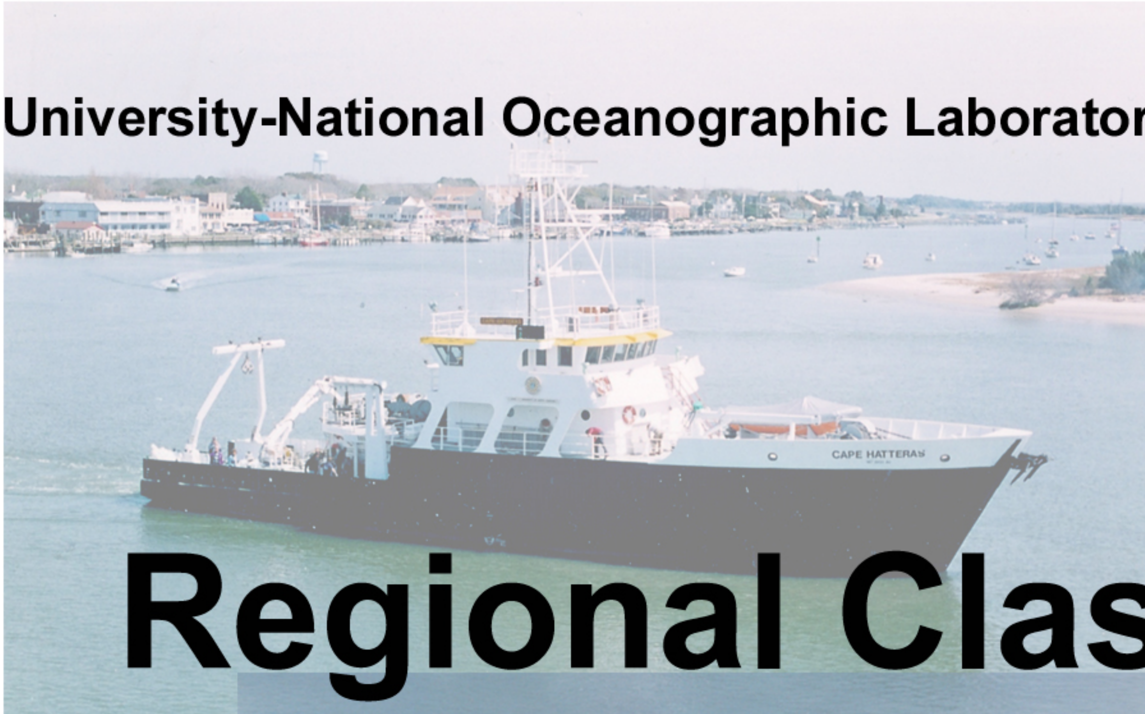
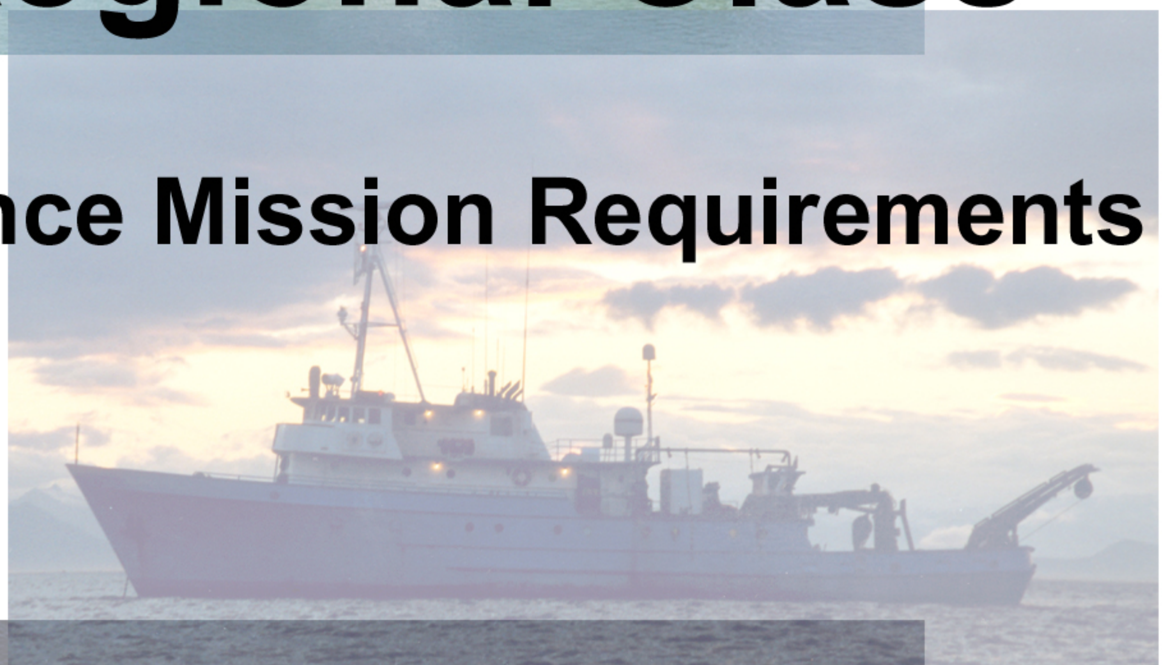
University-National Oceanographic Laboratory System



Regional Class

Science Mission Requirements



March 2003

University-National Oceanographic Laboratory System (UNOLS)

Science Mission Requirements for Regional Class Oceanographic Research Vessels

These Science Mission Requirements (SMR) were developed as part of the Academic Fleet Renewal effort outlined in the Federal Oceanographic Facilities Committee (FOFC) report: *Charting the Future for the National Academic Research Fleet – A Long-Range Plan for Renewal* published in December 2001. Funding for development of the SMR was provided to UNOLS through NSF Co-operative agreement number OCE 9988593 and through ONR Grant number N000140010742. Support and guidance for this project was provided by the following agencies:

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- Minerals Management Service
- Department of Energy

Version 1
March 6, 2003

Preface – Regional Class Research Vessel Science Mission Requirements

The timely replacement of the academic research fleet is vital to oceanographic research in the United States. The ships age and become more expensive to operate and they become less capable as scientific missions evolve. The Fleet Improvement Committee has over the past few years presented to the community compelling data showing that systematic replacement of the fleet must begin soon. If not, we will be using old and possibly unsafe ships and certainly ships that are not as capable as is needed.

The process used to construct new ships is many faceted, but a fundamental action is the formulation of the Science Mission Requirement: the SMR. The SMR states with as much specificity as possible what attributes the ship must have to perform the science envisioned. For example “What is the maximum sea state that a CTD cast can be taken in?” or “Is a core storage freezer needed and how big should it be?” The SMR provides a science capability framework for the steps between community input, vessel concept design, and final construction. It is not meant to serve as a final list of specifications, but as a list of science needs that may face prioritization during the funding and construction phase for the Regional Class vessels.

This document gives the best estimate of what the Science Mission Requirements are for a Regional Class Research Vessel. The document represents the work of over 70 people over the past 12 months. A meeting was held in Salt Lake City on August 15 and 16, 2002. Later the draft SMR was posted for public comment. Finally the Fleet Improvement Committee reviewed and finalized the document. The final document is then submitted to the UNOLS Council for approval, which it has received.

Although Mission Requirements and technology change with time this SMR represents a community consensus of what a Regional Class vessel should be capable of in the coming years. This document should be considered a living document that should be updated as new science requirements are identified and as new technical solutions become available.

This SMR should serve as the guiding document for concept designs, preliminary designs, and construction of new Regional Class Research Vessels.

Dr. Tim Cowles
UNOLS Chair
March 6, 2003

Dr. Larry Atkinson, Chair
UNOLS Fleet Improvement Committee
March 6, 2003

Regional Class Research Vessel

Science Mission Requirements

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Executive Summary

The Regional Class Research Vessel will be a general-purpose ship, designed to support integrated, interdisciplinary coastal oceanography in the broadest sense from shallow coastal bays and estuaries out to deep water beyond the shelf. The primary requirement is a maximum capability commensurate with ship size to support science, educational, and engineering operations in the coastal regions of the continental United States, including the Gulf of Mexico basin, with improved over-the-side equipment handling, station keeping, and acoustic system performance, while providing a stable laboratory environment for precision measurements. These vessels should be designed to be reliable, cost effective, and sufficiently flexible to meet the community needs over a span of 30 years. The summary table provides the minimum and desirable capabilities for major ship parameters. Additional details and explanations are provided in the text of the report. Prioritization and further refining the optimum values for each parameter should be completed prior to or as part of the development of concept designs.

Accommodations and habitability should be optimized in order to promote crew/technician retention and the resulting expertise for supporting the scientific missions. The design should maximize the sea-kindliness of these vessels and maximize their ability to work in sea states 4 (1.25 - 2.5 m wave heights) and higher. It is desirable for these vessels to operate effectively in sea state 5 (2.5 m to 4 m wave heights).

The stern working area should be open and as clear as possible from one side of the ship to the other and highly flexible to accommodate large and heavy temporary equipment. In addition, a contiguous work area is required along one side that provides area along the rail for coring and other operations. The area should be designed to provide a dry working deck with provisions to allow safe access for deployment and recovery of free-floating equipment to and from the water.

Additional deck areas should be provided with the means for flexible and effective installation of incubators, vans, workboats, and temporary equipment. There should be maximum visibility of deck work areas and shipside during science operations and especially during deployment and retrieval of equipment. Voice communication systems between the bridge, labs, berthing areas, working decks, and machinery spaces should be designed to effectively enhance ship control during science operations.

The design of weight handling appliances to safely and effectively deploy, recover and sometimes tow a wide variety of scientific equipment should be considered at the earliest stages of the design cycle. The entire suite of over-the-side handling equipment including winches, wires, cranes, frames, booms and other appliances should be considered as a system. Designs for over-the-side equipment should include innovative thinking and consider ideas that will reduce the amount of human intervention necessary for launch and recovery of equipment, both on wires and un-tethered, and that will control packages from the water to the deck. This will enhance personnel safety, reduce manning level requirements, increase operability in heavier weather and protect science and ship's equipment. The winches should provide fine control and should be capable of sustaining towing operations of large scientific packages continuously for days. However, impacts on engines, water making capability, and other factors when on station or moving at slow speeds for extended periods of time need to be considered in the design.

Flexibility and support for different types of science operations within limited space are the important design criteria for these vessels. Lab spaces should be capable of subdivision, providing smaller specialized labs. Benches and cabinetry should be flexible and reconfigurable. A high bay/hanger/wet lab space should support set up and repair of equipment, sample sorting, and other related functions. There should be accessible safe storage for chemical reagents and hazardous (non-radioactive) materials. There should be provision of dedicated storage/workshop space for science and ship use.

