



THE GLOSTEN ASSOCIATES  
*Consulting Engineers Serving the Marine Community*

# Regional Class Research Vessel (RCRV) Green Ship Design Alternatives

Presented by:

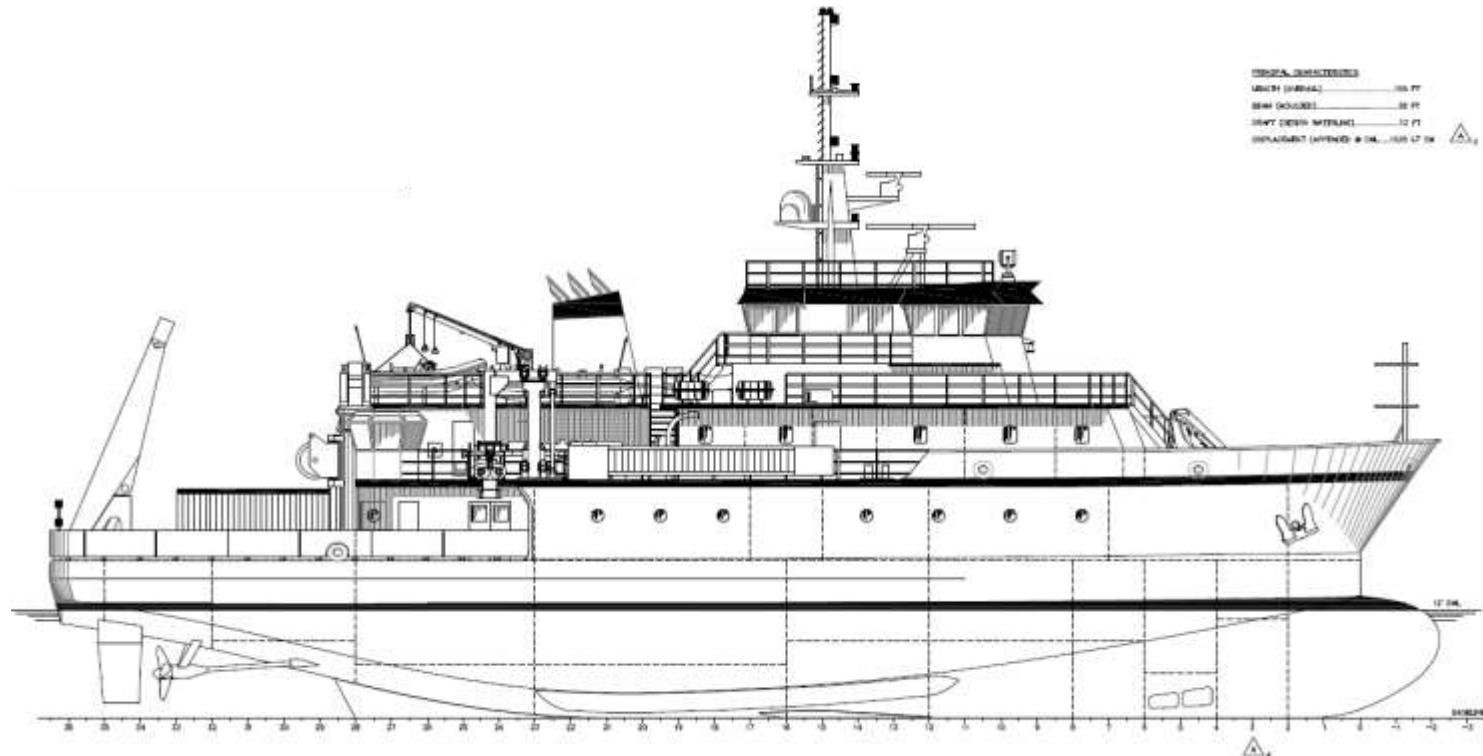
Tim Leach, PE The GLOSTEN ASSOCIATES



# Regional Class Research Vessel History and Status

## RCRV Brief History

- Design competition in 2006 for ONR
  - Set of science missions requirements
  - Design build approach
  - 155' LOA limit
  - Project canceled at end of competition (2008)





