Based on current projections, it seems clear that remotely operated vehicles (ROVs) will play an increasingly important role in oceanographic research. This rapidly evolving technology will serve for instrument deployment, sample collection, and observations in the water column and on the sea floor. As the size and complexity of ROVs decrease, the shipboard characteristics necessary to deploy them become less demanding. Planning for refits and replacement ships should incorporate the minimal requirements to install equipment necessary for ROV operations. Shipboard capabilities required for the operation of large (2 ton) ROVs include:

- launch and recovery gear (cranes or A-frames),
- tether handling gear (winches and power sheaves),
- navigation and vehicle tracking capability,
- vehicle control station (van or interior lab space),
- surface ship maneuverability and positioning, and
- clean, uninterrupted power supply.

Appendix I. Special Sampling Capabilities

A. Multichannel Seismic Capability

Major components of an advanced multichannel seismic system for academic research are:

- Streamer — A 3600-6000 m seismic streamer with reel. The reel is mounted near the stern, is 5 m high, has a 6-m x 6-m footprint, and weighs 15 to 20 tons.
- Acoustic sources — An array of up to 24 airguns towed from booms in strings or paravanes mounted on the stern. Deck equipment for handling airgun arrays and a close-by shop of maintenance are required.
- Compressors — Compressors that can supply up to 3000SCFM at 2500 psi. Some of the compressors could be in vans.
- Storage space — Ample storage space for streamer accessories such as tail buoys and spare secctions is required.

B. Acoustic Characteristics

In planning for any research vessel, particular attention should be given to acoustic characteristics. Earlier ship planning provided "quiet ship generators" that operated limited equipment for short periods in order to reduce radiated noise. Present operations involve continuously operating equipment such as multichannel seismic systems, multibeam echo sounders, sub-bottom profilers, side scan imagery, acoustic navigation, and Doppler current profilers. All of these have increased sensitivity to underwater radiated noise, sonar self noise, and shipboard airborne noise.

Analyses have shown that the most active acoustic frequencies, at which interference should be minimized are from 1 to 15 kHz for echo sounders; 4 to 500 kHz for seismics; and 50 to 300 kHz for Doppler profiling. Of these, the multibeam echo sounder "Sea Beam" has proved to be the most critical, and thus becomes the target for primary acoustic control. The current recognized limits for underwater radiated noise is 50 dB relative to $1\mu Pa^2/Hz$ @ 1m, 12.5 kHz.

The dominant underwater noise source is the propulsor. Special consideration should be given to provide acoustically quiet propellers. Propulsion machinery should have two stage mountings for the attenuation of low frequency structureborne noise. Likewise, auxiliary machinery should be provided with resilient mountings for the suppression of radiated noise. The prevention of bubble formation and sweepdown paths should be included in hull designs. Measures to minimize structureborne noise transmission should be included in ship structure specifications. In general, acoustics should become an essential element at the outset of new ship planning.

C. Submersible Handling

Although it is not the task of this report to include manned submersible requirements, it can be stated with some confidence that the requirement for at least one such vehicle will continue into the next generation of research vessels and bring about the need for a replacement submersible handling vessel on the occasion of the ATLANTIS II retirement. Furthermore, it can be forecast that the next generation of deep submersible probably will be a 6,000- to 10,000-m depth vehicle. Judging from DSV SEACLIFF such a submersible would weigh 25-tons compared with ALVIN at 16-tons.

Selected research carried out using FLIP.

1. Sonar bearing accuracy studies. Simultaneous determination of azimuth of a distant sound source using in-air optical and underwater acoustic techniques.

2. Mid-ocean surface swell measurements using multiple pressure gauges mounted at various depths along FLIP's hull.

3. Long-range sound propagation studies using a variety of vertically suspended hydrophone assemblages (three-point moors in water depths to 6 km).

4. Internal wave studies using triplets of isotherm followers or rapid profiling temperature sensors operated from 15-20-m booms.

5. Air-sea interaction studies using wave staffs, air turbulence sensors, etc., on booms extended away from FLIP.

6. Internal wave studies using narrow-beam, multi-channel acoustic Doppler sensors.

7. Radar backscatter studies (special antenna arrays installed for this purpose).

8. Optical properties studies.

9. Ocean ambient noise measurements as function of depth and sea static.

10. Noise of breaking waves using directional hydrophone arrays mounted on bottom of FLIP.

11. Provide tie between GPS and underwater acoustic systems for geodetic determination of baseline lengths from land to deep sea points (scheduled for Fall 1989).

12. Provide elevation difference measurements (using GPS and pressure) between land stations and sea surface for satellite altimeter ground truth (scheduled for Fall 1989).

Communication and Navigation

A versatile communication suite is necessary, particularly because in this compact type structure it is desirable to be able to select appropriate antennae and frequency bands to avoid interference with research equipment. Data transmission links for passing digital information, including satellite imagery, at 9600 baud or better should be included. Work with aircraft is anticipated, and communication is needed appropriate for such operations. GPS and Loran C systems should be available, with digital (RS 232) output for logging by the scientific party during drifting operations. Thought should be given to minimizing the number of antennae to reduce interferences with other topside activities.

Underwater acoustic communications and warning beacons are needed to facilitate work in the vicinity of submarine operating areas or transit lanes. Transducers and processing equipment should be available to permit using acoustic transponder navigation to document small-scale motions when moored. There also should be capability for tracking ROV's operated from the platform.

References

National Research Council, *Oceanography 1960-1970*, 1959.

Fisher, F.H. and Bishop, C.B., editors. *Stable Research Platform Workshop*, SIO Reference 87-29, April 1988.

Sea State		*Height*	
	Description	*Feet*	*Meters*
0----------	Calm-glassy	0	0
1----------	Calm-rippled	0 to 0.5	0 to 0.1
2----------	Smooth-wavelets	0.5 to 1.5	0.1 to 0.5
3----------	Slight	1.5 to 4	0.5 to 1.25
4----------	Moderate	4 to 8	1.25 to 2.5
5----------	Rough	8 to 13	2.5 to 4
6----------	Very rough	13 to 20	4 to 6
7----------	High	20 to 30	6 to 9
8----------	Very high	30 to 45	9 to 14
9----------	Phenomenal	Over 45	Over 14

tests on models using wind tunnels). This places a premium on designing the superstructure to produce minimal disturbance. Other booms, able to support substantial loads, should be available to hang payloads in the water without the instruments or their cables fouling on the underwater portion of the vehicle.

The booms should be installable in any quadrant of the vehicle and should be easily rigged once the ship is in the vertical position. Use of six or more booms simultaneously may be anticipated. Telescoping booms and masts, hydraulically extended, should be considered. For longer booms, active compensation for vehicle tilt should be considered.

The number of options in this category is quite large. It would thus be appropriate to convene a group of representative users to determine what booms/masts might be considered as general purpose, and what other options could be accommodated by installing mounting foundations for special-purpose units.