Each lab area should have a separate electrical circuit on a clean bus. Un-interruptible power should be available throughout all laboratory spaces, bridge/chart room, and science staterooms. Uncontaminated seawater should be supplied to most laboratories, vans, and several key deck areas. A separate high-volume seawater source with temperature control or sufficient flow to maintain ambient surface seawater temperature for incubations is required.

The ship should have the best available navigation capability with appropriate interfaces to data acquisition/display systems and ship control processors for geo-referencing of all data, dynamic positioning, automatic computer steering and speed control. The infrastructure and space for continuous underway sampling and data collection for as many ocean and atmospheric parameters as possible should be included in all design phases and construction details. Voice and data communication (e.g. satellite, cellular, VHF, HF, and UHF) to shore stations, other ships, boats, and aircraft will be made through the best available systems. High-speed data communication links to shore labs and other ships should be on a continuous basis.

The ship should be as acoustically quiet as practicable, requiring early planning in the choice of all shipboard systems, their location, and installation. Propeller(s) are to be designed for minimal cavitation and hull form should attempt to minimize bubble sweep down. Design criteria for noise reduction should take into account reducing radiated noise into the water that may affect biological research objectives, acoustic system performance and human habitability.

Heating, ventilation, air conditioning, and lighting appropriate to berthing, laboratories, vans, and other interior spaces being served should be carefully engineered and designed to be effective in all potential operating areas.

A thorough evaluation of construction costs, outfitting costs, annual operating costs, and long-term maintenance costs should be conducted during the design cycle in order to determine the impact of design features on the total life cycle cost. In particular, design possibilities on both sides of the significant tonnage breakpoints (300 tons US, 500 tons international) should be explored and assessed for initial and operating costs. The design should ensure that the vessel can be effectively and safely operated in support of science by a well-trained, but relatively small sized crew. The regional conditions, available ports, and shore side services should be considered during the design process.

Summary of Regional Class Science Mission Requirements

Parameter	**Capability or Characteristic**
Length	40 - 55 m (131' - 180')
Accommodations	16 to 20 non-crew personnel
Operational characteristics	
Endurance	21 days; surge capacity 30 days (15 transit and 15 station)
Range	8,000 nautical miles at optimal transit speeds
Speed	12 knots; 10 knots sustainable through sea state 4; 7 knots in SS 5
Sea keeping	Ability to work in sea states 4 (1.25 - 2.5 m wave heights); >50% operational in SS 5 (2.5 - 4 m wave heights).
Station keeping	Best available GPS and Dynamic positioning.
Track line following	Maintain a track line within ± 5 meters of intended track and with a heading deviation (crab angle) of less than 45 degrees with 25 knots of wind, up to sea state 4 (1.25 - 2.5 m wave heights), and 2 knots of beam current.
Ship control	0.1 knots from 0-5 knots; 0.2 knots from 6-12 knots
Over-the-side and weight handling	
Winches Wires Cranes Frames	New-generation integrated winch/crane handling systems. 2 hydro winches (10,000 m wire rope, electromechanical cable or fiber-optic cable - 1/4" to 1/2"); Trawl winch for 10,000 m 0.680 Fiber Optic and 9/16 trawl wire or next generation of wires - Interchangeable storage drums. A crane that can reach all working deck areas and capable of offloading vans and equipment weighing up to 8,000 lbs to a pier or vehicle in port is required: 16,000 lbs is desirable. Second, smaller articulated crane (4,000 lb capacity) with installation locations forward, amidships, and aft is desirable. Stern frame (min clear height of 15'; clear base of 15-20').
Towing	10,000 lbs tension at 6 knots; 20,000 lbs at 4 knots. Winches capable of sustaining towing operations continuously for days.
Science working spaces	
Working deck area	1,000 sq ft minimum clear area aft of deck houses; desirable 1,500 sq ft. Additional contiguous minimum 50' x 10' area along one side for coring, etc. Total amount of clear working area available on the aft main deck should be at least 1,300 sq ft.
Laboratories	Total lab space should be a minimum of 1,000 sq ft (1,500 sq ft is desirable) including: Main (dry) lab area (800 sq ft) designed to be flexible for subdivision; A fume hood and sink should be in the main and wet lab (2 sinks in main lab). Uncontaminated seawater in labs. Separate wet lab/hydro lab (400 sq ft) located contiguous to sampling areas. Electronics/computer lab; separate or part of main lab. A separate electronics repair shop/work space for resident (and visiting) technicians is desirable. High bay/hanger space for multiple purposes adjacent to the aft main deck is desirable; may be combined with wet lab/hydro lab. Climate controlled workspace or chamber (~100 sq ft) as lab or in van.

Summary of Regional Class Science Mission Requirements (continued)

Vans	Positions for 2 standardized 8 ft by 20 ft portable deck vans as lab, berthing, storage or specialized use. Space for 1-2 additional smaller vans is desirable.
Storage	~ 400-500 cubic feet of storage space that could also be used as shop or workspace when needed is desirable.
Science load	Variable science load should be least 50 LT.
Workboats	A 16-ft or larger inflatable boat located for ease of launching and recovery is required.
Masts On deck incubations Marine mammal & bird observations	Design criteria are presented so these science operation areas are not overlooked.
Science and shipboard systems	
Navigation	Best available GPS and Dynamic positioning.
Data network and onboard computing Communications: Internal & External	Navigation, computing, voice, and data communications (within ship and to shore) through the best available systems using current expert advice. Systems should be specified as close to actual delivery as possible.
Real time data acquisition system	Multibeam; 12 & 3.5 kHz; transducer wells; ADCP; portable seismic system; magnetometer; IMET (bow mast availability); clean power. Acoustically as quiet as possible. Minimize bubble sweep down.
Underway data collection & sampling	Promotes design of flexible and functional systems for data collection and sampling using advice from experts at the time of design and specification.
Visiting system installation and power	Build in capability to accommodate a variety of equipment.
Discharges	Ensure discharges do not impact science, health, and environment.
Construction, operation & maintenance	
Maintainability Operability Life cycle costs Regulatory issues	Statements to ensure that the design and construction of these vessels take into account the ability to maintain and operate within domestic and international regulations in a reliable and cost effective manner.

REGIONAL CLASS RESEARCH VESSEL
UNOLS Science Mission Requirements

Mission statement and overall characteristics

The Regional Class Research Vessel defined by these Science Mission Requirements and by the Federal Oceanographic Facilities Committee's (FOFC) Academic Fleet Renewal Plan will be a general-purpose research vessel capable of coastal oceanography in the broadest sense. The primary requirement is to maximize capability, flexibility, and performance commensurate with ship size in order to support research, education, and engineering operations in all coastal and near coastal regions of the continental United States. This work may be multi-disciplinary in nature and will often be centered on the continental margin, but can take place anywhere from shallow coastal bays and estuaries out to deep water beyond the shelf. By taking advantage of experience with past research vessel design, innovative new design approaches, modern equipment and technology, and the wisdom of experienced user and operator input to the design process, these vessels should be designed to effectively meet the needs of marine science and education for the next three decades.

These research vessels will be distinguished from their predecessors by several important features. Increased station keeping ability using dynamic positioning, improved performance of acoustic systems, and the use of fiber optics and other sophisticated winch and wire systems will allow these vessels to support many new and exciting research and education projects. Also important to the capability of these research vessels will be continuous high-speed communications with shore, other ships, and other data sources. These vessels will be designed to extend the seasons and weather that this class can safely and effectively operate in. Innovative weight handling and winch systems will improve the ability to deploy and recover equipment in higher sea states with less intervention by people on deck. Design features that will increase sea-keeping ability will also make these vessels and the people working in them more effective. Paying attention to habitability issues such as noise control, vibration, ventilation, lighting, and aesthetics will also increase the effectiveness and health of the crew and science party. Designing for reliability and ease of maintenance will also increase the availability of these vessels to support science and education. Lastly, given the smaller size of these vessels, they must be designed with flexibility in the use of limited space in order to maximize the number of different types of projects that can be supported.

These capabilities will allow these vessels to support a wide range of single-investigator and small multi-disciplinary research projects of shorter duration and closer to shore than those that require the larger classes of vessels. The type of projects supported will range from remotely operated and autonomous vehicle operations to mooring deployments, autonomous drifter deployments, and more traditional water, bottom, and net sampling cruises. Continuous sampling and profiling of the near surface water, ocean currents, near shore bottom, and meteorological parameters will enhance and complement the data from coastal observatories at the same time the vessels are supporting the installation and maintenance of key components in the observatories and taking advantage of the data in conducting research cruises. Public outreach and educational missions will be a major component of the operational profile of these vessels.

The design cycle for these vessels should take into account the need to build vessels that are not only capable for their size, but are efficient and cost effective to operate, maintain, and use. Equipment should be specified as late in the design/build process as possible in order to ensure outfitting with the most up-to-date technology possible. Flexibility should be built in for future upgrades and improvements. Specifications and design decisions should be made with input and review by expert user community groups or individuals. Safety, comfort, and functionality for the people living and working in these vessels should be an important design consideration.

Vessels in this class fall into a range that straddles key USCG and IMO regulatory thresholds. A careful analysis of the impact on construction costs and long term operating costs should be conducted as part of the design cycle in order to make intelligent decisions about the tradeoffs between science capability and overall cost and ease of operation. The size range and approximate operating characteristics were defined in the FOFC Fleet Renewal Plan. However, it will be important to define one or more vessels in this class that will provide a clear alternate choice in capabilities and costs between the many capable, but smaller local vessels and the larger Ocean Class research vessels. Regional differences will have to be examined and may dictate differences in outfitting and equipment, if not different hull forms and size. However, retaining as much commonality between the vessels of this class as possible would reduce the overall costs of design, construction, and operations. Previous efforts to build multiple vessels with the same design have proved to be effective and have produced real cost savings.

Science Mission Requirements (SMR) - Overview

The purpose of the science mission requirements is to set down design features and parameters that should be used as guidelines during the various design phases. There are some areas where there will be tradeoffs between two or more desired capabilities. By allowing more than one concept design, the possibility of finding ways to minimize these tradeoffs will be enhanced. A key concept is that ship systems are completely integrated with the science mission for these vessels. Sample mission profiles are included in Appendix I to provide examples of how these vessels might be used. It is possible that not all requirements can be fully realized in any one design and it will be necessary to refine priorities during the design phases. Regional priorities are described in Appendix II. Concept, Preliminary, and Construction design efforts should consider all elements in these requirements and make conscious decisions on how and if they can be addressed. These science mission requirements are organized with the following elements.

