

# Seattle Boat Show 2020: PYS Presentation

## Choosing the Right Battery for your Boat

By Jeff Cote

Pacific Yacht Systems Inc.

design • installation • service • support

# Passion for Boating



- Systems Design Engineer
- Owner/operator of Pacific Yacht Systems
- NMEA & ABYC certifications
- Published monthly columns
  - Pacific Yachting Magazine: Tech Talk
  - Northwest Yachting Magazine: Hot Wire
- Proud Owner: 36' Sailboat
- Favorite BC cruising grounds are Barkley Sound and the Broughton Archipelago



# About Pacific Yacht Systems Inc.



- Specialize in marine electrical and electronics
- Servicing the British Columbia and Western Canada
- Worldwide electrical design / consultation
- 2018 Recap:
  - Completed over 1000 boat projects
  - Designed / consulted on over 200 electrical projects
- Over 150 “How To” PYS Videos on YouTube
- [www.pysystems.ca](http://www.pysystems.ca) for schematics, design info, published articles, etc...

# Marine Batteries



Created by Jeff Cote of Pacific Yacht  
Systems Inc. [www.pysystems.ca](http://www.pysystems.ca)

# Engine Batteries (AKA cranking battery)



- Used to start the engine
  - E.g. thruster
- Designed to deliver high current for short period of time
- Should be immediately recharged by engine alternator
  - NOT designed to be left uncharged for long periods
  - NOT designed for deep discharge
- Capacity measured in Cranking Amps or Cold Cranking Amps



# Example: 8D Engine Flooded LA Battery



- Notice: Fill Caps

# Deep Cycle Batteries



- Used to supply power to devices on boat
- Designed for deep discharge over longer time
- Capacity measured in Amp Hours (Ahr)



# Lead Acid Battery Choices

## Two Types



- Flooded Lead Acid
  - Starter
  - Deep-Cycle
  - Dual Purpose
- Sealed Valve Regulated Lead Acid
  - Gel
  - AGM (Absorbed Glass Mat)
  - Carbon Foam AGM (i.e. Firefly)



# Flooded Lead Acid Batteries



- Flooded lead acid purchase cost (\$)
  - If properly maintained
- Liquid acid electrolyte
- Must use watertight battery box to contain any spilled battery acid
- Maintenance - top up with distilled water only
- Self-discharge of about 15% per month
- Practical available battery capacity about 35%
  - Bulk range: 85% to 50%
  - Example: 600 AHr battery capacity for 200 AHr useable capacity

# L16 Flooded Lead Acid



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# AGM Batteries



- AGM purchase cost (\$\$)
- Electrolyte is in Absorbed Glass Mat (AGM)
- Sealed Valve Regulated: Limited gassing
- No maintenance required
- Self-discharge of about 2% per month
- Practical available battery capacity about 55%
  - Bulk range: 85% to 30%
  - Example: 400 AHr battery capacity for 200 AHr useable capacity



# Example

## 16 X L16 AGM



# Firefly Oasis Batteries



- Carbon foam AGM purchase cost (\$\$\$)
- All benefits of AGM
  - Leak-proof, limited gassing, maintenance-free, faster recharge acceptance rate, limited self-discharge
- **Battery Life: 12/16 Times of Flooded**
  - (FF 3600/4700 cycles versus FLA 300 cycles at 50% DOD)
- **No premature aging at partial state of discharge**
- 2 Sizes: Group 31 and L15+
- Practical available battery capacity about 65%
  - Bulk range: 85% to 20%
  - Example: 300 AHr battery capacity for 200 AHr useable capacity

# Firefly Oasis Gr31 & L15+



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# Example: Firefly Oasis Group 31



# LiFePO4 Batteries



- LiFePO4 purchase cost (10 X FLA)
- Benefits
  - maintenance-free, fastest recharge acceptance rate, limited self-discharge
- **Battery Life: 12 Times of Flooded**
  - **(LiFePO4 3000 - 5000 cycles versus FLA 300 cycles at 50% DOD)**
- Large selection of battery sizes and voltages
- Holds steady voltage while discharged
- Practical available battery capacity about 80%
  - Bulk range: 100% to 20%
  - Example: 300 AHr battery capacity for 240 AHr useable capacity
- Highest energy density
  - Space & weight

