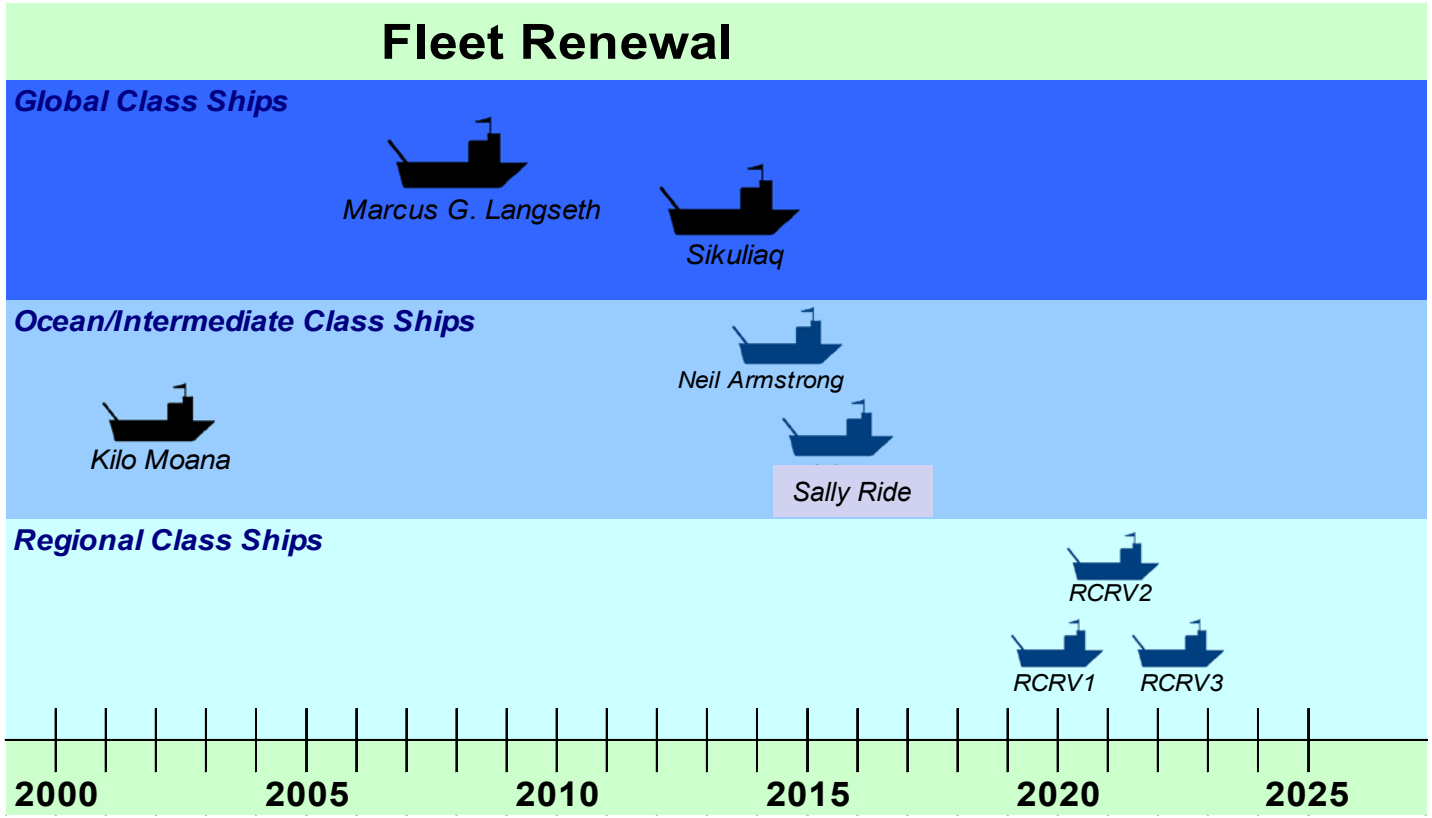
Regional Class Research Vessels

Innovations in Research Vessel Design

RCRV Project Update

November 18, 2014

INMARTECH



Academic Fleet Renewal is part of long-term UNOLS community planning

New Portraits in the UNOLS Fleet

R/V Sikuliaq

R/V Neil Armstrong

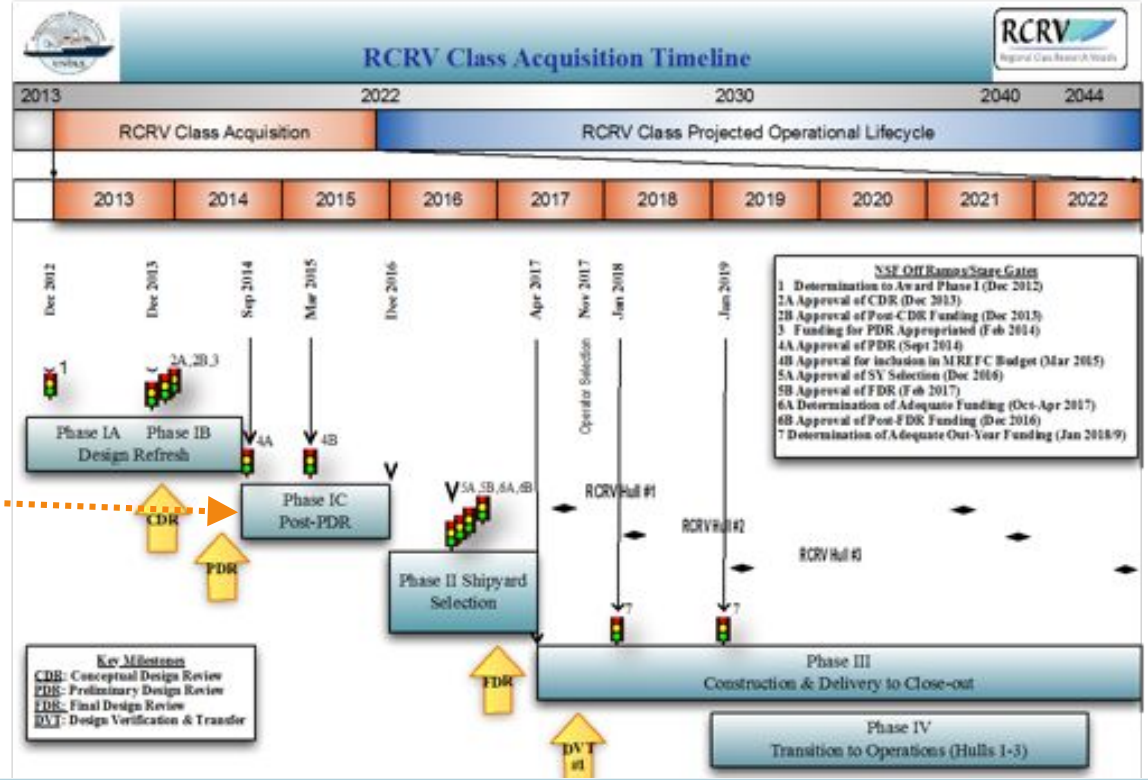
RCRVs will facilitate **coastal research and education**, serving many stakeholders.
Design and project management benefiting from lessons these builds.

RCRV Project Status and Timeline

- 4 phase, 10-yr project
  - **Phase I = Design Refresh**
  - **Phase II = Shipyard Selection**
  - **Phase III = Construction**