- **Mission statement**
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  - Data network and onboard computing
  - Real time data acquisition system
  - Communications - internal
  - Communications – external
  - U/W data collection & sampling
  - Acoustic systems
  - Visiting science system installation and power
  - Discharges
- **Construction, operation, & maintenance**
  - Maintainability
  - Operability
  - Life cycle costs
  - Regulatory issues

Science Mission Requirements - Details

Size and cost constraints (FOFC fleet renewal parameters)

The design phases will determine the overall size and cost of this vessel. However, the target size and cost were set in the FOFC Fleet Renewal Plan and serve as a benchmark for the design of this class of vessel. Even though it is intended that these vessels be more capable and larger than existing UNOLS Regional Class vessels, they should retain the lower operating costs, flexibility, and easy to operate characteristics of the existing vessels. The FOFC parameters were defined as:

Endurance: 30 days
Range: 15,000 km (8,100 nm)
Length: 40 - 55 m (131'- 180')
Science berths: 15 - 20
Cost: $25 million (This is interpreted to mean the total cost for design, construction, and outfitting in 2001 dollars)

These parameters are further defined by the science mission requirements described in this document. Depending on budgets and the further definition of science requirements and capabilities developed during the completion of one or more concept designs, these vessels could fall anywhere in the defined size range. Draft should be considered carefully so that operations in shallow areas and access to small coastal harbors are not limited while at the same time maximizing sea keeping. Endurance will need to be at least 21 days with a surge capacity to 30 days and science berths will be at least 16 with surge capacity to 20 or more. Range is not considered to be a significant design driver for these vessels and will be derived from speed, endurance, and hull form.

Cost will be a significant factor influencing the design, construction, and outfitting of these vessels. The budget and funding mechanisms available to the sponsoring agency for these vessels will determine the total budget for design, construction, and outfitting. The FOFC plan sets this number at approximately 25 million dollars per vessel in 2001 dollars. The actual amount available for detailed design and construction will be less than 25 million depending on how much is required for project management, outfitting, and preliminary design costs. Long term operating costs should be considered carefully in the design process so that decisions are not made that would drive up the yearly operating and maintenance costs.

A close examination of the impact that exceeding key tonnage thresholds (500 tons international & 300 gross registered tons) will have on construction and yearly operating costs should be conducted promptly. A major benefit of this class of vessel should continue to be the ability to accomplish a significant portion of the nation's research requirements while using a relatively smaller portion of the total marine science and ship operation budgets.

Accommodations & habitability

Accommodations

A minimum of 16 non-crew personnel in two-person staterooms is required and it is highly desirable to have the capacity to carry 20 or more when needed. Total complement would include an adequate number of maritime crewmembers to support the scientific mission, meet regulatory requirements, and support the need for proper maintenance of the vessel. The ability to accommodate up to 40 non-crew personnel safely on day trips should be included in design and outfitting decisions.

The non-crew personnel (often referred to as the Science Party) would consist of the personnel from the various scientific programs, the assigned marine technicians, technical support personnel for certain types of instrumentation (e.g. ROV/AUV groups, OBS groups, coring groups, etc.), foreign observers, education, and outreach personnel, and anyone else not part of the maritime crew.

The vessel should be designed for optimum habitability for normal science party size with the ability to expand to larger science party sizes when needed. Supporting infrastructure would be designed around the largest possible complement. Shower and toilet facilities should normally support no more than four people per unit. Staterooms should be designed to optimize the available space while maximizing habitability. Providing basic storage, washbasins, and limited workspace should be attempted in the design. Additional storage and larger workstations could be provided in common space elsewhere. Provisions should be made to accommodate gender imbalance.

The concept for designing a surge capacity that can be effectively used when needed is important to the flexibility of these vessels to support a wider range of potential projects. Making space such as a lounge or conference room convertible to bunk space or other effective use of space should be considered. The use of vans could be considered as long as the resulting accommodations are integrated into normal ship services, and they can be safely utilized. Past failures involving the use of berthing vans should be avoided.

The maritime crew and resident marine technicians should be berthed in single person staterooms to the maximum extent possible in order to promote crew retention and the resulting expertise for supporting the scientific mission.

Habitability

Heating, ventilation, and air conditioning (HVAC) appropriate to berthing, laboratories, vans, and other interior spaces being served should be engineered and designed to be effective in all operating areas. Laboratories shall maintain temperature of 70-75° F, 50% relative humidity, and 9-to-11 air changes per hour in all intended operating areas taking into account the full range of external sea water and air temperatures. Maintaining internal environmental conditions should consider the anticipated number of door openings (in a given period of time), and/or the normal door positions (open or closed) for each compartment's intended purpose.

Air circulation rates should meet shore lab standards (OSHA regulation 29CFR1910.1410) and SNAME standards for HVAC.

Some lab space should be clean for chemical analysis. This analytical lab space requires separate ventilation and/or organic filters, and if possible located in a separate lab space or specialized van. Safe storage and use of hazardous materials should take into consideration human health impacts.

The design should support maintaining acceptable noise levels throughout the ship and utilize specifications and standards applicable to vessels (USCG NVIC 12–82, IMO Resolution A.468 (XII) and OSHA regulation: 29CFR1910.95). These noise standards should be met as closely as possible at normal cruising speeds or in Dynamic Positioning (DP) mode, with ventilation systems operating at maximum levels, acoustic systems operating at maximum power, and with deck machinery operating. Noise reduction engineering should be integrated with design efforts at the earliest stages in order to incorporate noise level considerations in decisions about layout and arrangement of spaces.

Vibration should be minimized to conform to ABS and/or SNAME standards, and provisions should be made for mounting sensitive instrumentation in a manner to compensate for vibration and ship motion. Ship's motion is an important design criterion that will affect habitability and is addressed in the sea-keeping section.

Lighting levels should meet shore laboratory or office standards (OSHA). Lighting levels should be controllable for individual areas within labs to accommodate requirements for microscope work or other low light requirements. The ability to maximize the amount of natural lighting through the use of a sufficient number of port lights in lab spaces, staterooms, and common spaces should be included in the design.

HVAC performance, noise, vibration, and lighting standards should be defined for all occupied spaces on the vessel.

The productivity of all personnel sailing in these vessels can be enhanced by providing comfortable, aesthetically pleasing spaces, and by including, to the extent possible, areas for off-hour activities other than staterooms and workspaces such as a library, lounge, or conference room with tables, good lighting, video capability, and etc. Providing equipment and space for exercise should be considered. Staterooms should include connections to the ship's network and entertainment systems, but they need also to be separated from the noise associated with off-hour activities.

Operational characteristics

Endurance & range

Endurance should be twenty one (21) days with a surge capacity for thirty (30) days endurance (15 days at cruising speed and 15 days station work, see station keeping and towing). Some mission profiles will require continuous underway survey or towing operations at speeds from 4 knots up to the normal cruising speed. It would be desirable for these vessels to have 21-day endurance for these types of cruises. The design process should consider the impacts on engines, water making capability, and other factors when on station or moving at slow speeds for extended periods of time.

An 8,100 nautical mile (15,000 km) total range is desirable at optimal cruising speed.

Speed

12 to 14 knots maximum speed at sea trial is desirable and at least 12 knots is required. Optimum cruising speed should be between 10 and 12 knots with 10 knots sustainable through sea state 4 (1.25 – 2.5 m wave heights).

Speed control in sea state 3 or less (< 1.25 meters wave height) should be
0.1 knot in the 0-5 knot range and
0.2 knot in the 6-12 knot range.

Maximum speed and fine speed control should not be obtained at the cost of poor acoustical system operations, excessive noise, fuel consumption, or poor sea keeping.

Sea-keeping

Sea keeping is the ability to carry out the mission of the vessel while maintaining crew comfort and safety, and maintaining equipment operability. It is an important design criteria to maximize the sea-kindliness of these vessels and maximize their ability to work in sea states four and higher within the constraints of their overall size. It is desirable for these vessels to operate 50% of the time or greater in the wintertime in the Pacific Northwest and in the Northeast/Gulf of Maine. The use of bilge keels, anti-roll tanks or other methods to reduce the motions of these vessels should be incorporated in the designs.

In sea state four (1.25 – 2.5 m wave heights) these vessels should be able to:

- Maintain underway science operations at 9 knots
- Maintain on station operations 80 % of the time, including:
  - CTD operations 90% of the time
  - Mooring deployments 75% of the time
  - Coring operations 50% to 75% of the time
  - ROV operations 50% of the time
- Limit maximum vertical accelerations to less than 0.15 g (rms)
- Limit maximum lateral accelerations to less than 0.05 g (rms) at lab deck level
- Limit maximum roll to less than 3 degrees (rms)
- Limit maximum pitch to less than 2 degrees (rms)

At sea state five (2.5 – 4 m wave heights), these vessels should maintain 7 knots and be capable of station operations 50% of the time.

At sea state six (4 – 6 m wave heights), these vessels should maintain 4 knots and be capable of station operations 25% of the time.

At sea state seven or greater (>6 m wave heights), these vessels should be able to operate safely while hove to.

These motion criteria specifications should be verified as adequate and achievable during the earliest concept design phase. Otherwise, other motion criteria that result in ship motions that allow personnel and equipment to work effectively can be utilized during the concept design phase as long as the intent of the above sea keeping specifications is not sacrificed. Tables showing sea state and the practical effects of ship motion are included as appendices V and VI.

Station keeping

Station keeping is the ability to maintain a position and heading relative to a station or track line that allows the mission of the vessel to be completed. The Regional Class Research Vessel should be able to maintain station and work in sea states up through 4 (1.25 – 2.5 m wave heights) at best heading.

Dynamic positioning, using the best possible and multiple navigation inputs, should be possible, in both relative and absolute references in the following conditions:

- 25 - knot wind
- Sea state 4
- 2 - knot “beam” current

The maximum excursion allowed should be ± 5 meters (equal to navigation accuracy) from a fixed location for operations similar to bore hole re-entry and up to ± 20 meters for operations through sea state 4 at best heading.

DP system design and operation should minimize noise, vibration, and adverse effects on the operation of acoustic systems as much as possible, and these issues should be evaluated early in the design process.

Track line following

The vessel should maintain a track line while conducting underway surveys for spatial sampling and geophysical surveys within ± 5 meters of intended track and with a heading deviation (crab angle) of less than 45 degrees with 25 knots of wind, up to sea state 4 (1.25 – 2.5 m wave heights), and 2-knot “beam” current. This target may be required for ship speeds as low as 2 knots. Straight track segments shall be maintained without large and/or frequent heading changes.

