Outline of
Polar Research Vessel
Technical Specifications

(based on editing NBP[1] and ARRV[2] technical specifications
as well as results from PRV feasibility studies)

Intended to provide guidance for future development of PRV technical specifications.

December 15, 2006

[1] *Nathaniel B. Palmer* – July 27, 1999
[2] Alaska Region Research Vessel – December 2004

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TECHNICAL REQUIREMENTS
FOR A
RESEARCH VESSEL WITH ICEBREAKING CAPABILITY
FOR
UNITED STATES ANTARCTIC PROGRAM

1 INTRODUCTION

1.1 Purpose

These requirements provide a basis for the charter and operation of a general purpose, multidiscipline oceanographic research Vessel with icebreaking capabilities. It is the intent that the Contractor shall deliver and operate this ship complete in all respects for the service intended. The ship shall be fully equipped and fitted out in accordance with the best commercial marine practice.

1.2 Area of Operation

The primary mission area of the ship is the Antarctic. The ship is also expected to make periodic open ocean transits through, and carry out scientific missions in equatorial waters.

1.3 Concept of Operation

As with many oceanographic research vessels, this ship must be capable of independent operation for endurance periods as identified in the Technical Requirements. The principal base of operation will be in the southern latitudes to minimize transit time to the primary mission areas. The ship will operate from such ports as Punta Arenas, Chile or Ushuaia, Argentina for operation in the Antarctic Peninsula including Palmer Station and the Weddell Sea. The ship will also operate out of such ports as Hobart, Australia or Port Lyttleton, New Zealand for trips to the Ross Sea and other parts of the Antarctic. Because most logistics bases are remote from the ship operating area, reliability and maintainability of equipment are of prime importance. All systems must use up-to-date and proven equipment and material.

1.4 Relationship Between NSF and The Charterer

The Charterer is responsible for the operation and maintenance of the United States facilities in Antarctica. One of the tasks that the Charterer performs is management of research vessels operated by subcontractors. In this regard, the Charterer is now seeking an organization to provide and operate a research vessel with icebreaking capabilities.

1.5 Representative Mission Profile

A notional annual operating profile for the ship is shown below:

Activity	Days
Transit and science operations away from port	265
In-port preparations for science operations	35
Repairs and maintenance	65
	365

This annual profile is provided for illustrative purposes only, and is not contractually binding. It is not intended to restrict operation of the ship in any way. See Sample Charter, Special Conditions Clause 24, Employment, Paragraph (c).

1.6 Ship Size Estimate

The draft of the ship shall not exceed 30 ft, as this would preclude entry into Arthur Harbor at Palmer Station. There are no beam or displacement limitations on the ship.

1.7 Ship Trials

The ship shall be subject to dock and underway trials to show that all technical requirements have been satisfactorily filled prior to Charterer's acceptance of the Vessel and commencement of the Charter. A schedule of trials, including procedures and data to be taken, will be provided to the Charterer no later than three months after contract award. The trials will be performed under the supervision of Charterer personnel and their representatives.

1.8 Technical Evaluation of Responses

The technical requirements contained in this document, including all appendices, represent the criteria for performance, equipment, safety and operation of the research vessel sought through this Request for Proposal. The technical aspects of responses to this Request will be evaluated upon the manner in which the proposal accomplishes each of the technical requirements

Proposals shall include calculations and/or text to demonstrate compliance and understanding with the requirements. As an example, calculations shall be performed and included with the proposal on: resistance and powering, endurance, hull strength, stability, sizing and selection of propulsion machinery and ships service generators for the intended service, and other subject areas as appropriate. Repeating the technical requirements, as stated in this Request for Proposal, will be considered as non-responsive.

1.9 Construction Schedule

This shall also include a mock-up of a science stateroom.

In order to plan for orderly work performance, and to assure the Owner of a detailed program for contract requirements, the Builder shall develop and submit the following schedules to the Owner's Representative for his approval:

• **Design Verification Exercise Schedule**
As soon as practicable, but in no case later than 30 days following contract signing, a design verification schedule (see Section 043) shall be prepared providing dates for principal engineering documents and drawing submittals to ABS and the Owner.

• **Master Construction Schedule**
As soon as practicable, but in no case later than 45 days following contract signing, a master construction schedule shall be prepared providing dates for principal construction activities, prefabrication work, erection sequence, machinery installation, outfitting, testing, launching, trials and delivery. Updates of this schedule shall be furnished at least once a month to the Owner's Representative, along with identification of problem areas and plans for resolution of problems.

• **Working Drawing Schedule**
As soon as practicable, but in no case later than 45 days following contract signing, a working drawing schedule shall be prepared defining the number and types of working drawings (hull, mechanical and electrical) to be prepared by the Builder and describing those details necessary for compliance with the contract drawing and specifications. Sufficient time shall be allowed in the drawing schedule to assure for timely completion and approval action prior to work commencement defined in the various elements of the master construction schedule.

• **Test Schedule**
All structures and systems shall be tested in accordance with the requirements of the American Bureau of Shipping and these specifications. A schedule of all anticipated tests and inspections shall be developed by the Builder and submitted to the Owner within 45 days of contract signing.

All schedules shall be revised whenever necessary, and the Builder shall keep the Owner's Representative fully informed with regard to schedule changes, anticipated delays and reasons for such revisions.

2 ENVIRONMENTAL REOUIREMENTS

2.1 Ice Conditions

The ship will operate in annual ice from the ice edge up to and including the consolidated pack and fast ice. The ship is expected to routinely operate in partial coverage of first-year ice floes that could contain some glacial ice. Level icebreaking and ramming capability in annual ice will be required and is specified in Section 3.1, Icebreaking Capability.

2.2 Sea State

Data on sea states in the primary area of operation are shown below. Ship performance in those sea states is specified in Section 3, Operational Performance Requirements.

Sea State	Percentage Of Time Exceeded	Significant Wave Height (ft)	Associated Wind Speed (kt)	Average Modal Period (sec)
4	66	6	20	8.0
5	37	10	25	9.5
6	18	16	38	12.0
7	4	25	52	15.0

2.3 Air Temperature

The ship can be expected to encounter very cold temperatures during the Antarctic winter. The ship must be capable of operating in a minimum expected winter air temperature of -50 degrees F. Average winter air temperatures in the -10 to -20 degree F range are expected. Even at milder temperatures, a wind-chill index of -50 degrees F and lower can be expected to continue for days. Air temperatures in open water during the winter season could be as low as 10 degrees F, and with sea spray could lead to rapid deck and superstructure icing. The ship must be capable of operation in a maximum air temperature of 120 degrees F since the ship may perform scientific and logistics missions in equatorial and tropical zones.

2.4 Wind Velocity

Very high winds occur in Antarctica. The ship shall be capable of enduring a maximum sustained wind speed of 100 kt.

2.5 Sea Water Temperature

Sea water temperatures can be expected to range from a high of 90 degrees F to a low of 28 degrees F. The ship must be capable of operation in this range of water temperatures.

2.6 Precipitation

Precipitation in the form of rain, freezing rain, sleet, and snow can be expected. The ship layout and equipment must consider all of these conditions with the intent of minimizing accumulation aboard the ship, minimizing the potential adverse effect on ship operations, and providing for removal.

2.7 Fog and Reduced Visibility

Reduced visibility will occur during ship operations. The ship must have the navigational capability to operate in a safe manner during fog and reduced visibility conditions.

2.8 Topside Icing

Severe topside icing will occur at times due to the combination of cold seawater and air temperatures with high sea states in the primary operating area. Spray icing rates of 1/2 inch per hour can be expected in extreme events. The extreme icing event has been estimated to be a 24-hour exposure at this icing rate.

This extreme event results in the following ice accumulations and loads on the main deck forward of the superstructure.

Accumulation (inches)	Location	Load (lb/sq ft)
12.0	Horizontal Surfaces	43.6
9.6	Vertical Surfaces	34.8
10.8	Exposed Gear	39.4
10.8 Radius	Rigging and Stays	111.1 lb/ft

These loads shall be reduced linearly with height such that all loads are zero at 100 ft above the Design Waterline (DWL). Icing is assumed not to occur on the shell plating or area below the main deck (uppermost watertight deck). Icing loads shall also be reduced linearly with distance aft along the ship. Icing loads shall be constant with length over the foredeck and start to reduce aft of the forward end of the superstructure, resulting in zero load at the stern of the Vessel. The ship must be capable of surviving such an icing event. Icing in combination with wind heel and rolling are addressed in Section 3.8. Given the severity of the icing loads, the ship shall have clean decks and superstructure, free of all but essential fittings and equipment, to minimize ice accretion. In addition, the aft and starboard side working deck shall be fitted with a heating system to keep the decks free of ice and snow accumulation.

2.9 Green Ship

Diesel engines installed on the PRV must comply with recent U.S. regulatory requirements of the Environmental Protection Agency (EPA) that limit exhaust emissions, particularly nitrogen oxides (NOx). In addition, optional emission reduction equipment employing new technology can be installed to reduce emissions further.

In addition to reducing diesel engine exhaust emissions, the PRV will have a number of other "green ship" attributes. Among these is the ability to "cold iron" the ship which will allow the vessel to use shore-based electrical power and shut down all ship service generators in port.

3 OPERATIONAL PERFORMANCE REQUIREMENTS

3.1 Icebreaking Capability

The ship must be able to operate through first-year ice conditions of:

Level ice thickness		4.5 ft at 3 kt
Ice Strength	- flexural	100 psi
	- compressive	575 psi

The ship must also be able to encounter and transit pressure ridges of at least 6-ft sail height (corresponding to a keel depth of 20 ft) in the ramming mode of operation. In addition to ramming pressure ridges, the ship will periodically be expected to back and ram through level ice of 6-ft thickness in order to get to a desired science station.

3.2 Heeling and Trimming

A heeling system shall be installed in the ship capable of rolling the ship in ice by rapidly transferring water or fuel from one side of the ship to the other. The heeling system must be capable of rolling the ship from 5 degrees port list to 5 degrees starboard list and back again in 2 minutes in open water. The ship shall also have sufficient ballast tankage in the ends of the ship to change her trim by 3 ft both by the bow and by the stern.

3.3 Open Water Powering

The ship shall be able to maintain speed as given in the table below at any heading relative to the prevailing wind and waves as described in Section 2.2:

Sea State	Significant Wave Height (ft)	Ship Speed (kt)
4	6	14
5	10	12
6	16	7
7	25	5

3.4 Seakeeping

The ship must be able to maintain ship motions that do not exceed the values given below in sea state 6 (16 ft significant wave height) and short-crested seas (cosine squared spreading function) as described in Section 2.2 on any heading at speeds up to 8 kt. For the purposes of determining motions, the wind is collinear with the seas and a steady current of 2 knots is at 45 degrees to the wind and seas.

Significant Pitch	5 Degrees
Significant Roll	8 Degrees
Accelerations on the Bridge Wings	0.2 g's Athwartship 0.4 g's Vertical
Accelerations on Main Deck on Centerline at After Perpendicular	0.2 g's Athwartship 0.4 g's Vertical
Slamming	10 occurrences per hour
Deck Wetness at After Perpendicular	5 occurrences per hour
Deck Wet at 5 percent aft of Forward Perpendicular	5 occurrences per hour

3.5 Stationkeeping

The ship must be able to maneuver and keep station within a 300 ft diameter circle or 3 percent of the water depth, whichever is greater, in seas up to 12 ft significant wave height, 10 second average modal period, mean winds of 30 kt, and 2 kt of steady current. The wind and waves directions are collinear and the current direction is at 45 degrees to them. Ship heading can be selected to give best stationkeeping ability. A dynamic positioning system to control the propulsion and maneuvering systems to meet this criterion is specified in Section 5.4F.

3.6 Track Keeping

The ship shall be capable of remaining within 500 ft or 5 percent of the water depth, whichever is greater, of any specified straight trackline and shall be capable of maintaining its heading within ±15 degrees of its mean heading for all forward speeds between 1 and 6 knots. These tolerances shall be maintained in Sea State 5 or lower, with long-crested seas, as described in Section 2.2. The wind and waves are collinear and have an arbitrary heading relative to the trackline and there is a 2-kt steady current at 45 degrees from the wind/wave direction. A dynamic positioning system to control the propulsion and maneuvering systems to meet this criterion is specified in Section 5.4F.

3.7 Night Operation

Ship operations are based on year-round science. Long periods of darkness can be anticipated during the winter months due to the extreme latitudes of operation. The ship must provide adequate lighting, both interior to the ship and exterior, in accordance with the Illuminating Engineering Society Publication RP-12, “Recommended Practice for Marine Lighting”. In addition, science related lighting installations are required, including but not limited to:

Floodlights that illuminate the sea or ice surface outboard of all main weather decks and especially where science packages, personnel, or cargo may be lowered over-the-side.
Flood lighting that also illuminate the area outboard of the ship forward of the bridge where ice piece turn up as the ship breaks ice.
At least four large searchlights for night ice navigation.

3.8 Intact Stability

Intact stability requirements shall be determined in accordance with US Coast Guard Subchapter U including the lifting of heavy objects from the various cranes. In addition, the ship must be able to sustain a 100 kt beam wind heeling moment and an 80 kt beam wind heeling moment with the icing described in Section 2.8. The following criteria for adequate stability under severe wind and rolling conditions (weather criterion) shall be demonstrated for each standard condition of loading given in Subchapter U, with and without the icing load and with reference to Figure 1, as follows:

1. The ship is subjected to a steady wind pressure acting perpendicular to the ship's centerline, which results in a steady wind heeling lever, l_w , varying with heel angle as a cosine squared function of heel angle:

$$l_w = l_{wo} \cos^2 \theta \quad (1)$$

where l_{wo} is the wind heeling lever for the ship in the upright position. The heeling arm for an upright position is given by the following formula:

$$l_{wo} = \Sigma (p\ A\ z)/(2240\ \Delta) \quad (2)$$

where: Δ = displacement of the ship (LT)
A = projected lateral area of a part of the ship above the waterline

z = vertical distance from the center of A to the center of the underwater lateral area (approximated as a point at one-half the draught if the center is not known)

p = wind pressure (psf) exerted on A as function of height above the waterline:

$$p = 0.103\ v^2 \tag{3}$$

where v is in kt and is scaled based on a reference wind speed, v_o, the height z, and the height at which the reference wind is measured, z_o; for these purposes a 32.8 ft height is assumed.

$$v/v_o = 1 + c \ln [(z + z_1)/(z_o + z_2)] \tag{4}$$

with: c = 0.099754,
z_1 = – 0.02961 z_o,
z_2 = 0.053621 z_o

2. From the resultant angle of equilibrium, θ_o, the ship is assumed to roll due to wave action to an angle of roll, θ_r, to windward. The roll amplitude, θ_r, shall be taken as 25° or determined from model tests.

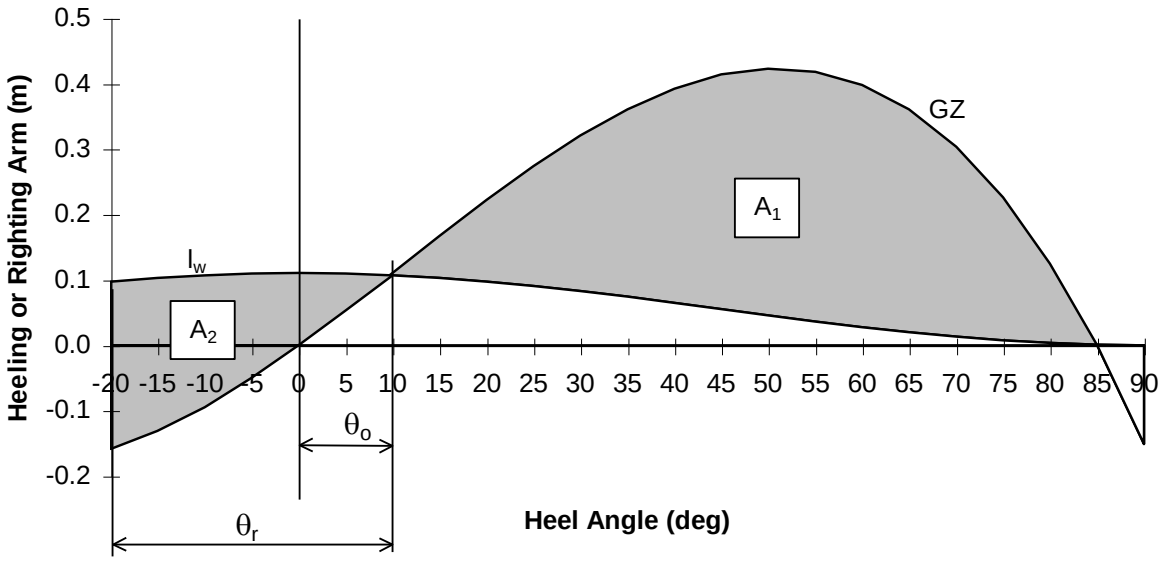

Figure 1. The intact stability weather criterion.