# Regional Class Research Vessel History and Status

## RCRV Brief History

- 2012 – NSF Selected an institution to develop design
  - Competitive bid
  - OSU selected
- Currently in Preliminary Design phase

### Vessel Particulars

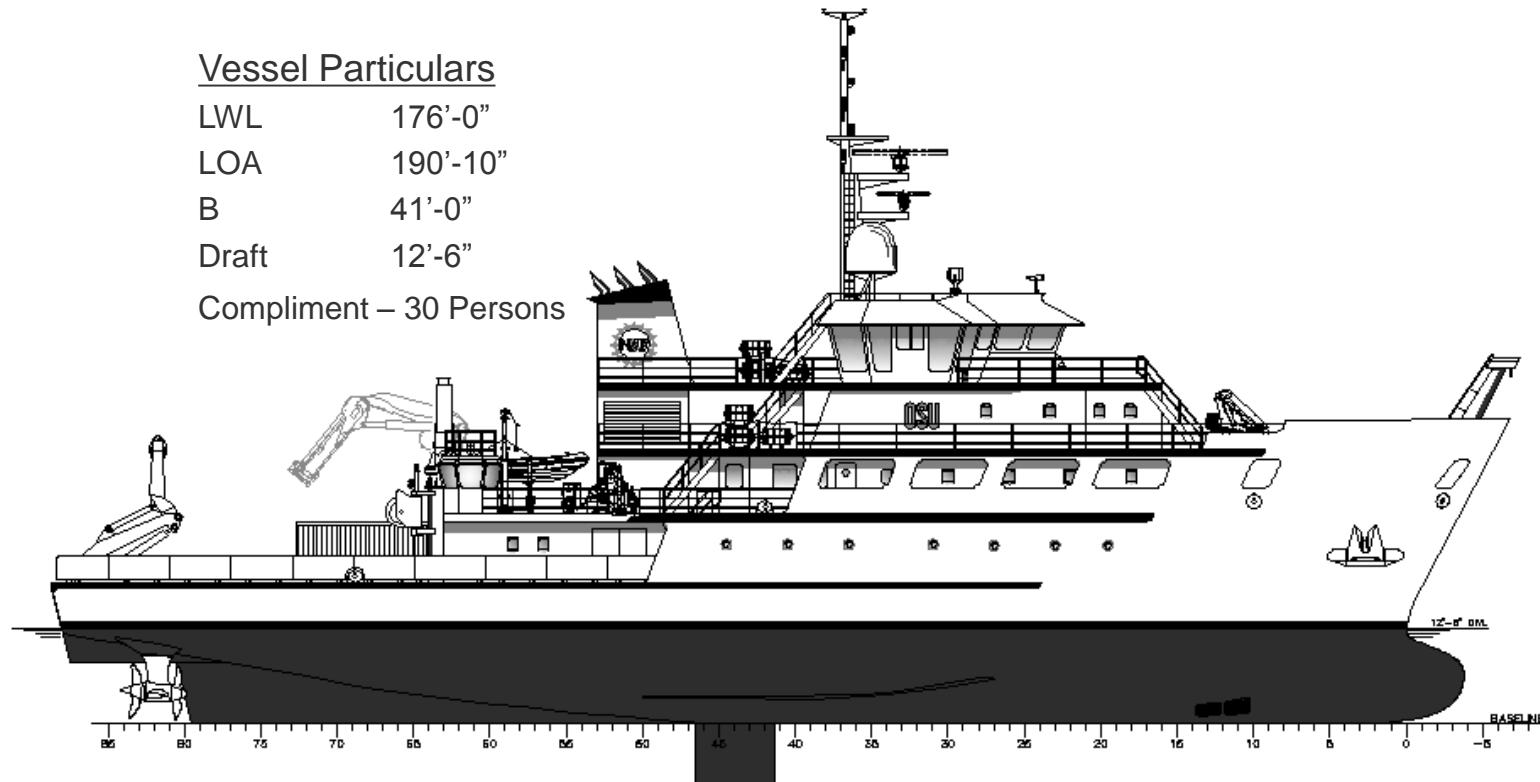
LWL 176'-0"