Ship control

The chief requirement for ship control is maximum visibility of deck work areas and alongside during science operations and especially during deployment and retrieval of equipment. This should be accomplished with a direct view to the maximum extent possible and enhanced with closed circuit television systems. Portable hand-held control units or alternate control stations could also be used at various locations that enhance visibility and communications with the working deck during over the side equipment handling. The functions, communications, and layout of the ship control station should be carefully designed to enhance the interaction of ship and science operations. For example, ship course, speed, attitude, and positioning should be integrated with scientific information systems. Voice communication systems between the bridge, labs, working decks, and machinery spaces should be designed to effectively enhance ship control during science operations. Also, an integrated bridge management and collision avoidance system should be provided to help ensure safe and efficient science operations in traffic congested coastal waters. Autopilot and DP systems should be integrated with sophisticated control settings that allow appropriate response levels for the type of work being conducted. These systems should also be designed to enhance manual control of the vessel whenever needed.

Ice strengthening

ABS Class C (ability to transit loose pack ice) may be desirable for one or more vessels of this class that may operate in the Gulf of Maine or further north. This does not imply a dedicated, ice strengthened, high-latitude research vessel.

Over-the-side and weight handling

Over the side handling

The design of weight handling appliances to safely and effectively deploy, recover, and sometimes tow a wide variety of scientific equipment should be considered at the earliest stages of the design cycle. The entire suite of over the side handling equipment including winches, wires, cranes, frames, booms, and other appliances should be considered as an integrated system and perhaps engineered and designed by a single contractor/manufacturer. Designs for over the side appliances and equipment should include innovative thinking and consider ideas that will reduce the amount of human intervention necessary for launch and recovery of equipment, both on wires and un-tethered, and that will control packages from the water to the deck. Heave compensation and other techniques designed to minimize stress on cables and equipment should be included in designs of these systems. This will enhance personnel safety, reduce manning level requirements, increase operability in heavier weather, and protect science and ship's equipment.

These vessels should have a stern frame or other appliance that provides a height from the attachment points for blocks to the deck of 24 feet and have a clear width between the legs of 15 feet minimum. A 20-foot clear area through the frame would be desirable and this width should extend at least 15 feet off the deck. At least 12-foot inboard and outboard reach is required and the ability to safely launch long towed bodies, 3-meter diameter mooring buoys, and other large packages is highly desirable. Stern weight handling appliances should have a dynamic safe working load of 20,000 lbs and should be structurally engineered to 1.5 times the breaking strength of the strongest cable to be deployed.

Weight handling appliances on the starboard and port sides should be provided with at least one permanent location near amidships on the starboard side. It would be highly desirable to have at least one additional "ready to use" temporary location near the starboard quarter and one on the port side of the main deck. A method for deploying small towed sensors or other packages from near the bow would also be highly desirable. Structural engineering, power sources, and control systems should be built in so that installation and removal of temporary weight handling appliances can be accomplished easily in port. Deck areas should be flush and clear for other uses when frames are removed. Weight handling appliances on the sides should facilitate operations such as coring, towing small packages and nets, deploying free floating equipment and moorings, and the safe handling of standard sampling packages. It is desirable that the CTD handling system deploy and recover the package (24 x 30 liter place rosette) directly to and from the wet lab or associated hanger or move it there with minimal handling. These systems should also be designed to work with multiple wire sizes, to support operations using multiple winch locations and to easily support switching from one winch or wire to another while on station.

Control stations(s) should be located to provide maximum visibility of over the side work. Control stations must provide the operators with the ability to monitor operations as well as provide them with protection.

The need for any human-rated load handling equipment is considered a capability that may be desirable for individual Regional vessels. This requirement should be identified early in the design cycle for that vessel.

Winches and wire

These vessels should be designed to operate with a new generation of oceanographic winch systems that are an integral part of the equipment handling and deployment system. The winches should provide fine control (0.1 m/min under full load); maximum winch speeds should be at least 100 meters/min; and constant-tensioning and other parameters, such as speed of wire, should be easily programmable while at the same time responsive manual control must be retained and immediately available at any time. Manual intervention of winch control should be available instantly for emergency stop and over-ride of automatic controls. Wire monitoring systems with inputs to laboratory panels and shipboard recording systems should be included. Wire monitoring systems should be integrated with wire maintenance, management, and safe working load programs. Local and remote winch controls should be available. Remote control stations should be co-located with ship control stations and should be located for optimum operator visibility with reliable communications to laboratories and ship control stations. Winch control and power system design should be integrated with other components of over-the-side handling systems to maximize safety and protection of equipment in heavy weather operation and to maximize service life of installed wires. Adequate provisions for connecting slip rings and ship's power and data network to the E-M and F-O cables should be included in the design.

Outfitting should include one or two normally installed hydrographic-type winches capable of handling up to 10,000 meters of wire rope, electromechanical, or fiber-optic cables having diameters from 1/4" to 1/2". Winches should be readily adaptable to new wire designs with sizes within a range appropriate to the overall size of the winch. Shorter lengths of wire may be necessary to save space, weight, and money. Required minimum lengths for each wire type should be determined for individual Regional vessels.

A heavy winch complex capable of handling up to 10,000 meters of 9/16" wire/synthetic wire rope, or up to10,000 meters of 0.68" electromechanical cable (up to 10 KVA power transmission) or fiber optics cable should be permanently installed. Smaller cable or shorter lengths may be acceptable depending on vessel size and area of operations. This is envisioned as one winch with multiple, interchangeable storage drums, of which only one would be installed.

Winches handling fiber-optic cable should be traction winches that allow storage of the cable under lower tension unless new technologies in wire construction allow otherwise. This includes winches for both 0.68" and smaller cables.

Additional special-purpose winches (e.g., clean sampling, pumping, multi-conductor) may be installed temporarily at various locations along working decks. Winch sizes and power requirements should be considered during the design phase in order to establish reasonable limits for the vessel size.

Permanently installed winches should be out of the weather where feasible to reduce maintenance and increase service life. The trawl/tow winch should be below the main deck if possible, but smaller winches may be located in semi-protected areas of the 01 deck to allow for better fairlead.

Wire fairleads, sheave size, and wire train details need to be integrated with the general arrangement as early in the design process as possible in order to increase the possibility of limiting wire bends and overly complicated wire train. Sheave sizes, number, and locations should be designed to maximize wire life and safe working load.

Details of winch location should include provisions for easily changing wire drums, spooling on new cable, and changing from one storage drum to another, and for major overhaul of winches so that these operations can take place with minimum time and effort in port. Some operations, such as re-reeving wires through fairlead blocks or switching the wire being used through a frame or with a traction winch, should be factored into designs so that the operations can be performed at sea safely and efficiently.

Cranes

A suite of modern cranes should be provided to handle heavier and larger equipment than can be handled by previous vessels of this size and should be integrated with the entire over-the-side handling system. A crane that can reach all working deck areas and be capable of offloading vans and equipment weighing from12,000 to 16,000 lbs to a pier or vehicle in port is desirable. Being able to load and offload equipment up to 8,000 lbs is required. This will generally mean being able to reach approximately 20 feet beyond one side of the ship (usually starboard) with the design weight. The main crane should be able to deploy buoys and other heavy equipment up to 8,000 lbs up to 12 feet over the starboard side at sea. Location of the main crane should minimize its impact on useable working deck space while still maximizing its ability to achieve reach and load requirements.

It may be desirable to have second, smaller crane with installation locations forward, amidships, and aft, articulated for work at deck level and at the sea surface, with weights up to 4,000 lbs. They would also be usable with re-locatable crutches as an over-the-side, cable fairlead for vertical work and light towing. If the design includes the need to store and launch boats or to deploy equipment from the foredeck, then as a minimum a crane location or other device should be provided forward. Over the side cranes should have servo controls and motion compensation or damping. The ship should also be capable of installing and carrying portable cranes for specialized purposes.

The need for any human-rated crane is considered a capability that may be desirable for individual Regional vessels. This requirement should be identified early in the design cycle for that vessel.

Towing

The ship should be capable of towing large scientific packages up to 10,000 lbs tension at 6 knots, and 20,000 lbs tension at 4 knots. Winch control should allow for fine control (± 0.1 meters/min) at full load and all speeds. Winches should be capable of sustaining towing operations continuously for days at a time.

Towing operations include mid- to low-load operations with mid-water equipment such as towed undulating profilers, single and multiple net systems, and biological mapping systems. Other systems may involve larger and spike loads such as deep towed mapping systems, bottom trawls, camera sleds, and dredges.

Science working areas

Working deck areas

A spacious stern working area with 1,000 sq ft minimum aft of deck houses open and as clear as possible from one side to the other is required. In addition, a contiguous waist work area along one side (starboard preferred) that provides a minimum of a 50 ft length of clear deck along the rail should be available. This area will allow for 10 to 15 meter piston coring and other operations. A minimum width of eight feet is needed for the coring operations and the overall width of the waist deck should be wide enough to accommodate all planned operations. The total amount of clear working area on the main deck aft should be maximized and equal at least 1,300 sq ft. It is desirable to accommodate at least a 10 meter (33 ft) core and up to 15 meter (50 ft) piston coring operations. The coring process design and design for other major operations should take place during the early design of the vessel. There should be space for up to two vans on the main deck with minimal interference with over the side operations.

Provide for deck loading according to current ABS rules (i.e. designed for a 12 foot head or 767 lbs/sq ft) and a minimum aggregate total of 40 tons on the main working deck. Point loading for some specific large items (such as vans and winches) should be evaluated in the deck design since these may generate loads of 1,500 lbs/sq ft or higher.

All working areas should provide 1”-8NC (SAE National Coarse Thread) threaded inserts on two-foot centers with a tolerance of ± 1/16” on center. The bolt down pattern should be referenced to an identifiable and relevant location on the deck to facilitate design of equipment foundations. The inserts should be installed and tied to the deck structure to provide maximum holding strength (rated strength should be tested and certified). Tie down points should be provided for any clear deck space that might be used for the installation of equipment including the foredeck, O-1 deck, bridge, and flying bridge, and should extend as close to the sides and stern as possible.

The stern deck area should be as clear as possible and highly flexible to accommodate large and heavy temporary equipment. Bulwarks should be removable and all deck-mounted gear (winches, cranes, a-frames, etc.) should be removable to a flush deck to provide flexible re-configuration.

The design should strive for a dry working deck with provisions for allowing safe access for deployment and recovery of free-floating equipment to and from the water. Traditionally low freeboard and stern ramps have been provided as means to accomplish this goal. The actual use of stern ramps has been limited in the past and should be included in new designs only if required by specific planned operations. Low freeboard facilitates launch and recovery operations, but results in wetter decks and less reserve buoyancy. The use of innovative design features to facilitate safe and effective equipment launch and recovery while maintaining dry and safe weather decks should be carefully considered. Removable bulwarks with hinged freeing ports to provide dry deck conditions in beam or quartering seas have proved effective. The use of a moon pool can be considered. The use of wood or synthetic decking material to protect equipment, promote draining of water, and to provide for safer footing should be considered.

