


Regional Class Research Vessel Design Design Summary

PREPARED FOR: Oregon State University Corvallis, Oregon			BY: Elizabeth E. White, PE PROJECT MANAGER
 1201 WESTERN AVENUE, SUITE 200 SEATTLE, WASHINGTON 98101-2953 T 206.624.7850 GLOSTEN.COM			CHECKED: Robert T. Madsen, PE PROJECT MARINE ENGINEER
			APPROVED: David W. Larsen, PE PRINCIPAL-IN-CHARGE
DOC: 12100-000-01	REV: -	FILE: 12100.05	DATE: 29 July 2016

Revisions

Revision	Description	Date
A	Updated report to reflect latest engineering documents	29 September 2016

Summary

The Regional Class Research Vessel (RCRV) has been designed to provide a robust operating platform for performing a variety of scientific missions. The design focused on supporting science mission requirements with flexible laboratory spaces, large aft working deck space, accommodations for scientists, technicians, and/or students, and an outfit of capable scientific equipment. Input from stakeholders, OSU, NSF and the science community, has been incorporated to the greatest extent possible. The result is a vessel that will be a highly capable platform for conducting regional oceanographic science.



The RCRV dimensions are 193'L x 41'B x 19'D with a design draft of 12'-6". The vessel is equipped with a suite of over-the-side handling equipment including an articulated A-frame aft, main crane capable of reaching the entire aft deck, CTD launch and recovery system (LARS), below deck oceanographic traction winch and a hydrographic winch located on the 01 Deck. The vessel is also equipped with a portable crane, portable winch and portable side A-frame. The vessel is outfitted with a suite of sonars including: multi-beam sonars, ADCP, and fisheries sonars. To support acoustically sensitive instruments and missions and increase habitability, the vessel has been designed to minimize underwater and airborne noise.

Principal Characteristics

Length Overall	192' – 10"
Length on Design Waterline	178' – 0"
Beam, at Main Deck	41' – 0"
Beam, Overall	50' – 2"
Depth, Baseline to Main Deck	19' – 0"
Design Draft	12' – 6"
Total Installed Power, Continuous.....	2,685 bkW
Propulsion	(2) dual propeller Z-Drives
Bow Thrusters	350 kW flush mounted, 280 kW retractable azimuthing thruster
Sustained Speed, Calm Water	12 knots
Estimated Maximum Speed, Calm Water	12.5 knots
Range, Sustained Speed	5,400 nm
Endurance	21 days
Displacement at Design Draft	1,492 LT
Lightship Weight (estimated)	1,191 LT
Science Payload & Portable Outfit Items	66 LT
Ice Classification.....	ABS C0
Main Lab	510 ft ²
Wet Lab	385 ft ²
Computer Lab	175 ft ²
Datapresence Center	215 ft ²
Main Deck (aft of the house)	1,930 ft ²
Main Deck (including side deck)	2,160 ft ²
Side Deck Length.....	70 ft
01 Deck (working area)	600 ft ²
Accessible Science Berth	1 Double Stateroom
Marine Technician Berth	1 Double Stateroom
Total Science Berths (with Accessible & Marine Technician Berths)	8 Double Staterooms
Crew Berths	7 Single Berths, 3 Double Berths
Total Compliment	16 Scientists/Marine Technicians, 12 Crew

Tank Capacities

Diesel Fuel at 95%	52,725 gallons
Ballast at 100%	74,400 gallons
Potable Water at 100%.....	6,800 gallons
Graywater at 100%	6,200 gallons
Black Water at 100%	700 gallons
Diesel Exhaust Fluid at 100%.....	3,550 gallons

Hull Form

The hull form was developed through a computational fluid dynamics (CFD) based hydrodynamic optimization process. The process combined a parametric geometry model and advanced nonlinear hydrodynamic simulations to find a hull form with reduced wave patterns and power. The vessel is equipped with a transducer array, located on the forward flat of bottom. In addition to minimizing power consumption, the hull form optimization sought to reduce the probability of bubble sweep down over the transducers, which can interfere with their use. Several other constraints were evaluated throughout the optimization effort for items such as thruster clearance, machinery, and deck space.