LOA 190'-10"

B 41'-0"

Draft 12'-6"

Compliment – 30 Persons





# Regional Class Research Vessel Green Design Process

## Areas Considered

- Hull
- Power Generation / Propulsion
- Auxiliary Systems
- Pollution Control
- Outfitting





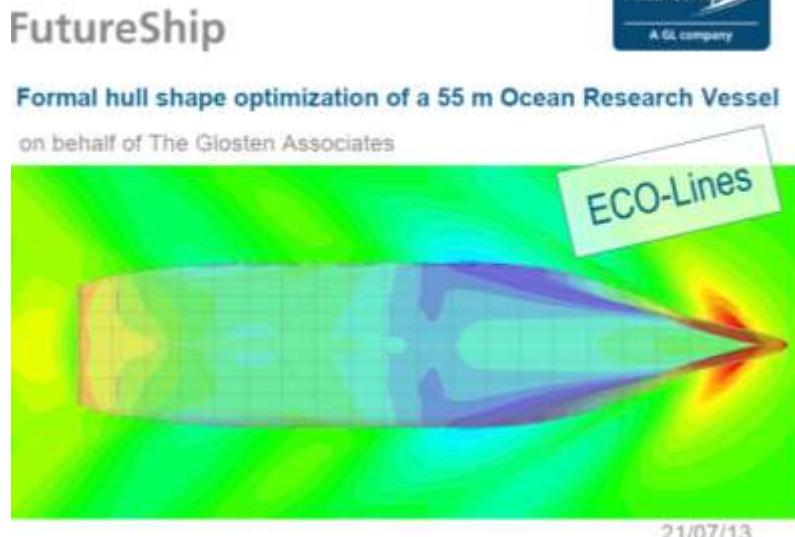
# Regional Class Research Vessel Green Design Process - Hull

## Green Ship Alternatives – Recommended for RCRV

Item	Recommendation	Benefit/Rationale
<strong>Hull</strong>		
Hull Optimization	Incorporated	Reduction in resistance
Hull Coatings	Recommend hard coating	

**FutureShip**

Formal hull shape optimization of a 55 m Ocean Research Vessel  
on behalf of The Glosten Associates



FutureShip  
A GL company

Formal hull shape optimization of a 55 m Ocean Research Vessel  
on behalf of The Glosten Associates