Hull Mountings

A flippable hull provides unique opportunities while alongside the pier for mounting equipment that will, after flipping, be located at the desired depth and position below the surface. To take full advantage of these opportunities, foundations for heavy equipment (e.g., large acoustic transducers—up to 10 tons) should be built into the ship. "Bolt-on", "bolt-to" mounting rails or similar structures should be provided for fastening lighter units, and for movable instruments that could be shifted from one depth to another, or brought up to laboratory level for adjustment, calibration, or repair. Cableways should be provided to accommodate connecting wiring protected from the wash of the sea over the hull.

Winches and Handling Gear

At least one major winch, installed in an enclosed area, is needed to handle 6,000 m of electromechanical cable of at least 10-mm diameter. The capability of installing alternate winches, e.g., to handle 4,000 m of 0.68-in diameter electromechanical cable, should be included. One or more tracks should be provided to move equipment along the hull while at sea in either the vertical or horizontal position. In the vertical, this should allow payloads to be assembled in the laboratory and moved down to operate at any depth along the hull. These tracks would also provide movable guides to prevent cables for suspended instruments from fouling on the hull.

Electric Power

At least 100 kw of clean power should be available for scientific party use, plus power (~ 1000 kW) for housekeeping, thrusters, winches, etc. There should be sufficient redundancy to provide continuous power for 50 days on station, yet permit shutdown of some prime movers for maintenance. Multiple circuits should be provided so that activities in separate spaces can be isolated from one another, with clean power available for sensitive equipment (computers, etc.). Capability should be provided for installation of storage batteries to provide minimal housekeeping and laboratory power for silent ship operations.

Environmental Disturbance

There should be adequate holding and processing tanks such that discharges from heads, showers, etc., will be in accordance with current best research ship practice. Garbage compacters should be provided such that trash will not have to be disposed of on station for at least 30 days. Cooling water discharges from engines, air conditioners, etc., should have multiple outlets so that investigators can choose the depth of discharge. Exhaust stacks should be arranged to allow venting in controlled directions. Major pieces of machinery (e.g., engines) should be mounted to minimize transmission of noise to the water.

Endurance

The platform should have 60 days endurance without need to refuel or re-provision. This requirement is based on providing the ability to remain on station, taking data, through a succession of weather fluctuations. Although landing of large helicopters is not required, deck and mast arrangements should allow for transfer of people and equipment by this means.

Habitability

The craft should accommodate a science party of up to 16 under conditions approaching those of today's conventional research ships (no more than four people per stateroom, nor more than eight per head/shower facility). Sleeping spaces should be adequately air conditioned and insulated from machinery noise. Operation in all ocean areas (except where ice would be encountered) should be anticipated, and habitability requirements should be met in both operating and towing attitudes.

Laboratory Space

About 1,000 sq ft of laboratory space should be provided, at least half of which should have the ability to maintain temperature at no more than 21°C and humidity less than 90% for operation of electronics and computers. Space should be capable of being sub-divided to accommodate several separate research groups and should be usable in both horizontal and vertical attitudes. Separated working or wet lab space should be available for equipment repair and for working with water samples. Uncontaminated water should be drawn from various depths with plumbing running to the wet lab. (Cool water from the bottom of the platform might be used for air conditioning).

Equipment mounting systems (e.g., Unistrut) should be provided. Dockside access to laboratory spaces should allow instrument packages with dimensions up to 4x8x8 ft to be lowered directly in.

Space should be allocated for science storage so that supplies, spares, and packing materials need not be kept in the working lab. This space could be remote from the labs, in a part of the ship not desirable for other use. Means (lifts, davits, elevators) should be provided for moving gear between decks and into position for deployment.

Booms and Masts

The platform will be used to deploy arrays of instruments in the water and the air. Boom and mast complexes are required to support and maintain the sensors, antennas, etc. Some should reach beyond the zone in which the vehicle itself significantly perturbs the air (order of 3 times the platform's widest dimension, but to distances to be determined by

More detailed consideration of various science missions, along with the major items noted above, leads to a variety of requirements on the type of platform needed for these several research communities.

General Configuration

The combined requirements of minimal disturbance of the surrounding water and low response to surface wave motion lead to choice of a long slim structure, with axis oriented vertically. The combination of draft and variation of cross-section area vis-a-vis depth should be chosen to achieve the necessary payload and minimal response to the spectrum of a well developed sea. Payload requirements will result from consideration of various capabilities developed below. Heave response to the seaway should be less than 5% of the rms wave height for sea state 6 with a superposed 15-18-second period swell of 10 m (crest to trough). Roll response should be less than 2° rms.

The above water section should be able to cope with 30-m waves and should provide substantial structure for supporting booms. It should have a topmost deck capable of being cleared for operation of small helicopters (two man) or for landing and lifting of loads from large helos. It should provide for working platforms close to the sea surface during periods of low sea state, as well as external decks on which small winches and other overside equipment-handling gear can be mounted.

Mobility

The platform should be capable of being towed to and from station at a speed of at least 8 knots. It should be capable of transiting the Panama Canal. Towing would use conventional seagoing tugs or offshore supply boats capable of carrying the gear necessary for mooring, and would assist in deploying and recovering the moor.

It is clear that this towing speed cannot be achieved with the craft in its research operating mode (axis vertical). Since it is undesirable to be forced to make personnel transfers at sea, this craft, like FLIP, must be capable of being manned while in some other attitude (e.g., axis horizontal) and under tow.

While propulsion for transit would not necessarily be provided, limited thruster capability (perhaps dual use of the azimuth control system) should be installed to allow maneuvering close to piers without the need for harbor tugs.

Station Keeping

The platform should be capable of being held in a three-point moor with ability to be rotated in the moor and moved laterally over a limited area (radius approximately 5% of water depth) by shortening or lengthening mooring legs using on-board equipment.

It should be provided with a thruster system capable of maintaining an arbitrary orientation to within ± 5° in 15-knot winds without mooring. Since operation of thrusters will disturb the surrounding water, there should either be multiple sets (e.g., three) at different depths, or the system should be movable in depth so that investigators can minimize the effects at depths of particular interest to them.

Ballasting capability should be provided to allow trimming so that mean tilts associated with load deployed asymmetrically (particularly on booms) can be compensated.

Draft Science Support Requirements for a Manned Spar Buoy Laboratory

Introduction

Needs for a manned spar buoy laboratory/stable ocean platform were articulated as early as 1959 by the National Academy of Sciences Committee on Oceanography (National Research Council, 1959) and several craft in this category were built and used in the 1960s (Bouee Laboratoire, FLIP, SPAR, POP). Only one of these (FLIP) had the mobility and versatility to carry out a wide range of research functions and has continued to support seagoing work up to the present time. The appendix lists a number of research projects for which FLIP has been used over its 26-year life. Like the bulk of the conventional ocean research craft, also built in that decade, FLIP is becoming increasingly expensive to maintain, while at the same time new research requirements have emerged beyond her present capabilities. Given the long history of fruitful use of FLIP, it appears appropriate that consideration be given to her replacement with a new vehicle.