A clear foredeck area should be capable of accommodating small, specialized towers, booms, and other sampling equipment as much as possible. Providing tie down sockets, power, water, and data connections will facilitate flexible use of this space.

Additional deck areas should be provided with the means for flexible and effective installation of incubators, vans, workboats, and temporary equipment. (See relevant SMRs below for details)

All working decks should be equipped with easily accessible power, fresh and seawater, air, data ports, and voice communication systems. Adequate flow of ambient temperature seawater for incubators should be available on decks supporting the installation of incubators.

All working decks need to be covered by direct visibility and/or television monitors from the bridge. Gear deployment areas should maximize direct clear visibility.

Laboratories

Lab - Number, type, and size

The majority of the lab space should be located in one or two large lab(s) that can be reconfigured, partitioned, and adapted to various uses to allow for maximum flexibility. This flexibility is an important design criterion.

To the maximum extent possible, labs should all be located on the same deck adjacent to each other and adjacent to the main working deck areas. Labs should be designed to minimize their use as general passageways. Doors and hatches should be designed to facilitate installing large equipment, loading scientific equipment, and bringing equipment and samples to and from the deck areas. Doorsills should be temporarily removable.

A total of at least 1,000 sq. ft. of lab space is required and 1,500 sq. ft. is desirable (dimensions below are approximate guidelines). On this class of vessel, the additional lab space may need to be provided in well designed and integrated laboratory vans in order to provide the flexibility in the amount of lab versus deck space available.

The main (dry) lab area (up to 800 sq ft) should be designed to be flexible with the provision for subdivision into smaller specialized labs.

A separate wet lab/hydro lab (up to 400 sq ft) is to be located contiguous to sampling areas.

An electronics/computer lab should be provided as a separate lab or as a defined area in the main lab. This space should be dry and separated as much as possible from sources of electronic noise. It may include a central watch standing space that should accommodate visiting science equipment as well as normally installed equipment. Provisions for remote displays in other labs should be part of lab designs.

A separate electronics and equipment repair shop/work space for resident technicians that includes provision for repair bench space for visiting technicians is desirable. Storage space for resident technician spares and tools should be defined in the design so that it is not taken from useable laboratory space. A small separate room or partitioned space for IT (server, telephone, and network) equipment is desirable.

High bay space for multiple purposes adjacent to the aft main deck is desirable. This space could support protected set up and repair of equipment, sample sorting, and other related functions. In this size vessel this function could be combined with the wet lab/hydro lab hanger space.

A climate controlled workspace or chamber (approx. 100 sq ft) is required. This can be provided using a van or to some degree by providing a well-designed area that can be partitioned from the main lab or wet lab. If the vessel size or layout allows, the space might be provided as a separate lab space that can be used for other purposes as well. This space should be capable of controlling temperature to ± 0.5°C. Lighting should be controllable and programmable.

Design of HVAC systems should be integrated with designed partitioning of laboratory spaces so that temperature control can be achieved. Access to labs should be designed to minimize effect on air-conditioning systems and climate control. Lighting control should also take into account partitioning plans

Space for two (20 cu ft) stand-alone refrigerator/freezer units with similar configuration and refrigeration equipment capable of maintaining temperatures between –15°C and 10°C (these temperature requirements should be verified during design) should be provided. Additional units (such as 80°C) could be accommodated at the expense of other uses of lab space or in van space when needed. Built in units should not be needed and should not be included unless the space could be used for alternate purposes when not needed as refrigerated space.

Lab - Layout and construction

Flexibility and support for different types of science operations within limited space are the important design criteria for these vessels. Benches and cabinetry should be flexible and reconfigurable (e.g. SIO erector set and/or Unistrut™). Bench and shelving heights should be variable to allow for installation and use of various types of equipment. The ability to easily install or remove cabinets and drawers as needed should be included. Provisions for large, flat chart/map tables, including a light table, should be incorporated in the lab design.

Refer to the section on habitability for guidance on the importance of lighting, air circulation, etc.

Labs should be fabricated using materials that are uncontaminated and easily cleaned. Furnishings, HVAC, doors, hatches, cable runs, and fittings must be planned to facilitate maintaining maximum lab cleanliness. Spaces and materials that may trap chemical spills should be avoided.

Static dissipative deck coatings to reduce static damage to electronics should be required in “ET” shop and computer/electronics spaces and recommended in other lab spaces. Deck coatings should protect the ship’s structure, be easily cleanable, easily repairable, and resistant to damage from chemical spills. Deck materials or padding should provide safe footing and minimize fatigue to working personnel that need to stand for long periods.

The distance from the deck to the underside of the finished overhead should be 7.5 to 8 feet. Headroom space and room for the installation of tall equipment should be maximized while balancing the need for cable trays, adequately sized ventilation ducts, lighting, etc.

Through the design process, minimize the incursion of “ship stuff” (e.g., air handlers, gear lockers, and food freezers) into the lab space.

Labs should have bolt downs (1/2”-13NC on two foot centers) in the deck in addition to Unistrut™ on the bulkheads and in the overhead. Bolt downs on one-foot centers should be considered for some areas.

Locations for one fume hood in the main lab and one in the wet lab should be included in the laboratory layouts. Exhaust ducting, electrical connections, and sink connections should be permanently installed in place to allow for easy installation and removal of fume hoods. Fume hood locations should accommodate hoods up to four feet wide.

Sinks should allow for flexible installation and removal, and additional sinks when needed. At least one location in the wet lab and two locations in the main lab should be provided with stubbed out plumbing at convenient locations. More locations can be provided if possible. Drains should be designed to work at all times, taking into account operating conditions that create various trim and list conditions, rolling, etc. Drains should be capable of being diverted over the port side, into holding tanks, or to the normal waste system, and should allow for continuous discharge of running water. Sinks should be large enough to accommodate five gallon buckets and the cleaning of other equipment.

Work with radioactive materials should be restricted to a radiation lab van that remains isolated from the interior of the vessel.

Lab - Electrical

Each lab area is to have a separate electrical circuit on a clean bus with continuous delivery capability of at least 40-volt amperes per square foot of lab deck area with a total estimated laboratory power demand of 75 KVA (the amount of power needed will be verified at the time of design). Un-interruptible power should be available throughout all laboratory spaces, bridge/chart room, and science staterooms. The use of modular UPS design should be considered. Separate circuits should be available for tools and other equipment that will not interfere with clean power circuits. Use current IEEE 45 or equivalent standards for shipboard power and wiring and current IEEE standard for UPS and clean power specifications.

Electrical service for the labs should include:

- 110 VAC, single phase 75-100 amps service for each lab;
- 208/230 VAC, 3-phase, 50 amps, “readily available” (i.e., in the panel, or 1-2 outlets);
- 480VAC, 3-phase available “on demand” (for example run into the lab from auxiliary outlets on deck).

There should be dedicated science wire-ways with dedicated transits to all science and instrumentation locations, including locations at the bow, at the seawater intake locations, and at winches. Science wire ways should be separated from power and other signal cables. There should also be non-energized wiring installed and dedicated to supporting project science systems (appropriate gauge and number of conductors determined during design phase). Provisions for easy installation and removal of temporary wiring should be made.

Lab - Water and air

Uncontaminated seawater should be supplied to most laboratories, vans, and several key deck areas. This water must be collected as close as possible to the bow and piping must be made from materials acceptable to the majority of science users. Provisions for keeping piping clear and clean should be included in the design. Provisions for changing pumps, valves, and piping when necessary should be included in the design. Provisions for connecting multiple users in addition to semi-permanent equipment should be provided. A backup or alternate system should be considered. Provision of space and connections as close to the intake as possible are desired.

Clean hot and cold water should be provided to sinks and equipment in labs and on deck. Good feed water to instrumentation to make 18 mega-ohm water (e.g., Millipore Milli-Q) is required. Ship’s reverse osmosis water is not adequate without further treatment. Space or equipment for adequate clean water (18 mega-ohm) supply should be provided.

A separate, higher volume seawater source with temperature control or high enough flow to maintain ambient surface seawater temperature for incubations should be provided. Sea chest location and maintenance should be designed for proper operation on a continuous basis. This system should be separate from fire fighting, ballast, and ship service saltwater systems or designed as part of a flexible and redundant seawater supply system that allows operation of ship’s service systems without interfering with science operations.

The ship’s service compressed air supply (@100 psi) should be available in the labs and have the ability to add filters as needed. Clean dry air needs are to be handled by bottled air or user supplied filter systems. Volume of air and whether or not a continuous supply will be required should be considered during the design stages in order to ensure that installed compressors are properly rated. The need to support high volume or specialized air requirements such as seismic work, driving air powered pumps, or SCUBA tank recharging should be clearly specified and carefully considered early in the design process. Provisions for removable fixtures in the lab spaces designed to secure compressed gas tanks need to be included.

Design of seawater systems should be integrated with instrumentation requirements and should be conducted with review and input by expert user groups. In particular, current advice on acceptable materials and specifications for providing bubble-free uncontaminated seawater under all steaming and sea conditions should be sought.

Vans

Space should be provided to carry two (2) UNOLS/ISO standard 8 ft by 20 foot portable deck vans which may be laboratory, berthing, storage, or other specialized use. Berthing vans should be used only after careful consideration of safety, habitability, and maintenance issues.

- Hookup provisions for fresh water, uncontaminated seawater, compressed air, drains, Peck and Hale fittings, communications, alarms, data, and shipboard monitoring systems should be provided. Connections and other provisions for vans should be designed around UNOLS standard vans.
- Electrical connections for 20 amps 480 VAC 3-phase, 40 amps 230 VAC 3-phase, and 40 – 50 amps 208 VAC single phase should be provided. 110 VAC single phase may also need to be provided, but usually can be provided by panels in the van from step down transformers. (Verify requirements at time of design.)
- Vans should be capable of having weather-protected access to ship interior and be located in wave sheltered spaces. Safe access to and from the vans is the primary consideration.
- Radiation vans should be capable of installation so that they can be isolated from the interior of the vessel while still allowing safe access for personnel
- Supporting connections at more than one location around ship is desirable.
- Capability of offloading light or empty vans using ship's crane is desirable.

Science (and ship's) storage:

Although storage space for multiple legs will not be a requirement for this class of vessel, the provision of some storage/workshop space for science and ship use will enhance the effective utilization of lab space. Approximately 400 to 800 cubic feet of space that could be used for storage and as shop or workspace when needed would be desirable. Storage space on this class vessel would be used for shipboard technician's tools and shared used equipment in addition to project related equipment. An alternative concept would be to provide a temporary storage space that could be converted to surge berthing space when needed.

