UNIVERSITY NATIONAL OCEANOGRAPHIC
LABORATORY SYSTEM

ALASKA HIGH LATITUDE RESEARCH VESSEL

Scientific Mission Requirements for an Intermediate, Ice-Strengthened, General Purpose and Fisheries Oceanography Research Vessel

(Revisions: September 2000 and March 2001)

The original Science Mission Requirement (SMR) statement was prepared by a committee of the UNOLS Fleet Improvement Committee in 1998, and it served as the vehicle for initiation of the present design effort. The SMR has been considered and refined by the UAF Oversight Committee and the Alaska Regional Research Vessel (now referred to as the AHLRV) Advisory Committee. Amendments and revisions were approved in consultation with the naval architect (Glosten Associates).

Oversight Committee:

University of Alaska: Vera Alexander (Chair), Robert Elsner, Thomas Smith, Thomas Weingartner, and Terry Whitledge

Woods Hole Oceanographic Institution: Joe Coburn, Richard Pittenger, and Robertson Dinsmore

Advisory Committee:

Knut Aagaard, PhD, Polar Science Center, University of Washington

Larry Atkinson, PhD, Center for Coastal Physical Oceanography, Old Dominion University,

John Christensen, PhD, Bigelow Laboratory

George Hunt, PhD, Department of Ecology and Evolutionary Biology, University of California Irvine

Kenneth Johnson, PhD, Monterey Bay Research Institute

James Meehan, PhD, NOAA / NMFS

Suzanne Strom, PhD, Western Washington University

History: Construction of the R/V ALPHA HELIX was completed in 1966. The ship operated occasionally in sub-arctic seas (North Pacific, Bering, and Chucki) while operated by Scripps Institution of Oceanography (1966-1978) and more extensively by the University of Alaska (1978-present). ALPHA HELIX is the oldest currently operated research vessel in the UNOLS fleet. The ship's ice strengthening is modest (ABS Class C), and therefore its suitability for arctic work is subject to severe limitations. A replacement vessel having improved research and ice capabilities will substantially extend the range and capability of research support in these regions of great scientific interest.

The replacement research vessel under consideration will be capable of general oceanographic investigations in high latitude open seas, near-shore regions, and seasonal sea ice. It will not be expected to encounter multi-year ice during ordinary operations. By these criteria, the ship will occupy an important role not served by any other research vessel in the UNOLS fleet. Further, it's functions will differ substantially from those of the new Coast Guard icebreaker, USCGC HEALY, which is intended to support research throughout the Arctic, including the Central Arctic Basin, in conjunction with other national and international interests and operations.

Regional Needs: The ship will be capable of conducting seasonal oceanographic research in the North Pacific Ocean, Gulf of Alaska and the Bering, Chukchi, and Beaufort Seas. Interdisciplinary approaches and requirements for fisheries oceanography/marine ecological research indicate the need for diverse capabilities including over-the-side fisheries sampling as well as acoustic procedures. However, the ship is not intended to be engaged in routine stock assessment surveys. Operations will include multi-seasonal work, and, accordingly, the vessel will be ice strengthened sufficiently to work in seasonal sea ice.

An intermediate-size ship is necessary to permit multidisciplinary cruises of long duration, since access to fuel and other services will be limited in some cruises. The vessel construction and operation will conform to standards including ABS (ice classification), SOLAS (safety), MARPOL (pollution prevention, ISM (management), GMDSS (emergency communications), STCW (operations), and CASPPR (Canadian arctic pollution prevention). The primary requirement is maximum capability commensurate with ship size to support research operations in high latitudes and a stable work platform in anticipated sea states. These features involve optimal over-the-side equipment deployment, towing, and a stable, well-designed laboratory environment. The ship will accommodate moderately large scientific parties and must have flexible laboratory and deck space designed for multiple uses.

The research vessel proposed here would satisfy some of the National Oceanic and Atmospheric Administration's needs for high latitude ship support, especially for those programs involving active collaboration and partnership with academic institutions. NOAA has been conducting multidisciplinary research in the Gulf of Alaska and Bering Sea over the past several years, and has had a substantial requirement for general oceanographic and biological ship time. This requirement is an addition to the fisheries vessels needed for scheduled stock surveys. Given the critical economic and climatic importance of the region, it is reasonable to assume that such work will continue for the foreseeable future.