  - **Phase IV = Transition to Ops**

- Up-to-3 ship class acquisition
  - Leads to overlap of Phases III and IV

- Currently at start of Phase IC
- PDR approved by NSF

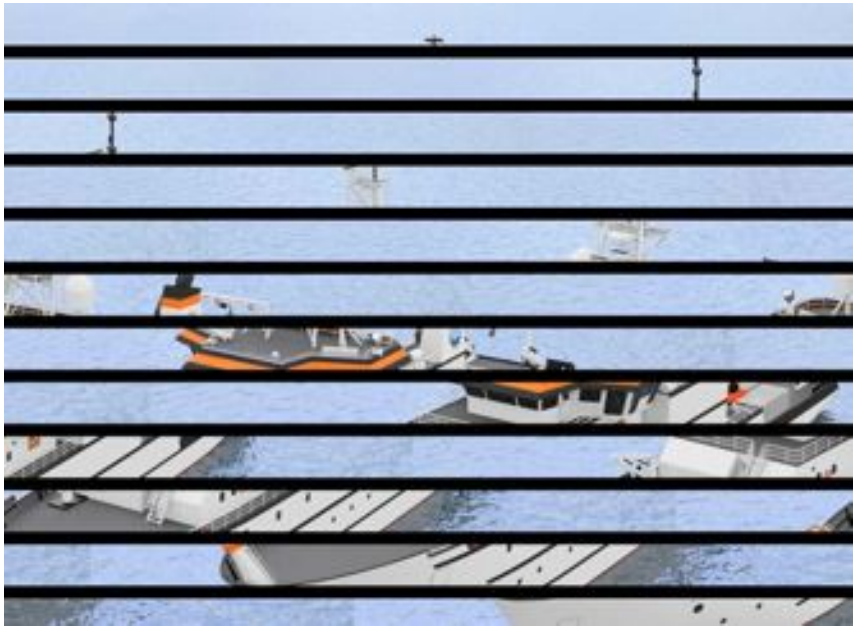


Vessel Description

Top Level Design Requirements

- Twin azimuthing drives and dynamic positioning
- A retractable centerboard to support integrated acoustic systems
- Large aft deck for operational flexibility and side-by-side 20' laboratory vans
- High bandwidth satellite telecommunications
- Acoustic quietness
- Energy efficient features
- ADA referenced accessible stateroom and labs
- Endurance- 21 days
- Mission Payload 50 long tons

