Brian Boschma / Max Critterdan

All Is Lost - Without Adequate Power

Power Budgeting

Solar Wind

Electrical Budget Worksheet (adapted from Pacific Cup)

1 Calculate your DC Loads:

Lighting	Amps	Hours	AH/Day
Running Lights			0.0
Masthead Tricolor Light			0.0
Anchor Light			0.0
Cabin Light (small)			0.0
Cabin Light (big incandescent)			0.0
Cabin Light (fluorescent)			0.0
Instrument Lights			0.0
Handheld Spot Light			0.0
Other			0.0
	Lighting AH		0.0

Galley	Amps	Hours	AH/Day
Propane Solenoid			0.0
Other			0.0
	Galley AH		0.0

Electronics	Amps	Hours	AH/Day
Autopilot			0.0
VHF (receive)			0.0
VHF (transmit)			0.0
SSB (receive)			0.0
SSB (transmit)			0.0
SSB Digital controller			0.0
GPS			0.0
Instruments			0.0
AIS			0.0
Energy Monitors			0.0
Stereo			0.0
Other			0.0
	Electronics AH		0.0

Plumbing	Amps	Hours	AH/Day
Fresh Water Pump			0.0
Bilge Pump(s)			0.0
Other			0.0
	Plumbing AH		0.0

Calculate using average water consumption.
This should be zero unless the boat leaks.

Gross Energy Consumption AH/Day	#REF!

2	Alternative Energy Sources				
	Device	Amps	Hrs/day	AH/day	
	Solar, avg			0.0	Assumes one large panel.
	Wind, avg			0.0	Assumes AIR Marine wind turbine in good location.
	Water, avg.			0.0	
	Contribution of AES AH/Day			0.0	
3	Net Energy Consumption, AH/Day			0.0	
4	Desired Hours Between Charging				
5	Range of Battery Use				For example, from 50-85% state of charge.
6	Recommended Battery Capacity			#DIV/0!	
7	Alternator Output, Amps				Target would be 25% flooded, 40% gel, of capacity.
8	Charge Efficiency Factor			0.85	Gels = 95%, flooded cells = 85%
9	Minimum Minutes to Charge			#DIV/0!	Assumes alternator runs at full output.

Power budget – dumbed-down version

Item	Amp draw	Est. duty cycle	Avg. amp draw
Plotter & AIS	0.42	1.00	0.42
Simrad pilot - driving	2.30	0.10	0.23
VHF - receiving	0.23	0.90	0.21
1 cabin light	1.00	0.20	0.20
Depth/wind/speed	0.20	1.00	0.20
2 cabin lights	2.00	0.05	0.10
Simrad pilot - auto, idle	0.10	0.80	0.08
Tricolor	0.15	0.42	0.06
Pressure water	4.50	0.01	0.05
VHF - transmitting	4.50	0.01	0.05
Bilge pump	2.00	0.02	0.04
Deck running lights	2.10	0.01	0.02
Deck light	2.00	0.01	0.02
Propane solenoid	0.50	0.02	0.01
Stereo - off	0.01	0.99	0.01
Simrad pilot - standby	0.09	0.10	0.01
Stereo - on	0.60	0.01	0.01
Anchor light	1.34	0.00	0.00
Steaming light	0.97	0.00	0.00
Total average current			1.71

Changes to reduce power consumption

- LEDs in running lights and frequently-used cabin lights
- Added foot pumps in galley and head; pressure water left off for duration
- Electric bilge pump switched off at night

IDEFIX Power Budget

Idefix – Olson 30 2010,2012
Great Results, Well Planned

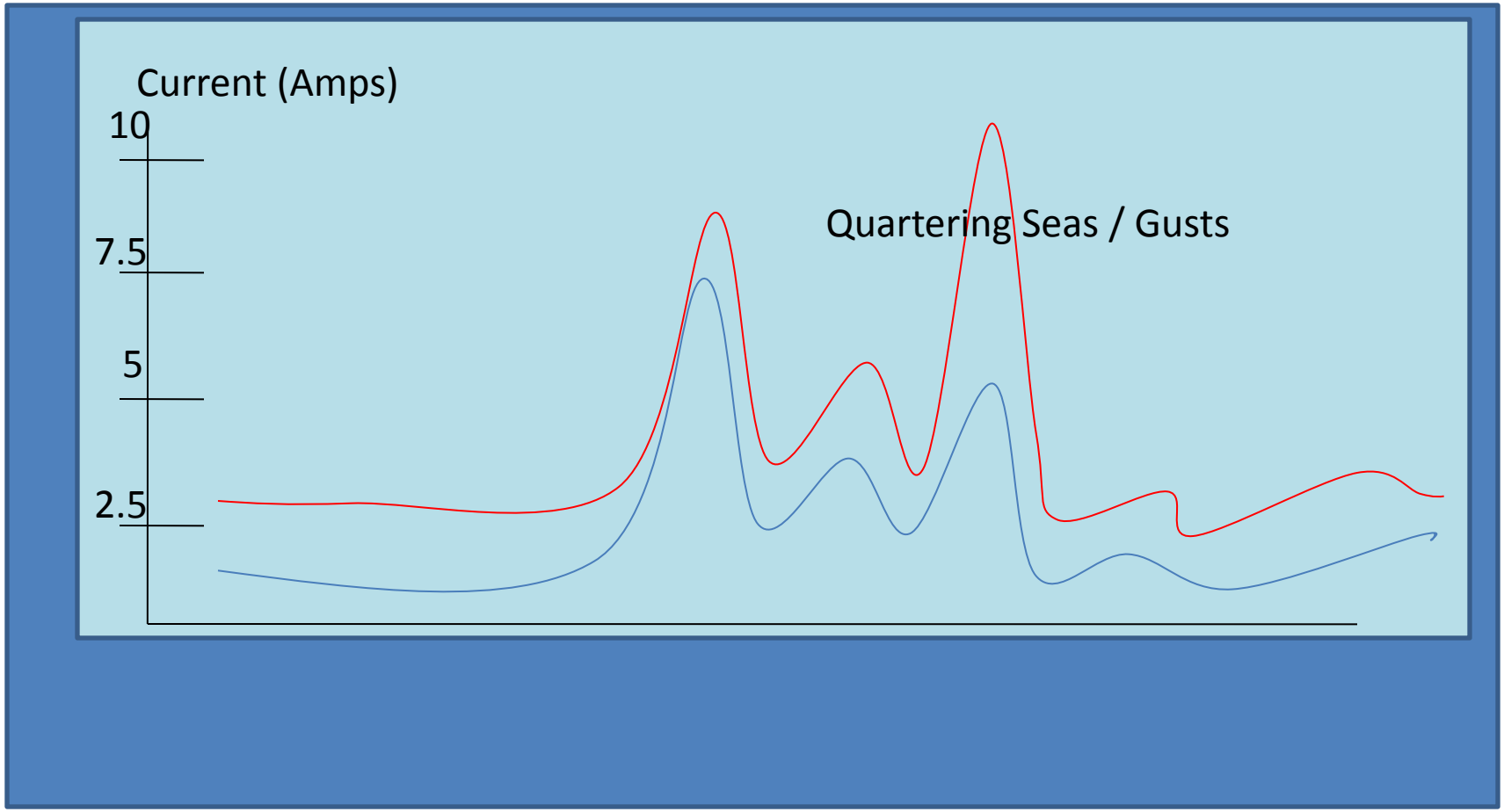
- Solar: 135W hanging off the stern + 40W on the cabintop, wired in parallel.
- Batteries: two 12V 110Ah AGMs wired in parallel with emergency cut-off switches (and fuses added after a short circuit fried all my wiring and detroyed a battery terminal).
  - sized the batteries so to sail half a transpac on battery power alone,
- AP: was two Raymarine X-5s . Power consumption was around 1.5A average, (an estimate).
- Power budget : estimated total energy use at about 56 Ah/day, and generation at about 58 Ah/day.
  - In reality, generation was much higher than this during day.
  - I'd go through about 25-35Ah every night, so use was pretty close to the budget
  - Ran VHF and AIS 24/7.
- On the 2010 SHTP we had sun pretty much the whole way, I had the batteries topped off about mid-day every day
  - On the 2012 SHTP, with overcast the first week or so.
  - My battery monitor had a cumulative error and I wasn't sure where I was on batteries.
  - On day 10 or so it was showing down 50Ah, but voltages were correlating with full charge, so I realized the problem was with the monitor, not the charging system.