There is increasing incentive for NOAA to work with UNOLS in order to make use of the regional vessels in the academic fleet. Programs such as FOCI and SEBSCC have had substantial ship requirements. During the past two years, a UNOLS vessel (R/V WECOMA) has been used in the Bering Sea in addition to the NOAA vessel Miller Freeman. However, there has been difficulty in scheduling some of the proposed cruises. With the addition of a dedicated regional UNOLS vessel designed for multidisciplinary high latitude research, NOAA's Alaskan program will have improved access to ship time. This activity and academic UNOLS use, as well as the strong likelihood of additional Bering Sea and arctic initiatives, is predicted to provide the number of sea days per year adequate to ensure a cost-effective operation.

Environmental Conditions: Operations in the Bering, Chucki, and Beaufort Seas will encounter extensive seasonal sea ice. The navigational severity of these regions varies abruptly north of the Pribilof Islands. For example, sufficient ice-strengthening for the anticipated ship will permit year-round operations south of St. Matthew Island, three months of the year near Point Barrow, and two months (August and September) in the Beaufort Sea offshore of Alaska and Canada (see Figure 1). Prudent avoidance of multi-year ice is anticipated.

The vessel will be required to work occasionally in the Bering Sea in January and February when ambient air temperatures ranges to -25 F, and sea temperatures are at the freezing point. In addition, there are likely to be occasions when the ship will work in mid- and low-latitude waters where air temperature can reach 90 F. Summertime operations in southeastern Alaska can also be quite warm, therefore the vessel needs adequate heating, air conditioning, and humidity control systems over a broad range of anticipated environmental conditions. High priority must be given to the hull design to ensure stable stationkeeping ability and a quiet hull form. A computer-based stability program will be required for regulation of weight distribution of ballasting, potable water, cargo, superstructure icing, and over-the-side operations.

It is useful to compare the characteristics of the planned vessel with others in the worldwide fleet of similar size and intended capability. There are, however, only a few research vessels of intermediate size sufficiently ice-worthy for the anticipated operations. These ships have been successfully employed for research in both arctic and antarctic regions:

ARANDA (Finland, 1989), 192 feet overall, 4,000 shaft horsepower, was constructed specifically for high latitude oceanographic research.

POLARBJORN and POLARSYSSEL (formerly POLARSIRKEL, Norway, 1975, 1976) 162 feet, 2,500 shp, were constructed as multipurpose expeditionary ships. POLARDUKE and POLARQUEEN (Norway, 1981, 1983) 213 feet, 4,500 shp are also in this latter category.

LAWRENCE A. GOULD (USA, 1997) 230 feet, 5,400 shp, U.S. Antarctic Program.

The American Bureau of Shipping (ABS) regulations for structural classification of ships operating in ice-dominated seas are regularly reviewed and refined. In recent years an effort has been made to coordinate the differing ice classifications of various nations having primary marine interests in the Arctic (Canada, Finland, Sweden, Norway, Russia, Germany, and UK). Essential as these designations are, it is important to recognize the difficulties and variability's inherent in their precise matching to the realities of at-sea arctic operations. Success of arctic operations also depends ultimately upon ill-defined properties, such as crew experience and training.

North Atlantic Variant: This SMR, with modifications, may be applied to a North Atlantic ice-capable general-purpose research vessel. Features of common design for a class of similar vessels, if achievable, could result in major cost savings.

Mission Objectives: The following cruise activities may be expected to be included in typical research missions:

- Oceanographic disciplines (physical, chemical, geological and biological) in North Pacific and Alaska regional seas, net tows, deep sampling, coring, instrument deploys and recoveries, seismic investigations.
- Fisheries research, not including stock assessment
- Coastal marine studies, sediment transport, pollution effects
- Marine mammal and bird studies
- Sea ice, water and atmospheric interactions
- Ocean engineering
- Marine biology

- Student training

Size: The ship will be of intermediate size (Class III UNOLS*)*. Not to exceed 220 ft loa. Moderate draft, not to exceed18 ft, will be essential for inshore coastal operations. 'Dual draft' possibility should be considered. Freeboard is to be 9-10 ft**.**

Draft restriction: Inshore operations in coastal waters of Alaska provide a strong incentive for shallow draft. The original designation of 15 ft has been eased, not to exceed18 ft. Alternate mooring in Seward harbor, occasionally required during unfavorable weather, can accommodate a vessel of this draft.

