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DATE: August 30, 2010

TO: Captain Bauke Houtman
Section Head, Integrative Programs
Division of Ocean Sciences, NSF

FROM: Dr. Clare E. Reimers
Chair, UNOLS Fleet Improvement Committee

C/c: Dr. Vernon Asper, UNOLS Council Chair
Dr. Bruce Corliss, UNOLS Council Chair-Elect
Jon Alberts, UNOLS Office Executive Secretary

SUBJECT: RCRV Request for Input

In response to NSF's March 25, 2010 memo requesting input from the UNOLS Fleet Improvement Committee (FIC) on specific questions addressing design features of the Regional Class Research Vessel (RCRV), the FIC has met through repeated teleconferences and prepared its recommendations. These recommendations are summarized in the attached TABLE 1 with additional information for reference in TABLE 2. In some cases, other members of the UNOLS community have been consulted for additional expert opinions.

It is the understanding of FIC that these suggestions will be taken under consideration by NSF and the institution(s) selected to refine the Glosten Associates design that was down-selected in October 2009. Overall FIC recommends that if time and funding allows, a substantial holistic redesign should take place that includes removing the bulbous bow and increasing the power, maneuverability, and aft deck space of the RCRV. Innovative hull and propulsion designs that could reduce fuel consumption and noise impact on the environment are also encouraged.

As the total number of ships in the UNOLS fleet is expected to decline, it becomes increasingly important that new ships are highly capable and fully equipped for the ocean science needs of the next several decades. It is also essential that steps to secure construction funds and move towards construction and operations continue as proposed. Please let FIC know what further assistance can be provided to the RCRV Project.

TABLE 1. FIC Responses to RCRV Request for Input Date of Request: March 25, 2010		
Areas of Inquiry	**FIC Response**	**Key Reference Documents**
1. Aft Deck	Aft deck space in the RCRV design needs to be increased. Open, flexible fantail space is a high priority for these vessels that are expected to be workhorses for short duration, diverse cruises including coastal mooring deployments/recoveries and other over the side equipment transfers (e.g., corers, ROVs, AUVs).	01 and Main Deck Plan DI-008-01; Inboard profile DI-008-01; DI-001 RCRV Contactor's Ship Specs: especially Sections 070 and 665.
i. With the two vans on deck, is the remaining aft deck suitable to support both current science operations through the A-frame and future science operations such as ROV and AUV deployments?	No. The aft deck space available with 2 vans on deck does not leave enough room for effective and unobstructed deck operations through the A-frame. ROV operations would not be feasible. AUV ops may be feasible if the AUVs and the handling systems are small.	
ii. With either one van or no vans on deck, is the aft deck suitable to support coastal ocean observatory deployments and recoveries?	No. Greater fantail space is recommended for maximum flexibility and accommodation of large or multiple coastal moorings including buoys and anchors (up to the load limits of the ship's crane).	
iii. Could the usable aft deck space be increased by shortening the deck house (i.e., moving structure forward) without compromising other important aspects of the design? Under this scenario the length overall would not increase.	Yes. A better design of the interior space primarily on the main deck could increase the usable aft deck space. Suggested changes are: eliminate van dock, hospital, incinerator, and one W/C. Reduce Hazmat area. Redesign should improve ease of access from aft deck to main and hydro labs.	
iv. Alternatively, should the aft deck length be increased? Under this scenario the length overall would increase, but only aft of the deck house as with the extension of the *SIKULIAQ*. The length of the forward deck house would not change.	Rather than alternatively, the aft deck length should be increased by both shortening the deck house and increasing the overall vessel length as much as the 300 GRT and cost limits will allow.	
v. If adding to the aft deck, what is the recommended number of frames to be added (24" increments)?	A minimum of 5 increments (10'), but ideally 10 (20').	
2. Z-drives and DP: The Global AGORS are the Academic Fleet's first exposure to Z-drives. Industry use of the Z-drives has greatly expanded and their designs have improved significantly since the early 1990s. The R/V *HUGH R. SHARP* is fitted	The operators of the *SHARP* report that the Z-drives have pros and cons and are still being evaluated. On the plus side, the drives allow extraordinary maneuvering at low speeds.	RCRV_Glosten Ship Specifications Sections 245 and 420; RCRV SOR.