As in other similar instances, the UNOLS Fleet Improvement Committee has sponsored the compilation of this draft set of science requirements for consideration by the ocean science community as it moves toward design and construction of an updated version of a craft to meet the needs of the 1990s and beyond. Most of the requirements presented below were assembled during a 1987 workshop at the Marine Physical Laboratory (Fisher and Bishop, 1988).

Three communities have found this type of craft to be useful in the past and look forward to broadened capabilities: marine physicists (acoustics, optics, radar), physical oceanographers (surface and internal waves, turbulence), and atmospheric scientists (low-altitude marine meteorology, air-sea interaction). Beyond these, examples of new uses include providing ground truth for satellite observations (e.g., satellite altimetry, surface roughness) and in geodesy, as well as occasional uses in biological oceanography and sea floor studies.

In physical oceanography and atmospheric science, the principal utility of this type of craft is in providing laboratory space and a rigid, stable mounting structure for sensing, recording, and analyzing conditions in the vicinity of the platform. This involves rigging of booms and platforms above the water to hold instruments or provide support points for sensors suspended in the water. It also implies use of remote sensing systems—acoustic under water and optical or microwave above. Primary parameters of concern are local velocity, density, temperature, and sea surface configuration (wave height, slope, etc.). In many types of research visualized in this category one is interested in near-surface conditions and thus one need not moor; however, it often is necessary to maintain a particular orientation (e.g., relative to the wind). The essential design requirement is for minimal disturbance in the surrounding water and air.

Underwater acoustic research, on the other hand, makes substantial use of the platform as a laboratory from which hydrophone arrays can be suspended and monitored deep in the ocean. This implies minimal heaving motion and ability to be moored (in the same manner as FLIP now is) in deep water in order that translation caused by wind and near-surface currents will not drag hydrophones through the more nearly stationary deeper layers. Ability to maintain orientation is also often desirable. Because acoustic conditions in stormy areas are of interest, the platform should be able to operate in relatively heavy weather. The same minimal heaving motion could be exploited in handling of ROV's or seafloor work systems in support of studies of phenomena at the ocean floor.

The functions, communications, and layout of the ship control station should be carefully designed to enhance the interaction of ship and science operations. For example, ship course, speed, altitude, and positioning will often be integrated with scientific operations requiring control to be exercised from a laboratory area.

Sea State		*Height*	
	Description	*Feet*	*Meters*
0----------	Calm-glassy	0	0
1----------	Calm-rippled	0 to 0.5	0 to 0.1
2----------	Smooth-wavelets	0.5 to 1.5	0.1 to 0.5
3----------	Slight	1.5 to 4	0.5 to 1.25
4----------	Moderate	4 to 8	1.25 to 2.5
5----------	Rough	8 to 13	2.5 to 4
6----------	Very rough	13 to 20	4 to 6
7----------	High	20 to 30	6 to 9
8----------	Very high	30 to 45	9 to 14
9----------	Phenomenal	Over 45	Over 14

Sea water:	Uncontaminated sea water supply to most laboratories and deck areas.
Vans:	To carry one or two standardized 8 ft by 20 ft portable vans which may be laboratory, berthing, storage, or other specialized use. Hookup provision for power, fresh water, drains, communications, data and shipboard monitoring systems.
Workboats:	One 16-ft inflatable (or semi-rigid) boat located for ease of launching and recovery.
Science storage:	Science storage space should be provided as feasible.
Acoustical Systems:	Ship to be as acoustically quiet as practical. Ship to have 12 kHz and 3.5 kHz echo sounding systems and provision for additional systems.
Navigation/ Positioning:	Global positioning System (GPS) with appropriate interfaces to data systems and ship control processors. Short baseline acoustic navigation system.
Internal Communi-cations:	Internal communication system providing high-quality voice communications throughout all science spaces and working areas. Data transmission, monitoring, and recording system available throughout science space including vans and key working areas. Closed-circuit television monitoring and recording of all working areas including subsurface performance of equipment and its handling. Monitors for all ship control, environmental parameters, science and overside equipment performance to be available in all, or most, science spaces.
External communi-cations:	Reliable voice channels for continuous communications to shore stations (including home laboratories), other ships, boats, and aircraft. This includes satellite, VHF and UHF. Facsimile communications to transmit high-speed graphics and hard-copy text on regular schedules. High-speed data communications (56 K Baud) links to shore labs and other ships on a continuous basis. Capability to receive realtime or near realtime satellite imagery.
Ship Control:	Chief requirement is maximum visibility of deck work areas during science operations and especially during deployment and retrieval of equipment.

Removable general purpose winches will include:

- Hydrowinch with interchangeable drums capable of handling 30,000 ft of wire rope, Kevlar synthetic line or electromechanical cables having diameters from 3/16" to 5/16" (Markey DESS-3 or equivalent) weight with wire 5 tons.

- Capable of loading and using portable winches such as a double drum winch with 15,000 ft of 1/2" trawling wire on each drum for large mid-water net towing.

Portable shelters available to winch work areas for instrument adjustments and repairs. Two winch control stations located for optimum operator visibility with reliable communications to laboratories and ship control stations.

Overside Handling: Various frames and other handling gear and more versatile than present to accommodate wire, cable and free launched arrays. Matched to work with winch and crane locations but able to be relocated as necessary.

Stern A-frame to have 15-ft minimum horizontal and 20-ft vertical clearance; 15-ft inboard and outboard reaches.

Provision to carry additional overside handling rigs along working decks from bow to stern.

Control station(s) to give operator protection and operations monitoring and be located to provide maximum visibility of overside work.

Laboratories: Approximately 1,200 sq ft of laboratory space including: Main lab area (700 sq ft) flexible for subdivision providing smaller specialized labs; Wet lab (300 sq ft) both located contiguous to sampling areas; plus Electronics/Computer lab and associated users space (300 sq ft); and freezer (100 sq ft).

Access between labs should be convenient.

Labs to be fabricated using uncontaminated and "clean" materials and constructed to be maintained as such. Furnishings, HVAC, doors, hatches, cable runs, and fittings to be planned for maximum lab cleanliness.

Cabinetry shall be laboratory grade including flexibility through the use of unistruts and deck boltdowns.

HVAC: Heating, ventilation, and air conditioning appropriate to laboratories, vans, and other science spaces being served. Laboratories shall maintain temperature of 70-75° F, 50% relative humidity, and 9-11 air changes per hour.

Power: Each lab area to have a separate electrical circuit on a clean bus with continuous delivery capability of at least 40-volt amperes per square foot of lab deck area. Labs to be furnished with 110 v and 220 v AC. Total estimated laboratory power demand is 40 KVA.