NSF-owned UNOLS RCRV



Other Design Drivers determined during refresh

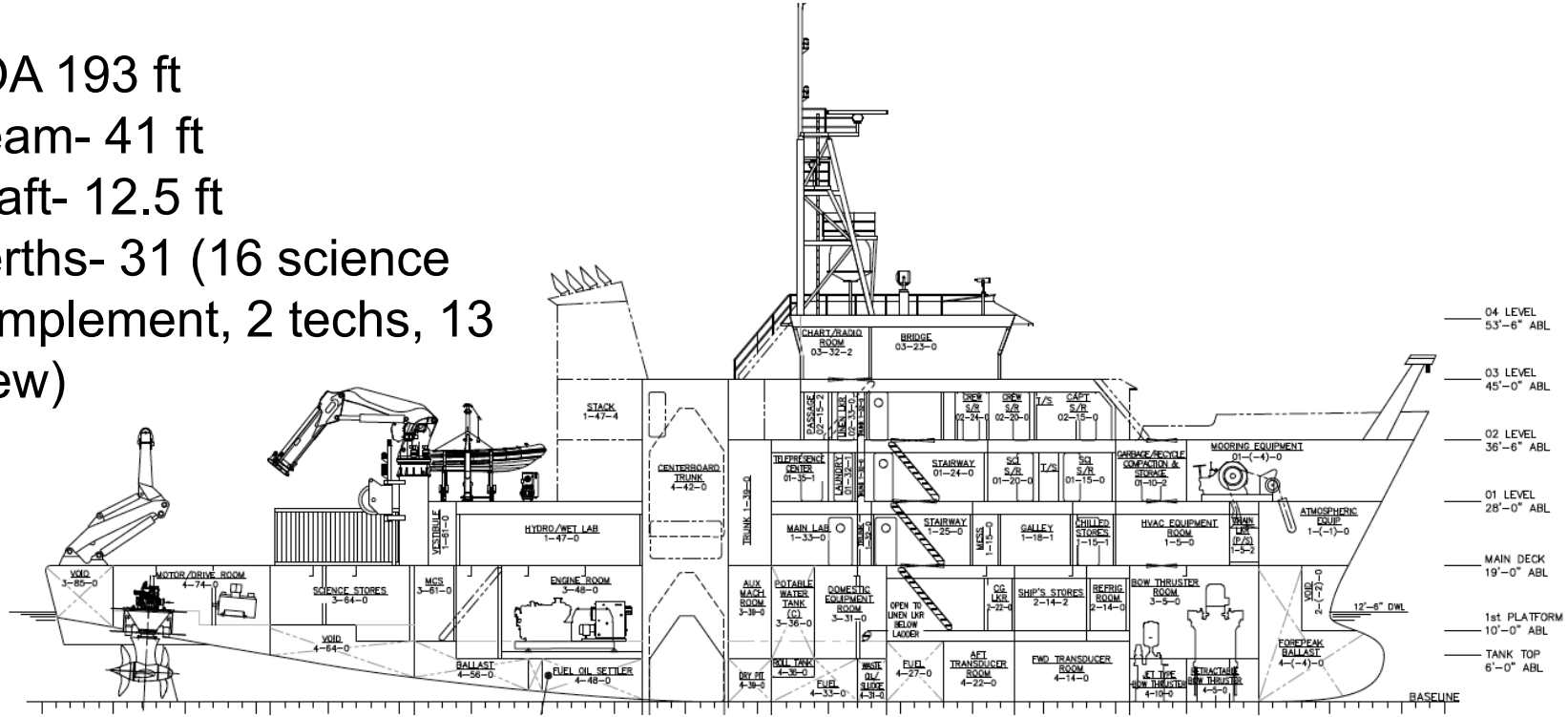
- ABS Ice Class: C0
- ABS DP Class: DPS-1
- Voluntary Enviro Certified: Green Marine & IAPH Environmental Ship Index (air emissions and other standards)
- Sea-keeping: U-tube anti-roll system

Noteworthy RCRV Innovations (evolutions…)