Endurance: The ship will be capable of remaining at sea for 45 days with the ability to transit for 15 days at cruising speed and to conduct 30 days' station work**.** Should be able to provide 60 days of hotel service.

Accommodations: Twenty-four scientific personnel (Including two marine technicians) can be accommodated in two-person staterooms. Officer and crew accommodations should be in single staterooms wherever possible. There will be a science library-lounge with conference room capability, and an exercise room.

Speed: Fourteen knots maximum, 12 knots in seas up to 12 ft (speed control +/- 0.5 knots in the 0-7 knot range).

Propulsion: The goal of attaining a "quiet" vessel in accordance with the recommendations of ICES Report #209 will preclude the use of direct drive diesels in favor of raft-mounted diesel-electric propulsion. Twin azimuthing thrusters (either Z-drives or Azipods) are suggested for enhanced maneuvering and trackline capability and for flexibility in ice operations. The ability of these types of thrusters to meet the noise criteria should be investigated.

Ice Strengthening: Superior ice strengthening is required for safe and secure operations in seasonal sea ice of the indicated geographical regions. Provision is needed for occasional exposure to heavy ice and sufficient hull sturdiness to withstand being unavoidably beset in pressured ice. Protection against severe superstructure icing is required.

Current ABS ice classifications indicate that a vessel of A1 class can operate independently year-round in "very severe" first-year ice, that is, 9/10 cover, 2 to 3.3 feet thickness, and independently in the arctic offshore shelf within landfast and shear ice zones. Beaufort Sea for example, August through September (Figure 1). Ice capability will include maintaining a speed of 2 knots in 2.5 feet of level ice and transit of 7-foot ridges. Short term, short distance, entry into the Central Arctic Basin is permitted when escorted by a vessel of A3 or higher classification.

A typical cruise in ice seasons might expect to require ice operations throughout one-third to one half of the cruise duration. Overall, projected mission profiles anticipate about 20-25% of ship time in ice.

Design and engineering work relating to ice strengthening will be undertaken in collaboration with specialists experienced in the dynamics of sea ice operations. Model testing in both open water and ice will be required.

Seakeeping: Stationkeeping by dynamic positioning will be required. The ship should be able to maintain station and work in seas up through 12 feet and be able to keep bow pointed into a 35-knot wind while on station

A refined set of sea-keeping criteria based on acceptable accelerations at speeds 0 to 10 knots in seastate 5 is proposed as follows:

Maximum vertical accelerations at work stations	0.20 g
Maximum lateral accelerations at work stations	0.10 g

Work station locations:

Aft outermost edge of aft working deck
At side Baltic room door
At starboard ship control console on bridge
At the center of the main lab

Maneuvering, Stationkeeping and Trackline Requirements

A goal of the ARRV design is compatibility with some elements of the new NOAA FRV-40 functional requirements. In this regard, the maneuvering and trackline criteria established for the FRV-40 are being considered for the ARRV:

Maneuverability

Ship to be capable of achieving a tactical diameter of less than 3 ship lengths in either direction at 13 knots, free route, at full load condition in calm water without use of the bow thruster. Ship to be capable of rotating about midships at zero forward speed in seas up to 8-ft significant wave height in a 2.5-knot current and 30 knot wind.

Stationkeeping

Ship to be capable of keeping station within a watch circle of one ship length diameter, on best heading, in seas up to 8 ft significant wave height, wind speeds up to 35 knots and current up to 3 knots, acting simultaneously. Wind and waves acting in the same direction. The requirement shall be satisfied with the angle between current direction and wind/wave direction from zero to at least 180 degrees. The Bretschneider short crested spectrum shall be used with modal periods of 7, 9, 11, and 13 sec to be considered minimum.

Precision trackline

Wind, waves, and current shall be considered acting in the same direction. Crab angle shall be considered the angle between the track and the ship's centerline. Environmental angle shall be considered the angle between the track and the environment, such that when the environmental angle is zero, the environment is opposite the trackline heading. All ship speeds shall be through the water.

Acoustic survey trackline

The ship shall be capable of automatically and manually maintaining track within a track error of 160 ft either side of the track while performing hydroacoustic surveys at speeds up to and including 11 knots, in seas up to 8 ft significant wave height, 3 knot current and 35 knot winds, for all environmental angles between 0 and 180 degrees port or starboard.