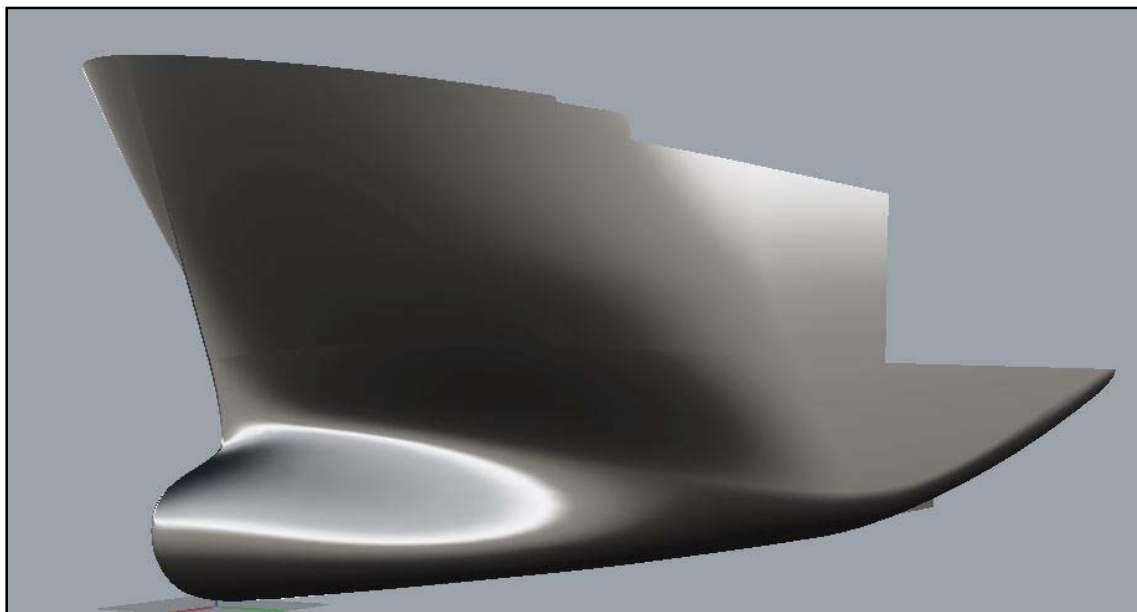


Figure 1 - Hullform

A preliminary evaluation of bubble sweep down was made using streamlines generated by the potential flow CFD calculations. The streamline crossing the outer edge of the transducer fairing (critical streamline) is traced forward to the bow. Since bubbles are assumed to be generated at the upper surface of the ocean, the greater the distance between the upper surface of the ocean and the critical streamline, the more robust the design is against bubble sweep down.

A secondary look at the bubble sweep down was made during the first round of model testing. Dye was injected into the water through holes on the stem of the vessel. This testing was undertaken in calm water at 12 knots as well as in a simulated Sea State 4 at 9 knots. The calm water results favorably showed that the streamlines would miss the transducer array. In Sea State 4, as the vessel pitches the streamlines start to become clouds that do pass over the transducer array. While some of this phenomenon can be attributed to the bulbous bow, the majority would be present regardless of the bow shape due to the shallow draft of the vessel and the probability of encountering entrained bubbles in the upper portion of the seaway.

Reducing the required/installed power through optimization has a greater effect on lifecycle cost than any other design component. Minimizing bubble sweep down allows more time to be spent collecting data. Balancing these two parameters translates to an environmentally friendly design with direct cost savings that can be passed on to the end user.

During design iterations following hull optimization an addition of eight feet of parallel mid-body was added to the vessel to accommodate the U-tube roll tank and mitigate weight margin risks. A second round of model testing with the lengthened hull was performed including resistance, propulsion, wake survey and propeller cavitation inception tests.

Arrangements

The RCRV has many mission capabilities similar to larger vessels but in a compact design requiring a highly efficient layout. The Main Deck is designed to provide enhanced accessibility in accordance with the direction given from NSF. Located on the Main Deck are the Main Lab, Wet Lab and Computer Lab as well as the Mess, Galley and a common Lounge. Also located on the Main Deck is a Science Stateroom designed to accommodate an individual with limited mobility.

The 01 Level is outfitted with a Data Presence Center for data collection and ship wide network racks, the remainder of the Science Staterooms, Laundry, and a Hospital. The foredeck of 01 Level is enclosed to provide a sheltered location for the mooring equipment as well as to provide a large open deck area forward on the 02 Level.

The crew staterooms are split between the 1st Platform and the 02 Level. Also located on the 02 Level is a small Gym and a Bridge Electronics Space.

The Pilothouse is designed with enclosed, overhanging, bridge wings and sloped windows for increased over the side visibility. A separate Chart/Radio Room is included in the Pilothouse.

The Pilothouse top provides an unobstructed area for mammal observation activities. The main mast, located on the Pilothouse top is designed to provide an accessible platform for scientific instrumentation.

Science Outfit

As the purpose of this vessel is to provide the science community with a robust platform from which they can conduct their work, considerable effort was expended to optimize the arrangement for the variety of science that could be performed onboard. Accordingly, the vessel includes the following features:

- The Main Lab, Wet Lab and Computer Lab are all adjacent resulting in optimal work flow between these spaces. These labs are configured to allow efficient use of the space with open, rectangular floor plans and portable furnishings. This allows for reconfiguration of the spaces as needed.
- Space is available in the Transducer Flat and Centerboard for a suite of sonars. The Transducer Flat will house an EM302 0.5 x 1 array as well as the standard suite of fisheries sonars. The Centerboard is designed to have interchangeable shoes allowing for a flexible, easily exchangeable location for additional sonars.
- The vessel is outfitted with an oceanographic traction winch located on the 1st Platform. The wire from this winch is led to a flagging sheave mounted near the crane pedestal which allows for ideal wire routing aft through the articulated aft A-frame or out to the end of the crane boom.
- The 01 Level winch deck area has been configured to support a range of operations. In the middle of this deck is the hydrographic winch that is typically led to the launch and recovery system. There is additional room on this deck to accommodate a portable winch, similar to the MacArtney Mash 2000 winches currently found in the UNOLS winch pool. This winch could be oriented to lead aft over the A-frame or placed on the Main Deck and oriented to lead to a portable side A-frame located on the starboard side.
- The entire aft working deck area is clear of non-essential gear and obstructions. On the port side is space and service connections for two 20-foot science vans. At the forward end of the van location is a vestibule to provide sheltered access to the vans from the

interior of the house. Services are provided for a third van on the aft working deck. An additional location, forward on the 02 Level, has been designated for a small 10-foot van.

- The main working deck, 01 Level winch deck area, and aft 02 Level are all serviceable by the main crane.
- A large Science Stores is located directly below the aft working deck. This is easily accessible through a large (60" x 60"), flush, quick-acting, hydraulically operated hatch with the main crane or via internal stairs.
- A Meteorological Mast is located on the forward 02 Level. This platform was optimized to ensure clean airflow to the variety of scientific instruments that could be located there.
- The vessel is equipped to provide full-time, high speed satellite connectivity for communications, internet access and data transfer including telepresence between researchers afloat and researchers, students and the public ashore.

Maneuverability

With twin Z-drives and two bow thrusters, the vessel is highly maneuverable. The directional stability of the vessel was tested as part of the initial model test program. It was found during these tests that the vessel was not entirely directionally stable, which is normal for a Z-drive vessel. Following the first set of model tests, a flat plate was added to the bottom of the main skeg. The subsequent tests showed an improvement in the vessel's directional stability. Since that testing took place, the vessel has been lengthened by eight feet and the headboxes, above the Z-drives, were elongated and optimized. The impact on the maneuverability of the vessel of these changes has not been model tested, it is anticipated that these changes may negligibly increase the directional stability of the vessel.

Station Keeping

Having the ability to maintain station over as broad a range of headings as possible is highly desirable. The bow thrusters were sized to be the largest units that could practicably fit in the Bow Thruster Room. The forward bow thruster is a retractable, azimuthing thruster with a maximum developed thrust of at least 4.8 t_f . The aft bow thruster is a flush mount, jet-type, azimuthing thruster for use in shallow water, docking and for additional thrust capability when used in conjunction with the retractable thruster. The flush mount thruster has a maximum developed thrust of at least 2.9 t_f .

The specified operating environment for which station keeping performance has been evaluated was 25 knots of wind, 1.9 m waves, and 2 knots of beam current. Figure 2 illustrates the capability of the vessel. The vessel is able to hold position with the wind and waves coming from all headings except for between 43° to 105° off the bow to the same side as the beam current.

CONSTANT ENVIRONMENT (THRUSTER UTILIZATION)
 Total thrust utilisation as a percentage
 of maximum available (reference calculated automatically)
 BOW