# Calculate Your Power Needs



- What is your daily power need?
  - Varies depending on the season, examples:
    - Cabin lights are turned on earlier in winter
    - Heating in the shoulder and winter season
- Largest DC loads
  - Refrigeration is the largest draw: 50 – 125 Amp-Hour per day
  - Inverter powering AC loads
  - DC loads from running diesel heater (especially hydronic)



# Typical Daily Battery Usage



Typical daily AHr budgets	AHr
Beneteau 33	85
Catalina 36	120
Suncruiser 38	225
Grand Banks 42	175
Ocean Alexander 48	375
Meridian 580	500

# Firefly L15+ Example



# Sizing Battery Capacity



- Criteria to choose your battery bank
  - Daily Amp-Hour (AHr) budget
  - Estimated time between charging? How often do you charge your batteries?
    - Every ½ day
    - Every 2 days



# Useable Battery Capacity



- At a minimum, **useable** battery capacity needs to be
  - Daily AHr budget X Estimated time between charging
  - Example: 200 AHrs X 2 days = 400 AHrs of useable battery capacity

# Recap:

## Lead Acid Battery Floor



### **BATTTERY “FLOOR”**

- To balance battery cost and life, you should never deplete your lead acid batteries below the following capacity:
  - Flooded: 50%
  - AGM/GEL: 30%
  - Firefly AGM 20%
  - LiFePO4 20%

# Recap: Lead Acid Battery Ceiling



## BATTERY “CEILING”

- Due to **lead acid battery** chemistry, charging above 85% of capacity (absorption stage) is time-consuming
- **LiFePO4** almost 100%



# Recap: Lead Acid Battery Capacity



## USEABLE BATTERY CAPACITY

- Therefore: while cruising effective useable battery capacity is:
  - Flooded: 35% (50% to 85%)
  - AGM/GEL: 55% (30% to 85%)
  - Firefly AGM 65% (20% to 85%)
  - LiFePO4 80% (20% to 100%)

# AGM vs Firefly vs Flooded Summary



	AGM	Firefly AGM	Flooded
Initial Cost	\$\$	\$\$\$	\$
Battery Life	1X	<b>4X</b>	1X
Useable capacity	55%	<b>65%</b>	35%
Maintenance	None	None	Regular top-off
Self-discharge	2% per month	2% per month	15% per month
Purpose	Dual	Dual	Single
Sulfation	Yes	No	Yes

# Sizing your Battery Bank



- Depending on your choice of lead acid battery, you will require the following:

Type	Useable battery capacity
Flooded	3 Times
AGM/Gel	2 Times
Firefly AGM	1.5 Times
LiFePO4	1.25 Times



# Sizing your Battery Bank Examples



- Examples, if you need 200 AHr of useable battery capacity, you will require:
  - Flooded: 600 AHr
  - AGM/GEL: 400 AHr
  - Firefly AGM: 300 Ahr
  - LiFePO4: 250 Ahr

# Battery Sizes and Types



- Batteries come in all sizes
  - Group 24, Group 27, Group 31
  - 4D, 8D
  - Golf Carts
  - Slimline
  - L16
- All battery sizes come in different lead acid types:
  - Flooded , AGM, Firefly AGM, Gel
- Flooded batteries are built specifically for a purpose
  - Starter
  - Deep cycle
  - Dual purpose