Towing trackline

The ship shall be capable of automatically maintaining a trackline within 330 ft with a crab angle less than or equal to 45 degree at a speed up to 3 knots with a towing resistance of 36,000 lbs. parallel to the track, in seas up to 8 ft significant wave height, 3 knot current and 35 knot winds, for all environmental angles between 0 and 45 degrees port and starboard.

Slow speed trackline for small samplers and towed devices

The ship shall be capable of automatically and manually maintaining a trackline within 35 ft with no restriction on crab angle at a speed of 1 knot, with a towing resistance of 4,000 pounds in seas up to 8 ft significant wave height, 3 knot current and 35 knot winds, for all environmental angles between 0 and 180 degrees port and starboard.

Deck Working Area: A spacious stern working area (2000-sq-ft minimum) with 50 ft of contiguous stern deck space and a dry working deck 9-10 ft above waterline. Working deck area is to be suitably heated to minimize icing.

Deck loading should support up to 1200-lbs./sq. ft. with an aggregate total of 45-50 tons. Heavy-duty hold-downs on 2-ft centers (standard UNOLS specification with Baxter bolts). Highly flexible should accommodate large and heavy equipment.

A useable, clear foredeck area to accommodate specialized towers and booms extending beyond the bow wave. All working decks will be accessible for power, water, air, and data and voice communication ports.

Cranes: One crane with a 20,000-lb capacity will be capable of reaching all working deck areas and able to offload vans and heavy equipment. A second smaller crane will be used as over-side cable fairleads for towing at sea. This crane should have a 1-ton capacity and could also serve for launching and retrieving the ship's boats.

Small knuckle cranes to be installed on the gallows to handle trawl doors.

The foredeck should be equipped with a small crane or boom capable of deploying instruments (requiring a conducting cable) well outside the bow wake. The crane should be capable of towing a I- or 2-m mid-water trawl at 5 knots.

Winches: Wire monitoring systems (showing line tension, amount of line paid out, and line speed in and out) with inputs to laboratory panels and shipboard recording systems. Local and remote control stations located for optimum visibility with reliable communications to laboratories and ship control stations.

Winch Requirements, General: Flexibility in the winch configuration is mandatory. The ability to easily remove or install winches on deck and replace winch cable reels is important. Winches must be as small as possible but still able to accommodate the anticipated workload.

Trawling: Capable of retrieving a net with a maximum catch weight of 25,000 lbs. and towed to a depth of 1000 m. Single conductor trawling wire of sufficient length to safely support the specified workload. The 25,000-lb catch weight is not required for research but could be needed if a large mass of fish is intercepted. In addition a small third wire winch to carry a conducting wire to the Scanmar unit is required.

Long-lining and crabbing: Not to be included in the design as it is anticipated that these activities will occur relatively infrequently and can be better accommodated by chartering commercial vessels.

CTD and hydro winches: A CTD package launched from the starboard side with a maximum working load of 6000 lbs. of .322-in, 3-conductor EM cable with a total length of 10,000 m. A retrieval speed of at least 60 m per minute is required. A duplicate winch will carry 10,000 m of 3x19-hydrowire rope (3 strands of 19 wires each). Winch drums should be interchangeable.

Deep-water conducting and coring/dredging winch(es): Support for various stern-launched instruments and trawls via the U-frame and having a wire with specifications described below. Minimum retrieval speed of 60 m/min at maximum load is required. This may be one winch with dual drums or two separate winches.

8,000 m of single conductor 0.680-in coaxial cable with a maximum working load of 10,000 lbs.
10,000 m of 9/16-in towing wire with a maximum working load of 25,000 lbs.
All wire reels are to be easily replaced to allow maximum flexibility in the use and mix of cables.

Coring and dredging: Capability for various coring techniques including multi-, box, and piston coring (20 meters) and dredging.

Over-the-Side Handling Requirements: Combination U-frame/trawling gantry and shallow-water CTD frame will be designed to meet the workload requirements specified above. The U-frame should be capable of handling two or more blocks simultaneously so that different Lear types can be interchanged quickly (MOCNESS tows alternating with bottom trawls).

A heated "Baltic" room located on the starboard side for the CTD, with the exterior side able to open and close. This staging area should have an overhead rail and 15-ft clearance. Its purpose is to protect the instruments and to launch equipment safely and rapidly. The Baltic room will have power outlets and will be accessible to the main and wet lab areas. This area needs to be heated to protect the CTD from freezing.

