ATTACHMENT B

TECHNICAL REQUIREMENTS

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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 shall be capable of independent operation for endurance periods as identified in the Technical Requirements. The principal base of operation shall be in the southern latitudes to minimize transit time to the primary mission areas. The ship shall 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 shall also operate out of such ports as Hobart, Australia or Port Lyttelton, 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 shall 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	Speed (kt)	Days	Time (%)	Comments
Ice Docked	0	15	6	Ship service only
Station Keeping	0	56	21	Constant Maneuvering
Dredging & Trawling	1-3	15	6	< 5 LT Avg Towline Pull
Towing Side Scan	6	9	3	< 2 LT Avg Towline Pull
Icebreaking	3	26	10	Full Power
Operating in Pack Ice	2-8	74	28	Full Power
Open Water Transit	5-14	70	26	Up to Sea State 7
Total Ops away from Port		265	100	
In Port staging Science Ops		35		
Repair and Maintenance		65		
Total Days		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 length overall (LOA) shall be less than 320 feet to facilitate turning in the tight passages and basins where the ship shall operate. 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, shall be provided to the Charterer for approval no later than three months after contract award. The trials will be witnessed by under the supervision of Charterer personnel and their representatives.

2 ENVIRONMENTAL REQUIREMENTS

2.1 Ice Conditions.

The ship shall 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 shall 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 shall 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 shall 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.

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

2.8 Topside Icing.

Severe topside icing shall 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 shall be capable of surviving such an icing event.. 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.

3 OPERATIONAL PERFORMANCE REQUIREMENTS

3.1 Icebreaking Capability.

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

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

The ship shall 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 shall 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 shall 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

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 shall 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 3.4 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 shall 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 5.8

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 5.8. 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 5.8

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 shall 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 shall 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:

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:

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

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:

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

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: $c = 0.099754$,
$z_1 = -0.02961\ z_o$,
$z_2 = 0.053621\ z_o$

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.

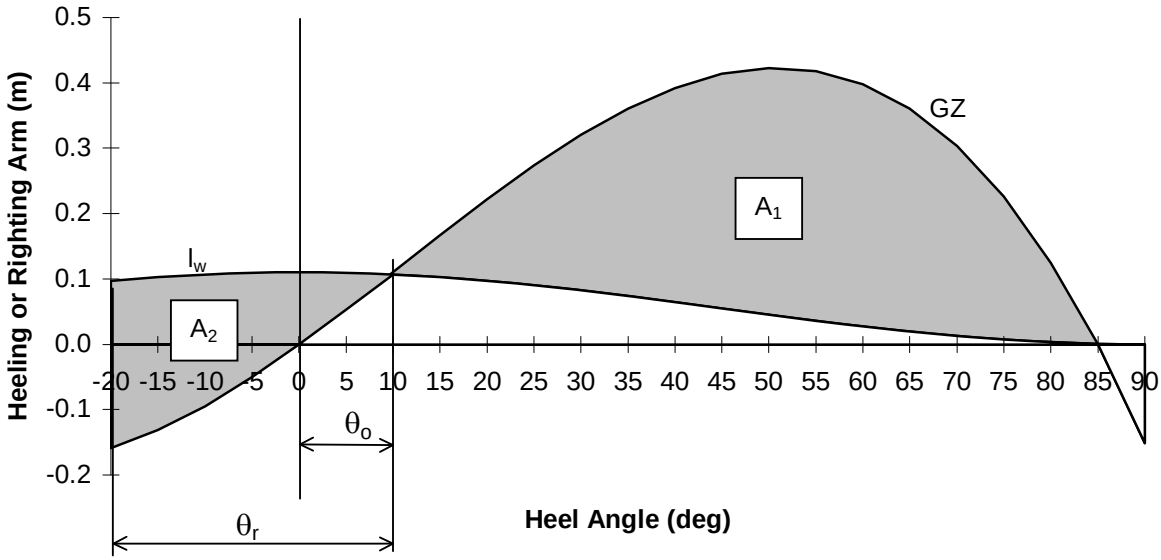

Figure 1. The intact stability weather criterion.

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 shall be met:
The heeling arm at the angle of equilibrium, θ_o, shall not be greater than 0.6 of the maximum righting arm.
The area A_1 shall 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 shall 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 Figure 2 and it is assumed that:

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.

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.

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.

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.