Adequate provisions should be made for ships stores and spares and may need to be included as a separate defined area in the same storage area. Providing adequate and specified storage for both the science project and ship's needs will help to ensure maintainability, operability, and prevent encroachment into science areas by required ship needs.

Provide accessible safe storage for chemical reagents and hazardous (non-radioactive) materials. The use of lockers or storage containers outside the lab space should be considered. Accommodating required separations of certain materials needs to be provided. Provisions for storing gasoline safely should be identified in the design. Radioactive materials would be stored and used only in radiation vans. Only working quantities of other hazardous materials would be stored in the labs. Provisions for safe storage of gas cylinders should be considered. (See lab water and air section above.)

Science load

Variable science load should be at least 50 LT. This load would include science related equipment, supplies, and instrumentation not normally installed on the vessel. Examples are mooring equipment, ROV systems, temporary winches, rock and mud samples, lab equipment, temporary cranes or frames, vans, and extra workboats. Items that would NOT be included are regularly installed winches (permanent and removable), stern A-frames, other normally installed handling equipment, rescue boats, and ship's workboats.

To prevent losing this variable science load to the inevitable growth in light ship displacement, a service life allowance of approximately 5% additional load capacity should be included in the design. The ship's ballast system should have the capacity and capability to compensate for a changing science load during a cruise.

Workboats

At least one (1) 16-ft or larger inflatable (semi-rigid or foam collar) boat should be located for ease of launching and recovery. The vessel should have the capability to carry and deploy a scientific workboat 16 to 22 ft LOA that may need to be accommodated at one of the two van location options or on other available deck space.

Required rescue boats may be capable of serving as a science workboat with careful planning. Otherwise, workboats will be required in addition to any IMO/USCG required rescue boats.

Masts

The main mast and a second lightweight and removable mast will both have yardarms capable of supporting up to five scientific packages weighing between 30 and 100 lbs. Radar, radio, and other RF frequency generators will not be installed on these yardarms, but meteorological packages could be. Meteorological packages should be mounted in locations where the airflow is disturbed as little as possible by the ship's structure. Provisions for mounting the lightweight mast in the least disturbed air possible should be included in the design.

The main mast should be designed such that ship's crew/technicians can easily/safely/comfortably work aloft on the mast to change sensors and instruments. Any secondary mast should be similarly designed or be easily lowered to service instruments. Connections and wiring will be installed to allow easy connection between sensors and instruments located on the masts and the vessel's fiber-optic data transfer network.

A crow's nest may be considered to support science operations such as marine mammal work, bird surveys, and others.

Clearance under bridges should be considered on a regional basis for determining the maximum allowable height (air draft) of the vessel. The use of innovative designs should be considered if bridge clearance is a limiting factor.

On deck incubators and optical equipment/instruments

Design of deck layout and science infrastructure should include consideration for carrying out a certain amount of deck incubation or optical experiments without interfering with other deck operations. This deck area must receive as much unobstructed sunlight as possible. At the same time, the weight of wet incubators may need to be considered for decks that are high above the baseline. Specifying deck area to be used for these experiments early in the design process will help to ensure that other design decisions do not have a negative impact on providing this capability and will ensure that the required services are provided. Other important design considerations are that a continuous flow of near surface seawater at ambient temperatures (< 1 degree C above ambient) is available with adequate flow (e.g., minimum 50 gals/min) using a dedicated system (i.e. not fire pump or flushing pump) in order to maintain the proper temperature for the experiments.

The advice and input of expert scientific user groups should be sought as part of the design process to ensure current requirements are met.

Marine mammal & bird observations

Design of the pilothouse area and/or flying bridge should include provisions for obstruction free (at least a combined180 degrees forward of the beam) observations by two to three scientific personnel. These bird and mammal observers will be on watch continuously during daylight hours and observation locations should include secured, but removable chairs, access to navigation/data network, and a protected location for portable computers and/or logbooks. Mounting locations for big eyes or similar devices may be required for some observers. Observer locations should be free from radiation hazards generated by RADARS and other communication equipment.

Science and shipboard systems

Navigation

Best available navigation (real-time kinematics, differential, P-code, and 3-axis GPS) capability shall be provided with appropriate interfaces to data systems and ship control processors for geo-referencing of all data, dynamic positioning, and automatic computer steering and speed control. Back ups and redundant systems should be provided to ensure continuous coverage.

Best available electronic charting (e.g. ECDIS) and bridge management system shall be provided.

GPS aided attitude heading reference system (AHRS) and/or other systems for determining ship heading, speed, pitch, roll, yaw, etc. as accurately as possible should be installed at the best location and integrated into ship and science systems.

Bridge navigation, management, and safety systems will meet all regulatory requirements and facilitate effective science operations with minimal manning. Systems should be designed so that any changes to bridge navigational display and control systems will not have any effect on science data collection processes. Communication of waypoint information between science and bridge system should be an integral part of the system. Specification, purchase, and installation of systems should take place as close to delivery as possible to ensure the most up-to-date systems.

Provisions for temporary installation of short or ultra short baseline acoustic systems and other navigations systems when necessary should be included so that they can be integrated with existing systems.

Data network and on board computing

A modern and expandable data network should be integrated into the design for all spaces on the research vessel including labs, deck areas, instrument locations, bridge, machinery spaces, common areas, and staterooms. Wireless networks should be available in laboratories. Connecting cables/wiring should be installed to all areas and include provisions for growth.

Specifications for actual cables/wiring should be made as close to installation as possible in order to assure the most up-to-date equipment. Routers, connectors, and associated equipment necessary to operate the network should be specified, purchased, and installed as close to delivery as possible for the same reason. The design and specifications for the data network, general computing capability, and on board post processing capability should be completed by a knowledgeable user and operator group based on best available equipment and technology at the time that is compatible with equipment commonly used by ship users.

High performance computing systems that are reliable and redundant will be needed for data logging, processing, plotting, and display, especially for multibeam swath mapping cruises. These systems will be used by shipboard technicians as well as the scientific party. Final selection of computers, disks, tapes, plotters, and screens should be delayed as long as practical, to keep current with technological advances and to insure compatibility with the vessel's operating institution.

Standards for shipboard wiring (IEEE 45 or current guidelines) address keeping signal and power wiring separate and should be adhered to. During the design phase routes for wires to be installed should be planned and layouts should include permanent non-energized wires as well as provisions for temporary wiring. Such plans should add flexibility and accommodate growth in equipment and temporary project equipment.

Real time data collection, recording, and display

A well designed "system" for real time collection of data from permanently installed sensors and equipment as well as provision for temporarily installed sensors and equipment that allows for archiving, display, distribution, and application of this data for a variety of scientific and ship board purposes should be designed and specified by a group of knowledgeable science users and operators. This “system” should be integrated with the data network and other onboard systems with access to data and displays available in staterooms and all working spaces. While planning for this system should begin at early stages to ensure that it is integrated into the ship’s infrastructure, the actual specification of hardware and operating system should be made as close to delivery of the vessel as possible to ensure an up to date system. Final location of intakes for underway seawater sampling should be determined following final hull design to minimize thermal contamination, bubbles, intake blockage, and to maximize water flow.

Internal communications

Internal communication systems should provide high quality voice communications throughout all science spaces, working, and berthing areas. Point to point and all-call capabilities are required such as 21mc and 1mc systems. A sound powered phone emergency system should be included.

All staterooms should have phones for internal communications. A primary and backup (spare) telephone switch capable of providing one voice line to every space on the ship and access to off-ship services such as INMARSAT or equivalent equipment should be provided. Voice telephone wiring to all spaces on the vessel should be installed. Consideration should be given to including installed equipment to support pagers, mobile phone/radio (UHF) communications, or other versatile methods for contacting key (or all) personnel.

Alarm and information panels should be installed in key workspaces, common areas, and all staterooms. The alarm system and information panels should connect to vans seamlessly.

The ability to install closed circuit television monitoring and recording of working areas should be provided to improve operations and safety.

The ability to install monitors (flat screen) for all ship control, environmental parameters, science, and over the side equipment performance should be available in all, or most, science spaces and common areas.

Infrastructure for internal communications and data networks should adhere to IEEE 45 standards (or current guidelines) for keeping signal and power wiring separate and other safe reliable design considerations.

External communications

Reliable voice channels for continuous communications to shore stations (including home laboratories), other ships, boats, and aircraft should be provided. This includes satellite, cellular, VHF, HF, and UHF (best available and required by regulations).

Voice and data communications should be provided through the best available systems (currently cellular (near shore) and satellite based systems). Plans should include high-speed data (best current capability) communication links to shore labs and other ships on a continuous basis; data transmission systems should be connected to internal networks and phone systems to provide accountable calling, network (internet), and email access.

Transmission of video, photographs, and large data sets, as well as access to data sources and web sites ashore on a continuous basis, should be available.

Facsimile communications or other methods to transmit graphics and hard-copy text at high speeds on demand are also required.

A programmable VHF and UHF radio-direction finder capable of supporting frequencies utilized by transmitters on drifters, AUVs, buoys, and other science systems should be available. Current and up to date requirements should be verified as close to delivery as possible.

Locations for satellite, cellular, and other line of sight antennas should be clear and as high as possible. The design should minimize interference between systems, provide for installation of additional systems, and ease of maintenance as much as possible. Provisions for some permanently installed wiring from temporary antenna mounting locations or from permanently installed antennae to the laboratories to facilitate user-installed antennae or receiving equipment should be included.

Design should include capabilities for acoustic communication with submersibles, data buoys, and underwater sensors based on currently utilized technology as well as the ability to tie underwater data transmission and voice signals with other communications systems. Provisions should be included for changing or installing underwater acoustic transducers as needed.

Plans need to provide locations for installing temporary antennae including antenna to receive direct satellite readouts of environmental remote sensing data. External communications systems should be completely integrated with internal voice and data systems to the maximum extent possible.

Underway data sampling and data collection

The infrastructure and space for continuous underway sampling and data collection for as many ocean and atmospheric parameters as possible should be included in all design phases and construction details. This would include, but not be limited to surface (or near surface) seawater temperature, salinity, fluorescence, chemical, and biological measurements. Provisions for adequate continuous flow of seawater in all underway conditions to all permanently installed and temporary sensors should be included. System design including proper location for equipment, pump materials and design, de-bubblers, screening, intakes, and plumbing materials that ensure accurate measurements should be made based on current advice from science experts.

Provisions for sampling clean, uncontaminated, and ambient temperature seawater while underway at all speeds should be included in the design.