Trawling Ramp: A trawling ramp will be located at the stern to allow net retrieval. The ability to fill the ramp's void to provide a work surface flush with the main deck is required. This can be accomplished by hydraulic and/or mechanical means or by a manually positioned inset. The inset must be easily removed and safely installed by tile ship's crane. The inset must also meet the deck loading requirements specified earlier for the main deck.

Trawling layout: The trawlway dimension, i.e., the distance from the top of the stern ramp to the centerline of the reel net, specified for the NOAA FRV-40 is 47 ft. This will require a suitable aft deck area to accommodate. Minimum width of stern ramp is to be 12 ft.

Control Stations: An enclosed heated control booth for operating all winches and cranes is required. Excellent viewing of all winches and work areas is needed. The option to use walk-around controls is also required.

Towing: Capable of towing large scientific packages with up to 10.000 lbs. tension at 6 knots and 25.000 lbs. at 2.5 knots. Capable of towing and trawling in moderately ice-covered seas with capability for protecting towed packages. Stern tube should be provided to depress cable below the water and ice as the package is towed.

Laboratories: Approximately 2000 sq. ft of laboratory space including:

Main lab area: (1000 sq. ft) flexible for frequent subdivision providing smaller specialized labs. Deck hold-downs on 2-foot centers throughout.

Analytical lab (200 sq. ft) with stable temperature control

Wet lab (500 sq. ft) accessible to working deck and main lab and Baltic room

Electronics/computer lab and associated user space (300-sq. ft.)

Two freezers (100 cu ft each)

Climate control chamber, I or 2, capable of maintaining -2 C, with at least one S suitable for primary productivity measurements. Alternatively, this could be put on a van for use as needed.

A science office would be desirable if space permits.

Convenient and ample, but watertight, access to the working deck from the labs should be provided for wheeling bulky gear onto the deck (perhaps fold-down doorsills). The labs should be designed so that none serve as general passageways. Access between labs should be convenient.

Labs are to be fabricated using uncontaminated and clean materials and constructed to be maintained as such. Furnishings, HVAC, doors, hatches, cable runs, and fittings to be planned for maximum lab cleanliness. Decks where chemicals are used should be covered with nonporous, chemical-resistant material. In the wet lab, all hinges, handles, etc. on cabinets will be plastic.

Two fume hoods are to be installed permanently in the main lab. The wet lab will have provision for installation of a portable fume hood with a flapper valve. This hood will exhaust to the 01 level or a higher weather deck.

Cabinetry should be high-grade laboratory quality, with flexibility of use provided by unistruts and deck boltdowns.

Heating, ventilation, and air-conditioning (HVAC) as appropriate to laboratories, vans and other science spaces being served. Laboratories to be maintained at 60-75 F, 50% relative humidity, and 9-11 air changes/hr. Filtered air provided to analytical lab.

Each lab area 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. Labs to be furnished with 110 v and 220 v AC. Total estimated laboratory power demand is expected to be 75 KVA. UPS-protected outlets in at least the main electronics, and analytical labs.

Uncontaminated seawater supply to most laboratories, vans, and several key deck areas. Compressed air supply to be clean and oil-free.

Vans: Two standardized 8 ft by 20 ft portable deck vans which may be used for laboratory, seismic compressors, storage, or other specialized use. Hookup provision for power, HVAC, fresh and uncontaminated seawater, compressed air, drains, communications, data, and shipboard monitoring systems. The foredeck should also have supporting connections for a single van. Ship should be capable of loading and offloading vans using it's own cranes.

Workboats: Two 20-to-22-ft semi-rigid boats located for ease of launching and recovery. Should be capable of carrying and deploying a scientific workboat (25-30 ft LOA) specifically fitted out for supplemental operations at sea including data/sample collecting, instrumentation, and wide-angle seismic measurement. Boat to have 12-hour endurance, including both manned and automated operation and clean construction. To be accommodated as an option.

Science deadweight: Approximately 100 LT, including fishing winches, vans and workboat, but not including permanently installed scientific outfit, such as oceanographic winches, cranes, and frames.

Science Storage: Total of 8000 CU ft accessible to labs by interior and weatherdeck hatch (es). Dumbwaiter for gears (not personnel). Deck hatches to storage areas or holds should be of sufficient size to easily pass a standard pallet. Half of the storage area is to include suitable shelving racks, and tie-downs, remainder open hold.