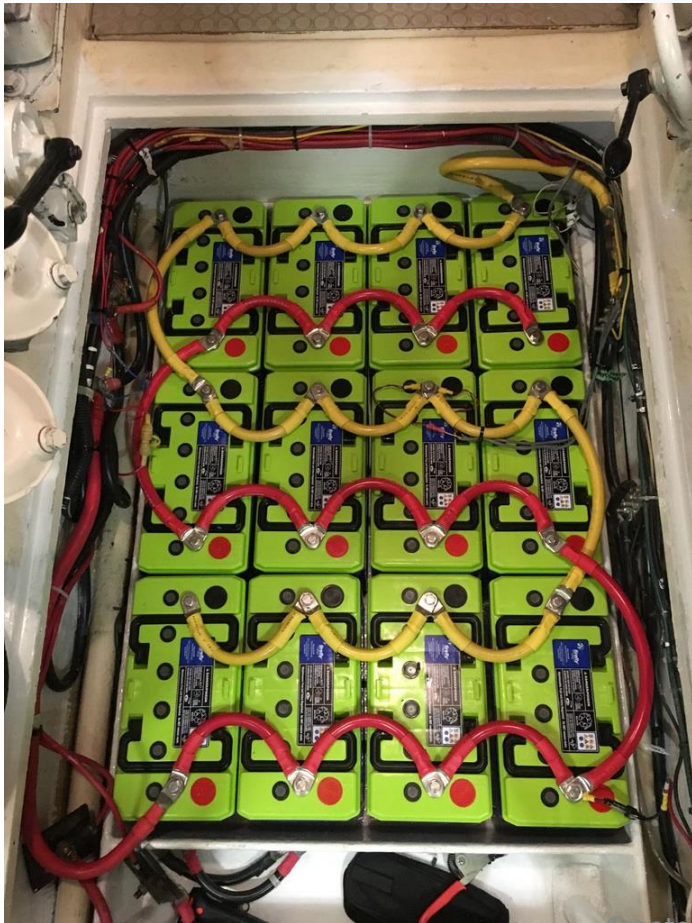
# Ideal Charge Rate for Batteries



- Importance of sizing minimum charge rate to battery size
  - **Minimum: ~ 10% of capacity**
- Reduce your charging time by increasing your charge rate
  - **Maximum: ~ 25% of capacity (AGM/Gel: ~ 40%)**
  - How often to you want to run genset/engine per day?



# Battery Install Firefly Examples



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# Battery Install Secured & Contained