Scientific Requirements for Small General-purpose Oceanographic Research Ship, Small Waterplane Area Twin Hull (SWATH)

March 1989

General:	The general aim of this study is to design a SWATH vessel that will provide a more stable platform in higher sea states and have a higher cruising speed (15 knots in sea state 5). On the other hand, this SWATH will be weight-limited; its payload will only be 50 LT including winches, cranes, and frames, but not fuel.
Size:	The size is determined by the requirements for a 15-knot cruising speed and a 2,000 mile range. It is expected that the size of the "box" will be approximately 100 ft long.
Endurance:	7 days; 2000 mile range.
Accommo-dations:	12 scientific personnel.
Speed:	18 knots in sea state 4; 15 knots cruising; sustainable through sea state 5; fine speed control between 0-6 knots.
Station Keeping:	Maintain station and work through sea state 5; limited work in SS 6.
Ice Strengthening:	None.
Deck Working Area:	Spacious work area - 2,000 sq ft minimum with contiguous waist work area along one side 12 x 50 ft minimum. Provide for deck loading up to 1,200 lbs/sq ft in selected areas and an aggregate total of 50 tons. A 15 x 25 ft centerwell to be provided. Holddowns on 2-ft centers. Highly flexible to accommodate large but not necessarily heavy equipment. A deck at the bottom of the centerwell to be 10 ft or less above waterline. All working decks accessible for power, water, air, and data and voice communication ports.
Cranes:	A modern crane to handle heavy and large equipment capable of reaching working deck areas and offload vans and heavy equipment up to 8,000 lbs to 20 ft. Crane to have servo controls and motion compensation and be usable as overside cable fairleads at sea.
Winches:	New generation of oceanographic winch systems providing fine control (0.5 m/min); constant tensioning and constant parameter. Wire monitoring systems with inputs to laboratory panels and shipboard recording system. Local and remote controls.

Acoustical Systems:	Ship to be as acoustically quiet as possible in the choice of all shipboard systems and their location and installation. Ship to have conventional 12 kHz, and 3.5 kHz echo sounding systems and provision for additional systems as needed. Transducers to be mounted so as to provide clean transmission and reception from both lateral (tracking) and vertical signals. Three transducer wells with at sea access for servicing and installation.
Navigation/ Positioning	Global Positioning System (GPS) and Loran C with appropriate interfaces to data systems in lab and ship control processors.
	Short baseline acoustic navigation system.
Internal Communi-cations:	Internal communication system providing high-quality voice communications throughout all science spaces and working areas.
	Data transmission, monitoring, and recording system available throughout science space including van and key working areas.
	Closed-circuit television monitoring of all outside working areas including subsurface performance of equipment and its handling.
	Monitors for all ship control, environmental parameters, science and overside equipment performance to be available in all, or most, science spaces.
External Communi-cations:	Reliable voice channels for continuous communications to shore stations (including home laboratories), other ships, boats and aircraft. This includes satellite, VHF and UHF.
	Facsimile communications to transmit high-speed graphics and hard-copy text on regular schedules.
	High-speed data communications links to shore labs and other ships on a continuous basis.
	Capability to receive real-time or near real-time satellite imagery.
Ship Control:	Chief requirement is maximum visibility of deck work areas and adjacent sea surface, during science operations and especially during deployment and retrieval of equipment.
	The functions, communications, and layout of the ship control station should be carefully designed to enhance the interaction of ship and science operations. For example, ship course, speed, attitude, and positioning will often be integrated with scientific operations requiring control to be exercised from a laboratory or deck working area.

Labs to be fabricated using uncontaminated and "clean" materials and constructed so they can be easily maintained in an uncontaminated condition. Furnishings, HVAC, doors, hatches, cable runs, plumbing, and fittings to be planned for maximum lab cleanliness.

Fume hood to be installed permanently in wet lab. Main lab to have provision for temporary installation of fume hood. Hood flues able to withstand acid fumes and situated so no fumes can be drawn back to occupied areas inside or on deck.

Cabinetry shall be of high grade laboratory quality including flexibility through the use of unistruts and deck boltdowns on 1-ft centers.

Heating, ventilation, and air conditioning (HVAC) capabilities as follows: labs shall maintain temperature of 70-75° F in all weather conditions, 25% relative humidity; and 9-11 air changes per hour. Each lab area to have a separate electrical circuit on a clean bus with continuous delivery capability of at least 40-volt amperes per square foot of lab deck area. Labs to be furnished with 110 v and 220 v AC. Maximum estimated laboratory power demand is 50 KVA. Uncontaminated sea water supply to wet and dry labs, and deck areas (including anywhere on the fantail). Compressed air supply to all labs and deck area; supply to be clean and oil free, with 100 lbs service pressure at outlets.

Special Science Facilities:

Science shop with workbench, vise, and basic hand and power tools.

Scientific freezer space = 36 cubic ft @ -20° C, and 50 cubic ft @ -5° C.

SCUBA support facilities — compressor, water entry platform and ladder, tank storage racks.

Space and capability for setting up and operating station for a small ROV; with deck space for cable payout and coiling, launch and recovery. ROV control center with video monitor, recording gear and communications in the main lab or on the bridge.

Undisturbed air flow at bow for air-sea interaction studies.

Van:

Capable of handling and carrying at least one standard 8 ft by 20 ft portable deck van, which may be laboratory, berthing, storage or other specialized use. Hookup provision for power, HVAC, fresh water, uncontaminated sea water, compressed air, drains, communications, data and shipboard monitoring systems. Van should have close, if not direct access to ship's interior. Ship should be capable of loading and offloading empty van using its own crane at dockside.

Workboats:

One 16-ft rigid hull boat with inboard or outboard power, and at least one 12- to 16-ft inflatable boat with outboard power.

Science Storage:

Readily accessible 1250 cubic ft minimum for operator's science support gear and resident technician's stores. Accessible safe storage for chemical reagents and hazardous (non-radioactive) materials.

Cranes: (2) — One articulated crane to handle large and heavy (up to 8,000 lbs) gear over both sides, on station and underway, with lateral motion damping, and an outboard reach of 14 ft on one side. This crane also capable of reaching all working deck areas for loading and off-loading of equipment (including empty van). Man-rated for launch and recovery of small submersibles. A second, smaller crane with re-location sites foreward, midships and aft; articulated for work at deck level and at the sea surface, with weights up to 4,000 lbs, also usable as over-the-side, cable fairlead for vertical work and light towing.

Winches: Two modern winches with state-of-the-art controls providing fine control (0.5 m/min); constant tensioning or with tension accumulator. Wire monitoring systems on both winches, with readouts on laboratory panels and shipboard recording systems, as well as on the bridge. Local and remote control boards. Winches to be re-locatable (in port) to allow reconfiguration of deck layout. Capable of transferring winch drums at sea.

Hydrowinch with interchangeable drums capable of handling up to 30,000 ft of wire rope, Kevlar synthetic line or electromechanical cables having diameters from 1/4" to 3/8" or 11 mm standard (e.g., Markey DESS-5 or equivalent). Slip rings with 6 conductors.

Trawling winch capable of handling 20,000 ft of 1/2" trawling or coring wire or 20,000 ft of 0.68" electromechanical cable (up to 10 KVA power transmission) or fiber optics cable. Can be operated with interchangeable drums. Slip rings with 6 conductors. A traction winch is a possible alternative.