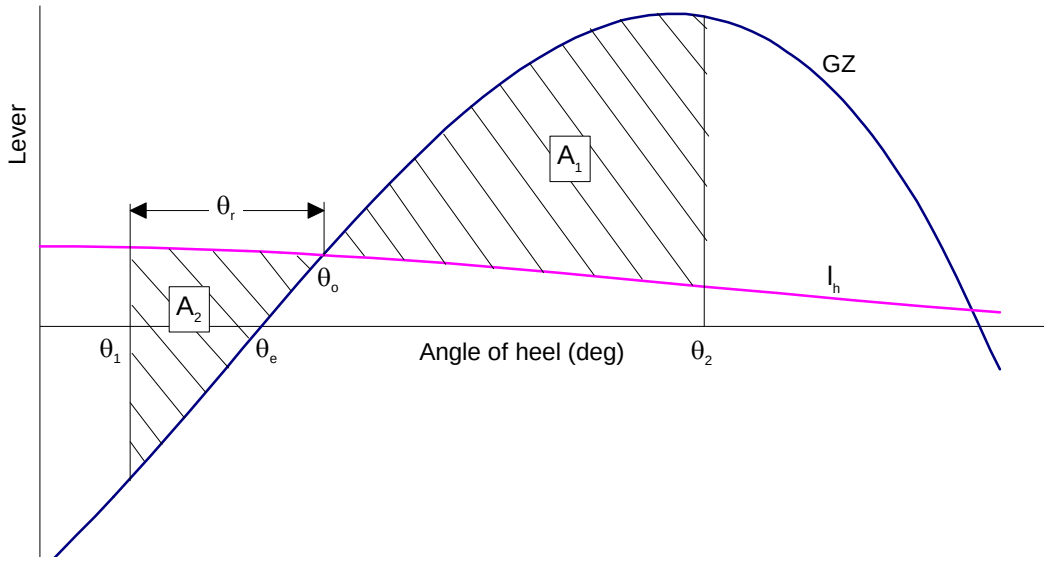

Figure 2. The damage stability weather criterion.

The angles in Figure 2 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 shall be met:
The margin line at side is not submerged at the angle of heel θ_o
The static angle of equilibrium θ_e is not greater than 15°;
Area A_1 shall 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 15 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 shall 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 shall 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 shall 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 shall 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, shall 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 5.6 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 shall 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 shall 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. . Ship-generated noise levels shall 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 4.18. Operationally quiet noise levels shall 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 shall operate with sensitive electronic equipment, computers, and data acquisition systems intended for scientific sensing and analysis. This equipment shall 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.

4 SCIENCE REQUIREMENTS

4.1 General.

During the period of this Contract, Charterer's personnel shall 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 minimum 5 feet wide. This area shall 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 threaded plugs for each socket and extra 40 hex head bolts and 40 eyebolts. The bulwarks shall be removable under each A-frame for approximately 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.

The foredeck shall be provided with one marine-grade brass 115 VAC power receptacle fed by one 20-amp circuit.

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 shall be watertight and shall 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 shall 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 shall be outfitted with sturdy metal workbenches and tool storage cabinets along the bulkheads. The space shall 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 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 shall 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 shall 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 shall 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 shall 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 shall 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 shall 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 shall 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 shall 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 shall 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 shall 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. Chain link fall protection on Starboard side and aft end of the helicopter deck shall be removable to allow loads to be dropped by this crane to the center of the helicopter deck. This crane shall have a safe working load capacity of at least 24 tons at the reaches required to meet the above requirements.

Additionally, a telescopic boom crane shall be positioned near the starboard quarter, servicing the after work area for lifting equipment aboard from the sea and for supporting fairlead sheaves for cables. This crane shall be able to support 5000 lbs. at a 30-ft reach, and 10,000 lbs. at a shorter reach. This crane shall be, a telescopic boom, full circle rotating crane. This crane, or a combination of other, and/or additional, ship’s cranes shall be able to transfer packages from the main deck starboard side, to the port quarter on the working deck, lift trawl blocks to all locations on the aft a-frame, and 55 gallon drums to the rack on the aft 01 deck.

There shall be a fixed, telescoping or articulated boom, rotating crane, with a safe working load of at least 2 T, installed on the foredeck, which shall 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 shall 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 shall be certified for marine service, and provided to reach all working deck areas, the cargo hold, and all locations where vans shall 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 shall 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 shall reach at least 15 ft beyond the transom and have a safe working load of at least 20 T.

There shall be an A-frame or telescoping boom on the starboard quarter of the ship with a safe working load of 20 T. This frame or boom shall reach 15 ft beyond the side of the ship and have a 20-ft clearance above the working deck. Bulwarks shall 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 T. The boom shall extend 15 ft beyond the starboard side of the ship in the fully extended position. This boom shall 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 shall 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 The door at the side of the ship, from which the boom is extended, shall be at least 7 ft wide, high enough to allow for the boom to be extended over the side, shall be hydraulically controlled, and open inboard. The positioning and rigging of the DUSH 5 winch and telescoping boom shall 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 shall be fitted with a Moon Pool of 72 in. round pipe, open to the main working deck, starboard side, and running vertically down through the ship to an opening of equal diameter in the hull bottom plate. The hull plate penetration shall be flared to minimize drag, preserve ship's speed, and fuel efficiency. 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. The Moon Pool opening at the working deck shall 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. This line shall be plumbed with a dedicated pump of the same make and model as the two pumps identified for the Uncontaminated Seawater System, that is a variable speed, 200 gpm model SB101*X1R5\V, manufacturer by Mono Pumps, Ltd., Manchester, England. This system shall

have a minimum of turns, which shall all be large radius turns to prevent ice clogging, and is to discharge, as with all other ship's fluids discharge, to the port side, just below the waterline. This discharge system shall not be tied into any other scientific piping system onboard the ship.