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with Z-drives and the R/V *SIKULIAQ* will also have them installed. New science missions such as deployment of ocean observatory components and the use for ROV's will require very capable DP systems.	This includes science operations, DP, docking and maneuvering around the dock. These drives assist the vessel in maintaining station when in Dynamic Position mode. A 3–6 month training curve is needed for new operators. Negatives include difficulty tracking straight at all speeds (critical for mapping missions). The drives provide steering, and very small movements tend to cause the vessel to oscillate. This oscillation tends to continue until the autopilot can find its head. A five-year service contract from Schottel was $40K (for R/V *SHARP*) without regard to other shipyard costs. There is also a long delay in availability of some parts. As great as 6–8 weeks lead time from Schottel.	
i. Considering both cost (installation and maintenance) and capability, as well as the experiences of the *SHARP* over the past several years, should the use of Z-drives be re-evaluated as an "option" for the RCRV?	The crux of this issue is whether the seakeeping/maneuvering requirements for the RCRV have been set stringently enough for the expected science missions. These requirements should be re-reviewed. Our records show the underway requirements are set at best heading, and the on-station conditions were deleted when the SOR was revised. The current design with twin screw conventional shaft driven fixed pitch propellers was selected to meet the existing SOR station keeping/maneuvering requirements with advantages of lower radiated noise, lower initial cost and lower maintenance expenditures. Any consideration of a change in propulsion system configurations must be made early in the design refresh process before the contract design goes out to bid for construction and not as a follow-on option at the shipyard. There are too many impacts on hull form to change this key element of the design late in the process. If the decision is made to install Z-drives, performance should be monitored carefully and if deemed necessary a spare parts pool be considered for long-lead items to avoid lengthy down-times. This is in light of the down-time experienced by the current	

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	AGOR z-drive vessels.	
3. Bow Thruster (Power, DP, and Noise): Bow thrusters are essential for DP capability and useful for maneuvering in close quarters including docking. Historically, many vessels in the academic fleet have been fitted with bow thrusters that are underpowered and/or noisy during DP operations. The *SHARP* is fitted with a tunnel thruster while the *SIKULIAQ* will be fitted with an azimuthing, low cavitation bow thruster that has been used on the NOAA FSV's, the R/V *RON BROWN* and other *Global Class* research vessels. Like the *SIKULIAQ*, the Glosten design for RCRV calls for a 467 kW (626 HP) Tees White Gill, 360 degree azimuthing bow thruster optimized for acoustic performance (i.e., low cavitation).		
i. What has been *SHARP's* principal use of the bow thruster? Maneuvering, docking, DP offshore?	The *SHARP*'s use for the bow thruster has been for docking and DP. The unit has been engaged less than 5% of underway time.	
ii. Has the *SHARP's* bow thruster proven effective with regard to size (HP) and performance (delivered thrust)?	It is ineffective at speeds greater than 3 knots and limits the conditions they can effectively use the DP system. The unit on the *SHARP* is loud when engaged. Its sound and vibration is greatest in lower berthing. It is difficult if not impossible to sleep below decks, and even on the 01 deck the noise is disrupting. The bow thruster is also underpowered and becomes ineffective in wind conditions of 25 kts and greater around the dock. The operators feel 25% more power is needed than what the current unit provides.	
iii. How does the HP and delivered thrust on the *SHARP* compare to the proposed azimuthing bow thruster for the RCRV? Is there confidence that the proposed bow thruster on RCRV will meet operational requirements?	Specified BT power for RCRV (630 HP) compares favorably with the *SHARP* (200 HP) and *OCEANUS* Class ships (350 HP) which have been notoriously underpowered. Again the operational requirements need to be re-assessed before concluding the proposed BT is adequate. Bow thrusters are essential in high wind conditions. Adequate bow thruster performance is also a safety/equipment issue. If a bow thruster is	