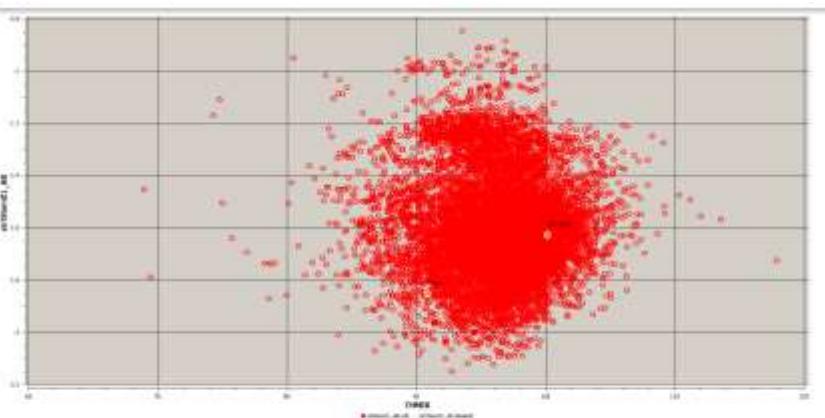
ECO-Lines

21/07/13



# Regional Class Research Vessel Green Design Process - Hull

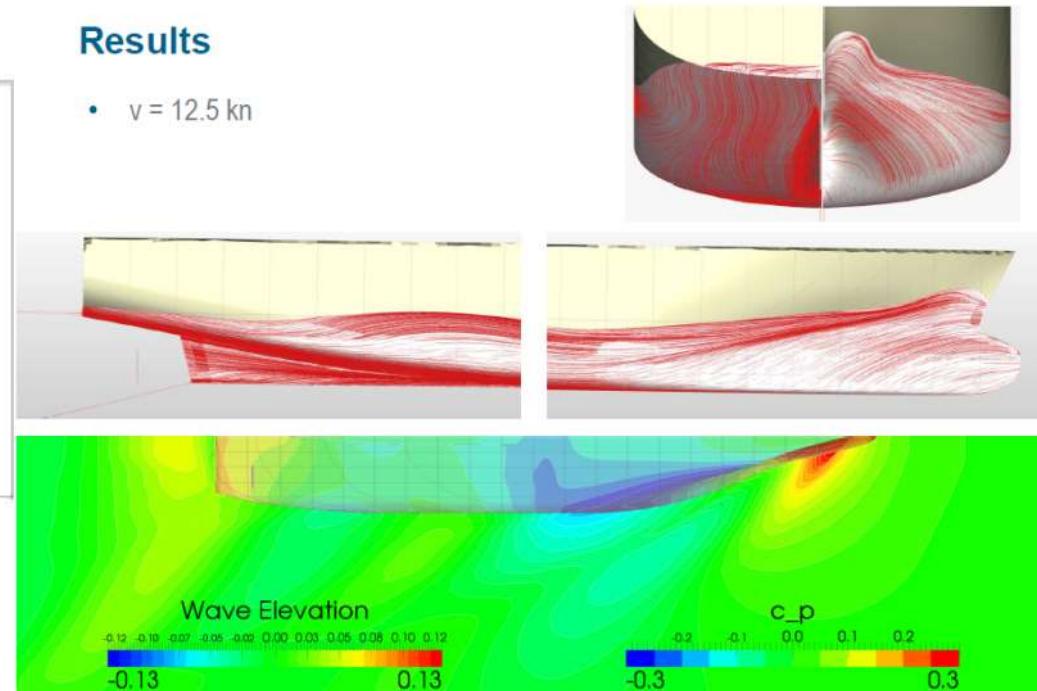
Item	Recommendation	Benefit/Rationale
<b>Hull</b>		
<b>Hull Optimization</b>	Incorporated	15% reduction in resistance at cruise speed



- weighted thrust (THMIX) vs. distance of most critical transducer stream line to water line at bow region (UpperStrlHeight) AB (12.5 kn)

### Results

- $v = 12.5 \text{ kn}$





# Regional Class Research Vessel Green Design Process - Hull

Item	Recommendation	Benefit/Rationale
<b>Hull</b>		
<b>Hull Coating</b>	Recommend hard coating with frequent in water cleaning	No biocide toxin release

**Speed Power Prediction**

Installed Propulsion Motor Power 650kW per Shaft

Ship Speed (knots)	Installed Power (kW)	Transit Condition (kW)	50% Fouled (kW)
2	650	0	0
4	650	130	130
6	650	260	260
7	650	390	120
8	650	520	180
9	650	650	250
10	650	780	320
11	650	910	420
12	650	1040	520
13	650	1170	630

Motor Power per Shaft kW

Ship Speed knots

— Installed Power  
- - - Transit Condition  
- ■ - 50% Fouled



# Regional Class Research Vessel Green Design Process – Power / Propulsion

## Green Ship Alternatives – Recommended for RCRV

Item	Recommendation	Benefit/Rationale
<b>Power Generation / Propulsion</b>		
Variable Speed Generators	Incorporated	Estimated 5-15% reduction in fuel consumption
Permanent Magnet	Recommended	Increased motor efficiency
Wake Adapted Propellers	Recommended	Increased propeller efficiency, decreased underwater radiated noise