The wind heeling arm curve shall be for a wind velocity of at least 100 knots without an icing load and 80 kt with an icing load. For each condition of loading, the following criteria must+ be met:

1. The heeling arm at the angle of equilibrium, θ_o, must not be greater than 0.6 of the maximum righting arm.
2. The area A_1 must be not less than 1.4 of area A_2.

3.9 Compartmentation and Limiting Drafts

Compartmentation and limiting draft requirements shall be determined in accordance with US Coast Guard Subchapter U.

3.10 Damaged Stability

Damaged stability requirements shall be determined in accordance with US Coast Guard Subchapter U. In addition, the ship must be able to sustain a 35 kt beam wind heeling moment and rolling appropriate for Sea State 4 in the damaged condition. The additional criteria for adequate stability in the damaged condition are of the same format as for intact stability. The righting arm curve and the heeling arm curve are shown in **Error! Reference source not found.** and it is assumed that:

1. The ship is subjected to a steady wind pressure acting perpendicular to the ship's centerline, which results in a steady wind-heeling lever, l_w, varying with heel angle. Wind velocity is a function of ship displacement, taken as 35 kt for this size ship.
2. In addition, a heeling arm due to the wave action is included in the heeling lever, l_h, acting on the ship. This dynamic effect of waves is represented by a rise of 4 ft of water on the weather deck, irrespective of ship size and freeboard.
3. From the resultant angle of equilibrium, θ_o, the ship is assumed to roll due to wave action to an angle of roll, θ_r, to windward. The roll amplitude, θ_r, is assumed to be a function of ship displacement and shall be taken as 12 deg.
4. A reduction of righting arm equal to $0.05 \cos \theta$ (ft) is included in the *GZ* curve to account for unknown asymmetrical flooding or transverse shift of loose material.

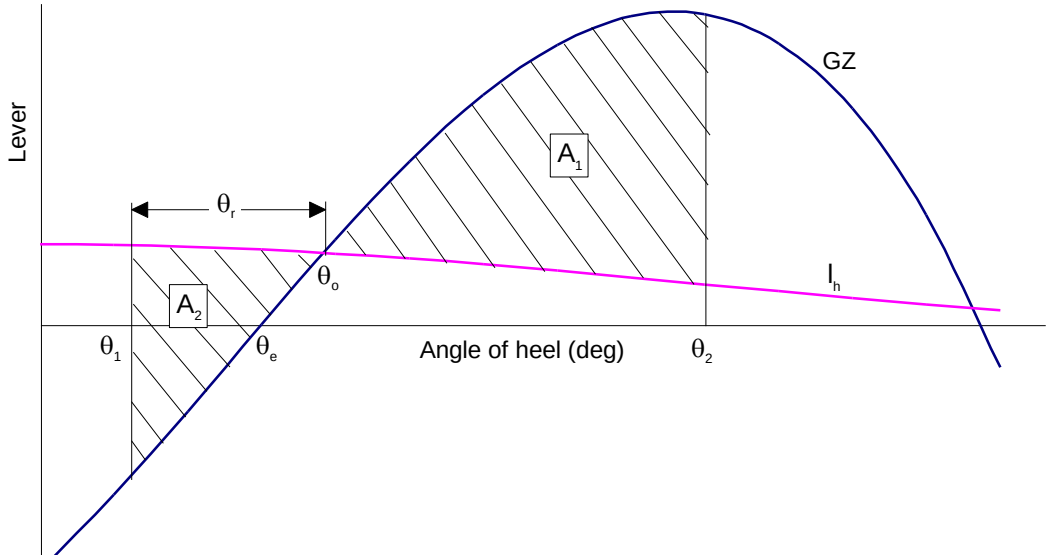

Figure 2. The damage stability weather criterion.

The angles in **Error! Reference source not found.** are defined as follows:

θ_o = angle of heel under action of steady wind (heeling moment);
θ_e = static angle of equilibrium (without wind effects);
θ_r = amplitude of roll to windward due to wave action;
$\theta_1 = \theta_o - \theta_r$ = maximum heel of the ship to windward;
θ_2 = angle of downflooding, θ_f, or 45° whichever is less.

Under these circumstances, at each standard condition of loading, the following criteria must be met:

1. The margin line at side is not submerged at the angle of heel θ_o;
2. The static angle of equilibrium θ_e is not greater than 15°;
3. Area A_1 must be not less than 1.4 of area A_2.

3.11 Endurance

The ship shall have sufficient fuel storage for 15,000 nm at 12 kt. There shall be a 10 percent margin of fuel left onboard when returning to port.

3.12 Service Life

A service life of 40 years is required.

3.13 Freeboard

The freeboard shall be 9 to 11 ft above the working draft (65% loading condition) to keep the decks as dry as possible while still allowing over-the-side work.

3.14 Vibration

The ship and its equipment shall be free of excessive vibration during open water and icebreaking operation. Open water vibration criteria are as follows. Vibration must not exceed the levels given in the latest revision of the "ISO Habitability Recommendations" for spaces occupied by the crew or scientific personnel. Hull girder vibration must result in velocities less than ± 0.37 in/sec vertically and ± 0.22 in/sec longitudinally or athwartship. Major substructures of the ship not inhabited by the crew must limit vibration to ± 0.1 g providing this level of vibration is not harmful to equipment mounted in the substructure including its supporting structure and mountings. Local structural elements must have vibration levels less than ± 0.25 g, be free of vibration induced structural damage, and generate noise levels less than 90 dbA. Shipboard equipment, as mounted, must be able to meet environmental vibration levels of ± 0.25 g. Vibration levels and balancing of rotating machinery shall meet regulatory requirements and accepted standards for good commercial practice. Vibration characteristics of the main propulsion machinery shall be in accordance with regulatory requirements and a recognized vibration standard.

3.15 Airborne Noise

The ship shall be capable of keeping compartment noise levels within guidelines of the Society of Naval Architects and Marine Engineers Technical Research Bulletin 2-25, "Ship Vibration and Noise Guidelines". This bulletin specifies noise levels as follows:

Location on Vessel	A-Weighted Noise Level (dBA)
Offices and Cabins	60
Pantry, Mess, Dayroom	65
Wheelhouse (Doors Open)	65
Wheelhouse (Doors Closed)	60
Radio Room	60
Machinery Space Duty Station (8 hr/day)	85-90
Machinery Space Enclosed Control Room	75
Workshops and Storeroom	85
Galley	75
All Laboratory Spaces	65

The owner shall have a noise analysis performed by a qualified subcontractor in accordance with SNAME Technical and Research Bulletin No. 3-37 and present the results to the Charterer no later than 90 days

prior to delivery of the Vessel. See Section **Error! Reference source not found.** for required noise control and isolation considerations with regard to the machinery.

No later than 7 days prior to delivery of the Vessel, the owner shall have sound pressure level measurements taken by a qualified subcontractor and provide results to the Charterer. Measurements shall be taken at locations where personnel would normally occupy operating stations such as at workbenches, desks, operating consoles, berths and seating in mess areas, lounges, offices, and cabins. Measurements shall correspond to normal head positions. At least two positions shall be measured in each space. Measurements shall be made at least 3 ft from large flat surfaces. Measurements must be omnidirectional and averaged over 2 to 5 sec.

Ear protection or similar protective devices are strongly recommended in all areas where the noise level exceeds 85 dBA. All doors accessing spaces where noise exceeds 85 dBA must be marked with signs requiring ear protection devices to be worn in this space.

3.16 Underwater Noise

Noise generated by the ship shall not interfere with the operation of the installed sonars (multi-beam bottom mapping system, Section 4.9, and other acoustic systems in Section 4.10). Ship-generated noise levels must not interfere with standard commercial single and multi-channel seismic survey operations as well as side scan or other towed sonars. Operating frequency ranges are identified in Section 4.9. Operationally quiet noise levels must be achieved over the entire range of ship speeds from 0 to 10 knots in wave conditions up to Sea State 4.

3.17 Electro-Magnetic Interference

The ship will operate with sensitive electronic equipment, computers, and data acquisition systems intended for scientific sensing and analysis. This equipment will be placed primarily in the labs, other scientific spaces, the winch control room, the bridge, and on any of the working decks. The Owner shall install electrical, navigational, communication, or other cabling in a configuration that precludes any inductive coupling or other types of interference on one cable due to proximity of other cables. Traps, filters, grounds, etc. shall be installed as necessary to prevent any electro-magnetic interference with scientific equipment. Special attention shall be given to the prevention of 60 Hz interference from fluorescent lighting fixtures.

3.18 Tests

Note: Text of this section was taken from Alaska Region Research Vessel Contract Specifications, December 2004 and is intended as a guide to the sort of material to be included in the PRV technical specifications.

Tests shall be conducted by the Contractor in accordance with the provisions herein and the requirements of the regulatory bodies.

Tests and trials, and related inspections, shall occur in stages to identify and remedy defective or improperly specified equipment, deficient design, installation and construction, and related problems as early as possible. Towards this end, test agenda and related procedures shall be written in accordance with Section 092.12 for the following stages or inspections, testing and trials as applicable to the item of work, material, equipment or system:

- Stage 1 – Shop Inspections and Tests
- Stage 2 – Construction Inspections and Tests
- Stage 3 – Operation and Performance Tests

- Stage 4 – Dock Trials
- Stage 5 – Builder's Sea Trials
- Stage 6 - Acceptance Trials
- Stage 7 - Special Tests

Each stage of inspections, testing and trials shall be completed in the proper sequence as described above.

All portions of the vessel and all work thereon including structure, fittings, systems and machinery shall be thoroughly tested after installation to demonstrate satisfactory workmanship, proper working order, alignment of all moving parts, tightness, suitability for the purpose intended and compliance with the requirements of these specifications. Any defects that may develop or become apparent from these tests shall be made good by the Contractor at his expense.

At a reasonable time before the vessel is ready for trials, the Contractor shall submit for approval a schedule of tests to be conducted, including test procedures to be followed and data to be taken. All tests shall be conducted by and at the expense of the Contractor.

Tests shall be conducted at reasonable times, and the Owner's Representative, inspectors and surveyors shall be notified a reasonable period in advance of the scheduling of tests so that they may arrange to be present.

Presence at and witnessing of tests by the Owner's Representative in no way relieves the Contractor of his full responsibility.

The Contractor shall provide all meters, gages and other special equipment and supplies required and shall be responsible for their proper installation, calibration and use and for their removal at the conclusion of the various tests.

The Contractor shall also provide all personnel required to run the tests and to record the data therefrom. Three copies of all final test reports shall be supplied to the Owner's Representative.

3.18A Shop Inspections and Tests – Stage 1

Shop inspections and tests shall be conducted for major equipment, systems and assemblies by the manufacturer to demonstrate proper manufacture, assembly, function and compliance with performance criteria prior to shipment. The Contractor shall require inspections and tests as discussed in this subsection by contract with the manufacturer.

Shop inspections and tests shall be performed in accordance with the recommendations of SNAME Technical and Research Bulletin No. 3-39, *Guide for Shop and Installation Tests*, as supplemented by other requirements of the regulatory bodies, the provisions of these requirements and the general practices of the equipment manufacturers.

Stage 1 of the test and trial program shall consist of at least the following shop

inspections and tests for the following equipment fitted on the vessel:

- Main diesel generator sets and ancillary equipment
- Main propulsion motors and ancillary equipment
- Azimuthing Z-drive propulsion units and ancillary equipment
- Bow thruster and ancillary equipment
- Machinery plant control and monitoring system and ancillary equipment
- Control and power distribution switchboards and ancillary equipment
- HVAC
- Interior communication, navigation equipment and ancillary equipment
- Science network
- Fire protection systems and ancillary equipment
- Doors, hatches, side port closures and hull fittings
- Cranes, winches, frames and booms
- Pollution abatement equipment
- Cathodic protection and anti-biofouling systems and ancillary equipment

Equipment either listed or not listed herein shall still be subjected to the manufacturer's standard quality assurance inspections and tests that might otherwise be performed during fabrication.

The manufacturers' standard practices for conducting and reporting shop inspections and tests shall be used and supplemented with the recommendations of SNAME Technical and Research Bulletin No. 3-39, Guide for Shop and Installation Tests, and the requirements of regulatory bodies. Factory inspection and test reports shall be submitted to the Owner prior to shipment from the manufacturer's facility.

3.18B Construction Inspections and Tests – Stage 2

Construction inspections and tests are static demonstrations that precede operational testing. These tests and inspections shall verify that equipment, systems and fabricated construction materials are installed in accordance with design work and the requirements of the manufacturer, regulatory bodies and Owner.

Memorandums shall be prepared in accordance with Section 092.9 identifying construction inspections, tests and procedures for the Owner's approval.

The inspections and tests shall be performed in accordance with the recommendations of SNAME Technical and Research Bulletin No. 3-39, Guide for Shop and Installation Tests, as supplemented by other requirements of the regulatory bodies, the provisions of these requirements and recommendations of the equipment manufacturers.

Stage 2 of the test and trial program shall consist of at least the following inspections and tests conducted in accordance with approved test memorandums:

• Cleanliness tests to verify cleaning and flushing of all Contractor fabricated and installed piping systems.
• Hydrostatic (and/or pneumatic when permitted) testing of all Contractor fabricated and installed piping systems.
• Insulation resistance testing and point-to-point verification of all Contractor

installed electrical cables and connections.
• Equipment alignments such as alignment of motor driven auxiliaries.
• Propulsion drive train alignment (motors, shafting, azimuthing propulsors).
• Static load testing of all load-bearing hull fittings including but not limited to padeyes, bitts and chocks.
• Pressure testing of Contractor fabricated structural and independent tanks.
• Tightness testing of weather deck doors, scuttles, windows, port holes, roller doors or other similar vessel features intended to be sealed to prevent passage of liquid, gas or atmosphere, including penetrations in watertight bulkheads and decks.
• Calibration of instrumentation.
• Welding inspections and quality assurance checks.
• Protective coating inspections and quality assurance checks.
• Hull fairness and alignment inspections and quality assurance checks of structural fabrications.

All construction inspections and tests shall be conducted to the satisfaction of the regulatory bodies and the Owner.

If, in the judgment of the Owner's Representative, the lighting levels appear to be inadequate or uneven in particular locations, the lighting intensity shall be measured and recorded at appropriate working levels in those locations. Proper illumination from emergency lights shall be demonstrated with all normal lighting turned off at night.

3.18C Operation and Performance Tests – Stage 3

Operation and performance tests shall be conducted to verify that equipment and systems operate and perform within the limits and tolerances prescribed by the design work and the requirements of the manufacturer, regulatory bodies and the Owner.

Memorandums shall be prepared in accordance with Section 092.9, identifying operation and performance tests and procedures for the Owner's approval.
The operation and performance tests shall be performed in accordance with the recommendations of SNAME Technical and Research Bulletin No. 3-39, Guide for Shop and Installation Tests, as supplemented by other requirements of the regulatory bodies, the provisions of these requirements and recommendations of the equipment manufacturers.

Stage 3 of the test and trial program shall consist of at least the following operation and performance tests conducted in accordance with approved test memorandums:

• All operational functions of equipment and systems shall be fully demonstrated.
• All performance criteria established for equipment and systems shall be fully verified.
• All control settings, safety trips, interlocks, alarms, fail-safe features, emergency shutdowns and other control features for equipment and systems shall be fully demonstrated. Demonstrations shall include all interconnecting cable and sensing devices.