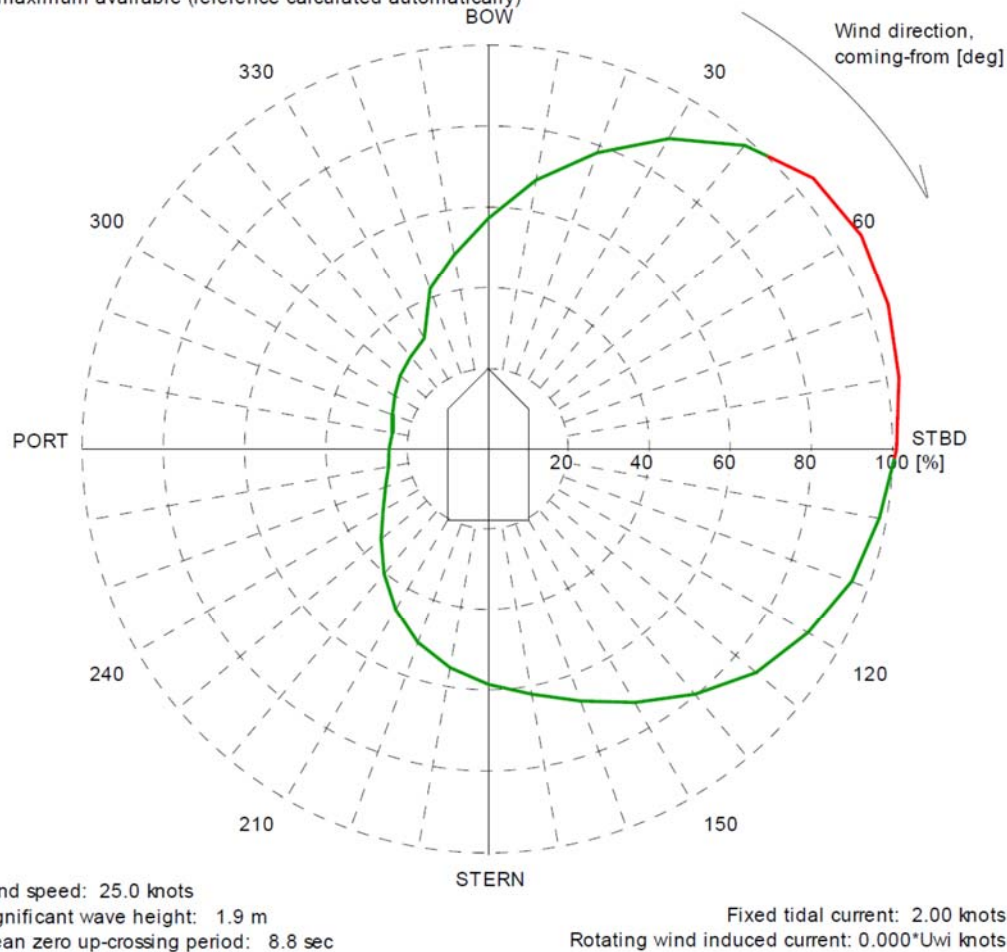


Figure 2 - Station keeping capability with 25 knots of wind, 1.8m waves, and 2 knot beam current from starboard.

Vessel Motions

Vessel motions can greatly affect the ability of people to perform science while at sea. It was a stated desire that the vessel be as “sea friendly” as possible. Though the design criteria was defined at the best heading, that criteria has been taken as an absolute minimum with an expectation for exceedance of the criteria. The vessel is outfitted with bilge keels that help to reduce rolling actions while at sea. Anti-roll tanks were evaluated and a U-Tube type tank is included in the design. Table 1 lists the limiting headings for meeting the vessel motions.

Table 1 – Limiting vessel operability

	<i>Limiting Heading</i>	<i>4 knots SS6</i>	<i>7 knots SS5</i>	<i>9 knots SS 4</i>	<i>12 knots calm water</i>
<i>Operability Criteria (at best heading)</i>		25%	50%	80%	100%
<i>Gulf of Mexico</i>	75°-120°	93%	94.1%	100%	100%
<i>Atlantic Coast</i>	75°-120°	74.4%	94.1%	100%	100%
<i>Pacific Coast*</i>	120°-135°	58%	65.6%	77.7%	100%

* The Pacific Coast motions meet the criteria for all other headings excepting those noted.

Structure

The design and specification of the hull and superstructure scantlings and materials are in accordance with ABS Ice Class C0 notation requirements for structural reinforcement and operating temperatures.

The hull of the vessel (Main Deck and below) is designed to be built of steel, with a 24" frame spacing. The framing is primarily transverse with the exception of the Main Deck which is longitudinally framed to better accommodate large deck loads and the deck socket grid. The superstructure (above Main Deck to 01 Level) is also designed to be built of steel and is transversely framed with 24" frame spacing.

The superstructure above the 01 Level is designed to be constructed of aluminum and is transversely framed with a 24" frame spacing. Aluminum plating is to be either 5083 or 5086 alloys and shapes shall be 6061-T6. The aluminum deckhouse is to be attached to the steel 01 Level deck via Detacouple 9009 consisting of 5083 or 5086 aluminum and steel.