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	underpowered, the ship may not have adequate control for recovery ops that take a long time to shut down (e.g., mooring work) when unexpected weather comes up.	
iv. Has the *SHARP's* bow thruster proven satisfactory with regard to habitability/noise during DP operations or docking?	No. Design measures will be needed to reduce noise and vibration from the BT on the RCRV, e.g., having a compartment or other spaces separating the BT from inhabited sections or installing the BT in a noise-insulated tank.	
v. Has the proposed White Gill azimuthing thruster been effective on other vessels with regard to habitability/noise during DP operations and docking?	The belief on the AGOR 23 Class is that the White Gill bow thrusters are underpowered. Part of this perception is that each of the stern thrusters is 3,000 hp. So, when the stern thrusters are loafing, the bow thruster is often at max power. Another issue is to ensure the bow thrusters are rated for continuous duty cycles at 100% power. One of the biggest issues with the bow thrusters is the requirement that they be azimuthing and not protrude below the baseline. This pretty much forces one to a White-Gill type thruster which is inefficient. A concept was developed several years ago that used a retractable azimuthing nozzled bow thruster that, when in the retracted position, served as a conventional tunnel thruster. This would allow the thruster to not hinder docking in shallow water. Allowing the use of a retractable thruster would provide more effective thrust and, combined with more demanding station keeping requirements, could give the design of the bow thruster more power. Such a design would be expensive, however, and would affect the hull design.	
4. Power: The main propulsion system was designed to keep operating costs low and with an average cruising speed of 10 knots. However, the Panel was concerned that the total power may have been reduced to the point where the vessel's ability to operate effectively and safely in higher sea states was compromised.	The Panel's concern remains.	
i. Without regard to operating cost, is a design cruising speed of 10 knots adequate	10 knots is minimally adequate for most regional missions. A cruising speed of 12	

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given environmental conditions (currents, etc.) in the coastal zone? Maximum design speed of the Glosten design based on model testing is 11.8 knots in calm water.	knots is desired so to insure the ship is not under-powered under strong current and/or high wind conditions. There may be some economy in faster cruising speeds in that the time at sea needed for many science missions can be reduced (which could also allow more science projects to go to sea per year). The trade off is the cost of personnel salaries at sea per project versus the costs of bigger engines and more fuel.	
ii. How does predicted fuel consumption (1289 gal/day at 10 knots), speed, and available horse power (for main propulsion) compare with the *SHARP*, *CAPE HATTERAS* and (say) *ENDEAVOR*?	A comparison made in Table 2 shows that the RCRV will fall between existing regional class and intermediates in fuel consumption. An important metric will be the slope of the fuel consumption vs. speed curve. The displacement of the RCRV approaches that of intermediates but its power is much less, indicating it is underpowered.	
iii. Has offshore performance been acceptable for these vessels?	*SHARP* is weather limited as compared to the intermediate class. We know that because *OCEANUS*, *ENDEAVOR*, and *SHARP* were doing joint ops several years ago and had to cease ops because of the weather impacts to *SHARP* when far offshore. Whether this should drive design changes in the RCRV depends on the range, coastal environmental conditions, and science missions of RCRV ops. The operational niche for these vessels needs to be clearly defined in the context of the capabilities of the entire UNOLS fleet.	
iv. Based on the results, does FIC have confidence that total HP on the RCRV is adequate to ensure operability?	FIC does not have confidence that the total HP proposed is adequate or the best trade-off for the vessel. In addition, any increase in size will necessitate a reevaluation of powering, as will any change in propulsion system.	
5. Van Mating. The *SHARP* has a unique design to mate vans to the ship's superstructure using top hatches and inflatable seals that can accommodate any van without having a specific mating surface on the van itself.	The van mating method used on *SHARP* appears to have become an undesirable design driver. Better to have an overhang from the 01 deck and vans located where their access and use can be well integrated with interior lab spaces.	UNOLS East and West Coast van pool websites for pictures of vans: http://www.shipops.oregonstate.edu/ops/vans/, http://marops.cms.udel