• All local and remote controls for equipment and systems shall be fully demonstrated at all stations.
• All local and remote instrumentation for equipment and systems shall be fully verified at all locations and among locations.
• Heat run tests for all electric motor driven auxiliaries shall be conducted.

Generator load testing shall be performed using load bank(s) having the capacity to fully load each generator in single and parallel operation at the generator's rated capacity. The load bank(s) shall be suitable for performing transient response tests and verifying governor and associated control system settings, safety trips, interlocks and automatic start-up and transfer of the load between generators.

All operation and performance inspections and tests shall be conducted to the satisfaction of the Owner.

Where two or more systems or equipment items interface, the tests shall also demonstrate satisfactory alignment and performance of the systems and equipment as a whole.

3.18D Dock Trials – Stage 4

Dock trials consisting of simultaneous dockside operation of the diesel generating plant, diesel generating plant controls and associated auxiliaries shall be conducted to demonstrate readiness for sea trials. In addition, certain installation, operational and performance tests unrelated to the machinery plant, but of particular interest in preparation for sea trials shall be conducted as part of dock trials, as specified herein. Dock trials shall be performed in accordance with the recommendations of SNAME Technical and Research Bulletin No. 3-47, Guide for Sea Trials, as supplemented by other requirements of the regulatory bodies, the provisions of these requirements and recommendations of the equipment manufacturers.

Dock trials shall consist of at least the following:

Diesel Generating Plant Preparation Tests. These tests shall include nonoperational cold checks of the plant, confirmation of proper operation of monitoring instrumentation, static tests of emergency shutdowns, alarms, speed limiting devices and overspeed trips, and other applicable start-up preparation tests, including checking coolant and lubricant levels.

Diesel Generating Plant Spin and Load Tests. These tests shall include spin and load tests of the diesel generator sets, propulsion motors, and azimuthing propellers in accordance with paragraphs 3.2 and 3.3 of SNAME Technical and Research Bulletin No. 3-47, Guide for Sea Trials. Remote control system features shall be demonstrated as part of these tests in accordance with paragraph 3.4 of SNAME Technical and Research Bulletin No. 3-47, Guide for Sea Trials, for each of the remote control stations (e.g., primary control position, bridge wings, IMACS, etc.). Trials shall be performed with ahead, neutral and astern propulsion up to the highest power consistent with the manufacturer's recommendations, the strength of the moorings and dock facility. Proper operation of the azimuthing propulsion units shall be verified. All local and remote controls shall be functionally demonstrated and related instrumentation shall be verified.

Azimuthing Propulsor Gear Tooth Contact Pattern Inspections. These inspections shall verify proper internal alignment of the upper and lower gear sets via tooth contact pattern checks after dockside propulsion tests using the manufacturer's procedures and acceptance criteria. Contact patterns on the gears shall be recorded by sketching the dimensional area of the pattern on a scaled outline of the tooth profile. This is an interim inspection; actual contact pattern acceptance will be based on the post-acceptance trial inspections.

Bow Thruster Tests. Complete functional testing of the bow thruster, controls and instrumentation shall be performed.

Auxiliary Systems Tests. In addition to the applicable auxiliary tests of paragraph 3.6 of SNAME Technical and Research Bulletin No. 3-47, Guide for Sea Trials, the proper operation of all other auxiliary systems and their components shall be verified, including at least the following:

- Compressed air system
- Lube oil systems
- Diesel oil systems
- Bilge systems
- Potable water system
- Sea water service and cooling systems
- HVAC systems
- MSD and sewage system
- Ballast system
- Sanitary flushing system
- Fire fighting systems
- Waste heat recovery systems
- Waste oil transfer system
- Oily water separator system
- Chill water system
- Steam system
- Uncontaminated seawater system

Diesel Generator Tests. The generators shall be tested in single generator and parallel operating modes. The diesel generators' response to transient load changes and all low voltage relays, safety trips, alarms, interlocks and controls shall be tested. All controls and instrumentation for the automatic start-up generators and transfer of load between generators shall be also tested.

Lifesaving Equipment Tests. The rafts, rescue boats, their winches and davits shall be tested for proper operation and performance.

Lighting Systems Tests. All lighting systems shall be tested for proper operation and performance.

Radio Equipment Tests. All radio equipment shall be tested for proper operation 1100 and performance, including tests for radio interference.

Navigation Equipment Tests. All electronic navigation and sounding equipment,

associated alarm systems and the ship's whistle and fog horn shall be tested for proper operation and performance. Proper installation of the compasses and all other navigation equipment shall be verified.

Anchor Handling Equipment and Ground Tackle Tests. The anchor handling equipment and ground tackle shall be tested by raising and lowering the anchors.

Internal Communication Systems. All internal communication systems required for vessel operations and safety shall be functionally demonstrated.

Science Network System. All aspects of the science network shall be functionally demonstrated.

Emergency and Lifesaving Equipment Survey. The vessel's emergency and lifesaving equipment shall be surveyed for proper stowage and provisioning.

3.18E Builder's Sea Trials – Stage 5

Builder's sea trials shall be conducted at sea prior to acceptance trials to check the operation of the machinery installation; make any adjustments necessary to establish proper operation; check compliance with vessel, equipment and systems performance requirements; and establish the vessel's readiness for acceptance trials.

Builder's sea trials shall be performed in accordance with these requirements, as supplemented by other requirements of the regulatory bodies and recommendations of the equipment manufacturers.

Builder's sea trials shall include the following trial events and related tests conducted in accordance with SNAME Technical and Research Bulletin No. 3-47, Guide for Sea Trials, and other relevant test memorandums. Other tests and trials shall be made at the Contractor's discretion:

Ahead Endurance Trials. This trial shall be conducted at the maximum continuous service rating of the engines for a period of not less than 4 hours duration.

Astern Trial. This trial shall be conducted in accordance with the manufacturer's recommendations regarding duration and maximum shaft speed.
Machinery Plant Control System Tests. Control system tests shall include local and remote stations and emergency controls.

Ahead and Astern Steering Test. This trial shall be conducted in accordance with the manufacturer's recommendations regarding duration and maximum shaft speed.
Navigation Equipment Tests. The compasses and electronic equipment shall be adjusted and calibrated as appropriate during initial phases of the trials.

Shaft Horsepower and Torsional Vibration. Shaft horsepower and torsional vibration, measured at the input to each Z-drive, shall be computed and recorded during trials using temporarily or permanently installed torsiometers. The data from the torsiometers shall be analyzed to verify torsional vibration amplitudes

acceptable to the propulsion system equipment manufacturers, ABS and the Owner over the entire operating speed range.

Loss of Electrical Power Test. This test shall be conducted to demonstrate safe operation of the vessel and emergency backup systems under loss of electrical generating power.

Quick Reversal from Astern to Ahead Test. Two tests shall be conducted in accordance with the manufacturer's recommendation regarding duration and maximum shaft speed.

Quick Reversal from Ahead to Astern Test. This test shall be performed with the ship proceeding ahead at maximum ship speed. Stopping time and head reach shall be recorded. Each test shall be repeated once.

Auxiliary System Test. Auxiliary systems and components that could not be fully tested during dock trials shall be tested.

3.18F Acceptance Trials – Stage 6

Acceptance trials shall be conducted at sea to demonstrate compliance with specifications, contract drawings and all other contractual obligations, as a prerequisite to regulatory certification and Owner acceptance of the vessel by the Owner.

Acceptance trials shall be performed in accordance with these Requirements, as supplemented by other requirements and recommendations of the regulatory bodies, and in accordance with SNAME Technical and Research Bulletin No. 3-47, Guide for Sea Trials and equipment manufacturers' recommendations.

Acceptance trials shall at least consist of the following trial events and related tests conducted in accordance with approved test memorandums:

Ahead Economy Trials. The economy trial shall be conducted at the 12-knot speed continuously for a period of 4 hours. The fuel consumed during this trial shall be determined. The vessel displacement at the beginning of the economy trials shall be the full load condition plus remaining contract modification and service life margins.

Ahead Endurance Trials. This trial shall be conducted at the maximum rating of the diesel generator sets for a period of not less than 4 hours duration. Displacement shall be noted at the beginning and end of this trial.

Speed Trials. Speed trials shall be conducted on reciprocal courses in accordance with SNAME Technical and Research Bulletin No. 3-47, Guide for Sea Trials, at generator loads corresponding to 80% and 100%, with the vessel loaded to the full load condition.

Astern Trial. This trial shall be conducted in accordance with the manufacturer's recommendations regarding duration and maximum shaft speed.

Machinery Plant Control System Tests. Control system tests shall include tests from the wheelhouse, bridge wing, IMACS and local control stations.

Ahead Steering Test. This trial shall be conducted in accordance with the requirements in references.

Astern Steering Test. This trial shall be conducted in accordance with the manufacturer's recommendations regarding duration and maximum shaft speed.

Turning Circle Test. This trial shall be performed at full speed and 12 knots.
"Z" Maneuver Test. Both 10°/10° and 20°/20° heading angle change tests shall be conducted at vessel speeds of 12 knots and full speed.

Pullout Tests. Shall be performed to port and starboard in conjunction with Turning Circle Test.

Spiral Test. Either the direct or reverse spiral tests shall be performed if the Pullout Tests identify any directional instability, but only to the extent necessary to determine the spiral loop width.

Thruster Tests. The bow thruster tests shall include the dead-in-water test described in SNAME Technical and Research Bulletin No. 3-47, Guide for Sea Trials and the following additional tests:

• Tests shall be performed to determine the maximum forward speed that the bow thruster is effective.
• Tests shall be performed to determine the lateral thrust in both directions at zero speed.
• Refer to items 'P' and 'X' below for use of thruster(s) in "crabbing" maneuvers and station keeping tests.

Quick Reversal from Ahead to Astern Test. This test shall be performed with the ship proceeding ahead at maximum ship speed, and also with the ship proceeding at 12 knots. Stopping time and head reach shall be recorded. Each test shall be repeated once. Displacement shall be determined and noted.

Quick Reversal from Astern to Ahead Test. Two tests shall be conducted in accordance with the manufacturer's recommendations regarding duration and maximum shaft speed. Displacement shall be determined and noted.

Slow Speed Maneuvering Tests. Tests shall be performed which demonstrate the vessel's ability to satisfy the slow speed maneuvering requirements.

Crabbing Maneuver Tests. Tests shall be performed to demonstrate the vessel's ability to perform crabbing maneuvers (lateral movement of the vessel with no significant fore or aft vessel motion). The maximum sideways velocity achievable using the crabbing maneuver shall be determined with and without bow thruster(s) to port and starboard. Displacement shall be determined and noted.

Standardization Trials. This test shall be performed in accordance with the requirements in the references.

Anchor Windlass Tests. This test shall be performed in accordance with the requirements in the references.

Navigation Equipment Tests. Proper calibration of the compasses and electronic equipment shall be verified by USCG and ABS prior to builder's trials. They do not need repeating if no major changes have taken place that affect navigation equipment.

Miscellaneous Auxiliary Systems Tests. Auxiliary systems that are not suited for complete testing under dockside conditions, or which can more accurately be tested while underway, shall be tested during these trials. These include at least the following:

- Galley equipment.
- Heating, ventilation and air conditioning systems.
- Potable water treatment system.
- Ballasting system.
- Sewage system.
- Communication equipment.
- Navigation equipment.
- Elevators under vessel motion.
- Lube oil systems.
- Fuel oil systems.
- Hydraulic oil systems
- Cooling water systems

Airborne Noise Survey. Shall be conducted in accordance with Section 092.8 of the requirements.

Vibration Survey. Shall be conducted in accordance with Section 092.8 of the requirements.

Shaft Horsepower and Torsional Vibration Measurements. Shaft horsepower shall be measured and recorded during speed trials using temporarily or permanently installed torsiometers, similar to the builder's trials.

Station Keeping. The dynamic positioning system shall be demonstrated to the satisfaction of the regulatory bodies and the Owner. Displacement shall be noted.

The performance of auxiliary propulsion plant components shall be observed and recorded and other special considerations applicable to the diesel generating plant shall be made during trials as delineated in SNAME Technical and Research Bulletin No. 3-47, Guide for Sea Trials.

After acceptance trials have been completed, the vessel shall be returned to the Contractor's facility and selected equipment, as directed at the discretion of the Owner and required by the regulatory bodies, shall be immediately opened for posttrial examination. These examinations shall include, but not be limited to, the following:

- Azimuthing propulsion units gear tooth contact pattern checks (upper and
- lower gear sets).

- Propulsion drive train hot alignment readings.

- Hull structural inspection (all spaces, including underwater diver inspection)
- and superstructure (where visible)

3.18G Special Tests and Reports – Stage 7

Special tests are those tests that require special simulation or test facilities and are not directly related to specific equipment or systems.

.3.18.G.1 Lightship Survey

When all the work on the vessel is substantially complete, but prior to sea trials, a lightship survey shall be conducted in accordance with ASTM Standard F1321, Guide for Conducting a Stability Test. The test shall be conducted under the witness of the USCG, ABS and the Owner. The Contractor shall furnish written notification of the

test to the USCG, ABS and the Owner no less than two (2) weeks prior to the intended test date. Additional notification requirements of the regulatory bodies shall be the responsibility of the Contractor.

.3.18.G.2 Inclining Test

An Inclining Test of the vessel shall be conducted in accordance with ASTM Standard F1321, Guide for Conducting a Stability Test. The test shall be conducted under the witness of the USCG, ABS and the Owner. The Contractor shall furnish written notification of the test to the USCG, ABS and the Owner no less than two (2) weeks prior to the intended test date. Additional notification requirements of the regulatory bodies shall be the responsibility of the Contractor.

.3.18.G.3 Stability Report

Upon successful completion of the inclining experiment and determination of the lightship characteristics, a stability test report shall be prepared establishing the displacement, and vertical and longitudinal positions of the center of gravity in the lightship condition. The test report shall be prepared using hydrostatic information applicable to the as-inclined waterplane of the vessel (as-inclined trim and heel considered), as obtained from the General HydroStatics program. Copies of the report shall be submitted to the USCG for approval and to the Owner for the Owner's information. The USCG-approved report and magnetic media files, in an agreed format, of both the report and the supporting GHS data shall be furnished to the Owner.

.3.18.G.4 Noise Surveys – Does science community want this?

Note: Text of this section was taken from Alaska Region Research Vessel Contract Specifications, December 2004 and is intended as a guide to the sort of material to be included in the PRV technical specifications.

Airborne noise shall be measured within each interior space and at various topside locations during sea trials and reported in accordance with International Standard (ISO) 2923, "Acoustics - Measurement of Noise On Board Vessels." Wherever the noise acceptance levels have been exceeded, diagnostic measurements including 1/3 octave readings shall be made to identify offending noise sources and transmission paths.

Modifications, where necessary, shall be made at the Contractor's expense until the noise criteria are satisfied. Additional measurements shall be taken following completion of the modifications to affirm that the criteria are met, and further modifications shall be made at the Contractor's expense until the criteria are met.

.3.18.G.5 Vibration Surveys – Does science community want this?

Note: Text of this section was taken from Alaska Region Research Vessel Contract Specifications, December 2004 and is intended as a guide to the sort of material to be included in the PRV technical specifications.

Structural resonance tests shall be conducted during construction to predict the natural frequencies of propulsion machinery foundations and of the completed hull and superstructure. These tests shall be performed as early as practical following erection of these structures so as to provide an opportunity to make modifications that will ensure that the natural frequencies will not coincide with propulsion system blade rate and machinery excitation frequencies.

Vibration response of structure and machinery shall be measured during sea trials and reported in accordance with International Standard ISO 4867, Code for the Measurement and Reporting of Shipboard Vibration Data, and International Standard ISO-4868, Code for the Measurement and Reporting of Local Vibration Data of Ship Structures and Equipment. Measurements at each test location shall include the Maximum Repetitive Amplitude (MRA) of displacement of the multi-frequency, real-time recording of the vertical, longitudinal and athwartship vibration at each measured location. Where equipment is used which measures time-averaged rms values instead of MRA values, the rms values shall be converted to the equivalent MRA values per SNAME Technical & Research Bulletin 2-29, Guide for the Analysis and Evaluation of Shipboard Hull Vibration Data, for comparison with the MRA criteria. Equivalent criteria may be substituted if agreed by DNV, the equipment manufacturer and the Owner.