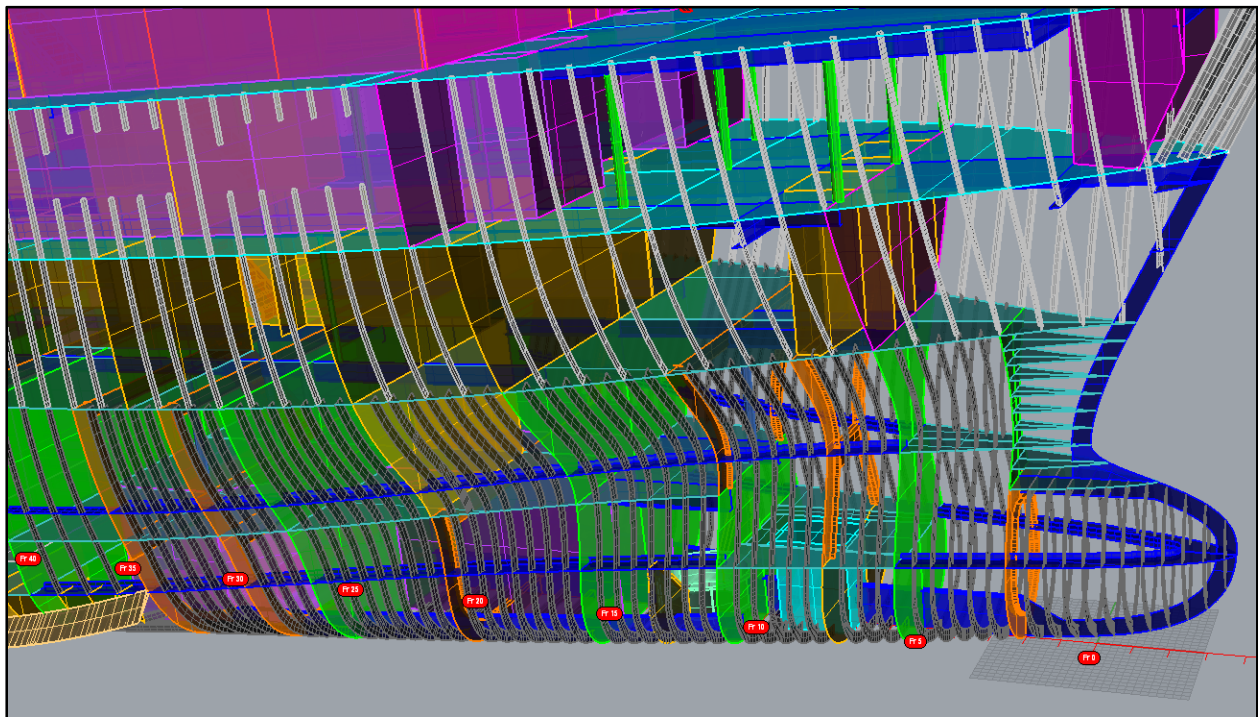


Figure 3 - Screenshot of 3D Structural Model

Weight Estimate

The vessel lightship weight has been calculated using the standard US Navy based Ship Work Breakdown Structure (SWBS) format. The lightship weight of each SWBS group has been estimated based on the available design information. The 100 group structural weight has been developed based on a 3D surface model for the hull and superstructure plate, frames, and stiffeners. (See Table 2.) The major equipment in the 200 – 500 groups are estimated individually. The system weights are based on estimated quantities of pipe, cable, etc. from schematics specific to this vessel as well as parametric system weight information based off the *R/V Sikuliaq* shipyard accepted weight estimate. The outfit items of group 600, such as joiner panels, were modeled in a 3D model similar to what was used for the 100 group items.

The lightship weight and vertical center of gravity (VCG) is summarized by SWBS group below:

Table 2 - Estimated lightship weight and VCG

SWBS	Entry Description	Weight (LT)	Weight Margin (LT)	VCG (ft)	VCG Margin (ft)
100	Hull and Deckhouse Structure	589.16	35.0	16.08	0.25
	Steel (including weld, mill, doubler and insert allowances)	524.30			
	Aluminum (including weld, mill, doubler and insert allowances)	61.94			
200	Propulsion Plant	41.09	3.8	9.37	0.75
300	Electric Plant and Cabling	100.70	10.1	17.00	1.00
400	Communications, Navigation, and Ship Control	9.07	2.0	39.66	1.00
500	Auxiliary Machinery	133.91	16.0	18.44	1.00
600	Outfit and Furnishings	156.90	13.0	24.77	0.25
700	Science Mission Systems	72.76	8.0	24.15	1.00
	Lightship Subtotal (without margins)	1,103.59		18.16	
	Margin		87.85		0.54
	Lightship at Delivery (with margins)	1,191.44		18.70	
1200	Post Delivery Outfit	14.99	1.0	20.04	0.50
	Operational Lightship (with margins)	1207.42		18.72	

The expected transverse center of gravity of the vessel is 0.1 feet to port. The expected longitudinal center of gravity is 85.88 feet aft of Frame 0 (at approximately Frame 43).

Intact & Damage Stability

The intact and damage stability for the vessel is in accordance with the applicable regulations in 46 CFR Subchapter U – *Research Vessels*. The vessel will also carry a SOLAS certificate. The SOLAS Special Purpose Ships intact stability criteria is identical to the USCG intact criteria. There is a difference in the application of damage stability approaches. The SPS SOLAS damage requirements are based on a probabilistic damage stability criterion. However, USCG applies only the domestic deterministic damage stability regulations for Subchapter U research vessels under 80 meters in length carrying a SOLAS certificate. The vessel is compliant with the evaluated stability criteria.

Loading conditions were run for the following scenarios: capacity, full load, mid-voyage, arrival. Personnel weight (crew and scientists) was included at 4.64 LT. Stores weights were included at 12.54 LT for the full load condition, decreasing to 6.3 LT in the arrival condition. A variable weight for science gear was assumed including 30 LT of weight on the Aft Working Deck, 15 LT of weight for the Vans and 5 LT of weight in the Science Stores.

Icing load cases were also calculated for the most limiting End of Life condition. A range of icing loads between 8 and 33 LT is considered. The vessel with icing loads is only subject to intact stability criteria. The icing load cases comply with the intact stability criteria in the governing End of Life (EOL) condition. In order to fully comply with the damage criteria at EOL it will be necessary for the vessel to carry ~30 LT of permanent ballast.

Tonnage

The calculated international gross tonnage for the vessel is approximately 1,470 tons.