4.8 Laboratories

Approximately 7,600 sq. ft. of dedicated laboratory spaces are required onboard the Vessel. The majority of these laboratory spaces shall 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 shall 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

Removal of the SeaBeam 2112 Multibeam Sonar System. The SeaBeam 2112 Multibeam Sonar System shall be removed prior to provision of the new Multibeam Sonar Bathymetric System. This shall be accomplished by a mutually agreed to division of labor between the Owner and Charterer.

4.10 Provision of the Multibeam Sonar Bathymetric System.

The vessel will be available for major upgrade installations and dry docking during the austral winter (June-July) of 2002. The multibeam sonar system installation required by this agreement will occur at that time. ECO will place an order for the required sonar system in sufficient time to meet the required installation schedule.

The Owner has identified a Simrad EM120 multibeam Sonar System with a combination of titanium window for the receive array and a polyurethane window for the transmit array. Any divergence from these parameters must be agreed upon by Charterer and Owner prior to purchase and installation of a system.

The Owner shall provide a fully engineered, installed, tested and documented multibeam 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. The Owner shall 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. However, Owner's maintenance obligation for the Multibeam Sonar Bathymetric System under both this Section and for the entire Charter contract is exclusively limited to those services provided free of charge to Owner under the unit's manufacturer's warranty as required to be provided under Section 4.9. All contractual responsibility for, consequences from a failure , and all associated costs required to restore the unit to proper function above and beyond the standard warranty provisions provided above shall be solely for the account of Charterer. 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 shall 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 shall 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 multibeam system and associated instrumentation will be accepted after fulfilling all criteria in the Sea Acceptance Test as defined by the Charterer. The multibeam Sea Acceptance Test will be conducted during the vessel acceptance test.

4.11 General specifications for the Multibeam Bathymetric Sonar System

The system, A Kongsberg-Simrad EM120 Multibeam echo sounder system, shall consist of vendor supplied acoustic arrays, cabling, transmitting and receiving electronics, associated power supplies, hardware and software, and ice protective array acoustic windows 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.

4.12 Multibeam Bathymetric Sonar System Minimum Performance Specifications

Performance specifications for the Kongsberg-Simrad EM120 system installed on the vessel are based upon the following reference assumptions:

a. Projectors in the transmit array are housed in the hull behind an ice protection acoustic window of composite urethane materials.
b. The Receive array hydrophones are housed behind a titanium ice protection window.
c. The ocean floor being sampled, for the purpose of this performance specification, is assumed to be sandy bottom.
d. The ship-radiated noise level, with the vessel performing underway bathymetric operation, is approximately 53 dB.
e. Sea conditions are calm; no swell.

Operating Depth Range: 100 meters to full ocean depth
Acoustic Frequency: Between 6 kHz and 30 kHz
Roll, Pitch and Yaw Compensated Swath Width Coverage (Range):
140 degrees at 100 to 2500 meter range
120 degrees at 2500 to 5000 meter range
90 degrees at 5000 to full ocean depth

4.13 Environmental Specifications:

Roll: +/- 20 degrees
Pitch: +/- 10 degrees
Air Temperature for Topside Electronics: 29 degrees Celsius
Water Temperature at arrays: –1.9 degrees Celsius

Relative Humidity: 90%

4.14 Echo 4Processor Specifications

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 shall be provided that indicates the time of active signal detection.

Echo processing shall 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 shall be logged in real-time and integrated in the datagrams at the exact time when the parameters went into effect. Specify proper control of roll, pitch, and yaw biases. Provide proper and accurate synchronization of inputs from all peripheral equipment (master clock, navigation, MRU, external trigger, etc.). Provide both binary and ASCII data formats.

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

4.15 Charterer or Customer Furnished Equipment (CFE):

The Charterer will supply an analog hardcopy plotter.

4.16 Charter supplied data.

The Charterer will supply the following ship's data, but the Owner is to specify the required source and system interface in detail:
Digital input of sound velocity profile
Event time
Course and speed input (0.1 degree and 0.1 knot resolution)

4.17 Additional information supplied by the Owner:

The Owner shall describe in detail any additional function(s) of his system not required by or described in this specification.

4.18 Acoustical Systems

The ship shall 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 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 practicable. Windows shall 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) shall be installed in a space adjacent to the acoustic windows with six ft of clear height above for deployment of project specific acoustic sensors.

4.19 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 two of 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 shall be made to easily supply 115, 208, 440 VAC power to all six containers. Fresh water, uncontaminated seawater, and drains shall be installed for the four containers located in the cargo hold. Electrical power circuits available to the container shall 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.

4.20 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 shall be about 25 ft in length. The boat shall be built of steel, fiberglass, or aluminum, and capable of withstanding the minimum air temperatures described in Section 2.3. The boat shall be ice-strengthened to operate around the ice floes within the pack in air temperatures as low as -10 degrees F. It shall be outfitted with a VHF radio and suitable safety equipment. The boat shall provide a stable, comfortable and seakindly platform from which to conduct oceanographic research.