Acoustic systems

Acoustic capabilities and quiet operation are important design criteria for this class of vessel. Each ship should be as acoustically quiet as is feasible considering the choice of all shipboard systems, their location, and installation. Special consideration should be given to machinery noise isolation, including heating and ventilation. Propeller(s) are to be designed for minimal cavitation, and hull form should attempt to minimize bubble sweep down. Consideration of specialized mounting arrangements for transducers to enhance system performance should be part of the design process utilizing past experience and expertise of equipment manufacturers and expert users. Design criteria for noise reduction should take into account reducing radiated noise into the water and ship that may affect biological research objectives, acoustic system performance, and habitability. Other design considerations should be directed at maximizing the performance of installed acoustic systems. Guidance, advice, and operational criteria from appropriate experts should be used during the design and construction process to accomplish these high priority goals and to identify the future scientific requirements.

Installed systems should be based on the currently best available systems and should include the following types of systems:

- 12 kHz single beam deep-sea echo sounder that meets the International Hydrographic Office (IHO) standards for accuracy.
- Sub-bottom profiler operating in the 2 to 8 kHz frequency range with an array suitable for use with a 10-kW transmitter, or best available system at acquisition time. The system should include a frequency and amplitude modulated transceiver with capability to operate at fixed frequency with variable ping length. Transducer space should be allocated for a parametric sub-bottom profiler
- A shallow depth multi-beam swath mapping system capable of one degree or best possible resolution for bathymetric mapping (meet IHO standards) and for guiding seafloor sampling/photography and enhancing other science operations. Towed or temporary (e.g. pole mounted) systems could be considered for this capability.
- Acoustic Doppler Current Profiling system with transducers for more than one frequency, hull mounted and capable of 1000 meter depth and fine scale shallow water performance.
- Systems for acoustic navigation, tracking, and communications with submersibles and other underwater systems.

Transducer wells, void spaces or dagger boards should include the following provisions:

- Locations fore and aft to optimize transducer operation.
- The ability to change and service transducers easily while the vessel is afloat.
- Several transducer-mounting locations that can be adapted to a wide variety of transducers within a reasonable size range. Use of centerboard or other innovative methods to place transducers in location for optimum performance.
- Design for expanding transducer numbers and changing requirements and equipment to ensure the ability to change and add acoustics systems over the life of the vessel.
- A location for installing a communications transponder in the transom of the vessel should be considered to allow acoustic communications with towed objects.

Provisions should be made in the structure of the hull and/or deck for mounting temporary transducer/transponder poles on one or both sides of the vessel.

Project science system installation

Provisions are required for readily installing equipment that is brought on board occasionally such as SeaSoar, MOCNESS, Deep Tow, Magnetometers, specialized ADCPs, slack tether ROVs, AUVs, remotely piloted aircraft, and other systems. The types of equipment will need to be defined during concept and preliminary design cycles, and as much flexibility as possible should be designed. Generally providing power sources, deck space, mounting locations and data connections will accommodate most needs, however, in some cases it may be necessary to provide fuel, hydraulic power, or other services.

The electrical system capacity and design should take into account provisions for the cruise-by-cruise connection of systems with large electrical motors or power demands. Multiple locations on deck, for vans, and in laboratories with provisions for multiple simultaneous connections should be possible for 480V 3-phase, 208 – 230V 3-phase and single phase, and 110V single phase with up to 50 amps service. Final design specifications should take into consideration common electrical requirements for currently used and planned equipment, and excess capacity should be included in the design to the maximum extent possible.

Discharges and waste

All liquid discharges from sinks, deck drains, sewage treatment systems, cooling systems, ballast pumps, fire fighting pumps, and other shipboard or science systems should be on the port side, with tanks capable of holding normal (concept designs should define a reasonable volume per person) discharges for a minimum of 24 hours. Design should allow for zero discharges on the starboard side, including deck drains, when required during normal operations.

A well thought out waste management plan should be developed during the design phases so that these vessels can prevent, control, or minimize all discharge of garbage and other wastes at sea. The use of all appropriate and best available systems and methods such as compactors, incinerators, vacuum toilets, low flow showers, oily water separators, efficient marine sanitary devices, recycling, adequate holding tanks, and others should be used to prevent, reduce, and control waste discharges. The location of garbage storage areas should be well defined. The vessel should be designed and equipped so that it can effectively adhere to all local, state, federal, and international (MARPOL) pollution regulations, to prevent contamination of science experiments, to protect the environment, and to ensure the health and safety of embarked personnel.

An on-deck hazardous storage capability for chemicals plus a holding capability for class C waste should be provided. Provisions for low-level radioactive waste storage will be incorporated in the radiation vans.

Discharges of engine exhaust, sewage system vents, from fume hoods, and from ventilation systems should be designed so they do not re-enter the ship's interior or ventilation systems and so they can all be directed away from the ship at the same time with proper placement of the relative wind (i.e. all on the port side aft). Exhaust and air system discharges should be separated from sensor locations as much as possible.

Construction, operation & maintenance

Maintainability

Starting with the earliest elements of the design cycle, a high priority should be the ability to maintain, repair, and overhaul these vessels and the installed machinery and systems efficiently and effectively with a small crew. This ability is a science mission requirement in the sense that increased reliability and fewer resources and man-hours devoted to maintenance and repair means more time and personnel support for science. Ship layout should include adequate space for ship repair and maintenance functions such as workshops with proper tools, spare parts storage, and accommodations for an adequate crew. Design specifications should include provisions for reliable equipment (including adequate backups and spares) that are protected from the elements to the maximum extent possible. Equipment monitoring systems and planned maintenance systems combined with configurations that provide for reasonable access by repair and maintenance personnel will help ensure that equipment remains in the best possible condition. Specifications for equipment should require all equipment vendors to provide parts lists, manuals, and maintenance procedures in electronic form for integration with a Computerized Maintenance Management System (CMMS). This will reduce the overall cost and effort for maintaining a reliable research vessel.

Operability

Design should ensure that the vessel could be effectively and safely operated in support of science by a well trained, but relatively small crew complement. The regional conditions, available ports, and shore side services should be considered during the design process. The impacts of draft, sail area, layout, and other features of the ship design on the ability to operate the vessel during normal science operations should be evaluated by experienced operators, technicians, scientists, and crewmembers.

Life cycle costs

A thorough evaluation of construction costs, outfitting costs, annual operating costs, and long-term maintenance costs should be conducted during the design cycle in order to determine the impact of design features on the total life cycle costs. Economy of operation has been a big benefit of the smaller classes of research vessels, and this aspect should be retained as much as possible in the new Regional Class designs.

Regulatory issues

The impact of USCG and international regulations on the design and outfitting of these vessels should be carefully considered. The size of the vessel will directly impact one or more regulatory thresholds, which will in turn impact manning levels, outfitting, and design criteria, which will have an impact on life cycle costs and operations.

The following mission scenarios are designed to show the types of work the Regional Class vessels may carry out. In some cases these scenarios illustrate how scientists currently adapt to existing vessels and point out areas that might suggest design features to accommodate science project equipment. They do not represent all possible scenarios and are intended to serve as examples. Distances are in nautical miles (nm).

Type of work:	2D and 3D high resolution chirp sonar (deep towed) profiling		
Number in science party:	13		
Time of year:	June – September		
Area of operations:	Mid-Atlantic U.S. (New Jersey shelf)		
Dist. From nearest port:	100 nm	Transit speed:	10 knots.
Dist. Survey/towing:	1,500 nm	Towing/survey spd:	4.5 - 5.5 knots.
Days on station	Days towing/survey	Days transit	Total days
2	18	2	22
Major or special equipment:	We will bring our own tow-body and towing winch. We will also install our own WAAS/DGPS navigation equipment and install a boom over the side (stbd) to track the fish.		

Type of work:	Piston coring – up to 10 meter long in up to 4,000 m water depth.		
Number in science party:	12		
Time of year:	Summer		
Area of operations:	Eel River/Santa Barbara/Monterey		
Dist. From nearest port:	100 nm	Transit speed:	9 + knots.
Dist. Survey/towing:	-	Towing/survey spd:	-
Days on station	Days towing/survey	Days transit	Total days
10	-	0 – 4	10 – 14
Major or special equipment:	Heavy gear handling and rigging for piston coring		

Type of work:	Launching & servicing gear on MARS (NEPTUNE) type observatories.		
Number in science party:	16		
Time of year:	Summer for most, some operations year round		
Area of operations:	Monterey Bay/ Juan de Fuca Plate		
Dist. from nearest port:	30 – 150 nm	Transit speed:	9 + knots
Dist. Survey/towing:	-	Towing/survey spd:	-
Days on station	Days towing/survey	Days transit	Total days
1 – 2	-	0 – 2	2 – 3
Major or special equipment:	Dynamic positioning, heavy gear handling on deck and lowering to bottom.		

Type of work:	Current meter moorings, ADCP & Triaxus/Sea Soar type survey, CTD transect, productivity experiments		
Number in science party:	16		
Time of year:	Spring or early summer, upwelling season		
Area of operations:	Coastal shelf – off Point Arena, California		
Dist. from nearest port:	100 nm	Transit speed:	10 knots
Dist. Survey/towing:	900	Towing/survey spd:	8 knots
Days on station	Days towing/survey	Days transit	Total days
7	5	3	15
Major or special equipment:	Crane and anchor sled for mooring work, ADCP, CTD, towed undulating profiler, incubators		

Type of work:	Demonstration of Oceanographic Techniques		
Number in science party:	30 - 40		
Time of year:	Spring or Fall		
Area of operations:	Offshore San Diego, Ca. or Monterey Bay, Ca.		
Dist. from nearest port:	15-20 nm	Transit speed:	10 knots
Dist. Survey/towing:	10 nm	Towing/survey spd:	1.4 knots
Days on station	Days towing/survey	Days transit	Total days
.25	.20	.20	.65
Major or special equipment:	.322 CTD, otter trawl, ADCP, Hydro cast on 1/4 in. wire, Bongo net tows, MOCCNES tows, Van Veen dredge		

Type of work:	Towed magnetometer study, marine mammal and fish study. Diving ops. Small boat ops.		
Number in science party:	14		
Time of year:	September		
Area of operations:	La Paz, Baja California Transit from San Diego.		
Dist. from nearest port:	40 -100 nm; 800 nm from home port	Transit speed:	10 knots.
Dist. Survey/towing:	350 nm.	Towing/survey spd:	4 knots
Days on station	Days towing/survey	Days transit	Total days
11	6	8	19
Major or special equipment:	Diving compressor to fill scuba tanks, 22 ft. survey/dive boat, 17 ft RIB, towed magnetometer, on deck aquaria		