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		.edu/uecvp/; *SHARP* photos provided by Bill Byam.
i. Has the crew of the *SHARP* found this mating arrangement effective?	From Bill Byam: "The system works well. We have two separate openings that are closed by removable doors when vans are not on board. We were struggling with where to store the doors when vans are on the ship as they are relatively large, 8' square. We have been keeping them on board, secured to the side of the vans and that has worked well. We have not carried any science vans that are not part of the UNOLS van pool, so all vans fit without deck space lost. Most other science vans that we have seen are no longer certified to go to sea, so we accommodate science needs by transferring their equipment to a pool van. It is a bit time consuming to hook up the general alarms and smoke detectors. Just part of the process."	
ii. Are there any changes that the ship's crew would recommend based on several years operation?	None reported.	
iii. Would FIC endorse incorporation of this specific design into the RCRV?	No. The need for a van dock is not supported. The van dock consumes aft deck space and creates congested human traffic areas. In the Glosten design the vans open across from unassociated adjacent spaces (e.g., Bosun stores) rather than into appropriate lab spaces.	
6. Bulbous Bow: Bulbous bows have caused significant bubble sweep down problems on recent research vessel designs such as the UK's R/V *JAMES COOK.* When pitching in a seaway, the bulbous bow sheds significant bubble "clouds" which degrade sonar performance. In general, modern bulbous bows decrease required horse power from 15–25% depending on the design. Model testing for the RCRV's "optimized hull" predicts a reduction of 22% in required horse power which represents a significant decrease in	FIC sees data gathering with geoacoustical scientific electronic systems (SES) as core activities in future science missions of RCRVs. It is desirable that SES be integral parts of the ship and not deployed using poles or towed vehicles. However, with this size of vessel and hull mounted SES there are significant risks of bubble sweep down effects especially with the bulbous bow. Numerical or basin model studies are not sufficient to predict impacts because bubbles do not scale. Strakes to direct bubbles away from sonar components may	RCRV Glosten Model Test Report

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the size of the propulsion motors and lowering of fuel consumption. The bulbous bow on the RCRV is integral to the hull as opposed to an appendage added to a standard bow form. Removal of the bulbous bow cannot be accomplished without completely redesigning the lines with potential negative impacts on trim and stability. Bubble sweep down is currently modeled only in calm conditions (CFD and other) where transducer performance is generally good to begin with. Accurate analysis of bubble sweep down in sea states indicative of offshore conditions is not currently available.	be required with impacts on fuel consumption, trim and stability. A center board offers a great degree of flexibility for sonar/sampling systems other than multibeam.	
i. Given the risks to transducer performance compared to potential cost savings, should the bulbous bow be eliminated?	The answer to this question depends on the cascading effects of previous design considerations and trade-off decisions. The bulbous bow design is an integral part of the entire current design and to remove it means changing the hull lines and redefining the required power. The question becomes, do we have the time and funding to go through a total redesign? If the answer is yes then eliminating the bulbous bow is highly recommended. Alternatively NSF must be willing to accept the contractual risks in the current design with the understanding they may need to remediate problems after construction.	
ii. Could the risks associated with a bulbous bow be reduced if a retractable centerboard were incorporated? (See Question 7 below)	For some transducers risks would be reduced, but not for the multibeam because of the size and shape of the transducer array. Installing a retractable center board would be difficult with the current design because it would require too many other changes to internal sections of the ship.	
7. Retractable Centerboard: The R/V *SHARP* is fitted with a bulbous bow and a retractable transducer centerboard. This vessel does not have a hull-mounted multibeam and all science transducers are currently located in the centerboard. *SIKULIAQ* will have both a centerboard and a hull-mounted multibeam along with other sonars. A bulbous bow was not considered on *SIKULlAQ* because of the		RCRV Glosten Ship Specifications Section 426