All-weather winch control station(s) located for optimum operator visibility of work area and overside gear, with fail-safe communications to deck level, laboratories, and bridge. A-frame controls included.

Overside Handling: Various frames, davits and other handling gear to accommodate wire, cable and free-launched arrays. Matched to work with winch and crane locations, and with moveable capstans, but able to be relocated as necessary.

Stern A-frame to have 15-ft throat (horizontal width at deck level and up to 15 ft off deck) and 20-ft vertical clearance, 12-ft inboard and outboard reaches. Man-rated for launch and recovery of small submersibles. Safe working load of 20,000 lbs. Controls to be located at A-frame and at winch control station.

Towing: Capable of towing midwater and benthic gear at speeds up to 4 knots with line tensions of 20,000 lbs.

Laboratories: Minimum of 1,000 sq ft of laboratory space allocated: 75% main lab (including separate electronics lab capability), and reconfiguration into smaller specialized labs. Wet lab to be located contiguous to sampling areas; main lab with temperature and humidity precisely controlled.

Labs to be located so that none serve as general passageways. Access between labs to be convenient. Dry lab and electronics lab areas with door sills to keep water out. Main lab access to be large enough to accommodate transfer of large equipment items.

Scientific Mission Requirements for Small General-purpose Oceanographic Research Ship

July 1988

General:	This monohull ship will serve as a general-purpose research vessel with limited endurance and maximum flexibility of operations. It is fully capable of continuous 24-hour operations. The primary design requirement is to combine multi-disciplinary capability with small size and cost effectiveness. Vessels of this size often serve educational programs in addition to their research work. For this vessel, endurance and cruising speed are secondary to broad operational capabilities and seakeeping qualities.
Size:	LOA = less than 150 ft; BEAM = not less than 30 ft; DISPLACEMENT = 500 to 650 tons; GROSS TONNAGE = < 300 tons; DRAFT = 7 to 10 ft.
Endurance:	21 days. Endurance formula should include 50% cruising and 50% on-station. RANGE = 5,000 nautical miles.
Accommo-dations:	12 to 16 scientific personnel in two-person cabins, under research cruise conditions. Expandable to 24 with a van. Up to 40 personnel on day trip basis. Crew size < 10.
Speed:	12-13 knots cruising; sustain 10 knots through sea state 4. Maximum speed = 14 knots. Speed control ± 0.1 knot in speed range from 0 to 6 knots. Design trade-offs should favor sea-keeping over speed.
Seakeeping:	Maintain science operations at these speeds and sea states: 9 knots in sea state 4 7 knots in sea state 5 4 knots in sea state 6
Station-keeping:	Maintain station and over-the-side vertical operations in sea state 4, without dynamic positioning. Bow thruster.
Ice Strength-ening:	ABS Class C (ability to transit loose pack ice) may be desirable for one or more vessels of this class, but distinct from a dedicated, ice-strengthened, high-latitude research vessel.
Deck Working Area:	Approximately 1500 sq ft with contiguous work area along starboard waist = 8 ft x 20 ft minimum for CTD and rosette sampler handling. Deck loading at 1500 lbs/sq ft. Heavy duty holddowns on 2-ft centers. Able to accommodate at least one (preferably two) 8 ft by 20 ft van yet retaining clear access to stern and waist work areas. Removable bulwarks with hinged freeing ports to provide dry deck conditions in beam or quartering seas. All working decks with multiple access for power, fresh and salt water, air and cableways for data and voice communication lines. Low freeboard at fantail (3 to 5 ft). No stern ramp.

Sea State	*Description*	*Height*	
		Feet	*Meters*
0----------	Calm-glassy	0	0
1----------	Calm-rippled	0 to 0.5	0 to 0.1
2----------	Smooth-wavelets	0.5 to 1.5	0.1 to 0.5
3----------	Slight	1.5 to 4	0.5 to 1.25
4----------	Moderate	4 to 8	1.25 to 2.5
5----------	Rough	8 to 13	2.5 to 4
6----------	Very rough	13 to 20	4 to 6
7----------	High	20 to 30	6 to 9
8----------	Very high	30 to 45	9 to 14
9----------	Phenomenal	Over 45	Over 14

	Dynamic positioning both relative and absolute in 35-knot wind, Sea State 5, and 1.5-knot current in depths to 6,000 m using GPS and bottom transponders; maximum excursion ± 150 ft.
Internal Communications:	Internal communication system providing high-quality voice communications throughout all science spaces and working areas.
	Data transmissions, monitoring, and recording system available throughout science spaces, including vans and key working areas.
	Closed-circuit television monitoring and recording of working areas.
	Monitors for all ship control, environmental parameters, science and overside equipment performance to be available in all, or most, science spaces.
External Communications:	Reliable voice channel for continuous communications to shore stations (including home laboratories), other ships, boats, and aircraft. This included satellite, VHF and UHF. Facsimile communications to transmit high-speed graphics and hard-copy text on regular schedules.
	High-speed data communications (via satellite) links to shore labs and other ships on a continuous basis.
Satellite Monitoring:	Carry transponding and receiving equipment including antenna to interrogate and receive satellite readouts of environmental remote sensing data.
Discharges:	All discharges will be on the port side with their holding tanks capable of holding for a minimum of 24 hours.
Ship Control:	Chief requirement is maximum visibility of deck work areas during science operations and especially during deployment and retrieval of equipment. This would envision a bridge-pilot house very nearly amidship with television monitors as well as direct, unobstructed stern visibility. Portable hand-held control units could also be used at various after deck locations during overside equipment handling.
	The functions, communications, and layout of the ship control stations should be carefully designed to enhance the interaction of ship and science operations. For example, ship course, speed, attitude, and positioning will often be integrated with scientific operations requiring control to be exercised by computer from a laboratory or working deck area. Also, a collision avoidance system should be provided to help insure safe, remote computer-controlled operations in traffic congested waters.