4.21 Scientific Electrical Power Requirements.

Each laboratory and related space, as defined in Appendix A, shall have a separate electrical circuit providing continuous, uninterruptible and conditioned 115 VAC electrical power (UPS). This electrical power shall be supplied from either of two completely separate and mutually redundant UPS systems. Each of these UPS systems shall 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 shall continue to be supplied to the laboratories.

4.22 Command and Control Ship during Science Operations

The ship shall 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 shall maximize coordination of ship control and scientific operations.

An Aft Winch and Ship Control Station shall 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 shall 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 shall maximize coordination of the ship control and scientific operations.

4.23 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 shall be filtered and free of oil and moisture.

4.24 Habitability for the Scientific Party

Owner shall provide berthing for Charterer's personnel. This shall include three single staterooms (Chief Scientist, Marine Projects Coordinator and NSF Representative) and 18 two-person staterooms. In addition, on cruises where scientific berthing requirements are high and upon 30 days notice to the Master, the Owner shall provide an additional 4-person stateroom , if available

Toilet, sink, and shower spaces shall be provided adjoining each stateroom. All doors from staterooms and toilet and sanitary spaces shall be fitted with kickout panels for emergency egress.

Single staterooms for the Marine Projects Coordinator and the Chief Scientist shall be sized to accommodate additional office furniture. There 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 shall be fitted with privacy curtains of flame retardant material in multiple person spaces. Bunk lights shall be provided. All drawers and doors shall be latched to prevent opening in a seaway. Portable furniture shall 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 mess room and two adjacent to the laboratories.

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

Charterer State Room Provisions:

Bed linens shall be good quality, minimum 230 thread count, all cotton, well finished material. They may be either white or colored with a fitted sheet, a top sheet and pillow cases. The fitted sheet shall have deep pockets and be large enough to fit the mattress. Enough linens shall be provided to supply

each stateroom with a complete set of linens. In addition, an inventory of at least 100% shall be held in reserve on board to allow for quick turn-around of the staterooms. Worn-out linens shall be removed from circulation and replaced out of the reserve inventory.

Blankets and Comforters shall be good quality, well finished material, with a thermal insulation rating appropriate for conditions aboard a vessel working in Antarctica. The blanket/comforter shall be colored to match the room décor. They shall be free of odor and lint. Inventories of both heavy comforters and lighter blankets shall be maintained in order to provide a set for every member of the Charterer's party. In addition an inventory of 100% shall be maintained on board. Worn-out blankets and comforters shall be removed from circulation and replaced out of the reserve inventory.

Pillows shall be of good quality, hypo-allergenic and of medium to firm support rating. They shall be free of odor and lint. Two pillows shall be provided for each member of Charterer's party. In addition, an inventory of 100% of maximum Charterer's compliment shall be maintained on board. Worn-out pillows shall be removed from circulation and replaced out of the reserve inventory.

Towels shall be of good quality, 100% cotton, heavy weight and well finished. A set of towels that includes a full body heavy weight towel (e.g. 31" x 54"), a heavy weight hand towel (e.g. 21" x 28"), a heavy weight wash cloth and a heavy weight floor mat (e.g. 24" x 36") shall be provided for every member of the Charterer's party. In addition, inventories shall be maintained at 200% . Worn-out towels shall be removed from circulation and replaced out of the reserve inventory.

Mattresses shall be hypo-allergenic, well finished and with a medium to firm rating . They shall be of a quality similar to those found in a good hotel. They shall be sized to accommodate standard twin size fitted sheets. They shall be free of odor or excessive stains. Worn-out mattresses shall be removed from circulation and replaced out of the reserve inventory.

The frequency of change-out of stateroom provisions shall be at a time mutually agreed upon by Charterer and Owner but Owner shall endeavor to replace any and all worn-out stocks in a timely manner to provide for high quality hotel provision.

4.25 Scientific Storage.

Approximately 1000 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 shall be good access to the weather deck and scientific spaces for easy loading and use.

4.26 Multi-channel Seismic Compressed Air System.

The ship shall be configured to support multi-channel seismic operations. These operations shall 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) shall be provided by the Charterer. The Owner shall supply the foundations, acoustic and vibration suppression equipment, piping, manifolds, electrical power cable, switchboards, and associated controls. The Owner shall provide an exhaust system for the units that minimize noise levels on working deck. In addition, the Owner shall 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.

4.27 Scientific Instrumentation Mast

The ship shall be provided with a scientific instrumentation mast that is capable of supporting aloft, a variety of Charterer's sensors and antennae. The mast shall 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 two areas immediately below 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 shall accommodate power and shielded data cables. The Mast and its platform shall 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 shall 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 comply with, unless otherwise agreed by Charterer, 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.

4.28 Antenna Arrangement

The following are priorities for antenna placement for the RVIB:

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.

Antennas associated with the GMDSS shall be given highest priority, while meeting the above item 1.

