UNIVERSITY NATIONAL OCEANOGRAPHIC LABORATORY SYSTEM

AN ALASKA REGIONAL RESEARCH VESSEL TO REPLACE R/V *ALPHA HELIX*

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

Prepared
on behalf of the
UNOLS Fleet Improvement Committee

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General: This vessel is proposed as a replacement within the UNOLS fleet for the R/V *Alpha Helix*, the oldest currently operated research vessel in the fleet. Construction of the R/V *Alpha Helix* was completed in 1966. The new ship will be capable of conducting general oceanographic and fisheries investigations in high latitude open seas, nearshore regions, and seasonal sea ice. It will not be expected to encounter multi-year ice during ordinary operations. It will satisfy essential year-round ship support needs for the northern North Pacific Ocean and subarctic waters, as well as seasonal access to the Arctic.

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 significant capability for over-the-side fisheries sampling as well as acoustic procedures. However, the ship is not intended to be used for 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. The vessel construction and operation will conform to standards including ABS (ice classification), SOLAS (safety), MARPOL (pollution), ISM (management), GMDSS (emergency communications), STCW (operations), and CASPPR (Canadian arctic pollution). The primary requirement is maximum capability commensurate with ship size to support research operations in high latitudes and a stable work platform in seas up to 8 feet. 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 (NOAA) 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 is in 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. New research initiatives with strong partnerships among agency, private entities, and academia are anticipated.

There is increasing incentive for NOAA to work with UNOLS to make use of the regional vessels in the academic fleet. However, there has been difficulty in scheduling the required time. With a dedicated regional UNOLS vessel designed for multidisciplinary high latitude research, NOAA's Alaskan program will have ready access to ship time. Presently, NOAA requirements are expected to approach half-time usage of this vessel. This activity and academic UNOLS use, as well as the strong likelihood of additional Bering Sea and arctic initiatives, provides the number of sea days per year adequate to ensure a cost-effective operation.

Environmental Conditions: Operations in the Bering, Chukchi, and Beaufort Seas will encounter extensive seasonal sea ice. The navigational severity of the regions varies abruptly north of the Pribilof Islands. For example, sufficient ice-strengthening for the proposed 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 temperatures may be as low as -25°C and sea temperatures are at the freezing point. Provision must be made to deal with the possibility of superstructure icing under these conditions. In addition, there are likely to be occasions when the ship will work in mid- and low-latitude waters where atmospheric temperatures can reach 32°C. 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 a stable station keeping ability and a quiet hull form. A computer-based stability program will be required for regulation of weight distribution of ballasting, potable water, cargo, 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 (shp), 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.

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 is being made to adjust and 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 variabilities 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.

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). Moderate draft will be essential for coastal operations.

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. It should be able to provide 75 days of hotel service.

Accommodations: Eighteen to 20 scientific personnel (including two marine technicians) can be accommodated in two-person staterooms. Single-berth staterooms will accommodate the licensed officers and chief scientist, and double-berth staterooms accommodate the remainder of the ship's complement. Gender matching will be accommodated by one or two single staterooms with optional pull-down transom berths. There will be a science library-lounge with conference room capability, and an exercise room (~200 sq. ft.).

Speed: Fourteen knots maximum (calm water cruising speed) and 12 knots in seas up to 12 feet (speed control +/- 0.5 knots in the 0-7 knot range).

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

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—the Beaufort Sea for example—August through September (Figure 1). Ice capability will include maintaining a speed of 3 knots in 2.5 feet of continuous 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.

Typically, when ice is present, one might expect to require ice operations throughout one-third to one-half of the cruise duration. Propulsion requirements will vary depending upon hull form and other characteristics. Diesel engines with reduction gear shafting are likely power plants for this vessel. Twin screw and twin rudder configurations will be the preferred propulsion mode, because of advantages in maneuverability, redundancy, propeller protection, and size.

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

Seakeeping: Station keeping by dynamic positioning. Able to maintain station and work in seas up to 12 feet and be able to keep bow pointed into a 35-knot wind while on station.

Deck Working Area: A spacious stern working area (2000-sq. ft. minimum) with 50 feet of contiguous stern deck space and a dry working deck 4-6 feet above waterline. Deck loading of up to 1200 lbs./sq. ft. with an aggregate total of 45-50 tons.

Heavy-duty hold-downs on 2 foot centers (standard UNOLS specification with Baxter bolts). Highly flexible to 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.

All portions of working decks will be visible from the bridge by television monitors.