Vans:	To carry two (2) standardized 8 ft by 20 ft portable deck vans which may be laboratory, berthing, storage, or other specialized use. Hookup provision for power, HVAC, freshwater, uncontaminated seawater, compressed air, drains, communications, data and shipboard monitoring systems. Vans must have heated water and sewage lines. Vans should have direct access to ship interior but located in wave sheltered spaces. Vans should be capable of withstanding arctic climate. Capability to carry additional portable non-standard vans (200 sq ft total) on super-structure and working decks. Supporting connections at several locations around ship, including the foredeck.
Workboats:	At least one (1) 21-ft inflatable (or semi-rigid) boat located for ease of launching and recovery. Capability to carry and deploy scientific work boat 25-30 ft LOA, specially fitted out for supplemental operations at sea, including data/sample collecting, instrumentations, and wide angle seismic measurements, to be accommodated as one of the two-van options above.
Helicopter:	Occasional landing of helicopter forward is envisioned with no provision for a permanently assigned craft necessary.
Science Storage:	Total of 15,000 cu ft of scientific storage accessible to labs by interior and weatherdeck hatch(es) and elevators. Half to include suitable shelving, racks, and tie downs; remainder open hold. The open hold should be equipped with heavy duty hold-downs on 2-ft centers. Hazardous materials storage should be provided with easy access to the labs.
Acoustical Systems:	Ship to be as acoustically quiet as practicable in the choice of all shipboard systems and their location and installation. Design target is underway, conventional echo sounding in Sea State 4 and acoustical dynamic positioning through Sea State 5. Ship to have conventional 12 kHz and 3.5 kHz echo sounding systems and provision for additional systems, including: • Acoustic Doppler Current Profiling (ADCP) system with both 150 and 300 kHz transducers hull-mounted. • Forward-looking submarine search-type sonar for mid-water trawl net guidance and ice navigation. • Hull-mounted transducers appropriate for dynamic positioning using seafloor transponders. • Transducer wells, one located forward and one aft. Pressurized sea chest to be located at optimum acoustic location for at-sea installation and servicing of transducers and transponders.
Navigation/ Communications:	Global Positioning System (GPS) with appropriate interfaces to data systems and ship control processors for automatic computer steering and speed control.

Heated staging and sampling area with overhead rail and 15-ft clearance at an optimum overside working area.

Capability to operate overside handling rigs along working decks from bow to stern.

Sheltered control station(s) to give operator protection and operations monitoring and be located to provide maximum visibility of overside work.

Towing: Capable of towing large scientific packages up to 10,000 lbs horizontal tension at 6 kts and 25,000 lbs at 2.5 kts. Capable of towing in ice-covered seas and protecting those packages while towing.

Laboratories: Approximately 2,000 sq ft of laboratory space, including: Main lab area (1,000 sq ft) flexible for frequent subdivision providing smaller specialized labs; Analytical lab (300 sq ft) with no exterior bulkheads and stable temperature control and Wet lab (300 sq ft), both located contiguous to sampling areas; Electronics/Computer lab and associated user space (300 sq ft); two climate controlled chambers (100 sq ft) capable of maintaining -2°C (one suitable for primary productivity measurements); and freezer (100 sq ft).

Labs should be located so that none serve as general passageways. Access between labs should be convenient.

Labs to be fabricated using uncontaminated and "clean" materials and constructed to be maintained as such. Furnishings, HVAC, doors, hatches, cable runs, and fittings to be planned for maximum lab cleanliness.

Fume hoods to be installed permanently in Main lab. Wet lab shall have provision for temporary installation of fume hoods.

Cabinetry shall be high-grade laboratory quality, including flexibility through the use of unistruts and deck boltdowns.

Heating, ventilations, and air conditioning (HVAC) as appropriate to laboratories, vans, and other science spaces being served. Laboratories has maintain temperature of 60 - 75° F, 50% relative humidity, and 9-11 air changes per hour. Filtered air provided to Analytical lab. Each lab area to have a separate electrical circuit on a clean bus with continuous delivery capability of at least 40-volt amperes per square foot of lab deck area. Labs to be furnished with 110 v and 220 v AC. Total estimated laboratory power demand is 75 KVA. Uncontaminated seawater supply to most laboratories, vans, and several key deck areas. Compressed air supply to be clean and oil-free.

Heavy-duty hold-downs on 2-ft centers. Highly flexible to accommodate large and heavy equipment. Removable bulwarks. Dry main working deck not greater than 6-8 ft above waterline.

Usable clear foredeck area to accommodate specialized towers and booms extending beyond bow wave. Foredeck area to accommodate helicopter landing or alternatively a laboratory van.

All working decks accessible to power, water, air, and data and voice communication ports.

Cranes:

A suite of modern cranes to handle heavier and larger equipment than at present: 1) to reach working deck areas and offload vans and heavy equipment up to 20,000 lbs; 2) articulated to work close to deck and water/ice surface: 3) to handle overside loads up to 5,000 lbs, 30 ft from side and up to 10,000 lbs closer to side; 4) overside cranes to have servo and motion compensations; 5) usable as overside cable fairleads for towing at sea; 6) cranes adaptable for manned egress onto ice surface.

Winches:

New generation of oceanographic winch systems providing fine control (0.5 m/min); constant tensioning and constant parameter. Wire monitoring systems with inputs to laboratory panels and shipboard recording systems. Local and remote controls.

Permanently installed general-purpose winches include:

- Two hydrographic-type winches capable of handling 30,000 ft of wire rope or electromechanical cable having diameters from 1/4" to 3/8".
- A heavy winch complex capable of handling 40,000 ft of 9/16" wire/synthetic fiber rope; or 30,000 ft of 0.68" electromechanical cable (up to 10 KVA power transmission) or fiberoptics cable. This is envisioned as one winch with multiple storage drums which could be interchanged.

Additional special-purpose winches may be installed temporarily at various locations along working decks. Winch sizes may range up to 30 tons (140 sq ft) and have power demands up to 300 hp.

Sheltered winch control station(s) located for optimum operator visibility with reliable communications to laboratories and ship control stations.

Overside Handling:

Various frames and other handling gear to accommodate wire, cable and free launched arrays. Maximum hoist capacity 30,000 lbs. Matched to work with winch and crane locations but able to be relocated as necessary.

Stern A-frame to have 15-ft minimum horizontal, 25-ft vertical clearance; 12-ft inboard and outboard reaches.

Scientific Mission Requirements for Intermediate Ice-Capable, General-purpose Oceanographic Research Ship

February 1989

General:	The ship will serve as a general-purpose arctic research vessel. It will be ice-strengthened to increase the capability of the UNOLS fleet to work in ice-covered seas. An intermediate-size ship is necessary to conduct multidisciplinary cruises of long duration since access to fuel and other services will be severely limited. The primary concerns are hull strength and endurance with seakeeping and speed being secondary.
Size:	The size ultimately is determined by the requirements. However, it is intended that this be an intermediate size (Class III, UNOLS; 150-199 ft LOA), which has limited ice capability and endurance.
Endurance:	Ninety days; providing the ability to transit 30 days at cruising speed, 30 days station work, and 30 days hotel service. 15,000 mile total range.
Ice Capability:	This ship should have the ability to operate in 9/10 first-year ice and of maintaining a speed of 3 kts in 2.5-ft continuous ice cover and capable of transiting 7-ft ridges. This corresponds approximately to the Canadian ice classification #2 and the ABS classification 1AA. Ship must be able to be withstand being beset by ice. Because it is expected to work in the Canadian arctic, it should meet Canadian specifications for ice-worthiness and pollution control.
Accommodations:	20-24 scientific personnel in two-person staterooms. Science Library-Lounge with conference room capability. Science office.
Speed:	12 knots cruising; 10 knots sustainable through Sea State 4. Speed control $\pm$ 0.2 knot in 0-7 knot range, $\pm$ 0.1 in the 0-2 knot range.
Seakeeping:	Maintain science operations in following speeds and sea states: 10 knots cruising through Sea State 4 8 knots cruising through Sea State 5 6 knots cruising through Sea State 6
Station-keeping:	Maintain station and work in Sea State up through 5. Ship must be capable of maneuvering in ice leads. Considerations should be made to minimize ice buildup on superstructure and hull during severe icing conditions.
Deck Working Area:	Spacious stern working area of 1,500 sq ft minimum with up to half enclosed (minimum of 10 ft clearance overhead) for weather protection. Contiguous work area along one side (8 x 80 ft minimum) to allow piston coring. Provide for deck loading up to 1,200 lbs/sq ft and an aggregate total of 90 tons.