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.

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.

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:

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

4.29 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.

4.30 Auxiliary Hydraulic Requirements.

Separate from any emergency stops required in Sections 4.4 - Winches and 4.5 - Cranes, a local emergency stop shall be installed for the aft deck hydraulics that are used by the Charterer. The emergency stop shall be installed in waterproof junction box with highly visible signage. The Owner shall be responsible for maintaining and testing the emergency stop at a minimum of once per year or as conditions warrant.

The Owner shall provide for installing two hydraulic operator stations on the 01 deck in safe and convenient locations aft of the paint locker. The Owner shall accomplish this by connecting to existing hydraulic lines and extending them to one inch above the scupper on the 01 deck. The Charterer will furnish and install the remainder of the hydraulic operator stations from the 01 deck scupper to the control valves.

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 shall 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 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.

5.3 Propulsion Plant

5.3.1 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 0 and 0 above. The propulsion machinery shall be capable of being controlled from the machinery control room, the pilothouse, bridge wings (port and starboard), and aloft conning station.

5.4 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.

5.5 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.

5.6 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.

5.7 Fuel

Since fuel supplies are limited in Antarctica, it is necessary to require that the main propulsion and auxiliary machinery shall have the capability of operating on marine diesel fuel type DFM (commercial quality, marine diesel fuel). Power levels to meet operational requirements shall 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 shall have the ability to burn JP-5 mixed with marine diesel fuel to extend the range of a long cruise when necessary. The Owner shall 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.

5.8 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 shall 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-0 shall be provided. Stationkeeping and Track keeping performance requirements are given in Section 3.5 and 3.6 0.

5.9 Overboard Discharges.

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

5.10Sea 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 shall 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.

5.11 Internal Communications

5.11.1 Telephony

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 mess room, 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.

5.11.2 Premises Distribution System

The Owner shall provide a Premises Distribution System (PDS) to facilitate the exchange of digital information over a Local Area Network (LAN). The Owner shall remove the existing PDS and install a new PDS. The Owner shall install the PDS in such a manner that it is compliant with ANSI/TIA/EIA-568-B, the Commercial Building Telecommunications Cabling Standard. Testing and verification of the

new PDS will be performed by the Charterer's Technical Representative (CTR). The PDS shall include a combination of media; copper from the Equipment Room (LAN Office) to each Work Area Outlet (WAO) and fiber optic from the Equipment Room to each Telecommunications Closet (TC). The copper channels shall be used immediately following successful completion of the Field Acceptance Test (FAT). The fiber optic channels shall go dark after successful completion of the FAT and are for future applications that may require higher bandwidth. The new PDS requirements, including performance, topology, installation and verification specifications, are outlined below.

5.11.3 Performance Specifications

Copper Channels – The copper channels shall provide a minimum of 100Base-T performance in an electrically noisy environment.
Fiber Optic Channels – The fiber optic channels shall provide a minimum of Gigabit Ethernet performance.

5.11.4 Topology Specifications

Copper Channels – The copper channels shall be laid out in a star topology from the Equipment Room to each WAO. The copper channels shall consist of a Core Layer, a Distribution Layer and an Access Layer. Fiber Optic Channels – The fiber optic channels shall be laid out in a star topology from the Equipment Room to each TC. The fiber optic channels shall consist of a Core Layer and a Distribution Layer.

5.11.5 Relevant Documentation

A. ANSI/TIA/EIA-568-B, Commercial Building Telecommunications Cabling Standard, provided by Owner.
B. NEC, National Electrical Code, provided by Owner.
C. General Arrangement (GA) blueprints detailing the locations and routes of all items associated with the PDS, provided by Charterer.
D. All manufacturer's data related to the PDS cabling and equipment, provided by Owner.
E. UL 486A and UL 486B, provided by Owner.
F. TIA 570 Standard, Owner provided.

5.11.6 PDS Physical Sections

The six PDS physical sections are the Entrance Facility, Equipment Room, Trunk Cabling, Telecommunications Closets (TC), Horizontal Cabling and Work Areas. The requirement for each are outlined below.

5.11.6.1 Entrance Facility

The Owner shall provide two terminated copper channels from a waterproof junction box on the external 01 deck to the Equipment Room. These channels may be used during port and dry dock periods for landline connections in lieu of expensive satellite connections.

5.11.6.2 Equipment Room

The Equipment Room shall be located in the LAN office on the Main Deck.
The Equipment Room shall contain the core switching equipment (active), the main cross-connect (MC) to the trunk lines (passive), and the TC for the main deck.

5.11.6.3 Trunk Cabling

Trunk Media - The trunk cabling shall consist of plenum high-count copper cables and plenum fiber optic cables between the core switching equipment in the Equipment Room and each TC. Each copper trunk cable shall be a minimum of 24-UTP and shall support six (6) CAT5e drops per trunk. Each copper trunk cable shall be screened or shielded to reduce Electromagnetic Interference (EMI) and Radio Frequency Interference (RFI) that is present in the trunk route. Each fiber optic trunk cable shall consist of four (4) pairs of multimode fiber optic cables: 62.5/125 micrometers (um) diameter and support wavelengths of 850 and 1300 nanometer (nm) cores . All trunk cabling shall be routed from the Equipment Room into the overhead in the Electronics Lab, into the vertical wire transit and then to each TC.