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ice capable hull form.		
i. For the vessel's suite of transducers, has transducer performance been acceptable to scientists using the *SHARP?*	As a whole the response from science has been favorable. U. Del has installed several science-provided transducers for specific projects with usually 2–4 weeks lead time required for fabrication and mounting. The size of the bays, 24”x24" limits some installations such as larger multibeam transducers. The other negative comment has been the ADCP lost data from surface to the transducer, the top 10' of the water column. This will always be a problem for shallow water science and can only be solved by the use of a pole mounted ADCP, which creates another set of problems.	
ii. To what extent has the crew of the *SHARP* used the centerboard's ability to change out transducers while alongside? Has the concept worked well operationally?	This has proven to be routine and relatively easy. Care must be taken to insure that the seals are re-established when installing the bays. U. Del. operators have also lifted the entire centerboard out of the ship with their crane several times for maintenance and painting.	
iii. Based on the concerns with the bulbous bow above, should a retractable centerboard be reconsidered for the RCRV? If so, for which acquisition systems? FIC should keep in mind that there will be impacts on internal space and arrangement.	If the decision is made to retain the current hull lines with the bulbous bow and current power arrangements, then NO, a retractable center board should not be considered because of the impacts on interior space. However, if the complete ship hull lines are redesigned to remove the bulbous bow and increase the power to make up for the loss of the bulbous bow, then, with the changes in transducers as noted below in question 7.iv, the need for a retractable center board should be re-evaluated as on *SIKULIAQ*. FIC favors the second more ambitious redesign path.	
iv. Given the vessel's potential operating area, should the list of hull-mounted sonar systems be revisited for the RCRV? If so, what adjustments to the sonar suite are recommended?	FIC recommends eliminating the 1x1 EM302 in favor of a .5x1 EM710 (75 kHz, much smaller, depth range to 2000 m), and swapping the 3.5 kHz array for a parametric SBP (e.g., TOPAS). The higher frequency unit would probably fit in the flat of the keel. Overall it is important that the sensor suite will motivate users involved in coastal mapping and other acoustic surveys to request the RCRV.	

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8. Underwater Radiated Noise (URN) Criteria: URN treatments and vibration damping can add significantly to the initial vessel cost depending on the standard being used. However, the secondary advantages with regard to habitability, improved working conditions, and transducer performance are well known. ICES 209 was developed specifically for fisheries vessels, but several potential standards for general-purpose research vessels have emerged in recent years, including the *SIKULIAQ,* the *Ocean Class* AGOR's, and the UK's *DISCOVERY* Replacement. Discussion papers and a comparative URN curve for these projects are attached.		RCRV Enclosures 7,8,9,10
i. Have the maintenance costs or other operational issues for the URN treatments aboard *SHARP* been significant or problematic in any way?	Bill Byam reports that they have not experienced costs yet, but he anticipates that some will occur. The largest may be the replacement of the engine and raft mounts for the isolated generators that need changing every 5 years. They have had some problems with noise sources and determining the causes. For example, there was a gear noise identified at the last acoustic testing, but neither the drive manufacturer or the engineers can pin point the source. Habitability receives high marks on *SHARP* due to the low noise levels.	
ii. Should the project continue to strive to meet ICES at a reduced speed similar to the *SHARP*?	FIC agrees that there are many advantages to a ship that strives to meet ICES under a realistic set of operational conditions similar to *SHARP*. These advantages include improved habitability, reduced anthropogenic impact on marine life, and less interference with shipboard acoustic systems. The tradeoffs of concern are loss of maneuverability (e.g., no consideration of Z-drives), and higher construction and maintenance costs. As with prior questions, a decision needs to be made whether ICES or some other standard is the best fit for the vessel's mission. Propeller design is critical. Glosten's propeller design does promise to minimize cavitation.	
iii. Do the recent URN trials for the	Recent URN trials indicate machinery noise	