Propulsion System/Power Generation

The propulsion system is designed to provide maximum capability within the mission requirements and physical constraints of the design. Design considerations included speed and power, maneuverability, station keeping, reliability, flexibility, and efficiency.

The selected propulsion system configuration is an integrated diesel-electric system with twin azimuthing Z-drives and two azimuthing bow thrusters. The details of the equipment are listed in the table below. The design of the propulsion system was developed in close coordination with the integrated electrical plant design.

Table 3 - Propulsion system

Electrical Power	Three (3) identical variable speed diesel generator sets	Engine: 871 bkW @ 1800 RPM, EPA Tier IV emissions, with unlimited 10% overload Alternator: Variable speed, water-cooled, 990 kVA at 1800 RPM
Propulsors	Two (2) identical azimuthing, twin propeller Z-drive thrusters	650 kW, ice class C0
Propulsion Motors	Two (2) electric motors	Water-cooled AC electric motor, 650 kW at 1200 RPM
Bow Thrusters	One (1) retractable azimuthing propeller thruster	Fixed pitch ducted propeller, electric motor driven L-drive, 280 kW
	One (1) shallow draft azimuthing jet thruster	Vectored thrust, vertical electric motor driven, 350 kW

The advantages of the selected propulsion system are high maneuverability, redundancy, and flexibility. This creates a capable propulsion system that can be operated effectively and efficiently for the varied operational and mission demands of a general purpose research vessel. The propulsion system meets all of the propulsion requirements with significant margin.

Speed and Powering

A scale model of the vessel was tested at the model basin at Centrum Techniki Okrętowej in Gdansk, Poland. Results from the model testing were used to make predictions of the resistance of the vessel and wake survey. These results were then used to customize the design of the Z-drive propellers to minimize cavitation while maximizing efficiency.

The customized propellers were tested to find the cavitation inception point. The predicted cavitation inception point is above 11 knots. Final powering was calculated using the custom propellers and data from the resistance testing.

The vessel's service speed will be 12.0 knots, and its maximum speed 12.5 knots. Shaft horsepower required to meet the given operation criteria is reported in the Table 4.

Table 4 – Clean hull power requirements

Condition	Speed (kts)	Motor Shaft Power (kW)
Calm Water	12.0	420
Sea State 4	9.0	407
Sea State 5	7.0	353
Sea State 6	4.0	214
Towing, 20,000 lbs	4.0	285
Towing, 10,000 lbs	6.0	195

Integrated Electrical Plant

The ship is powered by an integrated diesel electric plant, where the ship’s science, hotel and the propulsion loads are powered from a common bus. Electrical power is fed into a combined bus to allow for the generators to be sized for a variety of operating conditions. An integrated electric plant was then selected based on maximizing the following criterion:

- Low capital cost.
- High fuel efficiency.
- Low maintenance and operating costs.
- High system redundancy and operational flexibility.
- Efficient engine room arrangement.

The following scenarios were examined in the Electrical Power Loads Analysis:

- Transit at a ship’s speed of 12 knots, calm water in summer, winter, and temperate conditions.
- Full Speed (propulsion motors operating at a demand factor of 1.0), temperate conditions.
- Heavy Dynamic Positioning based from the position keeping predictions to hold position in sea state 4 with a 25 knot wind and a 2 knot beam current, temperate conditions.
- Towing based on towing a 20,000 lb load at 4 knots, temperate conditions.
- Loitering based on a light dynamic positioning case with minimal propulsion loads, temperate conditions.
- In Port used to verify the size of the shore power connection as well as to provide a lower bound for the generator sizing, temperate conditions.
- Emergency used to verify the size of the emergency generator.

Table 5 - Electrical plant load

Scenario	Propulsion Load ekW	House Load kW	Total Load kW	Margin kW	# Gens On-Line (819 ekW)	% Gen Load
Transit Summer	875	370	1245	111	2	83%
Transit Winter	875	370	1245	111	2	83%
Transit Temperate	875	342	1217	103	2	81%

Scenario	Propulsion Load kW	House Load kW	Total Load kW	Margin kW	# Gens On-Line (819 kW)	% Gen Load
Full Speed	1115	353	1468	106	2	96%
Heavy DP	1135	413	1548	138	3	69%
Towing	594	372	966	124	2	67%
In Port	-	241	241	36	1	34%
Emergency	-	118	118	18	E-Gen	80%

Figure 4 depicts the basic layout for the propulsion plant. To maximize engine efficiency, the generators operate in a variable speed mode. Operating in a variable speed mode allows the engine to operate similarly to what is seen in a direct drive propulsion engine or standard propeller curve. This results in a fuel consumption curve that is much flatter and more efficient over a broad power range when compared to a constant frequency application. With a flatter fuel consumption curve it is then possible to reduce the number of generators installed without negatively influencing fuel consumption, allowing the load on the generators to fluctuate efficiently over a broader range of approximately 40 to 95% of MCR. The power is rectified and fed to a common 1000 VDC bus. The 480 VAC ship's service switchboard will operate at a fixed 60 Hz.