The steady and alternating torque of the propulsion system shall be calculated from strain gage readings taken during sea trials. The readings shall be taken at the incremental power levels cited in the ISO vibration measurement standards.

Where measurements are required by the ISO standards at locations where local vibration occurs, the Owner will participate in the selection of these locations, and the Owner must agree to the locations decided upon.

Real-time recordings of all vibration data shall be stored on a suitable medium for later analysis. For purposes of assessing the actual amplitudes associated with each single frequency component, as necessary for evaluation against design prediction, a spectrum analysis of the real-time recording is required.

Treatment modifications shall be made where necessary to meet the vibration criteria. Additional measurements shall be taken following completion of the modifications to affirm that the criteria are met.

Baseline vibration signatures shall also be taken for all the propulsion system drive train, genset, pumps, and fans to form the basis for a future predictive maintenance program.

.3.18.G.6 EMI Testing – Does science community want this?

Note: Text of this section was taken from Alaska Region Research Vessel Contract Specifications, December 2004 and is intended as a guide to the sort of material to be included in the PRV technical specifications.

The Contractor must provide an EMI Test Procedure to ensure the EMI requirements of Section 300 are satisfied. The test procedure must include a description of test site, instrumentation, equipment, modes of operation and measurements that will be recorded. The procedure must describe all test activities and pass/fail criteria for the equipment under test. Potential radiating equipment must be energized while susceptible equipment are energized and monitored for interference. If interference is detected, the active equipment must be de-energized one at a time until the interfering source is determined. Any extraneous signals generated by or caused by the active equipment must be termed interference. The following severity levels must be assigned:

Mild. A level of interference which, although detectable, does not hamper the detection and interpretation of a desired signal. This level of interference is mainly a background or nuisance type, with momentary (50 millisecond) disruption of equipment operation.

Medium. A level of interference that interferes with the detection and interpretation of a desired signal. This level of interference causes partial break-up or masking of the desired signal with some loss of signal content. Equipment operates in a degraded condition.

Severe. A level of interference that causes complete loss of a desired signal or interferes to the extent that desired signal information or message content cannot be interpreted. Equipment is inoperable.

EMI that exceeds the mild level as defined above must be corrected by the Contractor.

.3.18.G.7 Noise, Vibration and Resilient Mounting – Does science community want this?

Note: Text of this section was taken from Alaska Region Research Vessel Contract Specifications, December 2004 and is intended as a guide to the sort of material to be included in the PRV technical specifications.

The following surveys shall be performed prior to the underwater radiated noise tests:
• A system isolation and clearance survey to ensure that resiliently mounted machinery and equipment are properly installed; noise isolation features, including resilient mounts, resilient pipe hangers, and flexible connections are properly installed and undamaged; and that there are no sound shorts or acoustic deficiencies.
• An acoustic treatment survey to ensure that sound absorption materials, including damping tiles and transmission loss treatments, are in good condition and properly installed.
• A hull survey to identify potential sources of flow tones and flow excited rattles and noises.

.3.18.G.8 Airborne Noise Survey – Does science community want this?

Note: Text of this section was taken from Alaska Region Research Vessel Contract Specifications, December 2004 and is intended as a guide to the sort of material to be included in the PRV technical specifications.

Airborne noise measurements must be made on board the ship in accordance with Section 073. Measurements must be made in all compartments, spaces and locations, and the sound pressure levels compared to the appropriate specifications. Tests must be conducted with all ship systems operating. All areas specifically identified as being covered by a noise specification must be measured.
Prior to the start of the test, the following items must be completed:

• Inspect visually and aurally the compartments and spaces to be measured to finalize measurement locations. These locations must be the same in all tests.
• As far as possible, ensure that the staterooms and spaces are essentially complete including carpets, curtains and furniture where fitted.
• HVAC flow balancing.
• The acoustic treatment survey, including resolution of deficiencies.

With the ship operating in accordance with normal underway operating conditions for 12 kt transit condition, stationkeeping and trawling, the noise levels in the compartments and spaces of the ship must be measured. Measurements must be made at locations within a compartment or space that represent the general acoustic condition of the space and that are representative of locations normally occupied.

In staterooms, measurements must be made at the head of the berth(s) and at the desk. In public areas, measurements must be made at typically occupied locations. In machinery spaces, measurements must be made at watch standing positions, and/or gage board, alarm, telephone, and those areas where extended occupancies can

be expected. Weather deck locations defined in Section 073 must be measured. In passageways, measurements must be made about every 30 feet.

As a minimum, two measurements per space, deck locations and sanitary spaces excepted, must be taken. Noise measurements are not required in closets and wardrobes. Data log sheets must be used. Measured levels must be compared with the specified compartment or space noise criteria where appropriate and as noted on the data log sheets. When a space fails to meet its criteria, additional measurements and observations must be made to define the cause of the failure. Comments must be made in the appropriate part of the data log sheet on any observed conditions that could compromise the noise survey.

.3.18.G.9 Structure-Borne Noise Survey – Does science community want this?

Note: Text of this section was taken from Alaska Region Research Vessel Contract Specifications, December 2004 and is intended as a guide to the sort of material to be included in the PRV technical specifications.

The Contractor must perform a structure-borne noise survey and record structureborne noise measurements of equipment or machinery identified by the noise control engineering firm as noise critical and potentially affecting the noise signature of the ship.

Where identical items of equipment are installed on the ship in sets of two or more (i.e. generators, pumps, A/C plants, refrigeration plants, air compressors, etc.), each individual item in the set must be measured. Noise measurements of non-propulsion machinery may be made dockside. Constant speed components must be operated at normal load required for 100 percent full power load with the main propulsion plant inoperative. Variable speed components must be operated at speeds and loads that are required when the main propulsion plant is producing 50 and 100 percent of maximum continuous shaft horsepower.

Measurements must be performed in accordance with the procedures specified in MIL-STD-740-2, paragraphs 5.2 through 5.8, with the following exceptions:

• Measurements must be made in one-third octave bands up to 10 kHz. At the location on each item of equipment with the overall highest level, narrowband measurements (minimum 400 line analysis) must be made over the frequency ranges 0-100 Hz, 0-2 kHz and 0-20 kHz.
• Locations of accelerometer blocks must be precisely recorded and photographed.
• Measurements must be made on the foundation side, as well as on the machine side at resilient mounts.
• One-third octave band measurements must be made at resilient piping connectors where attached to equipment. Where identical items of equipment are installed in sets, the unit that exhibits the highest overall vibration level based on the measurements in paragraph (a) must be used as the sample. Measurements must be made at inlet and discharge connectors on the

equipment side and the piping side of the connectors.
• Accelerometers used for measurement of frequencies must have a resonance above 20,000 Hz or be otherwise approved by the Owner. Accelerometers must have sensitivities appropriate to the frequency and amplitude of the noise being measured.

Noise data must be provided in tabular and graphical form.

.3.18.G.10 Vibration Survey – including while underway – Does science community want this?

Note: Text of this section was taken from Alaska Region Research Vessel Contract Specifications, December 2004 and is intended as a guide to the sort of material to be included in the PRV technical specifications.

An underway vibration survey must be performed following the procedures of SNAME Code C-1 and C-4. Single amplitude displacement must be measured for the hull girder, superstructure and masts with the ship underway in water with a minimum depth of five times the draft of the ship. A steady acceleration run of 5 to 10 RPM must be conducted to determine critical operating frequencies. Steady speed runs must be performed in 5 RPM increments from 1/2 full power RPM to full power RPM. Additional runs of smaller RPM increments must be taken to determine the maximum amplitude at critical shafting resonance frequencies. The vibration survey at the propulsion machinery must be performed in accordance with SNAME Code C-5. Vibration must be within habitability limits of SNAME Technical and Research Bulletin 2-25.

.3.18.G.11 Sonar Self-Noise Survey – Does science community want this?

Note: Text of this section was taken from Alaska Region Research Vessel Contract Specifications, December 2004 and is intended as a guide to the sort of material to be included in the PRV technical specifications.

Underway sonar self-noise tests shall be conducted by the Contractor. The results of these tests must be documented in a test report to be submitted to the Owner.

Underway sonar self-noise tests shall be conducted from zero to maximum ahead ship speed in 1 kt increments, and steady state conditions, to determine the performance of sonars and sounders with respect to ship speed. The tests must be performed with the ship in normal underway operating conditions for hydroacoustic survey at 8 kt, trawling and stationkeeping, at the normal trim and ballast condition. The sonar self-noise measurements must be conducted at 500 ft and 1,600 ft water depths, and at deep water where ship bottom reflected noise has been determined to have minimal impact on the sonar self-noise levels. Measurements must be made in an area free from contacts, both ship and land.

The sonar self-noise testing shall include an acoustic calibration of the sonar transducers.

One-third octave acoustic data from the ship's self noise monitoring hydrophones shall be acquired in conjunction with sonar self-noise testing and during the underwater radiated noise trial.

.3.18.G.12 Underwater Radiated Noise Trial Requirements – Does science community want this?

Note: Text of this section was taken from Alaska Region Research Vessel Contract Specifications, December 2004 and is intended as a guide to the sort of material to be included in the PRV technical specifications.

Underwater radiated noise tests shall be conducted by the Contractor at an Ownerapproved acoustic range to fully characterize the underwater radiated noise. In addition, underwater radiated noise tests must include speed-dependent and machinery-dependent radiated noise measurements and hull vibration measurements adjacent to the propeller at 0 kt, 7 kt, 8 kt, 9 kt, 12 kt and maximum ahead speed. Results of all tests shall be documented in a single test report to be submitted to the Owner for review and approval prior to provisional acceptance of the ship. The Owner reserves the right to instrument the ship and to record the associated measurement data concurrently with radiated noise tests.
Hull vibration measurements shall be made using at least three triaxial vibration transducers attached to the hull plating – one above the propeller and two in the machinery space. During radiated noise measurements, the vibration transducer outputs, appropriately amplified, must be tape recorded and processed by the same procedures used for analysis of individual hydrophone signals.
One-third octave acoustic data from the ship's self noise monitoring hydrophones shall be acquired in conjunction with underwater radiated noise trials.
The acoustic treatment survey, airborne noise survey and structure-borne noise survey shall be completed prior to the underwater radiated noise tests.
General requirements for the underwater radiated noise measurements, both nearand far-field, are as follows:

Frequency range	10 Hz - 20,000 Hz
Bandwidth	1/3-octave band and narrow band (approx. 1 Hz bandwidth for information only)
Reference pressure	1 microPa at 1 meter
Reference distance	1 meter
Measurement distance for far-field	100 meters minimum
Water depth	150 meters minimum for far-field
Sea conditions	No whitecaps or breaking waves, ship roll or pitch does not cause water splash
Background noise from measurement ship (if a measurement ship is used)	Less than 2 dB increase over ambient in bands from 10 Hz - 20,000 Hz
Allowable measurement errors	Acoustic measurement error not to exceed +/-2 dB from 10 Hz to 20,000 Hz

The test site must be chosen to provide adequate depth and maneuvering room, freedom from shipping and local traffic noise interference, freedom from severe thermal and density gradients and avoidance of nearby steep bottom slopes and avoidance of an acoustically highly reflective bottom.

The trials agenda for the underwater radiated noise trial shall also include test schedules and must describe the test site. The test procedure must include plans for calibration of all instrumentation used in the measurements. The calibration plans must include provision for checking the calibration of the acoustic measurement and analysis system during the course of the test, as well as for pre-test and post-test calibrations.

.3.18.G.13 Far-Field Radiated Noise Procedures

Measurements of steady state radiated noise and the noise from cyclic noise critical equipment made in the far field of the ship shall be the preferred method of characterizing the ship's radiated noise levels for all operational states for which such measurements are reasonably possible. Far-field measurements are not acceptable for a signal-to-noise ratio (S/N) of less than 3 dB in a one-third octave band; for those cases near-field measurements are required.

During testing, the ship shall operate in the condition specified in the test procedure for each test run. It must maneuver to a closest point of approach (CPA) of approximately, but not less than, 330 ft from the measurement hydrophone buoy. A straight line course must be set 30 seconds before bow CPA, and no further rudder movement or speed change must occur until end of run is signaled by the test director, except in emergency.

Measurements of far-field radiated noise shall be made with a minimum of three omnidirectional hydrophones compliantly suspended from a buoy and at depths which cause the buoys to be equally distributed from 15 - 45 degrees depression angle from the ship. Signals from the hydrophones may be cabled or telemetered by radio link to the recording and processing station, where they must be appropriately amplified and recorded on an instrumentation-quality FM or digital tape recorder or stream-to-disk. If digital tape recording is used, it must be in ID-1 format.

An Adelaide mounted on the bridge wing can be used to determine the CPA, and a laser range finder to determine the distance at CPA. The test shall be initiated at the moment the bow passes the hydrophone at 90 degrees.

Each hydrophone signal shall be individually filtered and power averaged in 1/3 octave bands and in narrow band (approximately 1 Hz bandwidth) format from 10 Hz to 20,000 Hz. The signals must be averaged over 10 second periods.

Gain and hydrophone sensitivity factors shall be applied during processing so that the resulting levels are uniformly referenced to one μPa. They must then be individually corrected for any contribution from background noise if the S/N is between 3 and 19 dB. Radiated noise measurements with S/N of less than 3 dB shall be discarded,

while measurements with S/N of greater than 19 dB require no correction. The background noise level, LN, must be measured in real time several times during the trial, with the ship at a range greater than 800 m from the measurement hydrophones.

Each 1/3-octave band and narrow bandwidth level from each of the measurement array hydrophones shall be corrected to its 1 m equivalent level by applying an individual sound transmission loss correction. The distance used must be the average range between the center of the ship and the hydrophone over the 10-second signal averaging period. Transmission loss corrections must be determined as a function of range.

All of the measurement hydrophone outputs shall be averaged together over the appropriate sector of the ship's aspect. These averages will be the averages of the radiated noise intensities represented by the individual equivalent 1 m levels. An average centered on the ship's beam aspect and covering the sector from the point of bow CPA to stern CPA is desired.

Four repeat test runs shall be made for each ship operational state, and the radiated noise intensity spectra from all four runs must be arithmetically averaged to give the grand averaged spectrum for that operating condition. Port and starboard aspects shall be considered as separate operating conditions.

One-third-octave band averaged spectra in terms of equivalent 1 m source levels in dB shall be reported on graphs comparing the results with those specified for the particular operational state. Port and starboard aspect data for the same ship operating state shall be plotted on the same graph. Any frequency bands where the specified requirement is not met must be clearly identified. Narrow band data are to be treated in a similar manner and presented for information only.

.3.18.G.14 Navigation, Communication, and Mission Systems Electronics

Coaxial cables for equipment specified in Section 441 and for space and weight items shall be tested by a time domain reflectometer to the operating frequency, or to the frequency range for which the cable will be used. Testing must be performed after installation of the cables to ensure that the cables have not been damaged or degraded. For all other systems requiring coaxial cable, testing by time domain reflectometer is required only in the event of degraded performance after installation.

Equipment operational tests shall be performed. All acoustic systems must be operated simultaneously to the maximum extent possible at the required speeds and when performing stationkeeping and trackline tests. In addition, the Contractor shall perform continuity tests on signal and power cables, and ensure services are operational.

Upon completion of all antenna installations, the Contractor shall identify areas of the ship and conditions where the exposure limits of ANSI C95.1 are expected to be exceeded.

Mission systems, including scientific sonar systems, scientific instrumentation and mission handling systems, shall be tested to verify correct installation and system

performance in accordance with manufacturers' specifications.

The Contractor shall demonstrate the mechanical and electrical intrasystem and intersystem adjustments and alignment of the steering gear and ship's navigational system elements, including sonars, radar, gyrocompass and repeaters, DPS, other navigation equipment and science sonars.

Optical cable assembly loss testing shall be performed after termination in accordance with method B of EIA/TIA-526-14 at a wavelength of 1300 nm. The optical loss may not be greater than 1.7 dB. Single mode fiber optical cable assemblies must be tested for return loss in accordance with method 2 of Annex A of EIA/TIA-455-107. The optical return loss of the cable assembly, including both end connectors, shall be less than 30 dB.