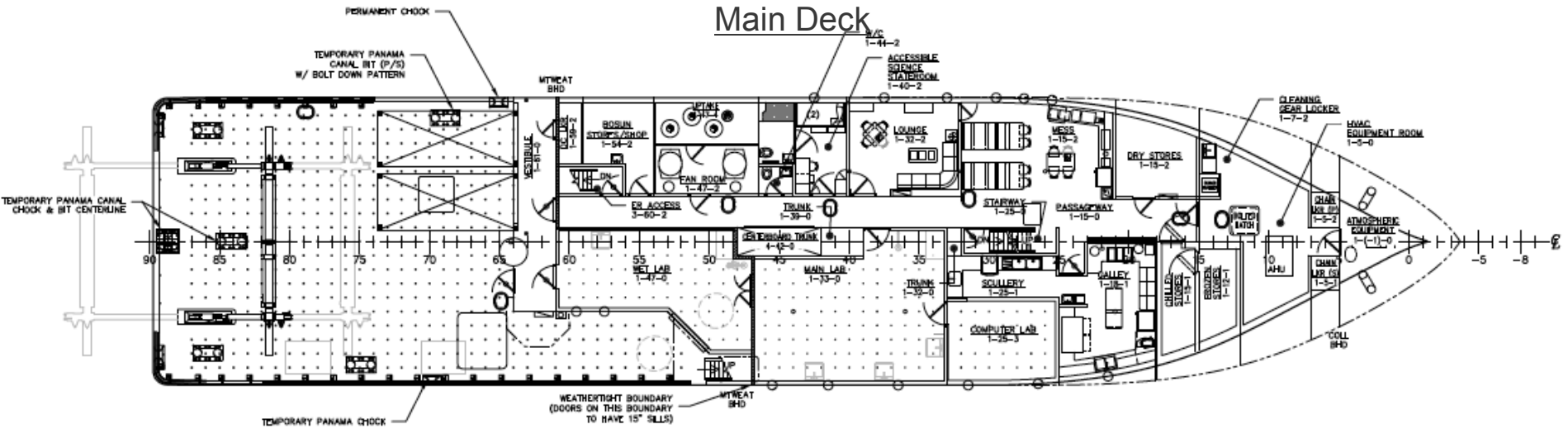
- Vessel Advancements
  - Power Generation (Siemens' Blue Drive Plus C)
  - Schottel Push Pull Z-Drive
  - Hull Design (optimized modified bulbous bow)
- Science Support Advancements
  - Stern Frame and LARS
  - Centerboard design
  - Incorporation of Deck Skidding
  - Telepresence Concept

Inboard Profile

LOA 193 ft
Beam- 41 ft
Draft- 12.5 ft
Berths- 31 (16 science complement, 2 techs, 13 crew)



General Arrangement



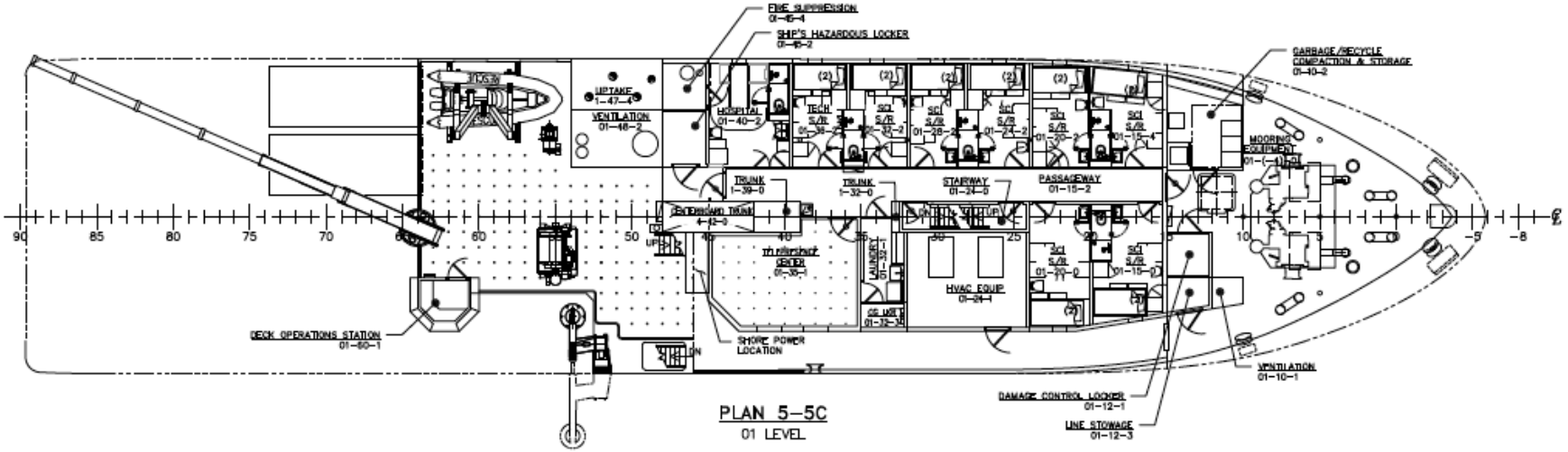
Main Lab	510 ft^2
Wet Lab	350 ft^2
Computer Lab	175 ft^2

Main Deck (aft of house)	2,020 ft^2
Main Working Deck (including side deck)	2,230 ft^2
Side Deck Length	70 ft