Facsimile communications to transmit high-speed graphics and hard-copy text on regular schedules.

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

Satellite Monitoring: Carry transponding and receiving equipment including antenna to interrogate and receive satellite readouts of environmental remote sensing data.

Ship Control: Chief requirement is maximum visibility of deck work areas during science operations and especially during deployment and retrieval of equipment. This would envision a bridge-pilot house very nearly amidships with television monitors as well as direct, unobstructed stern visibility. Portable hand-held control units could also be used at various after- deck locations during overside equipment handling.

The functions, communications, and layout of the ship control station should be carefully designed to enhance the interaction of ship and science operations. For example, ship course, speed, attitude, and positioning will often be integrated with scientific operations requiring control to be exercised by computer from a laboratory or working deck area. Also a collision avoidance system should be provided to help ensure safe, remote computer-controlled operations in traffic congested waters.

Sea State		*Height*	
	Description	*Feet*	*Meters*
0----------	Calm-glassy	0	0
1----------	Calm-rippled	0 to 0.5	0 to 0.1
2----------	Smooth-wavelets	0.5 to 1.5	0.1 to 0.5
3----------	Slight	1.5 to 4	0.5 to 1.25
4----------	Moderate	4 to 8	1.25 to 2.5
5----------	Rough	8 to 13	2.5 to 4
6----------	Very rough	13 to 20	4 to 6
7----------	High	20 to 30	6 to 9
8----------	Very high	30 to 45	9 to 14
9----------	Phenomenal	Over 45	Over 14

Capability to carry and deploy scientific workboat 25-30 ft LOA, specially fitted out for supplemental operations at sea including data/sample collecting, instrumentation, and wide angle seismic measurements. To be accommodated as one of the two-van option above.

Science Storage: Total of 5, 000 cu ft minimum of scientific storage accessible to labs by interior and weatherdeck hatch(es). Half to include suitable shelving, racks, and tie downs; remainder open hold. Chemical reagent storage in suitable location.

Acoustical Systems: Ship to be acoustically quiet as practical in the choice of all shipboard systems and their location and installation. Design target is underway, conventional and SEABEAM Swath echo sounding in sea state 4 and acoustical dynamic positioning through sea state 5.

Ship to have conventional 12 kHz, 3.5 kHz echo sounding systems and provision for additional systems, including:

-Phased array, multibeam Swath sonar system (equivalent to "Sea Beam") for guiding seafloor sampling/photography for and deep tow geophysical profiling studies; and for limited bathymetric charting;
-Acoustic Doppler current profiler; forward-looking submarine search-type sonar for mid-water trawl net guidance;
-Hull-mounted transducers appropriate for dynamic positioning using seafloor transponders;
-Transducer wells one located forward and one aft. Pressurized sea chests to be located at optimum acoustic locations for at-sea installation and servicing of transducers and transponders.

Navigation/ Communi-cations: Global Positioning System (GPS) with appropriate interfaces to data systems and ship control processors for automatic computer steering and speed control.

Dynamic Positioning Systems with both absolute and relative positioning parameters using both GPS and seafloor acoustic navigation transponders.

Internal Communi-cations: Internal communication system providing high-quality voice communications throughout all science spaces and working areas.

Data transmission, monitoring, and recording system available throughout science spaces including vans and key working areas.

Closed-circuit television monitoring of working areas.

Monitors for all ship control, environmental parameters, science and overside equipment performance to be available in all, or most, science spaces.

External Communi-cations: Reliable voice channel for continuous communications to shore stations (including home laboratories), other ships, boats, and aircraft. This includes satellite, VHF, and UHF.

Overside Handling:	Various frames and other handling gear to accommodate wire, cable and free-launched arrays. Maximum hoist capacity 30,000 lbs. Matched to work with winch and crane locations but able to be relocated as necessary. Stern A-frame to have 15-ft minimum horizontal 25-ft vertical clearance, 12-ft inboard and outboard reaches. Capability to carry additional overside handling rigs along working decks from bow to stern. Control station(s) to give operator protection and operations monitoring and be located to provide maximum visibility of overside work.
Towing:	Capable of towing large scientific packages up to 10,000 lbs horizontal tension at 6 knots, and 25,000 lbs at 2.5 knots.
Laboratories:	Approximately 2000 sq ft of laboratory space including: Main lab area (1000 sq ft) flexible for frequent subdivision providing smaller specialized labs; Hydro lab (200 sq ft) and Wet lab (200 sq ft) both located contiguous to sampling areas; Electronics/Computer lab and associated users space (400 sq ft); refrigerator (100 sq ft), and freezer (100 sq ft). Labs should be located so that none serve as general passageways. Access between labs should be convenient. Labs to be fabricated using uncontaminated and "clean" materials and constructed to be maintained as such. Furnishings, HVAC, doors, hatches, cable runs, and fittings to be planned for maximum lab cleanliness. Fume hood to be installed permanently in Wet Lab and have provision for temporary installation of fume hoods in Main lab. Cabinetry shall be high-grade laboratory quality including flexibility through the use of unistruts and deck boltdowns. Heating, ventilation, and air conditioning (HVAC) appropriate to laboratories, vans, and other science spaces being served. Laboratories shall maintain temperature of 70-75° F, 50% relative humidity, and 9-11 air changes per hour. Labs to be furnished with 110V and 220V AC. Uncontaminated sea water supply to most laboratories, vans, and several key deck areas. Compressed air supply to be clean and oil-free.
Vans:	To carry two standardized 8 ft by 20 ft portable deck vans which may be laboratory, berthing, storage, or other specialized use. Hookup provision for power, fresh water, uncontaminated sea water, compressed air, drains, communications, data and shipboard monitoring systems. Vans should have direct access to ship interior but located in wave sheltered spaces.
Workboats:	One 17-ft inflatable (or semi-rigid) boat located for ease of launching and recovery.