.3.18.G.15 Fishing and Overside Handling Equipment Trials

All fishing and overside handling equipment shall be demonstrated, including demonstration of trawling. Trawl nets, trawl doors, other fishing gear and a 1.0 m^2 Mocness will be made available by the Owner. Speed, maneuverability, propulsion plant power characteristics and machinery operations shall be demonstrated and ambient environmental conditions recorded to establish compliance with ship performance requirements. Temporary fishing permits will be arranged by the Owner.

As a minimum, the following trials shall be conducted:

• Midwater trawling. Operations shall include movement of trawl doors from stowage positions to service positions, payout of trawl net with net reel and outhaul winch, trawl net transfer to trawl winch wires, trawl net set, tow at 3,000 ft depth and 3:1 scope, trawl net haulback and transfer back to net reel, trawl net recovery with net reel and Gilson winch, and trawl net cod end handling with heavy lift crane. Proper functioning of the fish finder system, trawl control system, acoustic net mensuration system and net sonde system must be demonstrated.

• Bottom trawling. Operations shall include movement of trawl doors from stowage positions to service positions, payout of trawl net with net reel and outhaul winch, trawl net transfer to trawl winch wires, trawl net set, tow at 1000 fathom depth and 1.5:1 scope, trawl net haulback and transfer back to net reel, trawl net recovery with net reel and Gilson winch, and trawl net cod end handling with heavy lift crane. Proper functioning of the fish finder system, trawl control system, acoustic net mensuration system and net sonde systems must be demonstrated.

• CTD cast. Operations shall include lifting of a fully outfitted CTD system with each hydrographic winch and hydro-boom, deployment of the CTD system to 12,000 ft, haulback and recovery onto the baltic room deck. Proper functioning of the CTD deck unit and hydrographic winch slip rings must be demonstrated.

• Hydrographic survey. Operations shall include demonstration of proper operation of the scientific sounder system, acoustic doppler current profiler

and multi-beam sonar system in conjunction with normal ship's navigation 1615 sonars.

• Scientific instrument tow. Operations shall include lifting of a fully outfitted 1.0 m^2 Mocness with heavy lift crane, towing of the Mocness with a hydrographic wire and A-frame, and subsequent recovery of the Mocness with crane, A-frame and traction winch.

3.18H Tests and Trials Program Documentation

.3.18.H.1 Test & Survey Program Plan

Note: Text of this section was taken from Alaska Region Research Vessel Contract Specifications, December 2004 and is intended as a guide to the sort of material to be included in the PRV technical specifications.

The Contractor shall prepare a comprehensive test program plan defining the approach to be used to implement the inspection, test and evaluation requirements of this section. The test plan shall define the Contractor's test organization, documentation development and control processes, interfaces between the test organization and other Contractor organizations, interfaces with the Owner, quality assurance provisions, processes for test conduct, processes for control and handling of test equipment.

The test program plan shall be submitted within 90 days after NTP for review and approval of the Owner. A final plan shall be submitted, for review and approval of the Owner, 120 days after NTP.

.3.18.H.2 Test Program Numbering System and Index

A test program numbering system shall be developed that is related to the test stage and the specification section associated with the particular test. This system shall be used to assign identifying numbers to inspection, test and trial documentation. The same number shall be assigned to all documentation and data associated with a particular event.

A test program index shall be developed and maintained to provide a complete tabular listing of all inspections, tests and trials to be conducted, including any recommended special (Stage 7) tests. The index shall list by test number and title all Contractor conducted inspections, tests and trials. The index, and any subsequent revisions thereto, shall be provided to the Owner.

The numbering system and index shall be provided to the Owner for review and approval at least 45 days before commencement of the test program.

.3.18.H.3 Test Program Network and Schedule

A network shall be developed and maintained portraying the intended sequence of all Contractor conducted inspections, tests and trials. All predecessor and successor

inspections, tests and trials related to each event shall be clearly identified by the network.

A schedule shall be developed and maintained listing the planned and actual commencement and completion dates of each inspection, test and trial to be conducted. In addition to other required or pertinent information, the schedule shall clearly identify those inspections, tests and trials requiring regulatory body observance.

The network and schedule shall be fully integrated with the production network and schedule. Refer to the General Provisions regarding production network and schedule requirements.

The network and schedule shall be provided to the Owner for review and approval at least 45 days before commencement of the test program.

.3.18.H.4 Test Program Status Report

A status report shall be furnished depicting the completion status of all required tests and trials as of the date of report. The first report shall be submitted 30 days after approval of the test program plan. The report shall be updated and resubmitted to the Owner every four weeks during periods of reduced activity and every two weeks during periods of increased activity. Status will be a topic of progress meetings and management reviews.

.3.18.H.5 Inspection, Test and Trial Memorandums

Individual memorandums shall be written for each stage of the test program and for each equipment item, system and construction fabrication provided. Individual memorandums shall also be written for each trial event. All memorandums shall have the same general format and shall include, but not be limited to, the following:

• Identification of the equipment, system and fabrication to be inspected and tested.

• Identification number as described herein.

• References to regulatory body requirements, technical documents and specifications.

• Quality assurance coordinator certification (written) that the equipment, system or fabrication is ready for inspections and testing.

• Identification of prerequisite test conditions, inspections, tests and trial events.

• Statement(s) of required inspection and test conditions.

• Explanation(s) of necessary inspection and test preparations.

• List of all required instrumentation and equipment necessary for conducting the inspections and tests. Spaces shall be provided for recording the current calibration date of the instrumentation used.

• System or component rating, design condition, specifications and other salient technical information.

• Detailed inspection and test procedures that simultaneously address all requirements of the Owner, regulatory bodies, the specifications, contract drawings and the recommended procedures of equipment manufacturers.

• Data forms that include appropriate figures and diagrams and spaces for recording the quantitative values determined during the conduct of the inspections and tests. Each data form shall also indicate expected performance values and tolerance limits (acceptance criteria) for each measured parameter. Expected performance values shall conform to manufacturers' recommendations, specifications, or regulatory body requirements, whichever are more stringent.

• Spaces for dates, weather, humidity, temperature, nameplate data and other pertinent information, and signatures of Contractor's test and QA personnel, Owner observers and representatives of the cognizant regulatory agencies.

• Block diagrams or simplified schematics, as applicable.

• Comment sheets to record significant events and observations of the Owner witness, regulatory body representatives and Contractor's test and QA personnel during inspection and testing.

• Appendix for the later incorporation of the manufacturer's service representative field reports.

Each test memorandum shall be submitted to the Owner for review and approval at least 45 days prior to conducting the inspections and tests. Test memorandums shall be submitted as they are completed, in lieu of bulk submittal (to allow for Owner review).

Trials agenda shall be prepared covering all trial events and inspections to be conducted during dock trials, builder's sea trials and acceptance trials. A separately bound agenda booklet with applicable memorandums and schedule attached shall be provided for each of the three sets of trials.

Trial memorandums and agenda booklets shall be submitted to the Owner for review and approval at least 60 days prior to conducting the trial events and inspections.

.3.18.H.6 Sea Trials Handbooks

A handbook shall be provided prior to getting underway to at least all Owner and regulatory body personnel to be on board during builder's sea trials and acceptance

trials. The handbook shall preferably be pocket size and shall include, as a minimum, the following information:

Emergency procedures for collision, fire and man overboard events, designated emergency squads.

Schedule of trial events.

Organizational chart including names of individuals responsible for control of the vessel and conduct of each event.

Roster of individuals on board (riders list).

Plan view of deck arrangements showing locations of muster stations, lifesaving appliances and first aid stations.

.3.18.H.7 Compartment Close-out Checklists

A booklet of compartment close-out checklists shall be provided that document the tests and inspections. The booklet shall be submitted to the Owner for review and approval at least 45 days prior to commencing compartment close-outs. The checklist shall be periodically updated and a status of compartment close-outs submitted to the Owner every two weeks during periods of reduced activity and every week during periods of increased activity.

.3.18.H.8 Memorandum Reports

Completed memorandums shall be submitted to the Owner and shall include any marked-up pages of the test procedure, all completed data sheets, comment sheets, field reports and all supporting data such as computer printouts, strip charts, magnetic tapes and disks, and photographs. All test data that are not an integral part of the test procedures shall be annotated with the test number, date, and any other pertinent information. Completed memorandums bearing the signatures of test and QA personnel and representatives of the Owner and cognizant regulatory agencies shall be submitted to the Owner for review and approval within 30 days following completion of inspections and testing.

The Owner's Representative shall be provided with a copy of field data sheets as recorded immediately following the completion of the inspections and tests.

The field engineer(s) of each major equipment manufacturer shall be required by the Contractor to submit to the Owner a report following each on-site visit describing the inspection and test findings. These reports shall be attached to and submitted with the test program memorandums. Manufacturer's field engineer reports shall not be considered as a substitute for memorandums.

.3.18.H.9 Reports of Dock and Sea Trials

Reports of dock trials, builder's sea trials and acceptance trials shall be submitted to the Owner for review and approval.

The content and format of the dock trial report shall be similar to that provided for memorandum reports described above.

The content and format of the sea trial reports shall be in general accordance with SNAME Technical and Research Bulletin No. 3-47, Guide for Sea Trials, as supplemented and modified to accommodate the particular provisions of this vessel's test program and type of trials conducted.

A draft version of the sea trial report shall be provided to the Owner for comment within 15 days following completion of the subject trials. The final reports shall be provided within 15 days following receipt of Owner comments regarding the draft reports.

The acceptance trials report shall include the following subsidiary reports:

Trials report for speed
Trials report for fuel consumption
Trials report for bow thruster performance
Trials report for low speed and crabbing maneuvers.
Trials report for zigzag tests
Trials report for turning circles and pullout tests
Trials report for special demonstrations, tests and/or verifications of performance criteria stated in the specifications.

Trials report of information necessary for developing the Contractor-furnished, bridge-mounted maneuvering poster and booklets required by the Administration.

.3.18.H.10 Conduct of Tests and Trials

Identify tests and trials where charterer's oversight is required.

Note: Text of this section was taken from Alaska Region Research Vessel Contract Specifications, December 2004 and is intended as a guide to the sort of material to be included in the PRV technical specifications.

Each inspection, test and trial shall be witnessed by the Owner, except where the Owner may provide written authorization to proceed with a particular event without Owner representation.

A minimum of a 48-hour notice shall be provided to the Owner that a required inspection and test will take place. A minimum of a two week notice shall be provided to the Owner for upcoming trials.

Coordinating witness of tests and trials by regulatory bodies shall be wholly the

responsibility of the Contractor.

Field engineers of all major equipment manufacturers shall be on site and required by the Contractor to be on site during the initial check-out and testing of their supplied equipment.

The Owner's Representatives shall have freedom of access to all test personnel and representatives of the manufacturer and regulatory bodies to discuss any aspect of the inspection, test and problems found.

The signing of any memorandum data sheets by the Owner's Representative signifies only that the inspection and test were conducted in accordance with the approved memorandum and that the Owner's Representative then believes that data were accurately recorded. Owner acceptance of the completed memorandum will be documented by separate correspondence from the Owner's authorized representative to the Contractor.

Any costs resulting from the Owner's inability to commit to witness of a delayed test or trial without at least 48 hour prior notice shall be at the Contractor's expense.

To minimize re-scheduling of tests, equipment and systems shall be checked and pretested as necessary to ensure readiness for witnessed testing.

The Owner may elect to witness shop inspections and tests at the manufacturer's facilities. The Contractor shall notify the Owner at least 7 days in advance of when a shop inspection and test is to occur. The Owner will then elect whether to attend. Two weeks' notice shall be provided for any testing to be conducted at foreign manufacturers' facilities.

Subsistence shall be provided during sea trials for 15 persons serving as Owner's observers during builder's sea trials and 25 persons serving as Owner's observers during acceptance trials. If the vessel is out overnight, suitable berthing arrangements shall be made. Where transportation between the vessel and shore is required and where transportation between points of debarkation and the shipyard is required, the Contractor shall furnish the transportation.

.3.18.H.11 Test Performance and Data Collection

All inspections, tests and trials shall be performed in accordance with Owner approved test agenda and memorandums prepared in accordance with Section 092.9.

During extended steady state tests and trials, data including lubricating oil, fuel oil, cooling water, exhaust gas and combustion air pressures and temperatures, propulsion plant RPM and other necessary data shall be recorded at regular intervals not exceeding 30 minutes. Data shall be recorded more frequently if required by regulation or recommended by the references. Data shall also be recorded more frequently, as necessary, to reveal the true operating conditions being observed or to forewarn of component or system malfunction during tests of transient performance and tests of short duration.

Actual performance values observed shall be recorded during each test event, rather

than noting that performance is “satisfactory.”

A machinery plant log book, shall be maintained during all tests and trials.

.3.18.H.12 General Requirements Applicable to Trials

Successful completion and approval of dock trials is a prerequisite to conducting builder’s trials and successful completion and approval of builder’s trials is a perquisite for acceptance trials. All pre-dock and sea trial planning items listed in the SNAME Technical and Research Bulletins and others applicable to the project shall be performed prior to commencing trials.

During the conduct of required trials and related tests, the vessel shall be under the control of the Contractor, with representatives of the Owner and regulatory bodies on board to determine whether or not work done by the Contractor has been satisfactorily performed.

The Contractor shall provide a crew and pilot licensed for the water to be navigated and the vessel tonnage. Operation of the vessel and its equipment and systems, and control of tug services and dockside assist personnel, shall be carried out by these licensed persons in a safe manner.

The Contractor shall provide fully trained emergency response squads to respond to emergency conditions during trials.

Sea trials shall be conducted in deep unconfined navigable waters suitable for speed trials. The required water depth shall be calculated in accordance with SNAME Technical and Research Bulletin No. 3-47, Guide for Sea Trials.

Weather and sea conditions shall be suitable for collection of the data and in accordance with the provisions of SNAME Technical and Research Bulletin No. 3-47, Guide for Sea Trials. The actual location of the trials will be at the discretion of the Contractor.

All installation, operation and performance tests of the following systems shall be completed and approved prior to commencing other dock trials: firemain, sound powered telephone systems (excluding elevator telephone systems), sliding watertight door system, ventilation shutdown systems, engine and fuel system shutdown systems, steering indicating system, fire detection system, machinery room fixed fire extinguishing system, general alarm system, and bilge and tank level monitoring system.

At the time of sea trials, the vessel shall be in a state of material readiness suitable to meet any possible emergency at sea, such as collision, fire, man overboard, personal injury or grounding. The Contractor shall provide a written notice to the Owner that the vessel is in the aforementioned condition and can be safely taken to sea for trials. This correspondence shall be transmitted to and received by the Owner at least two days before commencing sea trials.

The Contractor shall obtain all USCG certificates that are required to conduct sea

trials. Prior to trials, the vessel shall be equipped with all necessary safety, fire fighting and life saving apparatus as required by the USCG.

Temporary rigging, industrial equipment and debris shall be removed from the vessel before sea trials. All paint shall be dry at the time of trials.

All draft marks and tank soundings shall be read dockside immediately prior to departing for sea trials and dockside immediately upon returning. The specific gravity and salinity shall be determined at the time draft marks are read, unless waived by the Owner.

Acceptance trials shall be conducted with the vessel at full load displacement and at the design waterline.

A complete set of technical manuals for major equipment shall be made available to the Owner during trials. During sea trials, data shall be readily available to observers and trial results posted in the vicinity of the data collection and computation center.

.3.18.H.13 Termination of Tests and Trials

A test shall be terminated if the equipment being tested fails to meet the acceptance criteria of the test procedure. The cause of the failure shall be identified.

Continuation of those parts of a test which are not affected by the failure may continue if acceptable to the Owner. After correction of the failure the test procedure shall be rerun at the Contractor's expense; however, if acceptable to the Owner, those steps previously accomplished and not affected by the failure or correction need not be repeated.

If unfavorable weather conditions exist during the course of sea trials which would endanger the vessel or which would compromise or put in question the validity and accuracy of the test results, the trials shall be terminated for later rescheduling at the Contractor's expense. The trials shall be rescheduled by the Contractor, subject to the approval of the Owner.

Trials shall be terminated and rescheduled at the Contractor's expense in cases where the scheduled trial time is insufficient to determine the performance of the vessel. Once a test has been confirmed and is subsequently canceled or deferred for any reason, the Owner shall be notified immediately.