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SHARP (attached) support the idea that a different standard than ICES is more achievable and appropriate, such as the limits being used for the ARRV?	will often drive URN above ICES. The curve for *SIKULIAQ* makes allowances at these low frequencies suggesting it would be more appropriate and achievable.	
iv. Alternatively, would FIC endorse the use of the URN limits currently being used for the Ocean Class AGOR's or the *DISCOVERY* replacement?	There were noise tradeoffs for *SIKULIAQ* because of its science mission to be ice capable. Similarly, an affordable, achievable noise curve for the RCRV needs to be established keeping in mind the mission of the ship and the advantages of measures that reduce URN. FIC does not wish to endorse the limits set for the Ocean class AGOR's or *DISCOVERY* Replacement apart from the full design refresh process.	
9. Incinerator: There is no regulatory requirement for vessels to have an incinerator under MARPOL. Having an incinerator is an operational choice in lieu of storing waste aboard followed by proper disposal ashore.		
i. Given the trend in "green" vessel design and emerging coastal state clean air regulations, should a vessel operated primarily in the coastal zone be fitted with an incinerator?	FIC recommends that a waste management plan must be established for the RCRVs. Trash compactors, and storage plans that promote shore-based recycling is preferred over a shipboard incinerator. Future air quality standards may limit incinerator use, and they add upkeep costs.	
II. Should the alternate provisions for handling waste be considered during the Phase I Project Refresh?	Yes as stated above.	
iii. Would FIC prefer space currently used for the incinerator be used for other ship or science purposes? If so, what?	Eliminating the incinerator will allow some redesign of aft 01 deck that could provide more space for science uses including possibly a space for incubators. Some space will need to be retained for trash storage.	
10. CTD Operations: The current Glosten design for RCRV has CTD operations conducted over the starboard side between frames 22–25.		RCRV Glosten General Arrangements
i. Does FIC endorse the ability to route the CTD cable over the stern A-frame?	The capability of routing .322 conducting cable over the stern A-frame should be included for maximum operational flexibility. There are desirable uses such as towed CTD strings.	

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ii. If so, if it were feasible and cost effective, should the stern A-frame be capable of the same "hands-free" deployment and recovery capability for science packages as the side handling device?	FIC is concerned that a hands-free stern A-frame capability would be a daunting design problem. Too many different instrument packages need to be deployed from the stern that would require multiple docking heads. Changing heads would consume a great deal of shiptime. A-frames need to stay "generic". If future science packages lend themselves more to a hands-free system, it could be retrofitted.	
iii. Similarly, should the main deck crane be capable of the same "hands free" deployment and recovery capability when using portable deck winches and/or the ship's fixed winches? This capability is under consideration for *SIKULIAQs* main deck cranes.	Again FIC thinks this is premature. No existing multipurpose deployment and recovery capability exists. The RCRV's crane will need to be general purpose for loading and offloading operations. Retrofitting may become desirable in the future.	
iv. What specific improvements from the *SHARP* and *KILO MOANA* systems should be incorporated into the *Load Handling System (LHS) Functional Requirements* (and the resulting construction specifications) for over-the-side handling systems with similar hands-free capabilities? For example, are the docking head designs and materials acceptable to all science users?	This should be addressed by a panel of experts, including UDel and UH persons familiar with the systems. Improvements based on the *SHARP* and *KILO MOANA* experiences should definitely be part of the Phase I refresh. This panel should consider citing the American Bureau of Shipping (ABS) Rules for Building and Classing Underwater Vehicles, Systems, and Hyperbaric Facilities 1990 as opposed to the normal ABS lifting guide. The difference is that the dynamic factors of safety are higher (.75) than the normal lift rules (.33).	
11. Incubators: Incubator space is problematic (and controversial) in every research vessel design.		RCRV Glosten General Arrangements
i. Should dedicated incubator space be eliminated and the vessel operator allowed to deal with it on an as-needed basis?	The use of incubators is common on biological and multidisciplinary oceanographic cruises. A dedicated space that is minimally shaded, easily accessible, reachable by the ship's crane, away from stack emissions and radar, and suitably plumbed and outfitted for temperature controlled seawater delivery and for securing incubators should be required. The space set aside on the 04 deck in the current RCRV design is not suitable.	