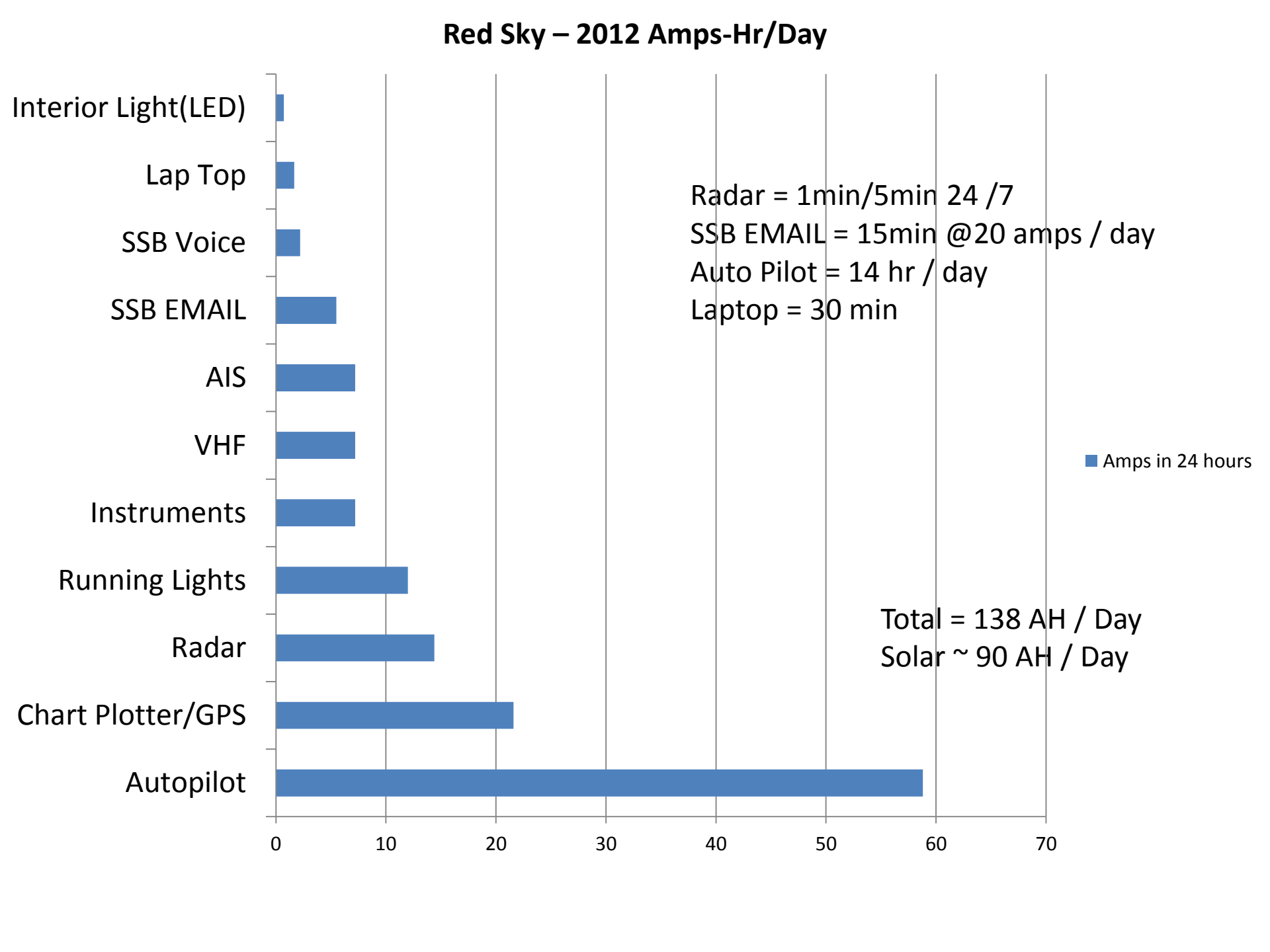
Idefix Budget

electric - TP	7.4W netbook			
	distance	2400		
	speed	7		
	hours	343		
	days	16		
		amps	hours/24	Ah/24
power budget:	AP	1	18	18
	AIS	0.25	10	2.5
	Laptop	0.9	10	9
	VHF	2.08	0.2	0.416
	nav lights	0.5	10	5
	instr	0.32	24	7.68
	music	0.42	4	1.68
	comm	2.5	5	12.5
	Ah/24	56.776		
	Ah total	908.416		
generation	installed P	175		
	Actual P	87.5	0.5	efficient
	Ah/24	58.3333333333333	8	hours sun
in-out	**Ah/24**	**1.55733333333334**		
	Ah tot	**24.9173333333334**		
	Instruments	mA		
instr:	ST60 speed	45		
	ST60 wind	65		
	batt mon	10		
	VHF	200		