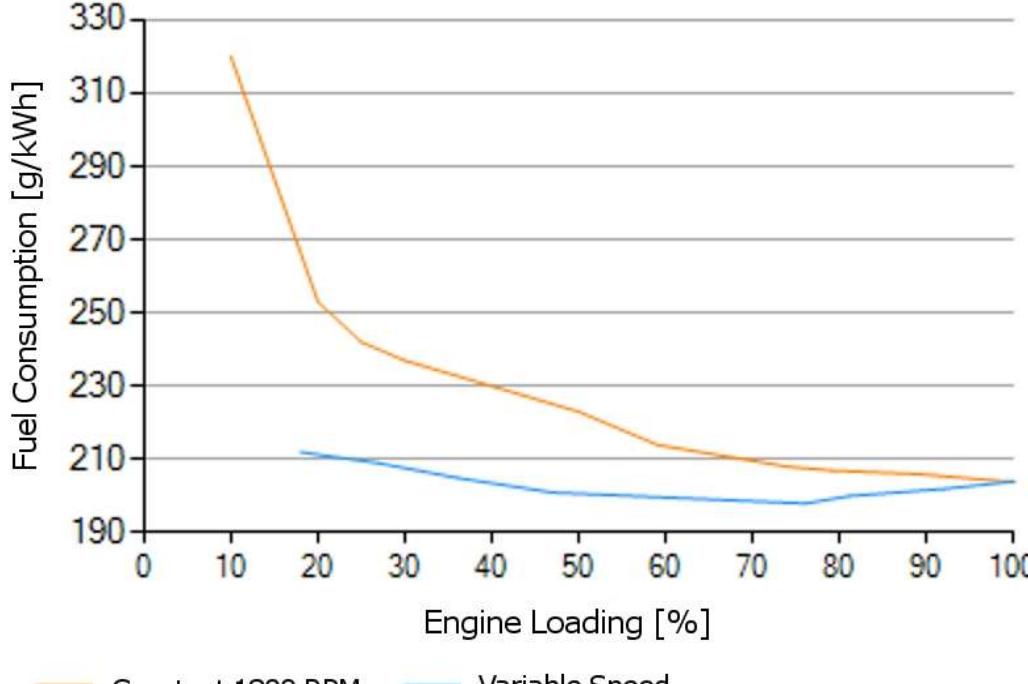


# Regional Class Research Vessel

## Green Design Process – Power / Propulsion

Item	Recommendation	Benefit/Rationale
<b>Power Generation / Propulsion</b>		
<b>Variable Speed Generators</b>	Incorporated	Estimated 5-15% reduction in fuel consumption

CAT 3512C



The graph illustrates Fuel Consumption [g/kWh] on the Y-axis (ranging from 190 to 330) versus Engine Loading [%] on the X-axis (ranging from 0 to 100). Two curves are shown: a blue line for Variable Speed and an orange line for Constant 1800 RPM. The Variable Speed curve shows significantly lower fuel consumption than the Constant RPM curve across all engine loadings.