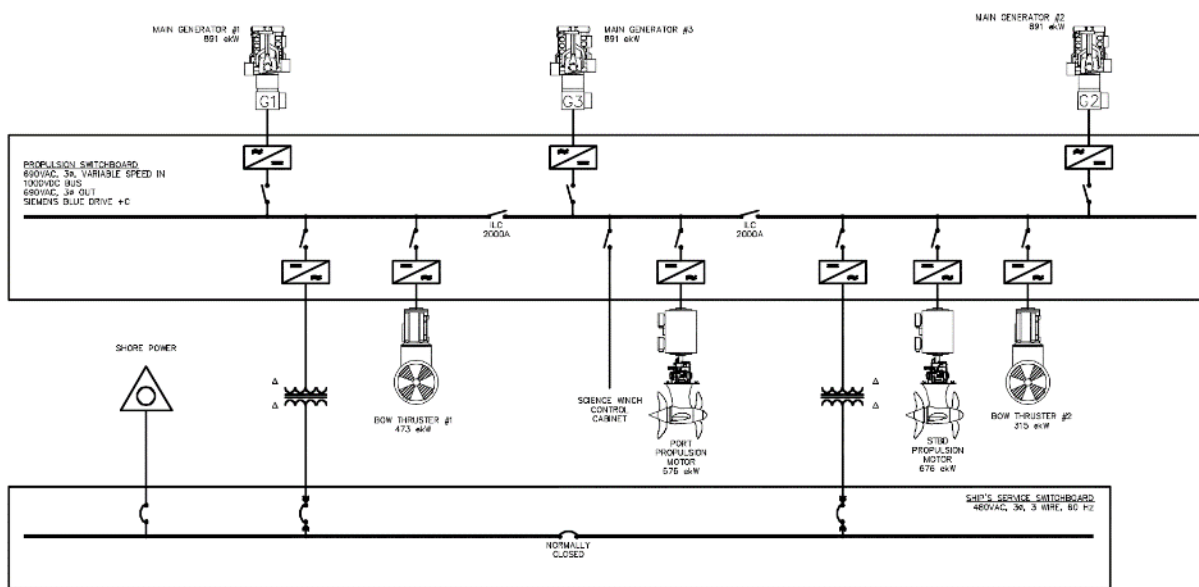


Figure 4 - Propulsion switchboard one-line diagram

Green Ship Initiatives

A number of green ship alternatives were examined in the areas of the hull design, propulsion system, auxiliary systems, pollution control, and outfitting. The options evaluated were considered in conjunction with the mission profiles of the vessel. The following table details the technologies that have been incorporated into the design.

Table 6 - Green ship alternatives incorporated into the design

Green Ship Alternative	Benefit/Rationale
Hull	
Hull form optimization	15% reduction in resistance
Hull coating (hard coating with frequent in-water cleaning)	No biocide toxin release
Propulsion	
Variable speed generators	Estimated 5-15% reduction in fuel consumption
Wake adapted propellers	Increased propeller efficiency, decreased underwater radiated noise
Twin propeller pods (Z-drives)	Increased propulsive efficiency
Electrical System	
VFD fans	Electrical savings, possible noise attenuation concern
Ultra-premium efficiency motors	3-10% electrical savings
LED Lighting	Lower energy use, higher upfront cost
Auxiliary Systems	
Waste heat recovery	Provides heat for HVAC, water makers, and domestic hot water. ~350 kW electrical savings
Climate control – waste heat heating	Can replace electric heat for large heaters, 70+ kW electrical savings
Novec 1230 fire suppression	Minimum application of greenhouse gas
Non-ozone depleting refrigerants	Minimize environmental damage
Pollution Control	
5 PPM OWS	Minimize oil discharge
Cascading fuel overflow system	Minimize risk of accidental fuel oil discharge
Environmentally acceptable lubricants	Minimize impact of accidental oil discharge
Minimize underwater radiated noise	Minimize noise pollution
Ballast water treatment system	Required, reduces spread of invasive species
EPA Tier 4 engines	Reduce engine air emissions
Solid waste storage	No incinerator air emissions
Outfitting	
3" minimum insulation	Reduce heat loss/gain
Sustainably sourced, environmental friendly materials	Minimize environmental impact

Additional technologies were also examined throughout this process. For example, biodiesel was considered as an alternate fuel, though this does not have a direct impact on the design of the vessel. It would be possible to use biodiesel in the vessel, however, it could present operational challenges.

Several other alternatives were examined and not incorporated into the design. These technologies are listed in the following table.