Typical Current Load for Type 1 Hydraulics and GP Tiller Wands

(there is no such thing as a low power autopilot and your amperage may vary)




Red Sky – 2012 Amps-Hr/Day
Interior Light(LED)
Lap Top
SSB Voice
SSB EMAIL
AIS
VHF
Instruments
Running Lights
Radar
Chart Plotter/GPS
Autopilot
0
10
20
30
40
50
60
70
Radar = 1min/5min 24 /7
SSB EMAIL = 15min @20 amps / day
Auto Pilot = 14 hr / day
Laptop = 30 min
Total = 138 AH / Day
Solar ~ 90 AH / Day
Amps in 24 hours

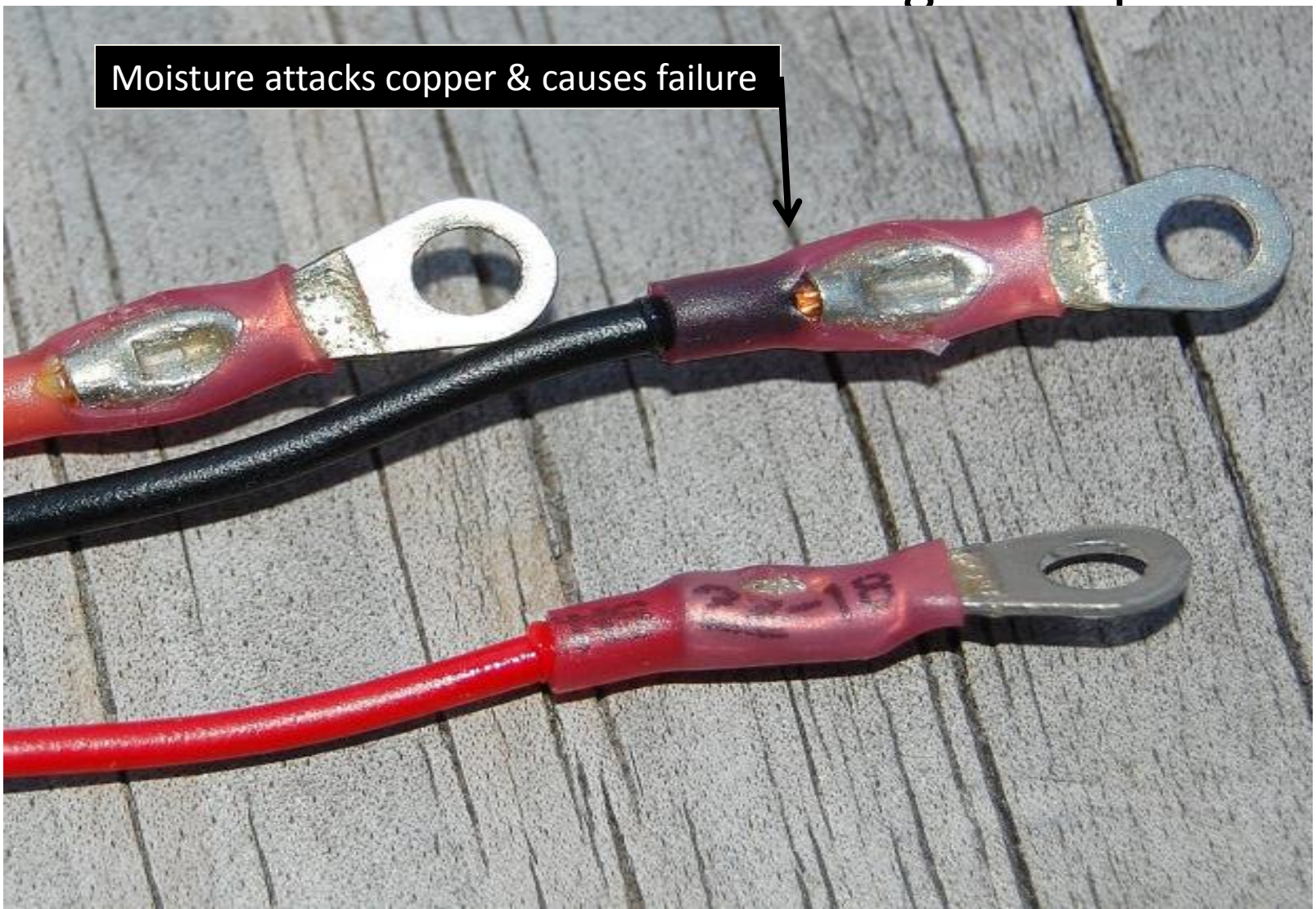
Power Connection Common Failures

- Crimp lugs pulling out.
- Corrosion of wires and connections.
  - Moisture wicking from open ends of wire.
  - Moisture absorption through low quality insulation.
  - Corrosion at screw terminations.
- Mechanical vibration causing crimp & soldered failures.
  - Minimize vibration via tie wraps at points of connection.
  - If you crimp don't solder, if you solder don't crimp (wisdom of local marine electrician).
- Screw terminations with bare wire tend to work lose over time (retighten after initial install and after use).