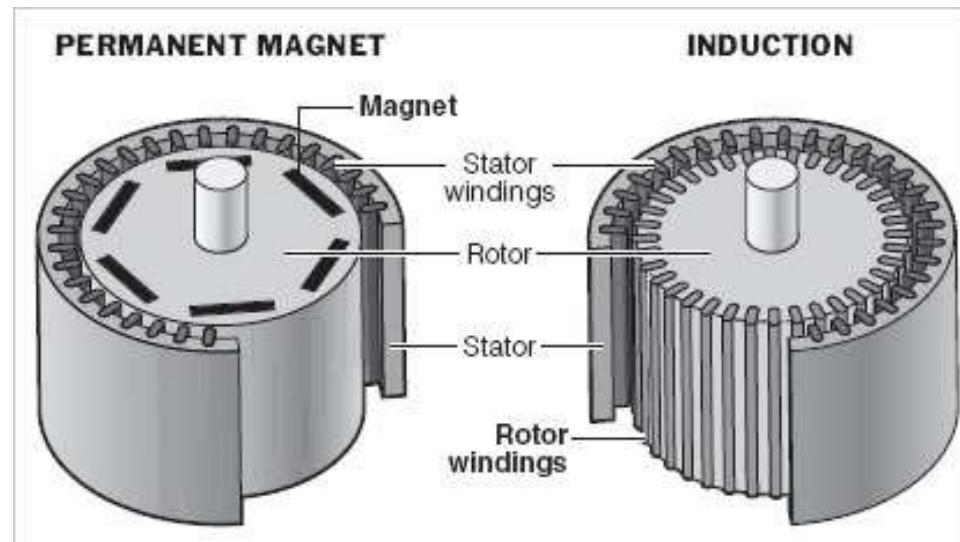
Engine Loading [%]	Constant 1800 RPM [g/kWh]	Variable Speed [g/kWh]
10	320	210
20	255	210
30	235	205
40	225	200
50	215	198
60	210	195
70	205	195
80	200	195
90	198	198
100	198	198



# Regional Class Research Vessel

## Green Design Process – Power / Propulsion

Item	Recommendation	Benefit/Rationale
<b>Power Generation / Propulsion</b>		
<b>Permanent Magnet Motors and Alternators</b>	Recommended	Increased motor efficiency





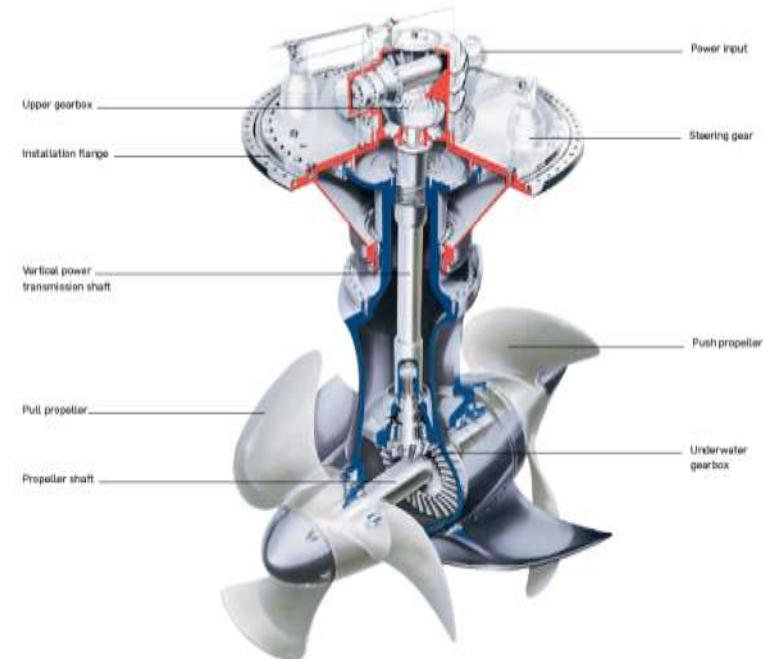
# Regional Class Research Vessel

## Green Design Process – Power / Propulsion

Item	Recommendation	Benefit/Rationale
<b>Power Generation / Propulsion</b>		
<b>Wake Adapted Propellers</b>	Recommended	Increased propeller efficiency, decreased underwater radiated noise

RELATIVE VELOCITY DISTRIBUTION IN PROPELLER PLANE  
AXIAL AND TRANSVERSAL COMPONENTS

Model No. M079 Tag No. 17680  
 $T_p=383.0$  mm  $T_a=382.0$  mm  $V_M=2.038$  m/s  $R_p=95.5$  mm