Space on the port side for two vans (mated to superstructure)

General Arrangement

01 Level



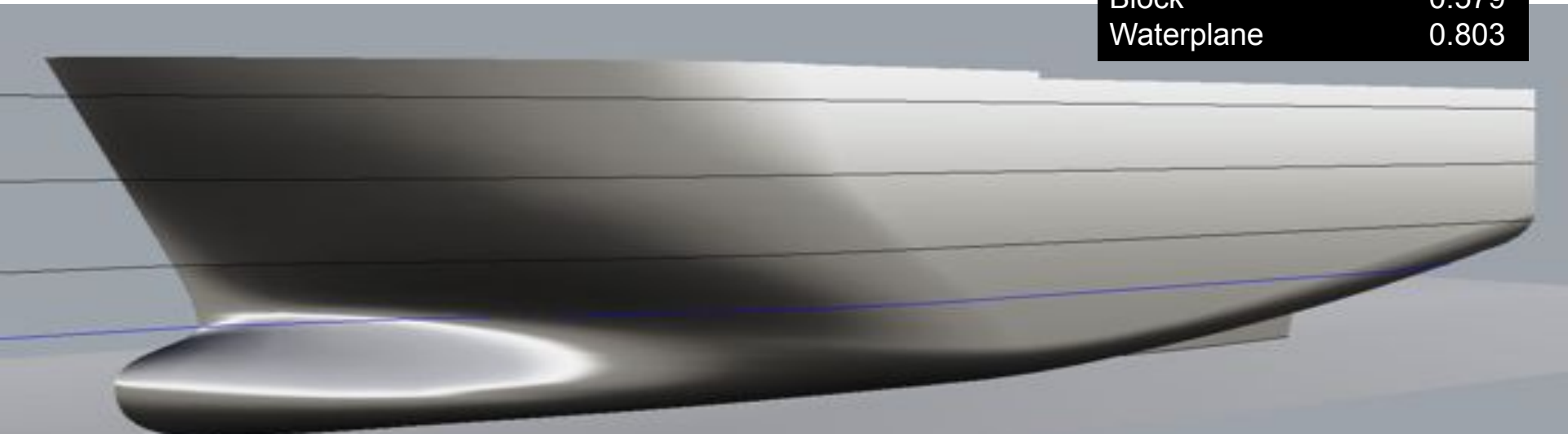
Telepresence Center	245 ft^2
Winch Deck Area	550 ft^2

Science Berths	8 Double Staterooms on O1 (includes accessible stateroom on Main Deck)
Marine Technician	1 Double Stateroom

Hull Form

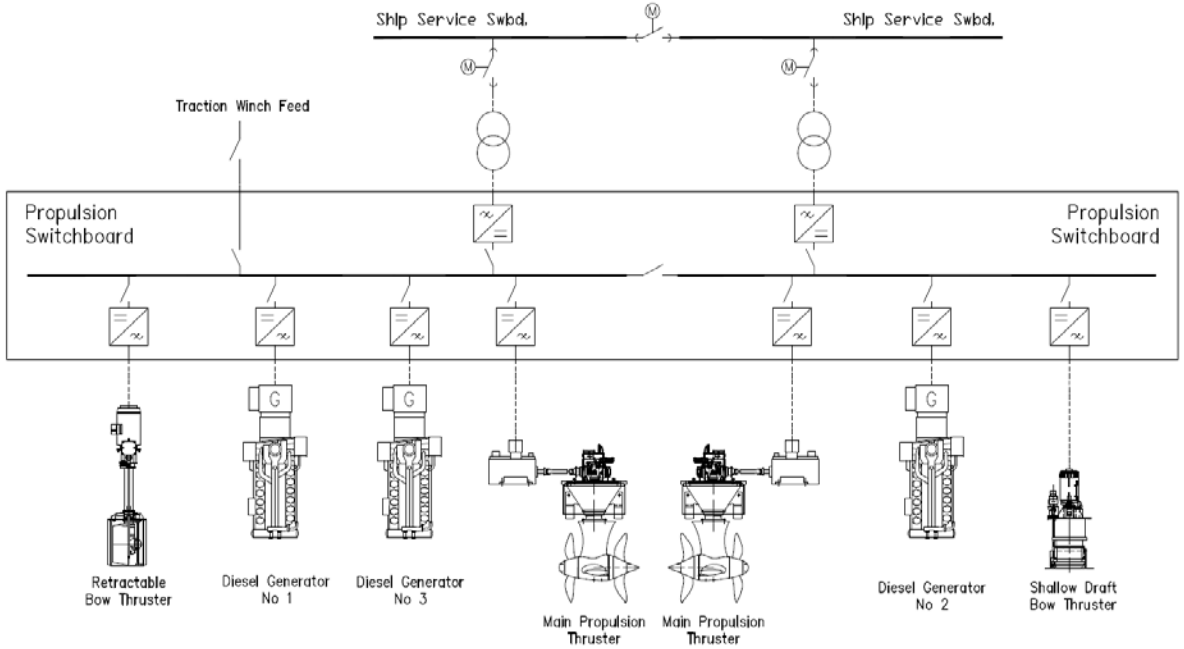
- Modified Bulbous Bow
- Lightweight Construction Materials
- Minimized ballast and No fixed ballast
  - Increases fuel efficiency by up to 6% at cruise speed
  - Reduces weight, lowering power requirements