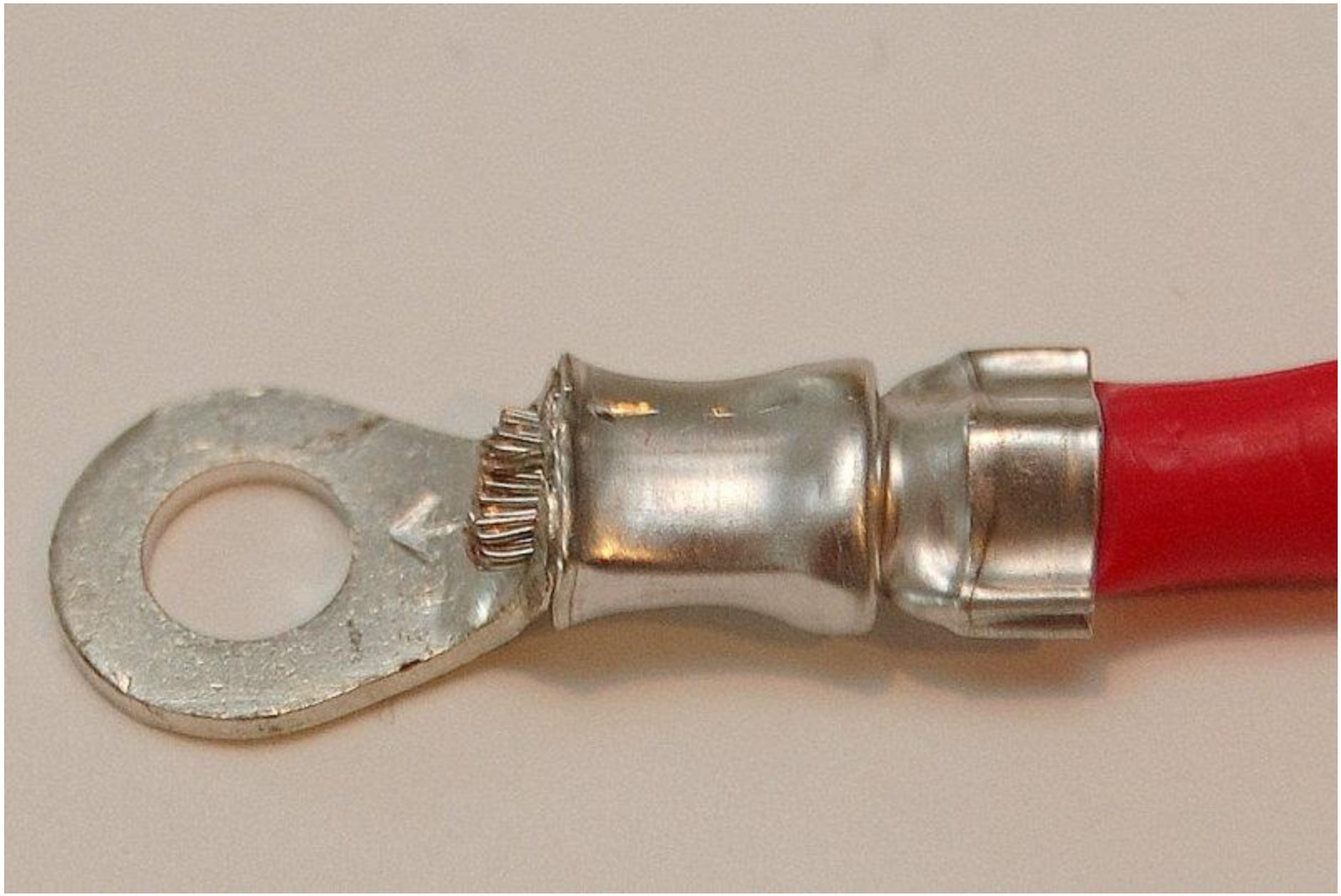
Single Dimple Crimp

Splits insulator-Solder expands hole

Use external heat shrink if single dimple



Proper Crimp Results in -



A True Seal Without Solder.
cross section of crimp

Example of a Double Crimp Tool

Proper Tie Wraps to Prevent Wire Vibration

Prevent motion from work hardening connections leading to failure

s/v Cinnabar-Schumacher 52

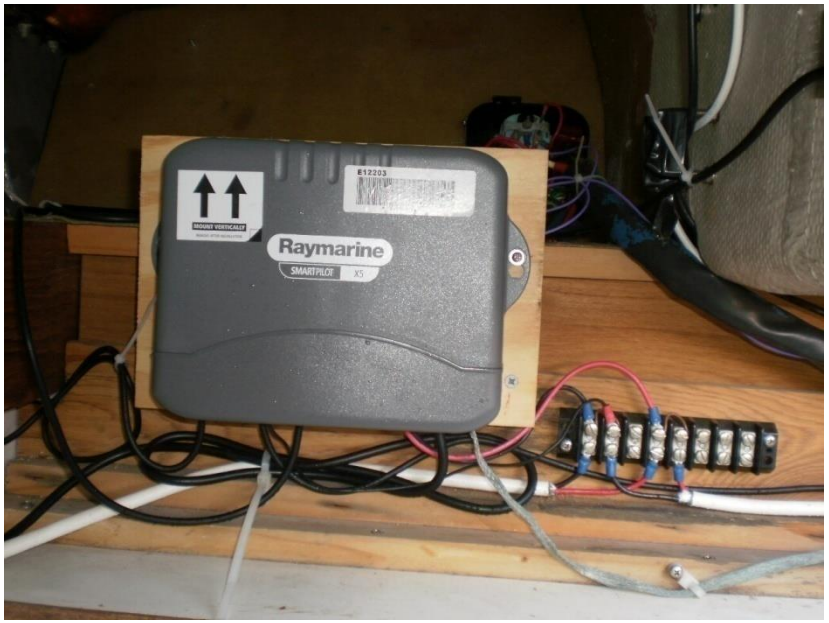
Ring Terminals all swaged and then sealed with epoxy filled heat shrink.

s/v Cinnabar

Sealed boxes and cable glands for wiring that keep moisture out.