Trunk Route - A new multi-cable transit (MCT) shall be installed between the vertical wire transit and each deck containing a TC. Specifically, blue ROX System MCT's, with the appropriate blocks to seal all trunk cables, shall be supplied and installed. The fill ratios for cables through the MCT's shall conform to the TIA 570 Standard. Six inch (6 in.) I.D. conduit shall also be installed from the ceiling of the vertical wire transit, through the deck of the 04 Emergency Generator Room (EGR), out of the EGR and into the existing conduit on the external 04 Deck. The trunk route shall then follow existing conduit into the HVAC Room, and then enter new conduit that shall be installed between the HVAC Room and the 04 Void (Gyro Room). Access plates for cable pulling shall be installed between each 90-degree bend and in internal spaces only. The Owner shall determine if MCT's are required at each end of the conduit and install them if necessary. The required location of the old and new MCT's and conduit along the trunk route is as follows from bottom to top:

a. New MCT above the door and ceiling between the Electronics Lab and the Bio Lab on the Main Deck. This requirement is already called out in another section of the contract but is repeated here for clarity.
b. New MCT above the ceiling between the Bio Lab and the outboard bulkhead of the vertical wire transit on the Main Deck.
c. New MCT between the vertical wire transit and the MPC office or MPC closet on the 01 Deck.
d. New MCT between the vertical wire transit and the Helo workshop on the 02 Deck.
e. New MCT between the vertical wire transit and the Conference Room on the 03 Deck.
f. New conduit for the 04 EGR Deck to the existing conduit on external 04 Deck.
g. Existing conduit from external 04 Deck to HVAC Room.
h. New conduit from HVAC Room to the 04 Void.

5.11.6.4 Telecommunications Closets (TC)

The plenum high-count copper trunk cables (primary UTP cable) shall be terminated in 110 punch down to 8-position modular patch panels. 8-position modular terminated patch cords (secondary UTP cable) shall be used to connect the corresponding patch panel ports. A 110 punch down to 8-position modular patch panel shall be used to terminate the horizontal cable runs (tertiary UTP cable). The plenum fiber optic trunk cables shall be terminated in a fiber optic panel.

All TC equipment shall be compatible with 19" racks. TC's shall be supplied with vertical and horizontal cable management organizers. All trunk lines shall contain service loops at each end.

The service loops shall be 15 ft. long, coiled and secured in the overhead. The TC's shall function and be located as follows:

1. Equipment Room (LAN office) for the Main Deck Distribution and Access Layer
a. One fiber optic panel to support 20 fiber pairs
b. Distribution patch panels for 288 drops (12 X 24 ports).
To Dry Lab: 2 panels for 48 ports
To 01 Deck: 3 panels for 72 ports
To 02 Deck: 3 panels for 72 ports
To 03 Deck: 2 panels for 48 ports
To 04 Deck: 2 panels for 48 ports
c. Access patch panels for 221 WAO drops on the Main Deck (10 x 24 ports).
d. Main Deck WAO Access drops shall be comprised as follows:

Dry Lab drops	74	
E-Lab drops	75	
Bio Lab drops	16	
Main Lab drops	30	
Hydro Lab drops		12
Wet Lab drops	2	
Aquaria Room drops		2
Main Deck Vans		4
Cargo Hold Vans:		4
Engine Control Room:	2	
Total Main Deck drops	221	

1. Main Deck Dry Lab Instrumentation Rack

a. One fiber optic panel
b. 4 fiber cable runs from Equipment Room, left dark.
c. 8 copper trunk lines from Equipment Room.
d. Distribution patch panels for 48 drops (2 X 24 ports).

2. **01 Deck MPC Office or Closet**

a. One fiber optic panel
b. 4 fiber cable runs from Equipment Room, left dark.
c. 15 copper trunk lines from Equipment Room.
d. Distribution patch panels for 72 drops (3 X 72 ports).
e. Access patch panels for54 WAO drops on the 01 Deck (3 x 24 ports).

3. 02 Deck Helo-Hangar Workshop

a. One fiber optic panel
b. 4 fiber cable runs from Equipment Room, left dark.
c. 15 copper trunk lines from Equipment Room.
d. Distribution patch panels for 72 drops (3 X 24 ports).
e. Access patch panels for 52 WAO drops on the 02 Deck (2 x 24 ports).

4. 03 Deck Conference Room

a. One fiber optic panel
b. 4 fiber cable runs from Equipment Room, left dark.
c. 10 copper trunk lines from Equipment Room.
d. Distribution patch panels for 48 drops (2 X 24 ports).

e. Access patch panels for40 WAO drops on the 03 Deck (2 x 24 ports).