Length of Waterline	178’ - 0”
Breadth, Molded	41’ - 0”
Depth, Molded	19’ - 0”
Design Draft	12’ - 6”
Hull Coefficients	
Prismatic	0.622
Maximum Section	0.931
Block	0.579
Waterplane	0.803



Propulsion System / Power Generation

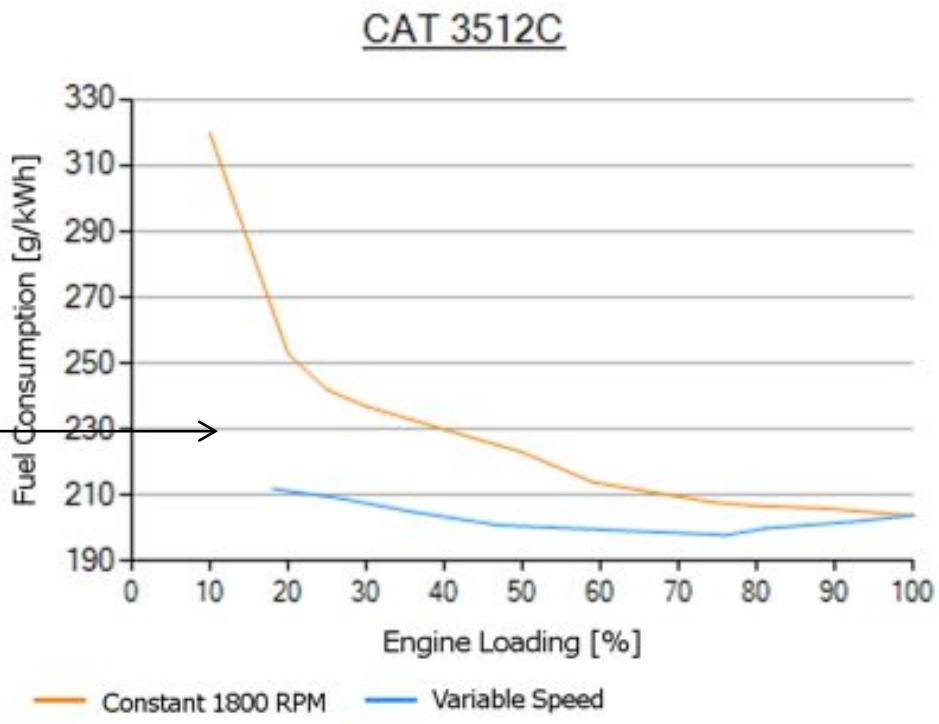
Integrated diesel electric propulsion with three variable speed DC generators, water-cooled AC electric motors and azimuthing propulsors



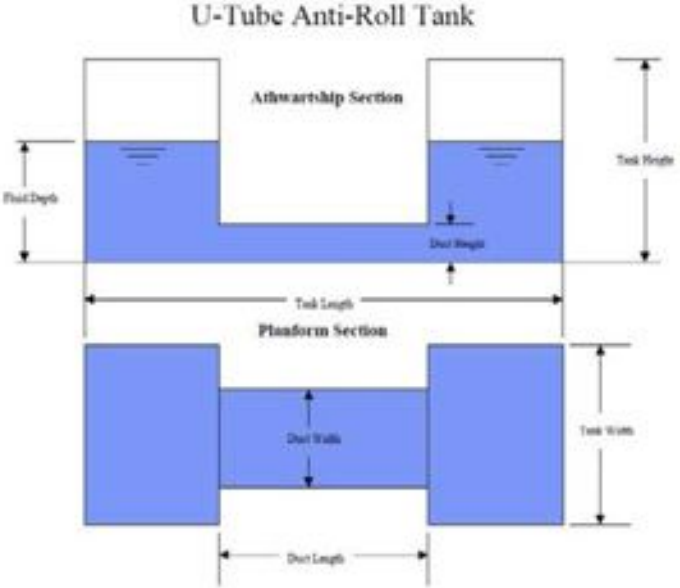
Scenario	Total Load kW	# Gens On-Line	% Gen Load
Transit Summer	1242	2	79%
Transit Winter	1300	2	84%
Transit Temperate	1216	2	78%
Full Speed	1760	3	73%
Heavy DP	1446	2	93%
Towing	1195	2	77%
In Port	248	1	37%
Emergency	143	E-Gen	97%