Raymarine X5 autopilot

Solar WInd



Icom M700Pro SSB

Mini 6.5 – SHTP 2012

Power Generation Alternatives

Alternator 30 - 100 amps
Charge controller adjustment
And connection is key

+

Plug into 110V

EFOY Fuel Cells used on Mini Transat 2012

Hydro Generation

45 amps vs 9 from gen

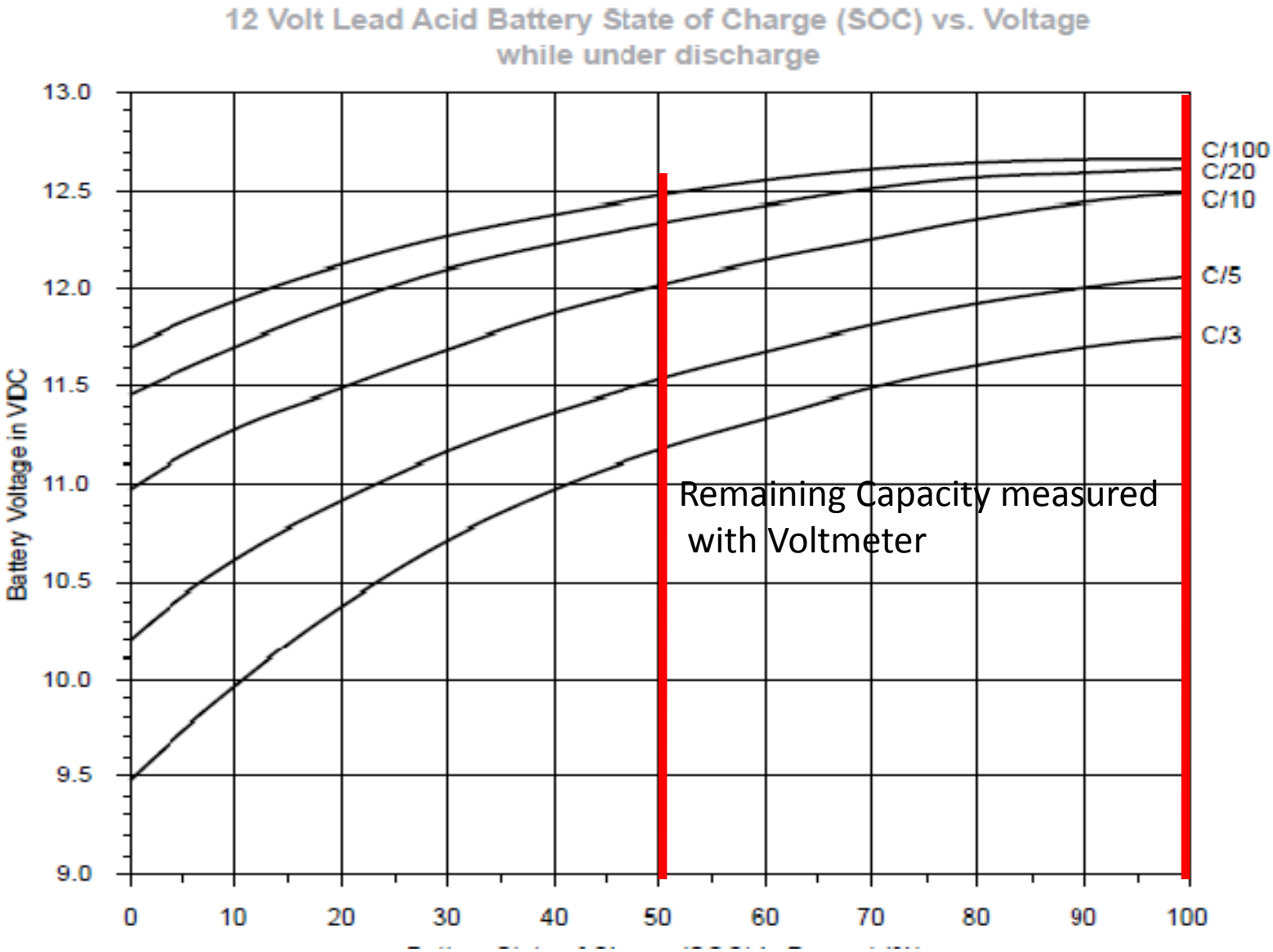
Charge Controllers

Alternator	Solar PWM	Solar MPPT	No Controller
Adjust charge profile.	Low cost ~ $25 @ ebay	Cost ~$70++	No Cost
Allows max efficiency of alternator.	Good battery control to keep from over charge.	Best utilization of solar output via “boost” of lower voltages. 30% improvement over PWM (claimed)	Solar connects directly to battery. Use as back up if you suspect a failure.
Alternator needs to have field wire access.	Higher end add battery monitoring	Higher end add battery monitoring	No control on overcharge, but not an issue in the SHTP.