Type of work:	Carbon Cycling on Continental Shelf		
Number in science party:	14		
Time of year:	All year		
Area of operations:	Northeast Continental Shelf		
Dist. from nearest port :	10 nm	Transit speed:	12 knots
Dist. Survey/towing:	1500 nm	Towing/survey spd:	6 knots
Days on station	Days towing/survey	Days transit	Total days
4	10	2	16
Major or special equipment:	ScanFish, Rad Van, CTD with rosette, incubations, in-situ array, ADCP with 2-4 m vertical resolution		

Type of work:	Shelfbreak Front Upwelling and Primary Productivity		
Number in science party:	20		
Time of year:	Spring to Fall		
Area of operations:	Shelfbreak on any coast		
Dist. from nearest port :	100 nm	Transit speed:	12 knots
Dist. Survey/towing:		Towing/survey spd:	1 to 5 knots
Days on station	Days towing/survey	Days transit	Total days
2	8	2	12
Major or special equipment:	Pumping SeaSoar, Tow-yo CTD, CTD with rosette, Rad Van, ADCP with 2-4 m vertical resolution		

Type of work:	Mixing by Solutions		
Number in science party:	12		
Time of year:	All Year		
Area of operations:	Continental Shelf		
Dist. from nearest port :	10 nm	Transit speed:	12 knots
Dist. Survey/towing:	2000 nm	Towing/survey spd:	6 knots
Days on station	Days towing/survey	Days transit	Total days
0	14	0	14
Major or special equipment:	Towed turbulence package, Acoustic backscatter instrument (need a transducer well), ADCP with 1-2 m vertical resolution, highly maneuverable vessel in shallow (50 m) water		

East Coast

- Take into account the broad continental shelf in the design as well as work beyond the shelf.
- Endurance from 21 to 24 days required
- Capable of winter time operations in the Gulf of Maine: heating, ice strengthening
- Coring capability for 5-meter cores required and 10 meters highly desirable.
- Some storage space as mentioned in the text is important. Since this vessel will be ranging from the Gulf of Maine to Florida, storage of some gear for cruises while away from homeport would be desirable.

Gulf of Mexico

- Science drivers include study of hydrography, gas hydrates, seeps, large active furrows, basin-scale circulation monitoring and modeling, interaction with active oil/gas exploration/production, and impacts of coastal/river runoff.
- Capabilities required include taking large diameter cores, deep tow profiling, and ROV work.
- There are no larger vessels in the immediate vicinity; closest is R/V SEWARD JOHNSON on the Florida Atlantic coast
- A vessel at the lower end of the Regional Class size range under 500 GT may not meet regional requirements. We need to provide capability in logical increments between existing coastal vessels (go for the gaps).
- Natural and man-made hazards in the Gulf must be considered (oil rigs, gas deposits, hurricanes).
- Between storms, weather is better than along other coasts. Storms can be as severe as in the Pacific or Atlantic, but of shorter duration.
- Some operations may require up to 24 science berths.

West Coast

- Operation in higher sea states (4 to low 5) and transits in the trough year round.
- Draft and size to allow operations in and near bays and estuaries and entry into small coastal harbors. Maximum draft of 12 feet desired.
- Requirement for international voyages to Mexico and Canada.
- Dynamic positioning with capability to hold station within the tolerance of navigation accuracy.
- Capability to handle slack tethered ROV systems, AUVs, and remotely piloted aircraft.
- Spring and winter time operations along entire west coast, except during storms.
- Carefully consider the possibility of staying below 500 GT and 300 GRT
- 500 GT is a benchmark for State environmental regulations. California (Oregon and Washington soon) has stringent environmental regulations that apply to coastal regions and harbors.
- Anchoring arrangements appropriate to deep, rocky bottoms and weather encountered along much of the West coast.
- Capability to install multiple point anchoring systems when needed.
- Acoustic system performance is a high priority.
- Coring capability for 5-meter cores required and 10 meters highly desirable.

Regional Class Research Vessel
Science Mission Requirements Study Process and Participants

Federal agencies were urged by the Academic Fleet Review (Schmitt et al., 1999; conducted for the National Science Foundation and approved by the National Science Board in May 1999) to begin the process of long-range planning for the renewal of the fleet. As a result of this report, the Federal agencies, through the Federal Oceanographic Facilities Committee (FOFC), and with input from the academic community (via UNOLS), produced a plan entitled "Charting the Future for the National Academic Research Fleet" <http://www.geo-prose.com/projects/fleet_rpt_1.html>. Over the next 20 years, the Plan calls for a fleet that is more capable than at present, but that has fewer vessels. In the Plan, four classes of ships (Global, Ocean, Regional, and Local) were used to describe the future fleet. Regional Class ships will continue to work in and near the continental margins and coastal zone, but with improved technology and more science berths than in current, comparably sized vessels.

A Regional Class steering committee was appointed by the UNOLS Council in February 2002 to lead the process of developing science mission requirements for this new class of vessel, which is the first step towards design and construction. The steering committee members were:

Wilford Gardner (Chair)
Texas A & M University

Bruce Corliss & Joe Ustach
Duke University

Dennis Hansell
Rosenstiel School of Marine & Atmospheric Sciences

Rich Muller
Moss Landing Marine Laboratories

Steve Rabalais
Louisiana University Marine Consortium

Tom Shipley
University of Texas

Denis Wiesenburg
University of Southern Mississippi

Starting with the parameters outlined in the FOFC fleet renewal plan and with previously published SMRs an online questionnaire was created and publicized widely in the UNOLS community. More than sixty researchers, ship operators, and technicians provided input that was used in preparing the initial draft of a new SMR.

A workshop was held on August 15-16th in Salt Lake City, Utah to draft comprehensive science mission requirements for the Regional Class. This workshop was funded through the UNOLS office grants and was attended by researchers, technicians, ship operators, funding agency program managers, and naval architects.

As a result of the workshop, a draft Regional Class SMR report was prepared and has been available for community review and input on the UNOLS web page. An executive summary description based on the SMR including a table of major characteristics is provided. The detailed SMR is a more comprehensive document that attempts to provide enough detail to guide the design and build cycle from concept designs to outfitting of the finished vessel. This makes for a much longer document than previous versions of SMRs, but we hope this will serve to ensure that important details are considered starting at the earliest stages of design. Certain parameters will require prioritization prior to or as part of developing concept designs.

All interested members of the community were asked to review the complete SMR document and provide feedback to help produce the final report. The online version provides comment blocks for each section. Community input to the Regional Class SMR Questionnaire is posted on the UNOLS website at <http://www.unols.org/fic/regional/rcsmrinput.html>.

This document and further developments in the academic fleet renewal process are posted to the UNOLS Fleet Improvement Committee web page:
http://www.unols.org/fic/

UNOLS and the Fleet Improvement Committee would like to thank all of the participants of the Regional Class Workshop and those who participated by providing community input.

Regional Class SMR Workshop Participants:

Thomas Althouse	SIO/UCSD	John M. Morrison	North Carolina State
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Regional Class SMR Community Input Participants:

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Steven Lentz	WHOI	Tom & Donna Wolcott	NC State
Randy Maxson	FIO	Louis Zimm	SIO
Kirk McIntosh	UT		

Beautiful Wind Scale & Sea State

#	Wind [knots]	Description	Sea State	Wave Ht [feet]	Effects at Sea
0	< 1	Calm	0	0	Sea like a mirror
1	1-3	Light air			Ripples with appearance of scales; no foam crests
2	4-6	Light breeze	1	< 0.3	Small wavelets: crests of glassy appearance, no breaking
3	7-10	Gentle Breeze	2	0.3-1.6	Large wavelets: crests begin to break, scattered whitecaps
4	11-16	Moderate breeze	3	1.6-4	Small waves, becoming longer; numerous whitecaps
5	17-21	Fresh breeze	4	4-8	Moderate waves, taking longer form; many whitecaps; some spray
6	22-27	Strong breeze	5	8-13	Larger waves forming; whitecaps everywhere; more spray
7	28-33	Near gale	6	13-20	Sea heaps up; white foam from breaking waves begins to be blown in streaks
8	34-40	Gale			Moderately high waves of greater length; edges of crests break into spindrift; foam is blown in well-marked streaks
9	41-47	Strong gale			High waves; sea being to roll; dense streaks of foam; spray may reduce visibility
10	48-55	Storm	7	30-30	Very high waves with overhanging crests; sea surface takes white appearance as foam is blown in very dense streaks; rolling is heavy and visibility reduced
11	56-63	Violent storm	8	30-46	Exceptionally high waves; sea covered with white foam patches; visibility seriously affected
12	> 63	Hurricane/typhoon	9	> 46	Air filled with foam; sea completely white with driving spray; visibility greatly reduced

Description of Ship Motion Criteria

Source: Marintek

DESCRIPTION	CRITERIA RMS-Value	COMMENTS	REFERENCE
VERTICAL ACC.:			
Exposure: 0.5 hour	0.10 g	10% motion sickness incidence ratio (MSI) (vomiting) among infrequent travelers general public	ISO 2631/3 1987 & 1982
1.0 hour	0.08 g		
2.0 hours	0.05 g		
8.0 hours	0.03 g		
Simple Light work possible	0.27 g	Most of the attention devoted to keeping balance	Connoly 1974
Light manual work might be carried out	0.20 g	Causes fatigue quickly. Not tolerable for longer periods	Mackay 1978
Heavy manual work might be carried out	0.15 g	Limits in fishing vessel	
Work of more demanding type	0.10 g	Long term tolerable for crew	Payne 1976
Passenger on a ferry	0.05 g	Limit for persons unused to ship motions	Goto 1983
Passenger on a cruise liner	0.02 g	Older people. Lower threshold for vomiting to take place	Lawther 1985
ROLL:			
Light manual work	4.0°	Personnel effectiveness	Comsrock 1980
Demanding work	3.0°	Personnel effectiveness	Hosada 1985
Passengers on a ferry	3.0°	Short routes. Safe footing	Karppinen 1986
Passenger on a cruise liner	2.0°	Older people. Safe footing	Karppinen 1986
PITCH:			
Navy Crew	3.0°	Limits to avoid damage to personnel	Comstock 1980
Light manual work	2.0°	Personnel effectiveness	Hosada 1985
Demanding work	1.5°	Personnel effectiveness	Hosada 1985
HORIZONTAL ACC.:			
Passenger on a ferry	0.025 g	1-2 Hz frequency. General public	ISO 263/1
Navy crew	0.050 g	Non-passenger and navy ship	
Standing passenger	0.070 g	99% will keep balance without need of holding	Hoberock 1976
Standing passenger	0.080 g	Elderly person will keep balance when holding	Hoberock 1976
Standing passenger	0.150 g	Average person will keep balance when holding	Hoberock 1976
Standing passenger	0.250 g	Average person max. load keeping balance when holding	Hoberock 1976
Seated person	0.150 g	Nervous person will start holding	
Seated person	0.450 g	Persons will fall out of seats	