Correction of defects or deficiencies shall be accomplished as specified in the contract. Following the examination and correction of defects or deficiencies, the equipment shall be closed and made ready for service.

Where an inspection, test or trial event has been demonstrated and accepted by the Owner and/or regulatory bodies and the equipment and system is subsequently modified and/or the integrity of previous testing compromised by ongoing work, the acceptance of the completed memorandum is retracted and the testing shall be repeated to the satisfaction of the Owner.

.3.18.H.14 Compartment Closeouts

After all work on the vessel is substantially complete, each compartment in the vessel shall be inspected with an Owner's Representative present to check fixtures, lighting, HVAC controls, coatings, joiner doors, outfitting and other miscellaneous items in the compartment. After the inspections of a particular compartment have been proven satisfactory to the Owner, the compartment shall be "closed out" by locking or otherwise preventing general access to the space.

Completion of all compartment close-out inspections shall be a prerequisite to acceptance of the vessel by the Owner.

After tests and trials, and just before the ship is delivered, all strainers shall be cleaned, all filter elements shall be replaced with new filters, and all systems' hydraulic and lubricating oils shall be changed.

3.19 Bubble Sweep Down & Ice Management

In order to ensure its ability to conduct bottom mapping in open water and during most icebreaking operations, PRV will have a box keel running the whole length of the bottom with its ends integrated into the bow ice knife and the stern skeg. The bottom of the keel will be wider than the top to avoid bubble sweep down and help clear ice from the acoustic arrays, which will be positioned as far forward in the box keel as possible. The depth of the keel will be 3 feet and its width will be determined from the width of the arrays.

4 SCIENCE REQUIREMENTS

4.1 General

During the period of this Contract, Charterer's personnel will install, secure, interconnect, and operate various instruments, equipment, etc. aboard the Vessel.

4.2 Deck Working Area

A fantail working deck area of approximately 4000 sq ft is required with a contiguous working area along the starboard side about 50 ft long and 12 ft wide. This area must be capable of withstanding local deck loads of 1500 lb/sq ft and a maximum total load of 100 LT. Flush deck threaded holddowns (internally threaded 1 inch UNC) shall be provided throughout the working deck area on 2 ft centers. Holddowns shall be supplied with brass threaded plugs for each socket and extra 40 hex head bolts and 40 eyebolts. The bulwarks must be removable under each A-frame for the full width of the frame. This fantail working deck and contiguous side working deck shall be heated to prevent formation of ice on the deck.

The ship shall also have a clear area on the foredeck near the bow for erection of specialized towers and booms that reach forward of the bow wave for gathering uncontaminated environmental samples. This area shall also have similar flush deck threaded holddowns on 2 ft centers.

All working decks shall be provided with 115 VAC power, sea water supply, compressed air supply, and LAN and internal communications receptacles.

4.3 Science Work Shop

Provide a Scientific Workshop of approximately 300 sq. ft., on the aft working deck, with access to that deck through a watertight double door with minimum clear width of 60 in. The space must be watertight and must be equipped with an overhead track, holding a chain fall running on the track, the system arranged to allow for the Charterer's personnel to lift equipment from the deck immediately outside the door, and pass it within the shop to land it on the work benches in the shop. The space must be well lighted for precision tool work, heated, ventilated and supplied with 115 VAC electrical outlets along the work benches, 3 each 440 VAC service outlets, 1 x 100A, 2 x 60A; and 2 each 208 VAC outlets. The space must be outfitted with sturdy metal workbenches and tool storage cabinets along the bulkheads. The space must also be wired into the ship's communications and data distribution systems with a telephone installed, and CCTV cable and Cat 5 data cable lead into the space.

4.4 Winches

The Owner is required to make permanent installation, for the term of the charter, of three government furnished oceanographic winches. One of these winches is a Markey Machinery DUSH 5 oceanographic winch, capable of handling 10,000 m of 0.322-inch diameter conducting cable. The second winch is a waterfall double drum Markey DUSH 5-5 winch, capable of handling 10,000 m of 0.322-inch diameter electromechanical cable and 10,000 m of ¼-inch mechanical cable. The third winch system is a Markey DUSH 9-11 winch, with side by side drums, handling both 10,000 m of 9/16 inch diameter trawling or coring wire rope and 10,000 m of 0.680 inch diameter electromechanical cable (10 KVA power rating and fiber-optics).

The DUSH 5-5 waterfall double drum winch and the DUSH 9-11 double drum winch must be located on the ship so as to allow wires from either of the machines to be led to both the Starboard A-Frame and to the Stern A-Frame in a safe and efficient manner.

The DUSH 5 single drum winch is to be located in the Oceanographic Staging Hangar called out separately in Appendix A—Additional Requirements for Laboratory and Related Spaces. This winch

must be located with adequate clearance to allow for the changing of winch drums, with wire wound on. The winch is to provide wire at safe and operationally proper wire scope and angle to the telescoping boom housed in the Staging Hangar, from which oceanographic equipment will be deployed over the side, through the Staging Hangar doorway.

All three of the government furnished winch systems are equipped with hydraulic power supply units, local control units, and remote control units, and remote wire read out devices for wire out, tension and speed. The hydraulic power supplies for the winches are to be installed by the Owner, in a location and arrangement that will minimize the noise intrusion on the scientific workspaces and habitability spaces on the ship during the operation of the winches. The remote control and read out devices are to be installed by the Owner in the Winch Control Room. Owner is to supply and install the wiring for connection of the controls and read out devices.

The Owner will install the above winch systems in accordance with the Technical Requirements. Each winch is to be installed by the Owner, with local control at a safe and operationally practical location near the winch, and remote control and read outs in a console in the enclosed, weather proof Winch Control Room called out separately in this Technical Requirement. The Owner will retain responsibility for the maintenance of the winches during the term of the charter. Equipment described in the below paragraph is to be supplied by the Owner.

Winch control stations must be sheltered, and located such that the operators have a clear view of the transom, staging hangar, and side work areas, and equipped with internal communications to the laboratory spaces and the bridge. Cableways must be provided by the Owner to allow for data lines from electromechanical cables, and from the wire remote read out units to be properly wired to laboratory spaces for access by data recording equipment. All winch equipment such as foundations, sheaves, and cranes, frames and booms must be sized to handle a working load equal to the breaking strength of the wire they handle as a minimum.

4.5 Cranes

Several types of shipboard marine cranes are required. Cranes shall be provided to load and unload the workboat and inflatables. At a minimum, one of these cranes must serve as the main cargo crane, to load and unload vans and heavy equipment to and from the cargo hold, all working decks alongside and aft of the house, and to the center of Helicopter Deck. This crane must have a safe working load capacity of at least 24 long tons at the reaches required to meet the above requirements.

Additionally, an articulated crane shall be positioned near the transom, starboard quarter, servicing the after work area for lifting equipment aboard from the sea and for supporting fairlead sheaves for cables. This crane must be able to support 5000 lb at a 30-ft reach, and 10,000 lb at a shorter reach. This crane must be an articulated, full circle rotating crane. This crane, or a combination of other, and/or additional, ship's cranes must be able to transfer packages from the main deck starboard side, to the port quarter on the working deck.

There must be a fixed, telescoping or articulated boom, rotating crane, with a safe working load of at least 2 LT, installed on the foredeck, which will provide for the deployment of personnel, gear and equipment over the bow, starboard side, to the ice surface, at least ten feet from the ship's side. This crane must also be ample to extend forward, over the bow bulwarks so as to carry a package at least ten feet forward of the bow.

Cranes must be certified for marine service, and provided to reach all working deck areas, the cargo hold, and all locations where vans will be stored. In order to effectively support the operations of the ship, it is essential that crane coverage be adequate to move vans, machinery, work boats, inflatable boats, and

oceanographic equipment about all of the working decks. The Owner is required to demonstrate how his proposed arrangement of shipboard cranes will accommodate this requirement.

4.6 Over-the-Side Handling and Staging Hangar

The ship shall be fitted with an A-frame to work off the stern of at least a 20-ft horizontal reach and a 30-ft vertical clearance. The A-frame must reach at least 15 ft beyond the transom and have a safe working load of at least 20 LT.

There must be an A-frame or telescoping boom on the starboard quarter of the ship with a safe working load of 20 LT. This frame or boom must reach 15 ft beyond the side of the ship and have a 20-ft clearance above the working deck. Bulwarks must be removable in the way of this A-frame or boom. Both the DUSH 5-5 and the 9-11 winch systems shall be positioned and provided with fairleads and all necessary equipment to work safely with either of the over-the-side devices.

An Oceanographic Staging Hangar is to be provided of about 900 ft^2 with a clear overhead height of 15'-6". The hangar is to be fitted with an overhead, telescoping boom with a safe working load of 6 LT. The boom must extend 15 ft beyond the starboard side of the ship in the fully extended position. This boom must be high enough above the deck of the Staging Hangar to allow for the outboard end of the wire with its termination, at the head block, to be positioned at least 12.5 ft. above the deck grating. The boom must be rigged so that the head block can be hauled inboard far enough to allow for a 5.5 ft. diameter package to be landed on the deck, and the door closed with the package remaining on the deck directly under the head block in its retracted position. The door at the side of the ship, from which the boom is extended, must be at least 7 ft wide, high enough to allow for the boom to be extended over the side, must be hydraulically controlled, and open inboard. The positioning and rigging of the DUSH 5 winch and telescoping boom must provide for adequate wire angle and scope to allow for proper level winding onto the winch drum. The Staging Hangar bulkhead that is adjacent to the working deck and the bulkhead adjacent to an interior laboratory shall each have watertight doors at least 5 ft. wide with a 30 in wide door within the structure of each. Additional requirements for the Hangar are specified in Appendix A—Additional Requirements for Laboratory and Related Spaces.

4.7 Moon Pool

The ship will be fitted with a circular Moon Pool 8 feet in diameter located on centerline. It will be able to be closed off at the bottom and top at the main working deck, and run vertically down through the ship to an opening of equal diameter in the hull bottom plate. The Moon Pool is to be located on the working deck in such a location as to allow for the erecting of a derrick with a footprint of at least ten feet square, over the opening, preferably as close to the LCG as possible to minimize vessel motion. The Moon Pool opening at the working deck will be covered with a removable flush mounted plate.

A suction pipe of at least 6 in inside dimension shall be fitted to the Moon Pool wall, at a location not more than one foot below the water line, for the purpose of siphoning off the upper layer of water and any floating ice in the Pool. The Moon Pool will not be used as a source for uncontaminated seawater.

4.8 Laboratories

Approximately 7,600 sq. ft. of dedicated laboratory spaces are required onboard the Vessel. The majority of these laboratory spaces must be on the main working deck, contiguous with each other, and adjacent to the working decks. No laboratory space shall act as a general passageway. There shall be a common, separate passageway communicating between the main working deck and the various laboratories. There must be convenient access between all laboratory spaces, working deck areas and scientific storage spaces.

The complete set of requirements for the shipboard laboratories is called out in Appendix A—Additional Requirements for Laboratory and Related Spaces of this Technical Requirement.

4.9 Multibeam Sonar Bathymetric System

The ship is to be provided with a fully engineered, installed, tested and documented multibeam swath sonar bathymetric system which operates at a frequency between 6 and 30 kHz, and is capable of detailed mapping of the sea floor from 100 meters to full ocean depths. Unless otherwise approved in writing by the Charterer, the choice of multibeam system must be one from the group of such devices that are currently in production and in successful use within the oceanographic community, such as the Simrad EM120 or equal. As with all systems which are to be employed on the Vessel whose mission is extremely remote to regular logistics and service facilities, the multibeam system must be of proven performance and reliability. The Owner must also provide for, from the manufacturer/supplier of the multibeam system, a minimum of 40 hours of user operational training, to be given to the Charterer's representatives aboard the ship at or near to commencement of the charter term.

The Charterer will operate the multibeam system during the term of the charter. Maintenance of the system transceiver hardware, cabling, acoustic arrays and windows, power supplies and associated displays, is the responsibility of the Owner. The system is to be provided, at a minimum, with a comprehensive five-year warranty package, which includes, in addition to hardware warranties, corrections and upgrades to the operating system software. Peripheral devices, such as large plotters and oceanographic data acquisition system hardware and software, which will be interfaced with the system, will be provided and maintained by the Charterer. The Charterer will provide materials such as plotter pens, paper, and data storage media.

All arrays and cables are to be fully installed by the Owner, with the main operating console for the system installed in the Dry Lab. Three complete copies of the operations, maintenance, users', service, and calibration procedures and manuals are to be provided to the Charterer for use with the operation of the system.

The Charterer will carry out sea trials of the multibeam system at the earliest practicable time, as dictated by the water depths and sea floor topography near the port of delivery of the Vessel. The Vessel will not be accepted for service until such time as the performance of the multibeam system, and other required Owner provided equipment and instrumentation is tested and found satisfactory for service by the Charterer. Tests of such equipment will be conducted during the Charterer's acceptance tests of the Vessel.

The performance requirements for the system are noted below.

1. The system shall consist of Vendor supplied acoustic arrays, cabling, transmitting and receiving electronics, associated power supplies, hardware and software to accomplish data acquisition and primary display. The delivered system shall fully implement the bottom mapping process. The delivered system shall include complete user and technical documentation to troubleshoot and repair the system.
2. As the installation that is considered in this specification is to be made on an icebreaking research vessel hull, the components of the system, which will be exposed to the sea, and ice, shall be built to a strength consistent with the surrounding bottom plating.
3. The Owner will have a survey of the multibeam hydrophone arrays and the vertical reference unit with reference to the ship's keel performed by a qualified subcontractor and the results will be provided to the Charterer.

I. General Specifications

- Operating Depth Range: Less than or equal to 100 meters to 11,000 meters
- Acoustic Frequency: Between 6 to 30 kHz
- Roll, Pitch and Yaw Compensated Swath Width Coverage (Range):

  150 degrees from100 to 3000 meters
  120 degrees from 3000 to 8000 meters
  No less than 90 degrees from 8000 to 11000 (full ocean depth)

- Average Beam Width: fore and aft transmit beam = 1 degrees
  nominal athwartship receive beam = 2 to 3 degrees
- Average Beam Separation: not greater than 2% of water depth,
- Operating Conditions:

  Roll: +/- 20 degrees
  Pitch: +/- 10 degrees
  Ambient Air Temperature for Topside Electronics: 100 degrees Fahrenheit
  Ambient Water Temperature at arrays: 28 degrees Fahrenheit
  Relative Humidity: 90%

- Depth Accuracy: 0.25% of water depth between 100 meters and 11000 meters
- Side Lobe Suppression: Better than 25 dB below maximum response on any beam
- Roll, pitch, and heave data are to be supplied by a Owner provided, state-of-the-art, solid state, vertical reference unit with supporting data from the ship's GPS and gyro. This unit is to be installed by the Owner at an accessible location, as near as is practical to the three dimensional center of motion of the ship.
- Plotting Outputs:

  Interactive: A CRT-based interactive survey display with options for real time non-navigational hardcopy and navigated hard copy.

II. Echo Processor Functions

- Self Calibration from pre-amp to detection stage, with calibration data available at the compute interface
- Refraction correction for the speed of sound through the water column and for sound speed at the face of the received array. Automatic download of sound speed profile in the system. Ability to record depths in corrected or uncorrected meters.
- Echo signal detection, arrival time computation, depth computation, and cross track distance computation for each beam.
- Bottom tracking for the generation of suitable detection windows. An output for the gating of other sonars must be provided that indicates the time of active signal detection.
- Echo processing must buffer bathymetric, calibration and echo strength for transmission to data logger via Ethernet TCP/IP datagrams, with IP address and service number being user configurable. The TCP/IP datagrams shall be formatted as single ping records in a format supported by the MB-System, version 4.6 or later data processing package (see http://www.ldeo.columbia.edu/MB-System/html/mbsystem_home.html for information).
- All parameter changes made by the operator must be logged in real-time and integrated in the datagrams at the exact time when the parameters went into effect. Also specify proper control of roll, pitch, and yaw biases. Proper and accurate synchronization of inputs from all peripheral equipment (master clock, navigation, VRU, external trigger…). Both binary and ASCII data formats desirable.