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ii. How would this space be better utilized for other science purposes?	The present planned space on the 04 deck would be better used for one or several satellite communication antennas and meteorological packages.	
iii. How does the *SHARP* deal with incubators and incubator plumbing? Is this an acceptable model?	The *SHARP* has a raw water manifold on deck that allows the hook-up of 4–8 hoses. Depending on the type of incubations, they have a waist high table that is placed on deck, horse troughs that are used for large samples and double containers for isotopes. The horse tubs and double containers can be located on deck or on top of the vans. This model is minimally acceptable. Its issues are that deck space is limited and often shaded, and the vans are in line with stack emissions and not easily accessible.	
12. **Berthing:** The Panel felt that the acceptable berthing arrangements were unclear in the design documentation.		
i. Given the size of the vessel, is it acceptable to have the lounge also used as the ADA stateroom?	A dedicated lounge on this size vessel is very important. The ADA stateroom should be kept separate and used like a non-ADA stateroom when no one with disabilities is aboard.	
ii. Should the lounge be used to expand general berthing capability? If so, how many bunks should it have?	No. The vessel is already designed with adequate berthing for the sizes of the lab, deck, and mess spaces. Adding more berths without increasing other spaces will make for inefficient and uncomfortable cruise experiences.	
iii. Has the convertible lounge concept on *SHARP* been acceptable to both science and the operator?	Most groups have preferred to keep the conference room/lounge as just that, a conference room/lounge. Bill Byam believes they have had only two cruises that used the lounge as a cabin. They have 14 bunks for science and can berth two more if they put science in with the cook and the technician. Most groups work with that number. Bigger groups typically request a bigger vessel.	
iv. If the vans are properly mated to the house, USCG inspected, and fitted with their own heads/showers, is the use of a berthing van acceptable to science?	Not advised for this size ship. The ship currently shows 16 science bunks, comparable to the *OCEANUS* class, yet with about 2/3 the lab space of *OCEANUS* class ships.	

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FIC should consider elimination of the hospital. 1. Eliminate the hospital and convert it to a usable science berth. This requirement pertains to inspected vessels and, given the operating area and significant impact on usable science space, is not considered necessary for the RCRV.	The hospital should be eliminated in favor of additional lab space. If it is made into an additional stateroom, then the amounts of lab space, mess space, sewage holding and deck space need to be adequate to accommodate 2 more people. Berthing should only be increased in conjunction with an increase in overall ship size.	
13. **Scientific Storage Space:** The Panel had concerns about the available science storage space, both temperature controlled and uncontrolled.		
i. Given the size of the vessel and its projected operating area, is the available built-in science storage space reasonable and adequate?	An effort should be made to increase lab storage space especially for items such as spare electronics equipment and science supplies. The lack of such space has been noted as a problem on the Cape class vessels. The amount of space dedicated to built-in hazmat storage is excessive, one or two smaller, portable lockers should be sufficient. The locations of the hazmat lockers may not be allowed by regulation, as they share boundaries with "critical" spaces (engine room, electrical machinery room).	
ii. Assuming no allowable increase in the size of the deck house but with potential increases in aft deck space, is there any existing space that should be re-allocated to science storage? If so, what space?	If the ship is lengthened, there is a chance that the small science hold aft might be enlarged. This will depend on placement of watertight bulkheads. In a design refresh, this should be looked at seriously.	
iii. If the aft deck space is increased such that there was still usable space with two vans on deck, would portable vans meet the requirements for science storage (both temperature controlled and uncontrolled)?	Storage vans are very useful and can be temperature controlled or not (meaning unheated/uncooled and no humidity control). There is an uncontrolled van used regularly on *WECOMA*, and it is especially useful for mooring and coring type equipment. Vans used in combination with adequate lab storage space could meet the science storage requirements.	

TABLE 2. RCRV vs. Existing Intermediate and Regional Class Vessels					
	RCRV	**Oceanus**	**Endeavor**	**Cape Hatteras**	**Sharp**
gross tonnage	<300	298	298	296	256
Displacement (long tons)	1035	1116		640	598
length (ft)	155	177	185	135	146
length (WL, ft))	152		165		135
beam (ft)	38	33	33	32	32
draught (ft)	12	17.5	18.5' aft / 12.5' forward	10	9.5
bow thruster	Elliott White Gill Model 32T3S-QR bow thruster	White Gill 350 HP trainable	J. Samual White Waterjet, 320 HP, DC variable speed and direction bow thruster	None	Schottel Tunnel Thruster
bow thruster HP	630	350	320	n/a	200
main engine HP	1730	3000	3050	1130	1500
speed (cruising, kts)	10	11	10	10	7
speed (max, kts)	11.8	14	14	12	12
range (nm)	5400	7000	8000	7000	3500
fuel capacity (gal)	35800	48000	56100	28695	13500
fuel consumption (gal/day) *	1432	1629	1515	885	583
fuel consumption (NSF estimate)	1289				700

*Estimated as (fuel capacity x 0.9) / (range/cruising speed / 24)