Variable Speed DC Power Generation

- Increase Fuel Efficiency
  - Variable Speed Power Generation
  - Power electronics produce 60Hz power
  - Optimal operating point
  - Increased fuel economy (g/kWh), especially at light loads
  - 5%-15% fuel savings



Sea Keeping



Located in hull frames 36 – 39.
(Duct width is same as tank width)

Table 7 Percent operability in the Gulf of Mexico

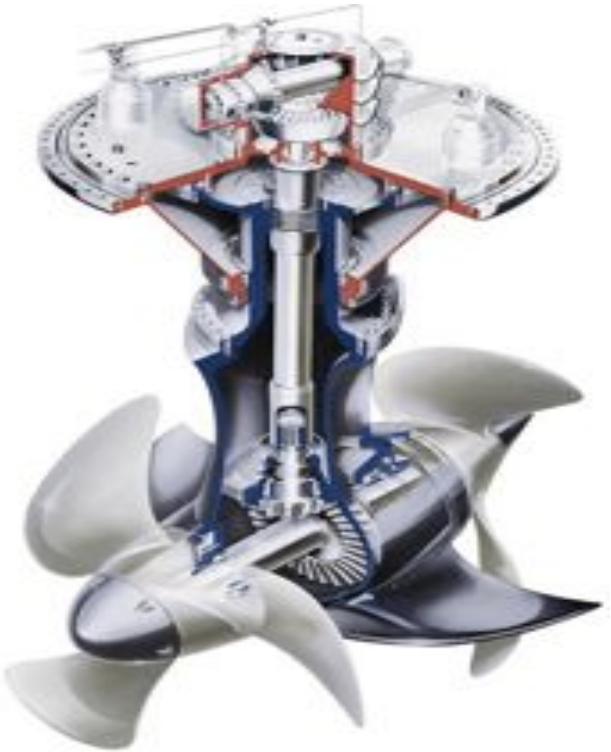
Operability: Gulf of Mexico					
	Heading	4 kts SS 6	7 kts SS 5	9 kts SS 4	12.5 kts Calm Water
Head Seas	0	98.9%	100.0%	100.0%	100.0%
	15	98.9%	100.0%	100.0%	100.0%
	30	96.0%	97.1%	100.0%	100.0%
	45	93.1%	94.2%	100.0%	100.0%
	60	93.1%	94.1%	100.0%	100.0%
	75	93.0%	94.1%	100.0%	100.0%
Beam Seas	90	93.0%	94.1%	100.0%	100.0%
	105	93.0%	94.1%	100.0%	100.0%
	120	93.0%	94.1%	100.0%	100.0%

Operability

Max Roll Displacement	3° RMS
Max Pitch Displacement	2° RMS
Max Lateral Acceleration	0.05g
Max Vertical Acceleration	0.15g

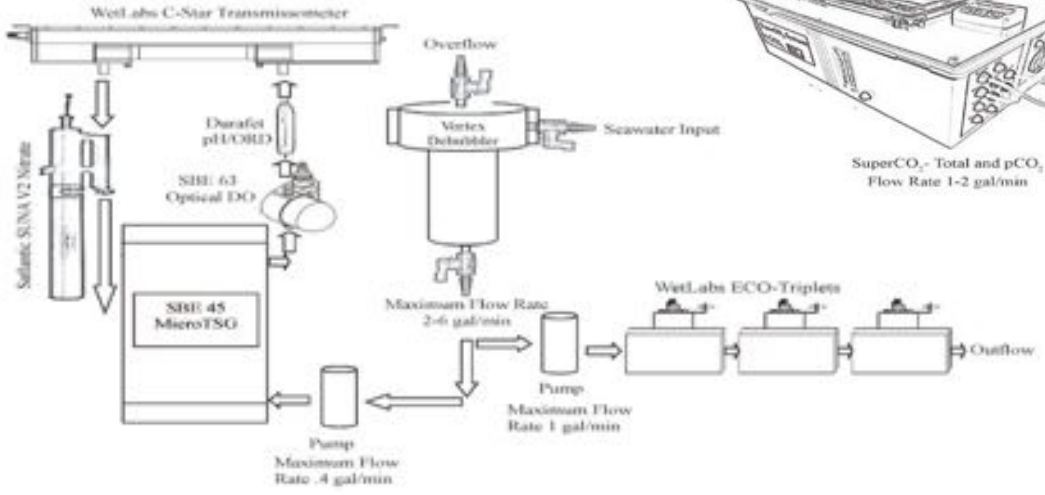
Propeller

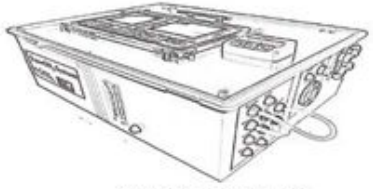
- Using Schottel STP Twin Propeller
  - Push/Pull, ducted, single shaft
  - Lower RPM (reduces cavitation, increases efficiency)
  - Reduced individual propeller size but greater surface area (increases efficiency and bollard pull)
- 4 Propellers are individually “wake adapted” for maximum efficiency.
  - Fits well with RCRV hull form