Schottel Twin Propeller



# Regional Class Research Vessel

## Green Design Process – Power / Propulsion

### Green Ship Alternatives – Not Recommended for RCRV

Item	Recommendation	Benefit/Rationale
<b>Power Generation / Propulsion</b>		
Battery Hybrid	Not Recommended	Minimal benefit with variable speed generators. Adds cost & weight.
Alternative fuels, LNG	Not recommended	Integration of LNG system incompatible with vessel design
Alternative fuels, Biodiesel	Not recommended	Biodiesel up to B20 may be possible, minimal design impact more significant fuel planning impact.

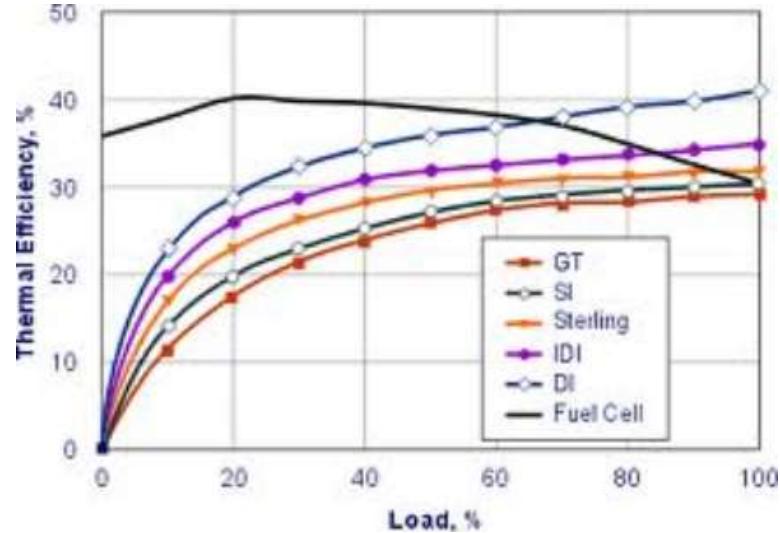
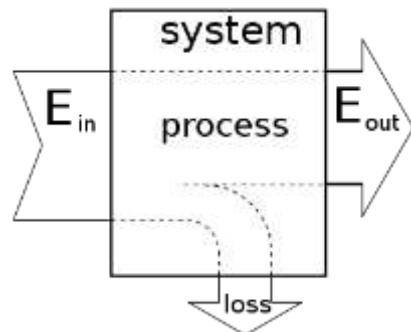


# Regional Class Research Vessel

## Green Design Process – Auxiliary Systems

### Green Ship Alternatives – Recommended for RCRV

Item	Recommendation	Benefit/Rationale
<b>Auxiliary Systems</b>		
Waste heat recovery	Incorporated	Provides heat for HVAC, water makers, and domestic hot water. ~350 kW electrical savings
Climate Control – Waste heat heating	Incorporated	Can replace electric heat for large heaters, 70+ kW electrical savings





# Regional Class Research Vessel

## Green Design Process – Auxiliary Systems

### Green Ship Alternatives – Recommended for RCRV

Item	Recommendation	Benefit/Rationale
<b>Auxiliary Systems</b>		
VFD pumps and fans	Consider further during PDR	Electrical savings, possible noise attenuation concern
Premium efficiency motors	Recommend (where appropriate)	3-10% electrical Savings for each motor
LED Lighting	Consider further during PDR	Lower energy use, higher upfront cost

