgrading Plan: TheWiring

- Biggest, non-catastrophic,problem will be labeling and identification
- Consider terminatingthe old wire at power posts and terminalblocks behindthe power paneland at the equipment
- Run Type 3 Boat Cable of the appropriate size fromthe power posts and terminal blocks to the component

TheUpgrading Plan: TheWiring

- Use only tinnedBoat 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

TheUpgrading Plan: TheCharger

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

UpgradingPlan: Inverter/Charger

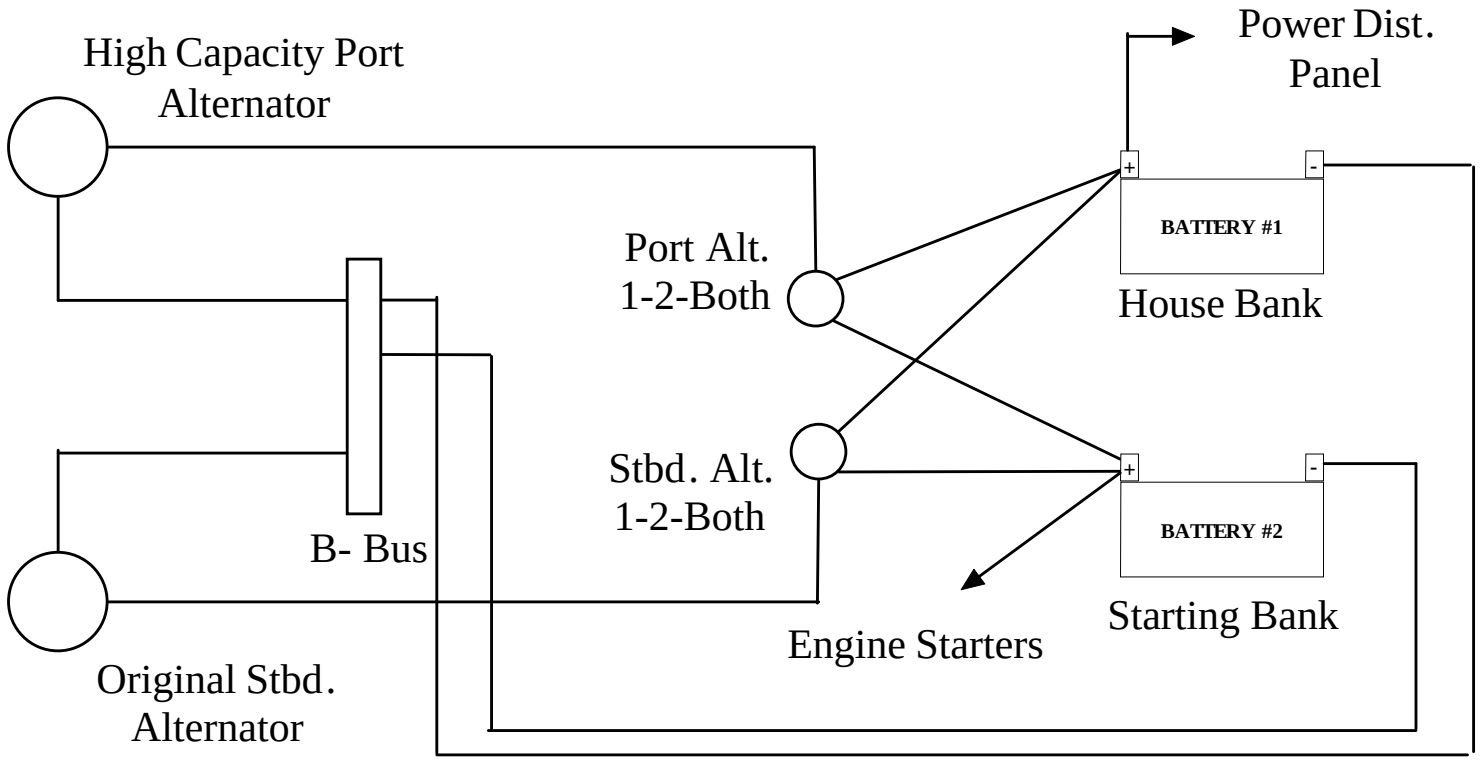
- Significant self-sufficient cruising; consider inverter/charger
  - 2.5 kw inverter/charger has 130 amp charger
  - Can charge a flooded battery bank at about 10% of the bank's capacity

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

UpgradingPlan: TheAlternator

- Consider installing a high capacity, externally regulatedalternator
- If twin engine,poss ibly 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.

UpgradingPlan: TheAlternator



Schematic for Controlling Alternator Output

UpgradingPlan: TheStarting 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 goingto be utilized
- Computedan honest energy budget
- Designedan electrical storage and replenishmentsystem to support
  - Remember the energy equation

Summary

- Surveyedw iring 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”
- Replacedthe overloadedand inadequate bus bars and pseudobus bars behindthe power panel
- Establishedthe boat ground
  - Eliminated ground loops and a myriad of other B- related problems

Summary

- LabeledALL wires; both B+ and B-
- Drew a basic schematic
- Upgradedat least one alternator
- Installed a three stage batteryc harger 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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- Hopefully it did make you into a better informedboat owner.
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InstallingInverter/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/

AnyQuestions