5. 04 Deck Electronics Void (Gyro Room)

a. One fiber optic panel
b. 4 fiber cable runs from Equipment Room, left dark
c. 10 copper trunk lines from Equipment Room.
d. Distribution patch panels for 48 drops (2 X 24 ports).
e. Access patch panels for24 WAO drops on the 04 Deck, 05 Deck, and Aloft Conning Station.

5.11.6.5 Horizontal Cabling

The Owner shall supply and install Category 5e, 4-pair unshielded twisted pair (UTP) cables from each TC to each Work Area Outlet (WAO) in quantities as specified on the GA blueprints. The cable shall be plenum covered and rated to 350 MHz. The cables shall be installed in a closed fashion above the ceilings and inside the bulkheads. Cable running down steel bulkheads from the ceiling to a WAO must be enclosed in conduit. Cable installed above the ceiling shall be installed in new cable ladders or hangers where necessary. The ladders or hangers shall be industry standard quality for network cable and must not crimp the cables.

The Owner shall terminate both ends of all UTP cables. After termination, all UTP cables shall have enough cable slack to provide for a clean dress and to prevent stress and sharp bends on the cables. After termination all UTP cables shall have approximately 2 ft. of cable slack spooled within the TC.

5.11.6.6 Work Areas

The Owner shall supply and install two, three or four –port (as specified) 8-position modular jacks and associated hardware at all work area outlets (WAO's). All WAO's shall be flush mount surface outlets unless the mounting bulkhead is steel. WAO's mounted on steel bulkheads shall use bulkhead-mount outlets and bulkhead-mount conduit to house the cables. Each WAO shall be labeled with a unique identification number. WAO's shall be labeled with deck number, room number and WAO number. Each port shall be labeled A, B, C or D as necessary. For example, the WAO in stateroom 117 on the 01 deck would be labeled as 01-117–01 with ports labeled as A and B.

5.11.7 Owner Submittals

A. List of termination and test equipment to be used.
B. Shop drawings indicating the intended PDS layout and pulling plan prior to the cable pulling.
C. Shop drawings detailing the proposed 110 cross-connect and patch panel mapping.
D. Cable Installation Pulling Plan consisting of cable identifiers, termination locations and labeling plan.

5.11.8 Color Codes and Labeling

A. Primary UTP cable (vertical trunk) shall be gray in color. Secondary UTP cable (TC patch cables) shall be yellow in color. Tertiary UTP cable (horizontal distribution) shall be blue in color.
B. Owner shall supply and install cable markers for fiber cables and UTP cables.
C. Owner shall use large font size on all labels. All labels shall fit snugly around cables and shall be positioned such that the labels can be easily read. Do not heat shrink labels on cable.
D. Owner shall supply and install engraved three-layer laminated plastic nameplate labels for all TC racks, frames, and wall mounted panels.
E. Colors shall be black print on white background.
F. Size shall be 3 in. wide by 3 in. high at a minimum.
G. Nameplate shall use double-sided tape for adhering to surfaces.
H. The Charterer's Technical Representative (CTR) must approve the labeling scheme prior to implementation. All cables shall have a unique identifier approximately 4-6" from each end. All TC connecting hardware shall be identified on the blocks. All WAO hardware shall be identified on the faceplate. Handwritten labeling is not acceptable. Electronically produced legible labels are required. A floor plan with clearly marked WAO numbers shall be included. All cabling in the new PDS shall be labeled and documented to include the following: cable number, cable type and start and end location.

5.11.9 Termination

A. All optical fiber terminations are to be made by personnel trained and certified by manufacturer of fiber and connectors to be installed using the appropriate certified tool kit and equipment.
B. Cables shall be terminated with connecting hardware of the same category or higher.
C. Installed transmission performance of components shall meet requirements of different performance categories; (i.e., cables and connectors that are not rated for the same transmission capability shall be classified by the least performing component in the link).
D. The connecting hardware used for UTP cabling shall be installed to provide minimal signal impairment by preserving wire pair twists as close to the point of mechanical termination as possible.
E. The amount of untwisting in a pair as a result of termination to connecting hardware shall be not greater than ½ inch for UTP cables.

5.11.10 Grounding

A. Ground busbars (technical and non-technical) shall be installed in each TC. All equipment racks, termination frames, conduits, sleeves, cable tray and other conductive materials shall be bonded to the non-technical grounding busbar with #6 AWG insulated conductor. Ground electrical systems and equipment in accordance with NEC requirements except where the Specifications exceed NEC requirements.
B. Use braided grounding strap for flexible bonding and grounding to the busbars.
C. Route grounding conductors along the shortest and straightest paths possible without obstructing access or placing conductors where they may be subjected to strain, impact, or damage.
D. Bond all adjacent sections of overhead cable tray with # 6 AWG conductor.