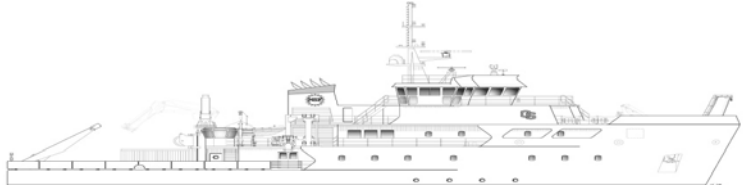
A Continuous & Robust Sampling Platform

Flow Through Sensors





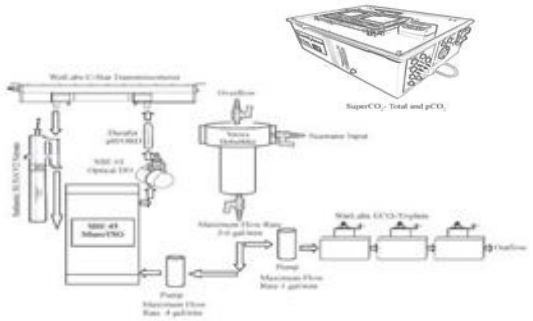
**Other Research Vessels provide only ancillary data such as Temperature and Salinity, few include transmittance and chlorophyll but rarely is this data provided in real time or QC'ed*



Data Stream

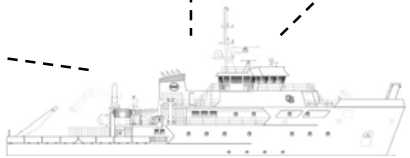
- Surface Salinity
- Surface Temperature
- Light Transmission
- Dissolved Oxygen
- pH/ Oxidation Reduction Potential
- Chlorophyll
- Phycoerythrin or Rhodamine
- Phycocyanin
- Colored Dissolved Organic Matter
- Turbidity- Red, Blue and Green Scattering
- Nitrate
- Total CO_2 and pCO_2
- Irradiance

Linking Scientists to Quality Real Time Data

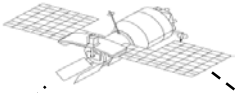


Flow
Through &
Met Sensors

Data Handler &
Acquisition System

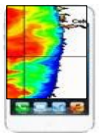


Continuous Data Collection Platform



Quality Control

Real Time
Data



Operational
Input

Monitoring

Outreach

Remote
Sensing
Validation

Deck Skidder Systems- For CTD

RCRV Centerboard Concept

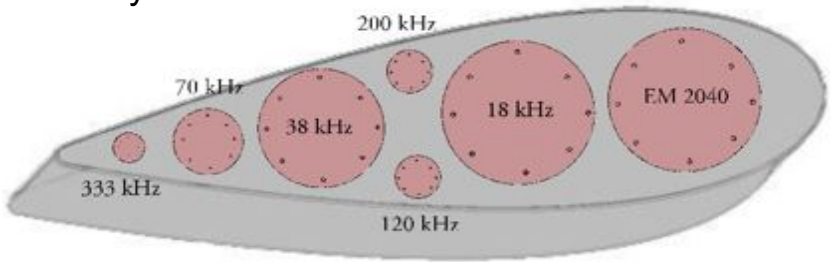
• Centerboard provides a platform for: *Evolving suites of sonars*; *Placing sonars below the bubble layer; Service/changeout of transducers without drydocking*.

• Incorporates removable 2-foot bottom section and interchangeable face plates to accomodate a variety of current and future sonars

• Centerboard will carry compact multibeam and ADCPs
  • These require tight repeatability in roll/pitch/yaw
  OR
  • Separate, Centerboard-mounted, Position/Attitude/Time System

  • RCRV will incorporate both

• *Currently Under Development*



One possible arrangement of sonars on Centerboard "Foot"

Discovery's and Sikuliaq's Centerboards

New R/V *Sikuliaq* Stern A-Frame Design

UNOLS "Standard Bolting Flange"

Built to UNOLS "App B" Standards (DLT=120kip)

Removable / Swappable Wings

Rotating Trunnion Style Cross Beam

Conclusions

- RCRV: Regional Class Research Vessels to meet national coastal ocean priorities within the 21st Century
- Much input from the science community has led to several innovations in the next generation RCRV science support systems.
- Close monitoring of the maritime industry has led to the incorporation of several next generation technologies used to improve efficiency and performance.


OSU