Tracks Amp Hours within your battery

The Argument for a Battery Monitor

Voltage is Very Load Dependent at Time of Measurement



200AH Batt

Load Current

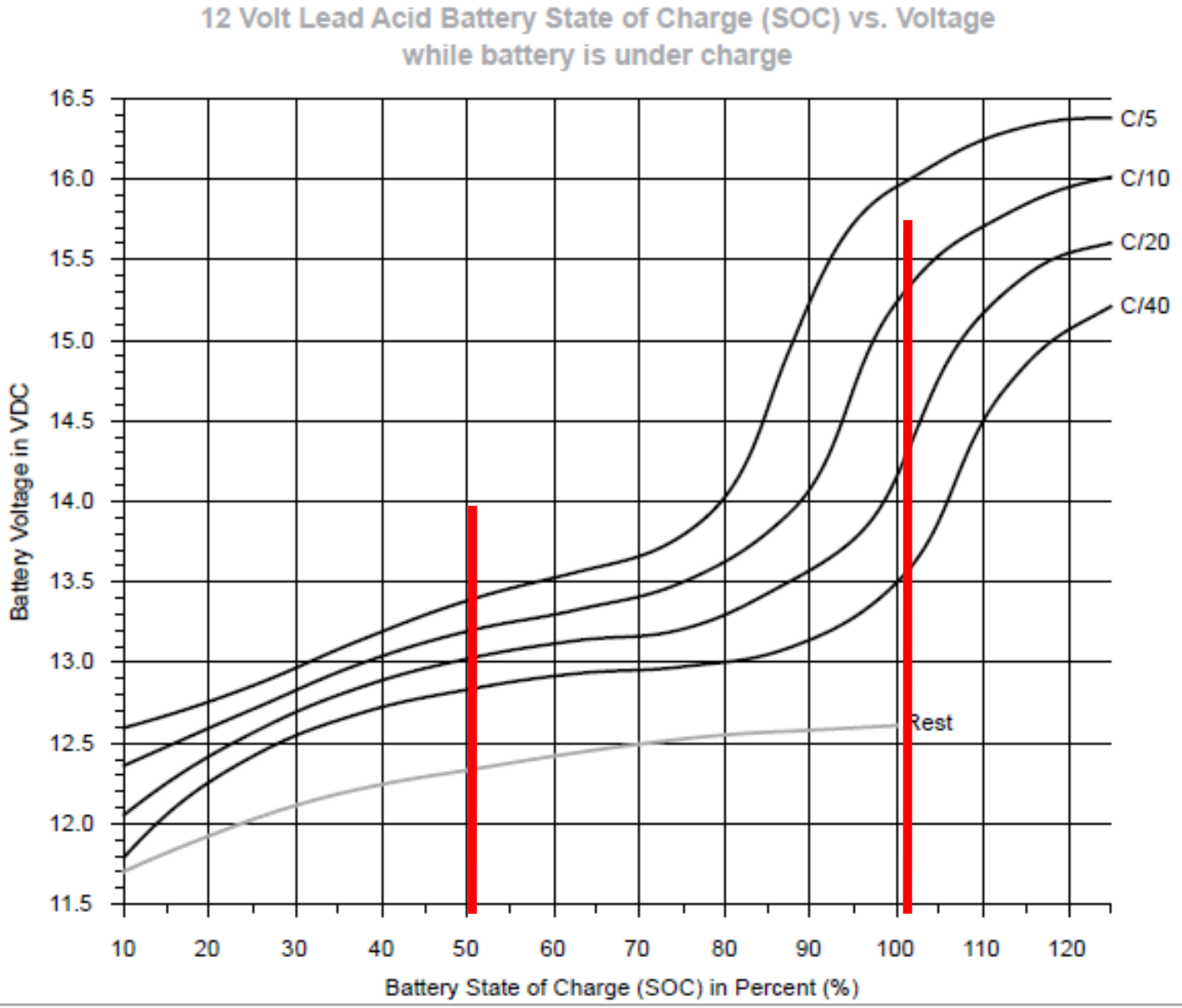
2A

10A

20A

40A

65A



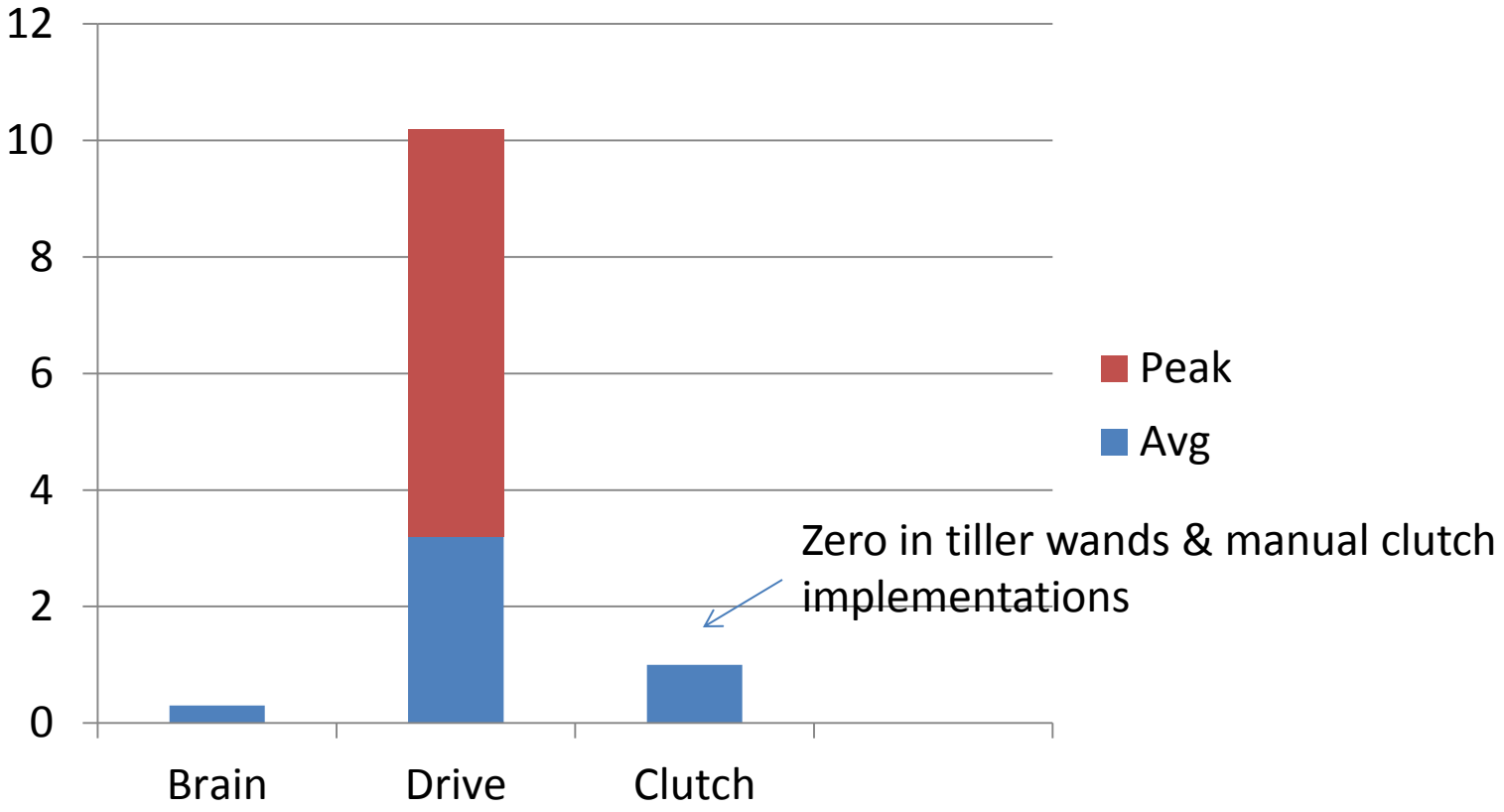
200AH Batt.
40A
20A
10A
5A

AP Power Use

- Helm load and sea state determine the power usage.
- Ignore the vendor's data, you will likely see several times the current stated in rough conditions.
- Worst case on this playing field is the first 300 to 400 miles: big winds, large seas, little sunlight.
- If you are going pure solar you have to size your battery bank to make it to the sunlight.