III. Items and Materials to be Furnished by the Charterer:

- Data logging and data display hardware and software
- Precision frequency reference (5 Megahertz).

- Analog hardcopy recorder (EPC-3200s, Raytheon UGR).

The Charterer will supply the following ship's data, but the Vendor is to specify the required source and system interface in detail:
- Digital input of acoustic velocity profile
- Event time
- Ship's heading input (0.1-degree resolution)
- Vessel pitch and roll input (0.01-degree resolution)
- Course and speed input (0.1 degree and 0.1 knot resolution)
- Vertical reference platform

IV. Additional information supplied by Vendor:
- The Vendor shall describe in detail any additional function(s) of his system not required by or described in this specification.

4.10 Acoustical Systems

The ship will be required to carry several acoustical systems in the course of its science operations. These include equipment in the frequency ranges as follows:

Seismic Recording	4 to 500 Hz
Echo Sounding and Acoustic Navigation	3 to 50 kHz
Doppler Current Profiling	75 to 300 kHz

The Charterer will provide two echo sounding systems at 3.5 and 12 kHz signal frequencies capable of recording precision bottom and sub-bottom topography at water depths below the keel to at least 4000 m. Additionally, the Charterer will provide an acoustic Doppler current profiler and a fish finding sonar. These units are:

Type	Sub-Bottom Profiler and Bottom-Track
Frequency	3.5 kHz and 12 kHz respectively
Model	Knudsen 320 B/R
Manufacturer	Knudsen Engineering Limited
Transducers	For 3.5 kHz array, ODEC TR-109 transducers, twelve transducers with four legs in parallel, with three transducers in series to each leg. For 12 kHz transducer, ODEC Model TC-12/34
Contact Info	Knudsen Engineering Limited 10 Industrial Road Perth, Ontario Canada K7H 3P2 TEL: (613) 267-1165 FAX: (613) 267-7085 E-Mail: judith@knudsenengineering.com
Aperture Info	Available from the Manufacturer

Type	Acoustic Doppler Current Profiler
Frequency	150 kHz Narrow Band
Model	RDI 150 kHz Narrow Band VM-ADCP
Manufacturer	RD Instruments
Transducers	VM-30 degree, 150 kHz Concave
Contact Info	RD Instruments

	9855 Business Park Ave. San Diego, CA 92131 TEL: (858) 693-1178 FAX: (858) 695-1459 Internet: www.rdinstruments.com E-Mail: rdifs@rdinstruments.com
Aperture Info	RD Instruments Application Note # 7, August 3rd, 1993
Type	Bio-Acoustic and Fish-Finder
Frequency	38 kHz, 120 kHz and 200 kHz
Model	Simrad EK-500
Manufacturer	Kongsberg-Simrad
Transducers	ES38B, ES120 and ES200
Contact Info	Kongsberg-Simrad 19210 33rd Avenue West Lynnwood, WA 98036 TEL: (425) 778-8821 FAX: (425) 771-7211 POC: Tom Healy
Aperture Info	Should contact manufacturer

The Owner shall install Charterer-furnished hydrophones and interconnect cabling to the Dry Lab. The hydrophone installations shall be flush mounted on the bottom of the ship near the bow on centerline and in an area of laminar flow. The area shall be chosen to minimize ice damage as far as practical. Windows must be acoustical transparent to the sensor installed over its operating range and strengthened to the same standard as the adjacent bottom plating to resist ice loads. Additionally, separate lockout sea valves with flanges (2 in and 4 in IPS) must be installed in a space adjacent to the acoustic windows with six ft of clear height above for deployment of project specific acoustic sensors.

4.11 Scientific Vans Storage

The ship shall be capable of accommodating up to six standard 20-ft ISO containers in a sheltered location on the aft working deck and superstructure decks (helo deck location can be used for these vans) that may be configured for laboratory, berthing, storage or other specialized use. Safe access shall be provided to all van locations with handrails provided on all ladderways. Provisions must be made to easily supply 115, 208 and 440 VAC power, fresh water, uncontaminated seawater, compressed air, internal communications (telephone), LAN connection, CCTV, alarms, and drains to the vans. Electrical power circuits available to the container must be 1 each 100 A and 2 each 60 A 440 VAC, 2 each 30 A 208 VAC, and 6 each 15 A 115 VAC, as a minimum. Section 5.7A provides hold storage for potentially four more 20 ft ISO containers.

4.12 Workboat

A workboat shall be provided that can be lifted aboard by ship's cranes and transported by the ship. The workboat is intended to carry a science team of 4 people plus boat operators and must be about 25 ft in length. The boat should be built of steel, fiberglass, or aluminum, and capable of withstanding the minimum air temperatures described in Section 2.3. The boat must be ice-strengthened to operate around the ice floes within the pack in air temperatures as low as -10 degrees F. It must be outfitted with a VHF radio and suitable safety equipment. The boat must provide a stable, comfortable and seakindly platform from which to conduct oceanographic research.

4.13 Inflatables

Additionally, the ship shall provide two semi-rigid inflatable boats (Zodiac Mk 5 or equal) with primary and secondary outboard motors for each boat. The ship shall provide a storage area aboard that allows easy launch and recovery of the boats.

4.14 Scientific Electrical Power Requirements

Each laboratory and related space, as defined in Appendix A, must have a separate electrical circuit providing continuous, uninterruptible and conditioned 115 VAC electrical power (UPS). This electrical power must be supplied from either of two completely separate and mutually redundant UPS systems. Each of these UPS systems must be installed in a separate enclosed, appropriately ventilated space, so as to provide continuous service. In addition to the 115 VAC UPS power, each of the laboratory and related spaces is to be provided with house current at 115, 208 and 440 VAC, in accordance with the Technical Requirements, Attachment A. These house current circuits are to be separate from the circuit to the UPS so that, in the event of failure of the UPS systems, power will continue to be supplied to the laboratories.

4.15 Command and Control Ship during Science Operations

The ship must provide good visibility of all working deck areas from the ship control stations on the bridge or bridge wings. This requirement can be met by closed circuit television with monitors at the bridge control station. The functions, communications, and layout of the ship control station must maximize coordination of ship control and scientific operations.

An Aft Winch and Ship Control Station must be provided. This station shall be a water-tight, HVAC heated and cooled to the same specifications as other habitable spaces on the ship, shall be arranged and outfitted so as to provide good visibility to the aft and starboard side working decks and associated cranes, frames, booms and wires. This space will have installed in it all of the remote winch, A-frame, and boom controls and read-out devices, TV monitor wired into the ship's CCTV system, ship's internal communications, and ship's maneuvering and stationkeeping controls. The functions, communications and layout of this Control Station must maximize coordination of the ship control and scientific operations.

4.16 Compressed Air Service

A ship service compressed air system is required to supply laboratory spaces, working deck areas, internally accessed vans and standard maintenance areas. This air supply must be filtered and free of oil and moisture.

4.17 Habitability for the Scientific Party

Two single staterooms (Chief Scientist, Marine Project Coordinator) shall be provided with private shower and toilet facilities. Twenty two-person staterooms shall be provided. Toilet, sink, and shower spaces shall be provided adjoining each stateroom. All doors from staterooms and toilet and sanitary spaces must be fitted with kickout panels for emergency egress.

Single staterooms shall be sized to accommodate additional office furniture, as dedicated offices for scientific personnel are not required. Each of these single staterooms shall contain a desk, a chart table with storage below, a two drawer file cabinet (except Marine Projects Coordinator's stateroom which shall be furnished with a four drawer file cabinet), arm chairs, a tackboard, and markerboard. These office areas in the single cabins shall be configured separately from, or partitioned off from, the berthing space in the cabin.

All berthing spaces shall be easily cleanable, well lighted, and provide a berth, secretary bureau, drawers, hanging space, lockers and a bookshelf for each person. Berths shall not be obstructed by pipes, ducts or other obstructions, and fitted with privacy curtains of flame retardant material in multiple person spaces.

Bunk lights must be provided. All drawers and doors must be latched to prevent opening in a seaway. Portable furniture must provide a fastening mechanism to be secured in a seaway.

All toilet and sanitary spaces shall be constructed so that they can be kept clean, workable and properly drained. Each toilet space shall have a toilet, shower, sink, mirror and appropriate hardware such as toilet paper holder, soap dishes, paper towel dispenser, shelving for toilet articles, hooks and proper lighting. Showers shall be fitted with grab rods and shower curtains.

Sanitary spaces with a sink, toilet, and associated hardware shall be provided in public areas, one near the messroom and two adjacent to the laboratories.

All laboratories and staterooms on the exterior of the superstructure or the hull shall have port lights.

4.18 Scientific Storage

Approximately 10,000 cu ft of scientific storage is required in an internal storage room with shelving racks (18 in wide, 18 in spacing, 100 lb/ft^2) and tie downs. There must be good access to the weather deck and scientific spaces for easy loading and use.

4.19 Multi-channel Seismic Compressed Air System

The ship shall be configured to support multi-channel seismic operations. These operations will be based upon deploying up to six 400 cubic inch water guns working at 8-sec repetition rates at 2000 psi. Equipment to support these operations (2 LMF compressors Model Number 1200) will be provided by the Charterer. The Owner will supply the foundations, acoustic and vibration suppression equipment, piping, manifolds, electrical power cable, switchboards, and associated controls. The Owner must provide an exhaust system for the units that minimize noise levels on working deck. In addition, the Owner will retain the responsibility for the operation and maintenance of the equipment during the charter period. Seismic equipment, such as computers, streamers, and water guns, will be government furnished.

4.20 Scientific Instrumentation Mast

The ship must be provided with a scientific instrumentation mast that is capable of supporting aloft, a variety of Charterer's sensors and antennae. The mast must be at least as high as the other ship's mast(s), and be fitted with an enclosed ladder, a cross tree platform at the height of other masts, and cable and wire ways for the accommodation of scientific cables.

This mast shall have, at its base, a wire conduit outlet, with a threaded cap, where the conduit provides for internal cable way to an area on the bridge where scientific sensors and equipment may be installed and operated, and to the Dry Lab. The outboard end cap of this conduit shall be fitted with stuffing tubes to accommodate Charterer's data and electrical wires from the science mast.

Cable runs for Science Mast must accommodate power and shielded data cables. The Mast and its platform must provide for an unobstructed 360-degree sky view for radiometers, and the ability to support IMET sensors unobstructed by smokestack exhaust plume and radar sweep. Other instruments, such as GPS antennae will be mounted on the Mast and its platform. The platform is to be at least 30 in. wide and equipped with safety handrails.

Owners are required to take into account the Antenna Priority listing below when locating any and all antenna systems, including both ship's and Charterer's systems aloft, in their proposed vessel design.

4.21 Antenna Arrangement

The following are priorities for antenna placement for the RVIB:

1) No antenna shall obscure any portion of the sky view of the science radiometers, and other small (0.5 cu ft) antennas that the Charterer will mount on 12 in stalks on the handrails of the science mast crosstrees.
2) Antennas associated with the GMDSS shall be given highest priority, while meeting the above item 1.
3) The Vessel's INMARSAT B system for science use shall be obscured as little as possible, and shall not be in the sweep of any radar beam, while still meeting items 1 and 2 above.
4) The Terascan remote sensing antenna shall be located no nearer than 15 feet to any INMARSAT antenna or other radiating antenna, shall not be in the sweep of any radar beam, and shall be obscured as little as possible while still meeting items 1 through 3.
5) The placement of all other antennas shall follow best practices, while meeting items 1 through 4 above.

HF Whip Antennas shall be the heavy-duty 35-foot Shakespeare whips, or similar.

Owner shall install Charterer-furnished coaxial cabling between locations for Charterer-furnished VHF antennas and Charterer-furnished VHF radios at the following locations:

1) The Marine Project Coordinator (MPC) office
2) The location for the Data Acquisition Displays in the Dry Lab
3) The Science Workshop

4.22 Gravimeter Room

Space shall be provided at the location of the Vertical Reference Unit for a Gravimeter that is approximately a 4 ft by 4 ft by 4 ft cube and weighs 200 lb.

5 ADDITIONAL SHIP REQUIREMENTS

5.1 General

The ship shall be built to the specifications of a recognized classification society (such as the American Bureau of Shipping). The ship shall be a US Flag ship and therefore comply with the regulations for Subchapter U—Oceanographic Research. The ship must be classed, suitably registered, and manned by personnel with appropriate licenses, documents and experience for unrestricted oceans and high latitude ocean service as specified by these regulatory bodies.

5.2 Regulatory Requirements

The vessel and propelling machinery shall be classed and shall be built under the survey of the American Bureau of Shipping for designation in the Bureau's record book by the following symbols:

ABS □A1□E Oceanographic Vessel, □AMS, □ACCU, □DPS-1, unrestricted service

ABS Record of Notation CRC for compliance with ABS Guide for Certification of Cranes (including the requirements of API 2C) and ABS Guide for Certification of Passenger Elevators. A Register of Lifting Appliances must be obtained.

The vessel shall be constructed in compliance with IACS PC-5 ice-going vessel requirements (proposed). The vessel shall also comply with:

GMDSS Sea Area A4

SOLAS

The vessel shall be U.S. Flag, loadlined, and will be inspected by the U.S. Coast Guard under 46 CFR Subchapter U (Oceanographic Vessels).

Note that estimated domestic gross tonnage is in excess of 1500 GRT but under 4000 GRT. The Certificates of Admeasurement obtained by the Contractor from the United States Coast Guard (or ABS), shall certify gross and net tonnage under both the domestic measurement system and the International Tonnage Convention. The Panama Canal Certificate shall be issued under the Panama Canal Universal Measurement System (PC/UMS) for the vessel under construction. The Panama Canal Commission, not ABS or USCG, acts as the issuing authority for the Panama Canal Certificate.

Certain sections of 33 Code of Federal Regulations (Marine Pollution) and 35 CFR (Panama Canal Regulations) apply.

The vessel shall be built under survey with the American Bureau of Shipping (ABS) and shall be classed in accordance with the ABS *Rules for Building and Classing Steel Vessels of Less than 90 meters* and the proposed IACS rules for Polar Class 5.

The vessel shall have vital system automation and meet the ABS ACCU automation requirements, and USCG regulations for an unmanned engineroom shall be used for

guidance in developing details.

The vessel as delivered shall comply with all applicable laws of the United States and the requirements of all regulatory bodies, including, but not limited to the rules listed below, and in force at the time of delivery:

• American Bureau of Shipping: *Rules for Building and Classing Steel Vessels less than 90 meters, 2001*
• International Association of Classification Societies (IACS) "Polar Ship Structures", Polar Class PC-5, Draft Issue of 2003.
• International Maritime Organization (IMO) MSC/Circular 1056, MEPC/Circular 399 "Guidelines for Ships Operating in Arctic Ice-Covered Waters", 23 December 2002.
• U.S. Coast Guard: "Documentation and Measurement of Vessels" (46 CFR, Parts 67-69)
• U.S. Coast Guard: "International Navigation Rules" (33 CFR, Parts 80-88)
• U.S. Coast Guard: "Load Lines" (46 CFR, Parts 41-47)
• U.S. Public Health Service Regulations

All necessary certificates and documents indicating compliance with the foregoing requirements and regulations shall be obtained by the Contractor at the Contractor's expense and furnished to the Owner at delivery. These certificates include, but are not limited to:

 Certificate of Classification (ABS)
 International Loadline Certificate
 U.S. Certificates of Admeasurement, both Domestic and International
 International Oil Pollution Prevention (IOPP) Certification
 FCC Certificates for radios
 Panama Canal Tonnage Certificate
 Deratting Exemption
 Certificate of Sanitary Construction
 Certificates of compliance with MARPOL Annex I and Annex V, and the following SOLAS certificates:
Cargo Ship Safety Construction Certificate.
Cargo Ship Safety Equipment Certificate.
Cargo Ship Safety Radio Certificate.
Safety Management Certificate.

The Owner shall be responsible for obtaining ABS certificates for Owner-furnished equipment.

The Contractor shall provide the materials, equipment and outfit items required for the ship to operate in compliance with regulatory body requirements, including the requirements of 33 CFR 164, 46 CFR 196 and for operations in latitudes higher than 35 degrees.