Cranes: One crane with a 20000-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 to launch 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 wave. This crane should be capable of towing a 1- 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. All winches must be in protected areas. Gantries with additional winches should be placed in selected locations.

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. Gantries with additional winches should be located in several areas:

Trawling: Capable of retrieving a net with a maximum catch weight of 25000 lbs. and towed to a depth of 1000 m. Single conductor trawling wire of sufficient length to safely support the specified workload. Dual winches. The 25000-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.

Hydrographic CTD winch: Support a CTD package launched from the starboard side with 0.322 in., 3-conductor EM cable with a total length of up to 10000 m. A retrieval speed of at least 50m/minute is required.

Deep-water hydrographic CTD and towing winch: Support for various stern-launched instruments and trawls via the U-frame, with a wire with specifications described below. Minimum retrieval speed of 60 m/min. at maximum load is required.

-8000 m of single conductor 0.680-in. coaxial cable with a maximum working load of 10000 lbs.

-10000 m of 9/16-in. towing wire with a maximum working load of 25000 lbs.

All wire reels are to be easily replaced to allow maximum flexibility in the use and mix of cables. Hydraulics for fisheries trawling should be available on all dual winches.

Coring and Dredging: Capability for various coring techniques including multi-box and piston coring (20 m) and dredging. The capability of collecting long cores in excess of 20 m is necessary.

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 gear 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 foot 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. There should be deck clearance between the starboard rail and the outside opening to the Baltic room so that the doors into the Baltic room are somewhat protected from seas slamming into the starboard side. Deployment/recovery of the CTD (and other oceanographic equipment) from the Baltic room could be accomplished with a squirt or hydroboom. When fully extended, the hydroboom should reach over the starboard side by at least 10 feet. The hydroboom should have a safe working load of 15000 lbs.

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 the ship's crane. The inset must also meet the deck loading requirements specified earlier for the main deck. Ramps need to be fitted with steam tubes to prevent icing. Serious consideration should be given to providing commercial doors as opposed to experimental doors. In that case, large winch cables and knuckle cranes or a special stern frame will be required to handle the gear.

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 10000 lbs. tension at 6 knots and 25000 lbs. at 2.5 knots. Capable of towing and trawling in moderately ice-covered seas with capability of protecting towed packages. Stern tube to depress cable below the water and ice as the package is towed.

AUV/ROV: The vessel should be capable of supporting AUV/ROV operations.

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, main lab, and Baltic room
>
> Electronics/computer lab and associated user space (300 sq. ft.)
>
> 2 freezers (100 cu. ft. each)
>
> A science office would be desirable if space permits.

Climate control chamber, 1 or 2, capable of maintaining -2°C, with at least one suitable for primary productivity measurements. Alternatively, this could be put on a van for use as needed.

Convenient and ample, yet watertight, access to the working deck from the labs for wheeling bulky gear onto the deck (perhaps fold-down door sills). 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 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. The fume hoods must not have down-drafts, but must pump sufficiently high to dissipate the output.

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. The system should meet reasonable quiet standards. Laboratories to be maintained at 16-24°C, 50% relative humidity, and 9-11 air changes/hr. Filtered air provided to analytical lab.

There must be provision for isolated laboratory space and storage space for dealing with hazardous material.

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 75 KVA. UPS-protected outlets in at least the main electronics and analytical labs. There must be abundant electrical outlets in laboratory and deck work areas.

Uncontaminated seawater supply to most laboratories, vans, and several key deck areas. This water must be collected as far out as possible in front of the bow. 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 its own cranes.

Workboats: Two 20- to 22-ft. semi-rigid boats located for ease of launching and recovery. Capable of carrying and deploying a scientific work boat (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. Clean construction. To be accommodated as an option.

Science Storage: Total of 8000 cu. ft. accessible to labs by interior and weatherdeck hatch(es). Dumbwaiter for gear (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, with the 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. This will require investing in a quiet heating and ventilation system. The hull must be designed to avoid bubble sweep down.

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

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: P-Code 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. There needs to be data handling/communication capability in each stateroom.

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.

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 and e-mail.

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.

High-speed data communication (via satellite) links to shore labs and other ships on a continuous basis.

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 would 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 wind screen 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 to optimize the view 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: Consider capability of accepting helicopter landings and operations, but not long-term assignment and hangaring. This is not essential if accommodation would create a significant increase in vessel length.

Figure 1. Alaska regional operating zones for the Intermediate Ice-Strengthened Research Vessel. Numbers indicate approximate months of the year when the ship's ice worthiness permit operations in seasonal sea ice.