E. Make connections in such a manner as to minimize possibility of galvanic action or electrolysis. Select connectors, connection hardware, conductors, and connection methods so metals in direct contact will be galvanically compatible.
F. Use electroplated or hot-tin-coated materials to assure high conductivity and make contact points closer in order of galvanic series.
G. Make connections with clean bare metal at points of contact.
H. Aluminum-to-steel connections shall be with stainless steel separators and mechanical clamps.
I. Aluminum-to-galvanized steel connections shall be with tin-plated copper jumpers and mechanical clamps.
J. Exothermic Welded Connections: No exothermic welds are to be used.
K. Tighten grounding and bonding connectors and terminals, including screws and bolts, in accordance with manufacturer's published torque-tightening values for connectors and bolts. Where manufacturer's torquing requirements are not indicated, tighten connections to comply with torque tightening values specified in UL 486A and UL 486B.

5.11.11 Cable Separation Distances

PDS cable crossing power cable shall do so at 90 degrees. PDS cable shall not be laid parallel and next to power cable whenever possible. PDS cables cannot share MCT's with any power cable. The following cable separation distances shall be maintained between PDS cable and other cable on the vessel:

A. Two ft. from the 600-volt cables in the vertical wire transit.
B. One ft. from any fluorescent lighting ballast.
C. Four inches from any power cable.
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5.11.12 Verification Specifications

A. Multimode Fiber Optic Cable: 62.5/125 micron at 850 and 1300 nanometers.
B. Multimode Fiber Optic Connectors.
C. UTP 24 AWG, UTP Category 5e Cable.
D. UTP Connectors, 8-position modular jacks configured per ANSI/TIA/EIA-568-B.
E. Punch Down Cross-Connects.
F. The total length of any UTP channel from the Equipment Room to the WAO must not exceed 97 meters.

5.12 External Communications.

The external communications suite shall be fully compliant with all GMDSS, FCC, and US Coast Guard regulatory requirements. The suite shall include, but not be limited to, commercial marine quality INMARSAT-C, HF, VHF, direction finding equipment, and a HF Weather Fax.

5.13 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 water fathometer, dual gyrocompasses suitable for high latitude operation, a Global Positioning System (GPS) with appropriate interfaces to other navigation systems, ship's barometer. The Owner shall ensure that

the master and all deck officers are fully trained and competent in the proper use of all navigation equipment.

5.14 Surface Search Radar.

One 10-cm and one 3-cm surface surveillance radar and associated collision avoidance systems shall be provided..

5.15 Aloft Conning Station.

The aloft conning station shall be enclosed from the weather, heated and sized to accommodate the operator and two observers with internal access from the superstructure. This conning station shall be at least 80 ft off the water with 360 degree visibility as far as practicable.

5.16 Auxiliary Systems

5.16.1 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.

5.16.2 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 shall 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 shall 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 shall take it to high latitudes where the sea surface temperature shall be approximately 28 degrees F and also to equatorial waters where the sea surface temperature shall 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

5.16.3 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 shall be provided. The Vessel's potable water system shall meet the standards of "United States Antarctic Program (USAP) Drinking Water Action Levels—EPA Regulations and Analytical Criteria (See Appendix C).

5.16.4 Waste Disposal System

An incinerator shall be provided that is suitable for burning paper, wood products, and other burnables. The unit shall 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 shall 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 shall 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 shall 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 shall be required to comply with additional USAP environmental protection policies that may come into effect during the course of the Charter.

5.17 Outfit and Furnishings

5.17.1 Messing Facilities.

A single messroom for all personnel is desired where cafeteria style service shall be provided. 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.

5.17.2 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.

5.17.3 Laundry Facilities. It is anticipated that individuals shall do their own laundry. It is therefore desirable that smaller capacity multiple unit laundry facilities shall be provided. These shall 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. Storage for detergent, a temporary clothes rod and a service sink with hot and cold fresh water shall also be provided.

5.17.4 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.

5.17.5 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. . Owner shall provide new cabinetry in common (02 level) lounge to contain Charterer supplied entertainment equipment. Mutually agreed upon furnishings (couches, etc.) will be added on a split-cost basis to update the lounge. Media for entertainment system (videos, DVDs) will be periodically renewed on a split-cost basis.

5.17.6 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.

5.17.7 Heated Pilothouse Windows. Every window in the pilothouse shall be heated to prevent icing.

5.17.8 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.

5.17.9 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 shall be provided that can maintain spare parts in good working order.

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

5.17.11 Low Friction Hull Coatings. The ship shall have the entire underbody of the ship coated with a low friction hull coating similar to International Paints Inerta 160, or equivalent as approved by Charterer.

5.18 Special Storage Requirements.

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 shall be sized to handle these containers and the hold shall have winches and equipment to slide vans into place. Service drops for 440 VAC and 115 VAC and general alarms shall be provided in the hold.

5.19 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 shall be capable of carrying four passengers and 2000 lbs. of payload over a 100 nm operating radius. Aviation fuel storage is required as well as suitable refueling facilities. Pilots and maintenance personnel shall 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 shall 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 4.2, shall be provided on 2-ft centers. The starboard side helicopter deck railing shall be hinged such that all safety railing can be changed easily between vertical and horizontal positions. The railing shall be kept vertical during cruises without helicopters. 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.