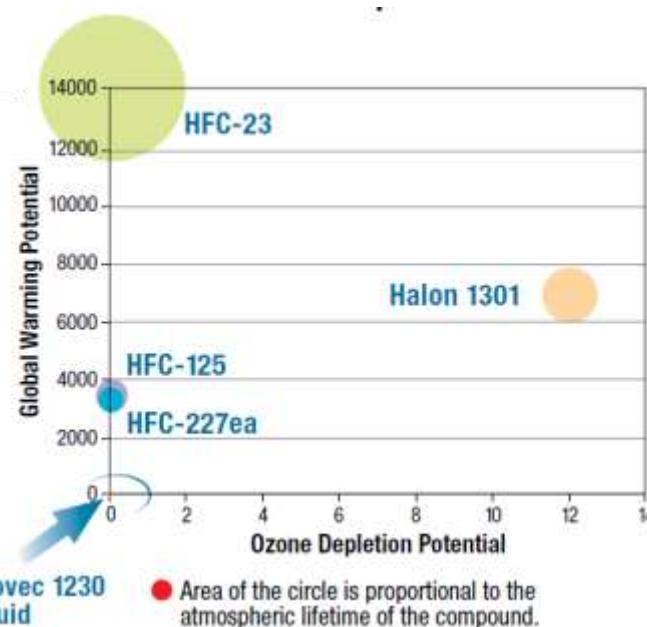




# Regional Class Research Vessel Green Design Process

## Green Ship Alternatives – Recommended for RCRV

Item	Recommendation	Benefit/Rationale
<strong>Auxiliary Systems</strong>		
Novec 1230 fire suppression	Incorporated	Minimum application of greenhouse gas
Non-ozone depleting refrigerants	Incorporated	Minimize environmental damage





# Regional Class Research Vessel

## Green Design Process – Auxiliary Systems

### Green Ship Alternatives – Not Recommended for RCRV

Item	Recommendation	Benefit/Rationale
<b>Auxiliary Systems</b>		
Climate Control – Heat pump	Not recommended	Less efficient than waste heat heating, equivalent to chiller A/C
Solar system	Not recommended	Minimal benefit with available installation area



# Regional Class Research Vessel Green Design Process – Pollution Control

## Green Ship Alternatives – Recommended for RCRV

Item	Recommendation	Benefit/Rationale
<b>Pollution Control</b>		
Biologic MSD	Incorporated	Clean effluent
5 PPM OWS	Incorporated	Minimize oil discharge
Fuel overflow system	Incorporated	Minimize risk of accidental fuel oil discharge
Environmentally acceptable lubricants	Recommended	Minimize impact of accidental oil discharge

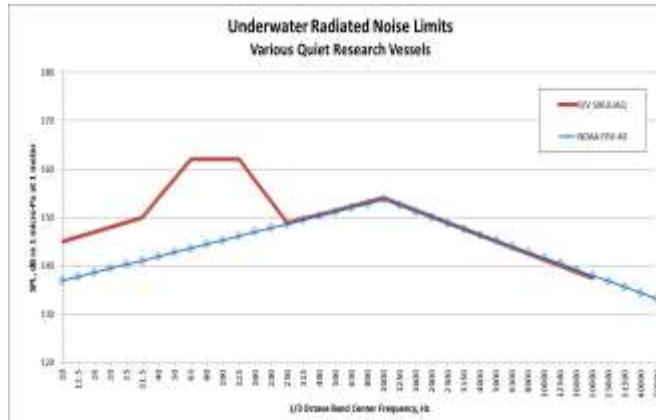




# Regional Class Research Vessel Green Design Process – Pollution Control

## Green Ship Alternatives – Recommended for RCRV

Item	Recommendation	Benefit/Rationale
<b>Pollution Control</b>		
Minimize underwater radiated noise	Incorporated	Minimize noise pollution
Ballast water treatment system	Incorporated	Required, reduces spread of invasive species
EPA Tier 4 engines	Incorporated	Reduce engine air emissions
Solid waste storage	Incorporated	No incinerator air emissions





# Regional Class Research Vessel Green Design Process

Great ship!

Good efforts to reduce impact in design!

- How does this get calculated?
- How do we compare to other ships?
- How does this get recognized?