Table 7 - Green ship alternatives not incorporated into the design

Green Ship Alternative	Rational
Propulsion	
Battery hybrid	Minimal benefit with variable speed generators, adds cost & weight
Alternative fuels, LNG	Integration of LNG system incompatible with vessel design

Green Ship Alternative	Rational
Electrical System	
Solar system	Minimal benefit with available installation area. Insufficient interior volume available for significant energy storage and support systems
Auxiliary Systems	
Climate control – air/air heat exchangers	Impractical due to space constraints, may offer benefit if feasible
Climate control – heat pump	Less efficient than waste heat heating, equivalent to chiller A/C

Noise and Vibration

The vessel is designed to be a quiet ship both aboard the ship and in terms of underwater radiated noise. Noise Control Engineering (NCE) performed the following analysis examining Airborne Noise, Sonar Self Noise, and Underwater Radiated Noise.

The intent is that the vessel will meet a modified noise curve based off of a combination of the requirements for the AGOR-27/-28, DNV Silent A, and Silent S criteria at speeds up to 8 knots (see Figure 5). To comply with the noise requirements, the following noise treatments are expected for the design:

- Single isolation mounts for all normally operating rotating or reciprocating machinery in the engine room, propulsion motor room, and auxiliary machinery spaces.
- Local damping on foundations of the propulsion motors and several other key auxiliaries in the engine room and propulsion motor room.

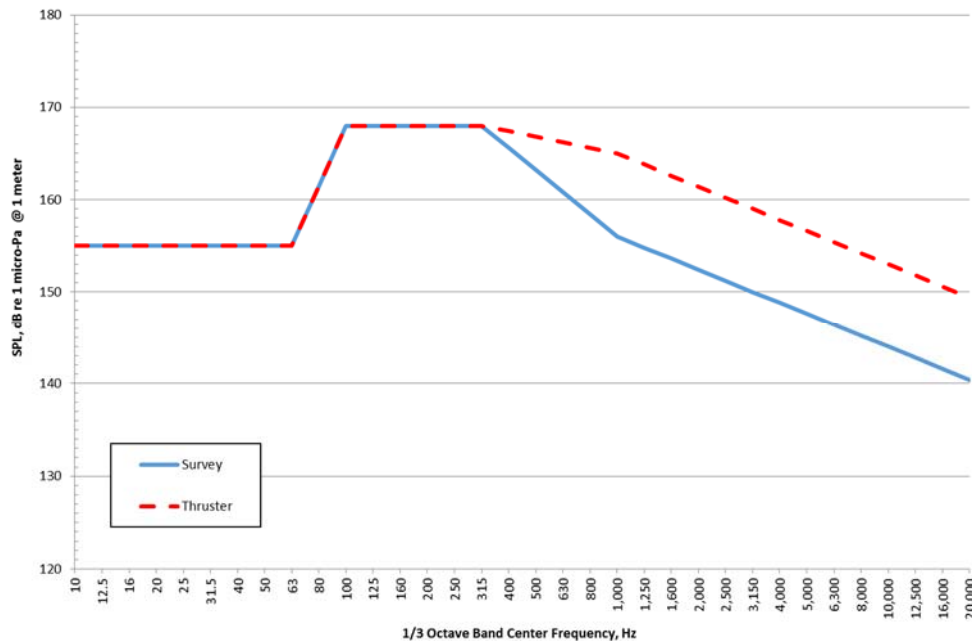


Figure 5 - Underwater Radiated Noise Criteria

Furthermore, to comply with the airborne noise requirements acoustic treatments will be applied throughout the vessel. Acoustic insulation will be applied to the bulkheads and deck heads in the engine room, bow thruster room and all fan rooms.

To reduce air and structure borne noise from the bow thruster, both source and pathway acoustic treatments will be used. Extensive use of damping material in the bow thruster room and the forward stores room will combine to minimize airborne noise levels.

Conclusions

As designed, the RCRV will provide a highly efficient and effective platform to support the nation's regional ocean area science needs. The contract design completes a cycle around the traditional design spiral touching on and confirming subjects such as vessel proportions, hydrostatics, freeboard and subdivision, general arrangements, structure, powering, capabilities, and stability. The current design stage allowing for the completion of detailed weight and cost estimates.

Two design features enhance the RCRV's versatility and communications ability. The design trades larger, traditional fixed laboratory space for a mix of flexible fixed laboratory space and large aft open deck to accommodate lab vans that can be installed to suit the mission at hand. Full-time, high-speed satellite connectivity provides increased data transfer and communications. This allows the vessel to facilitate telepresence between researchers onboard and researchers ashore as well as providing a means of greater outreach to students and the general public.

Outfitted with two bow thrusters and twin Z-drives, the vessel is able to keep position in a range of environmental conditions. Bilge keels and a U-tube type anti-roll tank work to minimize the motions encountered on-station and underway. Variable speed power generation allows for efficient operation of the diesel electric plant. The vessel design meets all expected environmental regulations that will be in place at time of construction. The suite of over-the-side handling equipment, SONARS, and onboard instrumentation combined with a telepresence capability allow scientists on the vessel and ashore to carry out their oceanographic investigations. The RCRV is a capable vessel that will support science as envisioned for the 21st century.