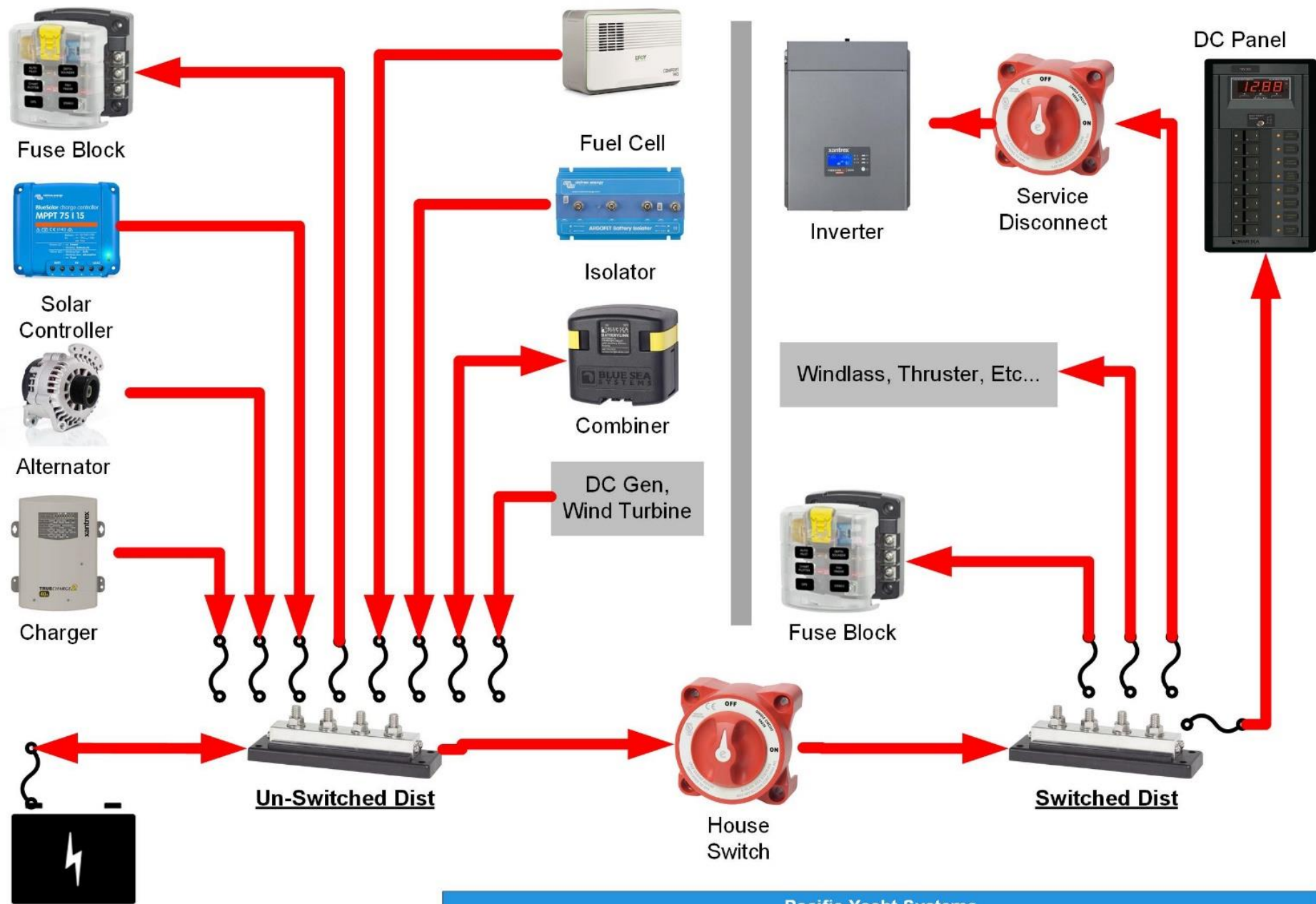
# Different Charge Methods



- Ways to create power
  - Charger(s)
  - Alternator(s)
  - Methanol Fuel Cell
  - Solar
  - DC Genset
  - Wind Turbine







# Smart Battery Charger



- Charges batteries from AC shore-power
- **Reduce** the charge time
- Choose the right charge curve
  - Flooded, AGM, Gel, Custom
- Three-phase smart charge cycle:
  - Bulk, Absorption, Float
- Right rate of charge for extended battery life
  - Minimize sulfation



# Old vs New Chargers



- Ferroresonant vs Smart Charger

	Ferroresonant	Smart Charger
Rate of charge	Half rated output	Full rated output
Charge curve	Simple	3 stage
Overcharging	Yes - Trickle	No - Float
Battery type settings	Flooded	Flooded, AGM, Gel
Temperature - compensated	No	Yes
Looks	Ugly	Pretty
Weight	Heavy	Light

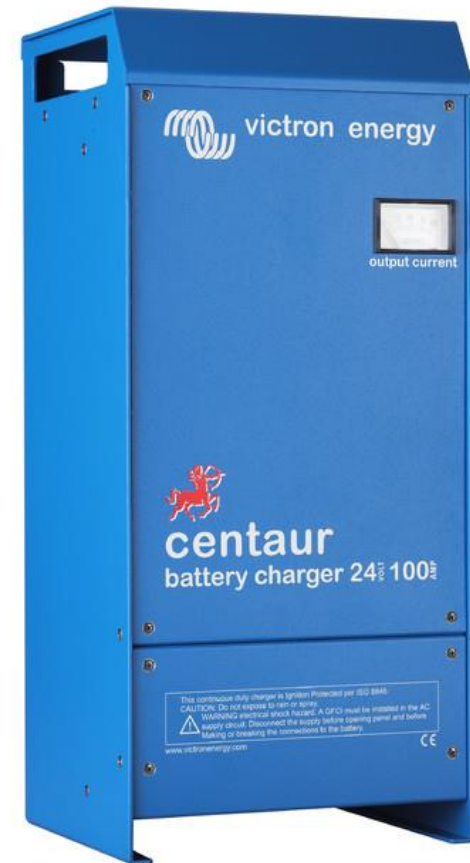


# Smart Charger

## Application - Multiple Units



- Reduce genset runtime by adding 2<sup>nd</sup> or 3<sup>rd</sup> charger in parallel
  - E.g. 1 hour morning and evening
- Charge at the right rate
- Min and Max Charge Rate
  - Flooded: 10% to 25%
  - AGM: 10% to 40%





Questions?

# Connect with PYS



- PYS Electrical Orientation for your boat
  - 90 mins: Batteries, DC distribution, charger, alternator, inverter
- PYS Design Services for DIYers
  - Electrical system designed by PYS (collaborative and to marine code)
  - Installed by yourself or other outfit
- Pacific Yachting magazine - Monthly Tech Talk Column
- Northwest Yachting – Monthly Hot Wire Column
- YouTube – 500K Views
- [www.pysystems.ca](http://www.pysystems.ca) 1000s of articles
- Monthly email newsletter



# Feedback



- Fill out brief Seattle Boat Show survey:  
[www.seattleboatshow.com/seminarsurvey](http://www.seattleboatshow.com/seminarsurvey)





# Pacific Yacht Systems

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