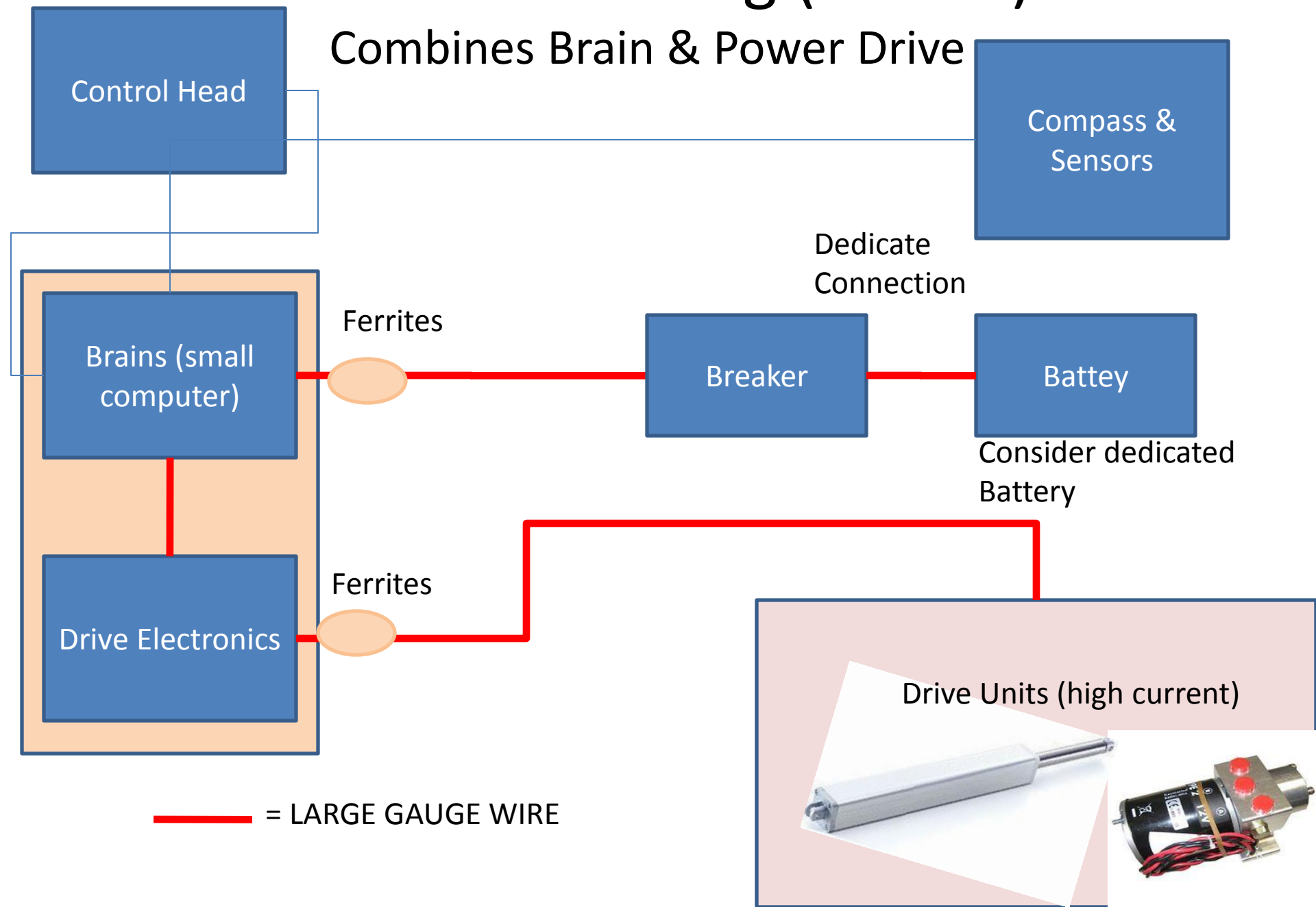
Autopilot Current Breakdown

for a below deck system don't ignore clutch power



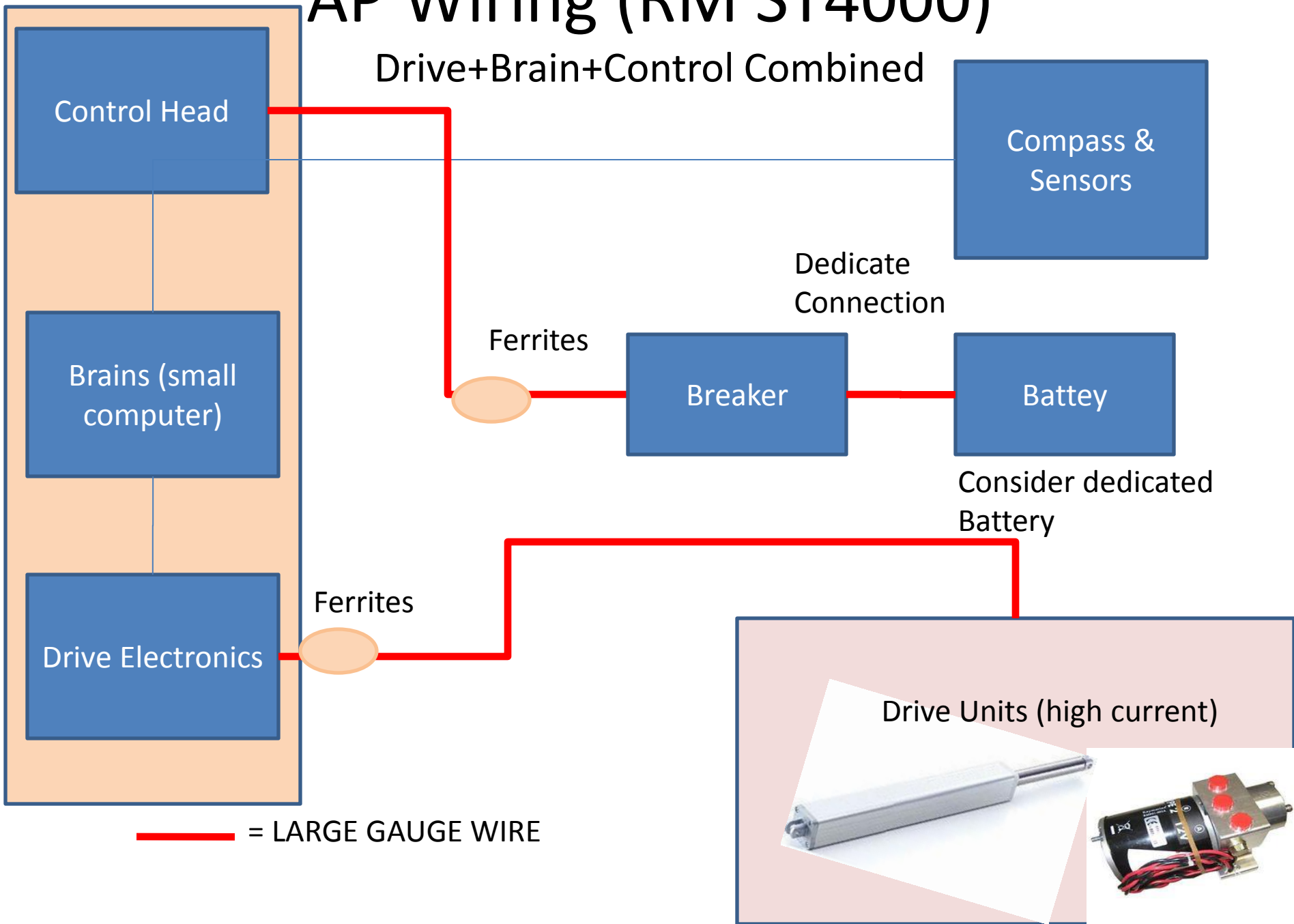
AP Robust Wiring (RM X5)