Materials shall meet the requirements of SOLAS and IMO Resolution MSC.61(67) (the FTP Code) for installations after 31 December 2003.

Design and installation of electrical and electronic systems shall be in accordance

with IEEE Standard 45-98, IEEE Recommended Practice for Electric Installations on Shipboard, and with the requirements herein.

Any changes that may be required by modifications to rules or regulations made subsequent to contract award, which involve either an increase or a decrease in contract price, shall be negotiated as a change under the contract.

All correspondence between the Contractor and the regulatory bodies shall be provided to the Owner on the date when such correspondence was sent or received.

5.3 Ice-Strengthening

The ship shall be designed to resist ice loads equivalent to those specified in the latest American Bureau of Shipping Rules for Ice Class A2 as a minimum. This classification is intended for unescorted operation in any first-year ice conditions.

Rudders, hull appendages, propellers and foundations that support equipment subjected to ice impact loads shall also be built to a similar icebreaking class suitable for this service.

5.4 Propulsion Plant

5.4A Main Propulsion Machinery

The mission of the ship requires that the propulsion plant be capable of adequately absorbing shocks due to propeller-ice impacts, adequately absorbing or generating propeller torque during ice impacts and/or ice milling to preclude stalling of the prime mover. All propulsion machinery shall be designed to class as described in Section 5.1 and 5.3 above. The propulsion machinery must be capable of being controlled from the machinery control room, the pilothouse, bridge wings (port and starboard), and aloft conning station.

5.4B Ice Deflectors and Nozzles

Use of propeller nozzles or ice deflection devices to reduce ice impacts and ice milling is acceptable recognizing that they have an impact on open water ship performance.

5.4C Cold Weather Starting

Provision shall be made for the possible cold weather starting of the prime movers. Specifically, during certain operations, only hotel services may be required while ice docked. After a period of time, the temperature of the lubricating oil may drop to a point where engine starting becomes difficult. Consideration should be given to having a lube oil heater or methods to heat lubricating oil in equipment and components.

5.4D Noise and Vibration Control

No machinery shall be mounted within 20 ft of any sonar receiver when measured parallel to the baseline from the nearest machinery foot to the centerline of the sonar receivers. Resilient mounts shall be determined and installed in accordance with the Machinery Noise Contribution Procedure—Appendix B that describes machinery and piping mounts for noise control.

5.4E Fuel

Since fuel supplies are limited in Antarctica, it is necessary to require that the main propulsion and auxiliary machinery have the capability of operating on marine diesel fuel type DFM (commercial

quality, marine diesel fuel). Power levels to meet operational requirements must be achievable using this type of fuel.

Some cruises may require refueling at McMurdo Station. Only JP-5 military grade fuel is available at this location. The ship must have the ability to burn JP-5 mixed with marine diesel fuel to extend the range of a long cruise when necessary. The Owner must consider and provide a limit for the ratio of JP-5 to marine diesel fuel that the ship's equipment can tolerate without service problems. This limit will be used to provide operational guidance to all parties, the NSF, the Charterer, and the Owner, should the Owner be successful in securing the charter.

5.4F Ship Control and Positioning Systems

For stationkeeping and track keeping, the Vessel shall have a ship control and positioning system with an integrated console where the operator can control all main propulsion and maneuvering systems by way of a single joystick. Control consoles shall be located on the bridge, on the bridge wings, and at the winch control station. Master control shall reside in the console on the bridge. The system must be capable of determining position by a Global Positioning System or Charterer-furnished bottom transponders. The Global Positioning System shall be provided with the ship. An automated positioning/track-keeping control system that meets all requirements for ABS classification of DPS-1 shall be provided. Stationkeeping and Track keeping performance requirements are given in Section 3.5 and 3.6.

5.4G Overboard Discharges

All overboard discharges shall be located only on the port side of the Vessel.

5.4H Sea Chests

During ice transiting and icebreaking operations, snow, small ice pieces, and entrained air will accumulate in the sea chest. This accumulation can be of such a magnitude to cause overheating of diesel engines and unscheduled shutdowns. To preclude clogging of the sea chests with snow and ice slush, sea chests must be located deep in the ship, be of adequate size, and be provided with baffles, large vent pipes to eliminate air, and piping for the recirculation of cooling water from the heat exchanger. A thermostatically controlled valve shall regulate the recirculating flow based on water temperature in the sea chest. These features are not required in the scientific sea chest for uncontaminated seawater.

5.5 Navigation and Communications

5.5A Internal Communications

The ship must have an internal communications system that provides high quality voice communications among all of the scientific spaces, the lounge/conference room, the messroom, the working deck areas, the Helicopter Hangar, and all ship control stations. This system is to be integrated with the ship's overall internal communication system that services all staterooms and other occupied spaces of the ship.

Category 5, 10-BaseT Ethernet drops are to be provided in each scientific space, see summary of number of drops per lab space below, and at least two drops to each of the cabins available to the Charterer's personnel on the ship. These pairs of network cable drops are also to be provided to all areas where vans may be secured in internal spaces of the ship or accessed from internal spaces of the ship, and also to central accessible points on each of the working decks. The network cables are to be routed to central points on each deck, with dual category cabling from the decks to the main computing area in the Electronics Lab.

The following describes the number of network (LAN) drops to specific scientific spaces:

Aquarium Room: 4

Wet Lab: 4, located along two working counters.
Aft Main Lab: 4, in sets of two on the two sides of the lab.
Bio Lab: 4, in sets of two in two locations near working counters.
Hydro Lab: 4 in sets of two near working counters.
Temperature Control Rooms: 4
Helicopter Deck: alarms, phone and LAN jacks for two laboratory vans.
Helicopter Hangar: 4 LAN jacks
Microscope Room: 2 at working benches.
Science Work Shop/storage room: 2 LAN jacks
Dark Room: phone only.
Conference Room and Library: 6 LAN jacks
Electronics Lab: 34 LAN jacks located 2 per workstation.
LAN Office: 4 LAN jacks
Dry Lab: 60 LAN jacks; 6 CCTV connections.
Electronics shop: 2 LAN jacks

Each of these spaces is to be fitted with a telephone, on the ship's main communications system.

A closed circuit television system (CCTV) is to be provided with cabling for monitors to be placed in all cabins available to the Charterer's personnel and monitors only to all laboratories, control rooms including the engine control room, conference room, mess hall, navigation stations, and science work shops. Cabling shall be installed for camera or computer input on the Bridge, working decks, at each winch and working deck so as to provide the ability to view oceanographic operations over the stern, at the starboard side in way of the A-Frame, at the Staging Hangar, and at the bow/foredeck. CCTV cameras are to be installed on this system by the Owner to provide view of all winch drums, and the working decks noted above. Owner will also provide output signal and cabling from ship's navigation equipment in order for Charterer to passively acquire ship's heading, speed, position, and meteorological data from the ship's systems. One coaxial television cable must be pulled from each cabin, and two from each laboratory space, two from each office, two from the winch control room, and a minimum of two from the bridge. These coaxial cables are to run from these locations to a place in the Dry Lab for connection to the Charterer's furnished CCTV equipment. All necessary line amplifiers and signal transmission equipment required to provide signal along the cables, particularly the longer runs, is to be provided by the Owner.

The CCTV system will be provided with enough channels to display data from all the cameras and inputs noted above and ten additional channels for scientific data display. Monitors and VCRs are to be provided and installed on the system in all cabins available to the Charterer's personnel, and monitors only in six of the main laboratory spaces, at least two on the bridge, in the mess hall, the conference room, and the Charterer's rep. (MPC) day room and cabin.

5.5B External Communications

The ship shall be fitted with standard commercial marine quality INMARSAT B (two-channel), HF, VHF, UHF, communications equipment to be in compliance with GMDSS and all other regulatory requirements. The ship must also be equipped with weather fax. The INMARSAT installation must be capable of sending and receiving both voice and data communications (56 kB). Note that the owner must install a redundant GFE INMARSAT B for science. Facsimile communications to send and receive high-resolution graphics and hard copy text on regular intervals is also required. As a minimum, the HF installation must be a fully synthesized 1000W 2-30 MHz transceiver with automatic antenna tuning for marine HF frequencies.

5.5C Navigation Systems

The ship shall be provided with a complete suite, with appropriate redundancy, of standard marine navigation and safety equipment including, but not limited to, collision avoidance radars, shallow and deep water (to at least 4000 m) fathometers, dual gyrocompasses suitable for high latitude operation, a Global Positioning System (GPS) with appropriate interfaces to other navigation systems, dual-axis Doppler speed log, ship's barometer, and dual anemometers suitable for the mission environment. The Owner shall ensure that the master and all deck officers are fully trained and competent in the proper use of all navigation equipment.

5.5D Surface Search Radar

One 10-cm and one 3-cm surface surveillance radar and associated collision avoidance systems shall be provided. Repeater displays for both radars shall be provided in the aloft conning station.

5.5E Aloft Conning Station

An aloft conning station is required with instrumentation and controls to fully operate the ship from this position. If the height of eye in the navigation bridge is 80 ft or greater, then the instrumentation and controls are not required in the aloft conning station. The aloft conning station must be enclosed from the weather, heated and sized to accommodate the operator and two observers with internal access from the superstructure. This conning station must be at least 80 ft off the water with 360 degree visibility as far as practicable.

5.6 Auxiliary Systems

5.6A Auxiliary machinery

Ship service generators shall be of sufficient number and size to provide power consistent with the mission of the ship. Electric power shall be 440 VAC and 60 Hz, and then split to provide 208 and 115 VAC ship service. The ship will be calling at ports where shoreside power is not available; therefore one ship service generator shall be capable of handling the in-port electrical load.

5.6B Heating, Ventilation and Air Conditioning

The HVAC system shall be able to maintain internal ship spaces between 65 and 74 degrees F, heated or air conditioned, at 50 percent relative humidity. Nine to eleven air changes per hour are required in laboratory spaces, as specified in Appendix A—Additional Requirements for Laboratory and Related Spaces. All supply air shall be filtered.

It is anticipated that two of the laboratories, the Dry Lab and the Electronic Lab, will experience higher the normal heat generation due to the numbers of electronic devices which will operate continuously and concurrently in those spaces. It is anticipated that the heat generated in the Dry Lab might be on the order of 165,000 BTU per hour; and for the Electronics Lab the heat generation may be around 60,000 BTU per hour. Therefore, the Owner must design the ship's HVAC in such a way as to accommodate these temperatures, and meet the above stated internal spaces temperature conditions.

It is also noted that the ship's intended service will take it to high latitudes where the sea surface temperature will be approximately 28 degrees F and also to equatorial waters where the sea surface temperature will potentially be above 90 degrees F. In all cases, the ship's HVAC system is required to perform to the above noted specifications. Therefore, the Owner should pay particular attention to the sizing and arrangement of the ship air conditioning and heating system components.

5.6C Evaporators

Evaporators, or other suitable desalination equipment, shall provide 15 LT of fresh water per day with one unit operating. There shall be at least two units aboard. Two days fresh water storage must be provided. The Vessel's potable water system must meet the standards of "United States Antarctic Program (USAP) Drinking Water Action Levels—EPA Regulations and Analytical Criteria (See Appendix C).

5.6D Waste Disposal System

An incinerator shall be provided that is suitable for burning paper, wood products, and other burnables. The unit must be sized consistent with the refuse generated in the course of performing oceanographic research with a full complement of scientists and crew aboard the Vessel. Incineration by electric or fuel is acceptable; recognizing the incineration unit must be capable of using the type of onboard fuel. Incinerator ash can be disposed of at sea. In addition to the incinerator, a trash compactor of suitable size shall be provided for the compaction of glass, metal containers, plastics, and other materials that will accrue from the galley and ship operations.

Provisions shall be made throughout the ship for the segregation of trash into combustible and compactable materials. This may take the form of separate trash containers in laboratories, galley, staterooms, and other spaces to eliminate or reduce the need to sort the trash. Any human waste, garbage, or other effluents must be treated in compliance with requirements of the Law of the Sea, IMCO, and the Antarctic Conservation Act. Holding tanks shall be provided such that all waste discharge from the ship can be stopped for a period of two hours during critical science operations.

The Owner will be required to comply with additional USAP environmental protection policies that may come into effect during the course of the Charter.

5.7 Outfit and Furnishings

5.7A Messing Facilities

A single messroom for all personnel is desired with cafeteria style service. The messroom shall be adequately sized for the entire complement of crew and scientific personnel, and configured in a manner that is suitable for meetings and showing movies.

5.7B Refrigeration and Dry Stores

Storage facilities for refrigerated and dry stores shall be consistent with the size of the crew and scientific complement for 90 days at sea.

5.7C Laundry Facilities

It is anticipated that individuals will do their own laundry. It is therefore desirable that smaller capacity multiple unit laundry facilities be provided. These must be adequately sized for the full complement of crew and scientific personnel. Hand irons and ironing boards shall be provided with storage for them in the laundry. There must also be storage for detergent, a temporary clothes rod and a service sink with hot and cold fresh water.

5.7D Exercise Room

An exercise room of approximately 15 ft by 20 ft is required for use by all personnel. The room shall be outfitted with the usual set of gym equipment such as a stationary bicycle, weight equipment and a rowing machine. Adjacent to exercise room, shower and sauna facilities shall be provided.

5.7E Lounge

A common lounge space shall be provided for officers, crew and scientists. The space shall be suitable for about twenty people and shall be provided with several card tables, arm chairs, sofas, end tables with lamps, magazine and book racks, bulletin board, waste paper baskets, and entertainment equipment. Entertainment equipment shall include a 25 inch (minimum size) color television, a video cassette recorder (American VHS format), DVD player, and stereo equipment.

5.7F Facilities for Emergency Personnel Increase

The ship shall be capable of accommodating additional personnel on a temporary basis if the ship is required to evacuate people from a ship or remote base. Although there are no special requirements for additional accommodations, provisions shall be made for lifesaving equipment (inflatable life rafts) to accommodate an additional 33 people. This requirement must be considered if new equipment is being sized to meet other aspects of this document.

5.7G Heated Pilothouse Windows

Every window in the pilothouse shall be heated to prevent icing.

5.7H Floodlights

Floodlights shall be mounted on brackets that can be temporarily swung outboard and rigidly locked in position to illuminate the water and ice surface directly adjacent to the ship. In additional, bow headlights and two powerful searchlights mounted above the bridge are required to assist in nighttime navigation.

5.7I Repair Parts and Storage

Repair parts shall be provided onboard for all mechanical, electrical, and electronic equipment and components in accordance with manufacturers recommendations for one year of operation. Supply parts inventories onboard shall be consistent with the mission of the ship which is logistically remote. Storage space must be provided that can maintain spare parts in good working order.

5.7J Deck Coverings

All exterior decks, the helicopter landing area and hangar deck shall be covered with a durable non-skid coating. This coating must survive one full year of ship operations.

5.7K Low Friction Hull Coatings

The ship must have the entire underbody of the ship coated with a low friction hull coating similar to International Paints Inerta 160.

5.8 Special Storage Requirements

5.8A General Cargo Storage

Below deck storage is required for about 10,000 cu ft of general cargo which could include four standard 20-ft ISO containers. The cargo hatch must be sized to handle these containers and the hold must have winches and equipment to slide vans into place. Service drops for 440 VAC and 115 VAC and general alarms must be provided in the hold.

5.8B Helicopter Support

The ship shall provide a helicopter landing deck, a hangar and sufficient space to support operation (parts storage, shop, etc.) for two helicopters in accordance with the new ABS H1 requirements or their equivalent. Helicopters will be capable of carrying four passengers and 2000 lb of payload over a 100 nm operating radius. Aviation fuel storage is required as well as suitable refueling facilities. Pilots and maintenance personnel will be included in the scientific complement when a helicopter is operated from the ship such that no additional accommodations are necessary. A functional internal access from the helicopter deck to the accommodation spaces is required.

The helicopter hangar and landing deck will be used for scientific purposes when helicopters are not onboard. In this regard, landing deck tiedowns similar to those provided for the working decks, Section 4.1, shall be provided on 2-ft centers. The hangar shall be provided with electrical power circuits as follows: 1 each 100 A and 2 each 60 A 440 VAC, 3 each 30 A 208 VAC, and 8 each 15 A 115 VAC, as a minimum.