Acoustical Systems: Ship is to be acoustically quiet according to the ICES-adopted noise curve as specified in ICES Cooperative Report #209. Noise radiation criteria should apply to 8 kts operating speed. Ship to have conventional 12 kHz and 3.5 kHz echo sounding systems and provision for additional systems, including: Shallow water multibeam echo sounding system, SIMRAD EK500 (or equivalent) with 38-kHz and 200-kHz transducers, Side scan sonar, Acoustic Doppler Current Profiling (ADCP) system with 150- and 300-kHz transducers hull-mounted, and Omni-directional search-type sonar for mid-water trawl guidance.

Transducer well: Large (3 ft x 6 ft) pressurized sea chests, one to be located forward and the other aft at optimum acoustic locations and for at-sea installation and servicing of transducers and transponders. (Or replace one transducer well with a retractable centerboard for transducer mounting. This would help diminish noise.)

Navigation: Differential Global Positioning System (DGPS) with GMDSS capability and with appropriate interfaces to data systems and ship control processors for automatic computer steering and speed control. Pitch/roll/yaw sensor system.

Internal Communications: Internal communication system providing high-quality voice communications throughout all science spaces and working areas. Point-to-point and all-call capabilities are required. All staterooms should have phones for internal communications.

Data transmission, monitoring, and recording system available throughout science spaces including vans and key working areas. Closed-circuit television monitoring and recording of working areas. Monitors for all ship control, environmental variables, science, and over-side equipment performance, to be available in all or most science spaces. High-speed data communication (via satellite) links to shore labs and other ships on a continuous basis.

External Communications: Reliable voice channels for continuous communication with shore stations, including home laboratories, other ships, boats, and aircraft. This includes satellite, VHF, and UHF.

Facsimile communications to transmit high-speed graphics and hard-copy text on regular schedules. Cellular and satellite phone or INMARSAT B, if reliable at time of construction. Programmable VHF and UHF radio-direction finder.

Satellite Monitoring: Carry transponding and receiving equipment, including antenna, to interrogate and receive satellite readouts of remotely sensed environmental variables. Special attention is needed in respect to antenna (e) placement.

Discharges: All discharges on the port side, with tanks capable of holding for a minimum of 24 hours. An on-board garbage incinerator is also required. An on-deck hazardous storage capability for chemicals plus a holding capability for class C wastes.

Masts: The main mast and a lightweight second 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. Connections and wiring will be installed to allow easy connection between these installed packages and the vessel's fiber-optic data transfer network.

Flying Bridge: Equipped with windscreen and an unobstructed view of the sky and water. It should have gyrocompass repeaters in each forward corner, ports for communication with the bridge, and access to oceanographic and ship's navigational data streams. Provision for mounting big-eye 25x binoculars on each side and the means for installing portable seating for observers.

Ship Control: The chief requirement is maximum visibility of deck work areas during science operations (especially during retrieval and deployment of equipment). The bridge/pilot house should be located for optimal viewing of the stern, with television monitors for viewing stern operations. Portable hand-held control units might also be considered at various aft-deck locations during over-side equipment handling.

The bridge should be designed for the possibility of having bird and mammal observation posts in the forward corners. These locations should have unobstructed views forward and to the side (90° arc), and each should be of sufficient size to accommodate two people working side by side, with at least one seated. Space is needed for resting a small laptop computer and connections used to access the ship's data transmission network.

The functions, communications, and layout of the ship control station should be carefully designed to enhance the interaction of ship and science operations. A collision-avoidance system should be provided to help ensure safe, remote, computer-controlled operations in traffic-congested waters.

Helicopter: Capability of accepting helicopter landings but not long-term assignment. Vessel operations in remote areas for extended periods will necessitate helicopter-landing capability to facilitate transfer of personnel and emergency medical evacuations. The ability to accommodate small 3-4 place helicopters is desired. The vessel will not be required to hangar the helicopter, and accommodation for helicopter crew and technicians, if required, will come out of the science berths.

Additional spaces

The following additional spaces and approximate areas have been identified:

Electronics workshop	150 sq. ft
Hazmat locker(s)	50 sq. ft
Incinerator/trash room	120 sq. ft
Aft control room	200 sq. ft