Combines Brain & Power Drive



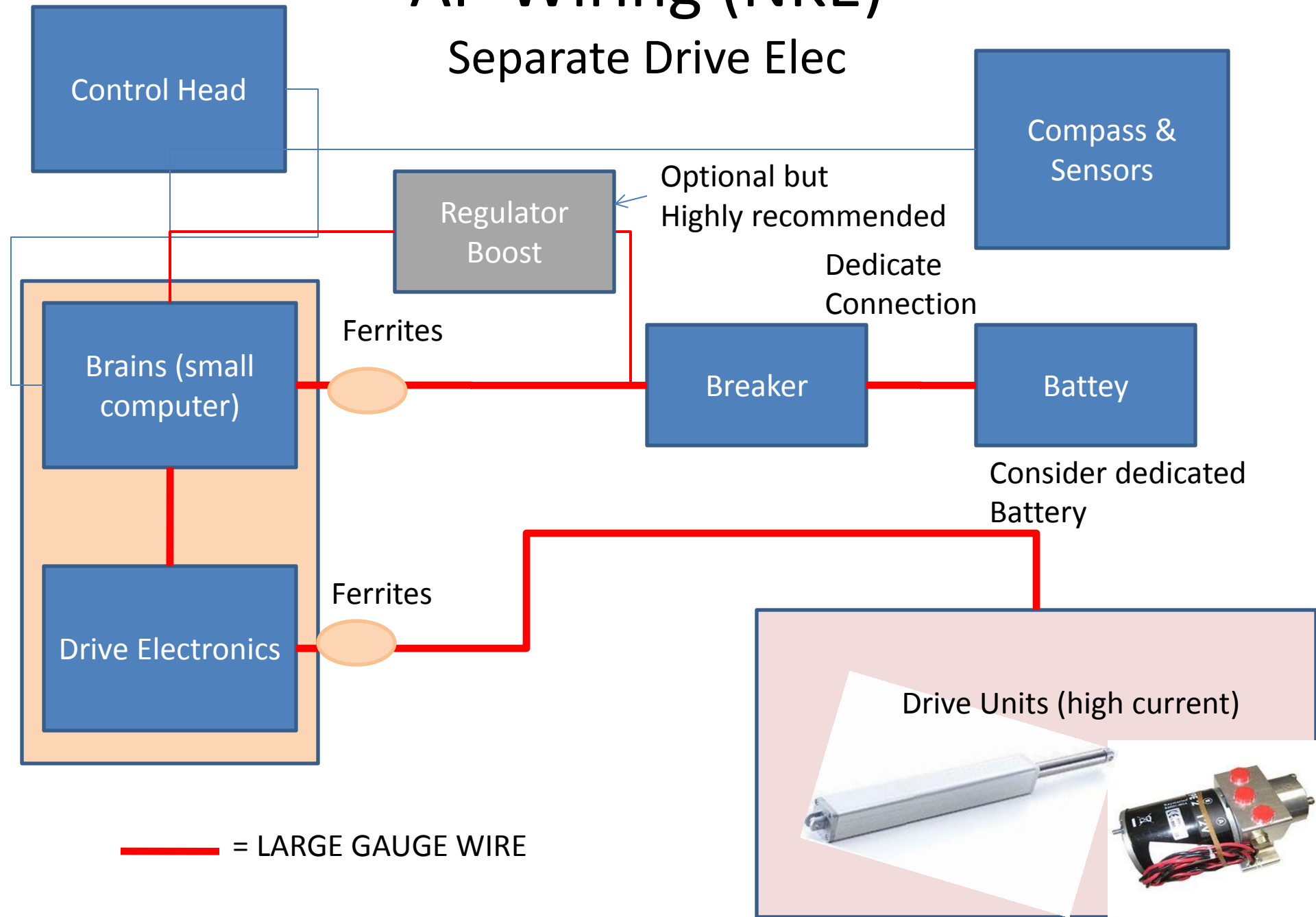
AP Wiring (RM ST4000)

Drive+Brain+Control Combined



AP Wiring (NKE)

Separate Drive Elec



Wire Sizes for AP/SSB Install

	10 amps 10’ run	10 amps 20’ run	20 amps* 10’ run	20 amps* 20’ run	
0.3 Volt Drop	16	14	14	12	Brains Connection **
1.0 Volt Drop	18	16	16	14	Drive Motor connection.

*SSB while transmitting. About 1.5 amps in receive. EMAIL 20Amps at ~50% duty cycle (very high current), voice ~30% duty cycle.
** Assumes Brain box drives motor (Raymarine).
NKE separates' Brain power lines from motor drive power lines, use wire size table for motor drive.
WH has standalone power box (separate wire to Brain), use wire size table for motor drive .