Station-keeping:	Maintain station and work in sea state up through 5. Dynamic positioning both relative and absolute in 35-knot wind, sea state 5, and 2-knot current in depths to 6,000 m using GPS and bottom transponders; maximum excursion ± 150 ft.
Ice Strengthening:	None: not intended for work in ice.
Deck Working Area:	Spacious stern working area: 2,500 sq ft minimum with contiguous waist work area along one side 18 x 80 ft minimum. Provide for itinerant (disposable) deck loading up to 1,200 lbs/sq ft and an aggregate total of 50 tons. One-inch bolt-down fittings on 2-ft centers grid pattern to provide accommodation for portable equipment. All working decks accessible for power, water, air, and data and voice communication ports.
Centerwell:	Approximately 15 ft x 30 ft centerwell accessible from working deck and interior deck.
Cranes:	A suite of modern cranes to handle heavier and larger equipment than at present; (1) to reach working deck areas and offload vans and heavy equipment to 20,000 lbs; (2) articulated to work close to deck and water surface; (3) to handle overside loads up to 5,000 lbs, 20 ft from side and up to 10,000 lbs closer to side; (4) usable as overside cable fairleads for towing at sea. Ship capable of carrying portable cranes for specialized purposes.
Winches:	Oceanographic winch systems providing fine control (0.5 m/min); constant tensioning. Wire monitoring systems with inputs to laboratory panels and shipboard recording systems. Local and remote controls. Permanently installed general-purpose winches include: - Two hydrographic-type winches capable of handling 30,000 ft of wire rope or electromechanical cable having diameters from 3/8" to 1/4". - A winch complex capable of handling 30,000 ft of 1/2" wire/ synthetic fiber rope; or 30,000 ft of 0.68" electromechanical cable (up to 10 KVA power transmission) of fiberoptics cable. This is envisioned as one winch with multiple storage drums which could be interchanged. Additional special-purpose winches may be installed temporarily at various locations along working decks. Winch sizes may range up to 20 tons (120 sq ft) and have power demands to 150 hp. Winch control station(s) located for optimum operator visibility with reliable communications to laboratories and ship control stations.

Scientific Mission Requirements for Intermediate General-purpose Oceanographic Research Ship, Small Waterplane Area Twin Hull (SWATH)

February 1988

General: The ship is to serve as an intermediate-size, general-purpose research ship. The overriding required characteristic is that the ship provide the most stable environment possible in order to allow both overside and laboratory work to proceed in greater capacity and in higher sea states than is now possible. Other general requirements are for large scientific parties and greater flexibility in use of laboratory/deck spaces than is now available aboard intermediate-size ships.

Size: It is intended that this SWATH ship have a general capability equivalent to an existing monohull research vessel of between 180-200 ft LOA. Available information indicates that such a SWATH vessel would be approximately 150 ft LOA and about 800 tons displacement.

The ship should have, or be capable of deballasting to, a harbor draft of not more than 16 ft.

Endurance: Thirty days; providing the ability to transit 15 days at cruising speed and 15 days station work (see stationkeeping and towing); 6,000 mile total range.

Accommodations: Twenty scientific personnel in two-person staterooms. Expandable to 24 through the use of van(s). Science Library-Lounge with conference room capability. 10-12 crew persons.

Speed: 12 knots cruising sustainable through sea state 4. Maximum speed 14 knots. Speed control ± 0.1 knot in 0-6 knot range; and ± 0.2 knot in range 6-14 knots.

Seakeeping: Maintain science operations in following speeds and sea states:

12 knots cruising through sea state 4
10 knots cruising through sea state 5
6 knots cruising through sea state 6

To provide exceptionally stable seakeeping capabilities. Design targets for at rest condition in the following sea states are:

	Sea State (Sig. Wave Height) SS-4 (6.9 ft)	SS-5 (12 ft)
Pitch (ampl)	3.0 degrees	4.0 degrees
Roll (ampl)	3.5 degrees	4.5 degrees
Heave (ampl)	2.2 ft	4.0 ft
Vert. Accel.	0.06 g	0.09 g
Horiz. Accel.	0.06 g	0.11 g

Monitors for all ship control, environmental parameters, science and overside equipment performance to be available in all, or most, science spaces.

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

Facsimile communications to transmit high-speed graphics and hard-copy text on regular schedules.

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

Satellite Monitoring: Carry transponding and receiving equipment including antenna to interrogate and receive satellite readouts of environmental remote sensing.

Ship Control: Chief requirement is maximum visibility of deck work areas during science operations and especially during deployment and retrieval of equipment. This would envision a bridge-pilot house very nearly amidship with television monitors as well as direct unobstructed stern visibility. Portable hand-held control units could also be used at various after-deck locations during overside equipment handling.

The functions, communications, and layout of the ship control station should be carefully designed to enhance the interaction of ship and science operations. For example, ship course, speed, attitude, and positioning will often be integrated with scientific operations requiring control to be exercised by computer from a laboratory or working deck area. Also a collision avoidance system should be provided to help ensure safe, remote computer-controlled operations in traffic congested waters.

Sea State		*Height*	
	Description	*Feet*	*Meters*
0	Calm-glassy	0	0
1	Calm-rippled	0 to 0.5	0 to 0.1
2	Smooth-wavelets	0.5 to 1.5	0.1 to 0.5
3	Slight	1.5 to 4	0.5 to 1.25
4	Moderate	4 to 8	1.25 to 2.5
5	Rough	8 to 13	2.5 to 4
6	Very rough	13 to 20	4 to 6
7	High	20 to 30	6 to 9
8	Very high	30 to 45	9 to 14
9	Phenomenal	Over 45	Over 14

Capability to carry and deploy scientific work boat 25-30 ft LOA specially fitted out for supplemental operations at sea including data/sample collecting, instrumentation, and wide angle seismic measurement. Boat to have 12-hour endurance including both manned and automated operation. "Clean" construction. To be accommodated as a one of two-vans option above.

Science storage: Total of 10,000 cubic ft of scientific storage accessible to labs by interior and weatherdeck hatch(es) and elevators. Half to include suitable shelving, racks, and tie downs; remainder open hold.

Acoustical Systems: Ship to be as acoustically quiet as practicable in the choice of all shipboard systems and their location and installation. Design target is underway, conventional and Sea Beam SWATH echo sounding in Sea State 4 and acoustical dynamic positioning through sea state 5.

Ship to have conventional 1kHz, 3.5 kHz echo sounding systems and provision for additional systems, including:

- Phased array, multibeam SWATH sonar system (equivalent to "Sea Beam") for guiding seafloor sampling/photography for and deep tow geophysical profiling studies; and for limited bathymetric charting.

- Forward-looking submarine search-type sonar for mid-water trawl net guidance.

- Hull-mounted transducers appropriate for dynamic positioning using seafloor transponders.

- Transducer wells: one located forward and one aft. Large pressurized sea chest (3 ft x 6 ft) to be located at optimum acoustic location for at-sea installation and servicing of transducers and transponders.

Navigation/ Communi-cations: Global Positioning System (GPS) with appropriate interfaces to data systems and ship control processors for automatic computer steering and speed control.

Selected vessels should be equipped with "dynamic positioning" capability to maintain the ship on station or on a trackline to the stationkeeping specifications under automatic control and appropriate navigational reference.

Internal Communi-cations: Internal communication system providing high-quality voice communications throughout all science spaces and working areas.

Data transmission, monitoring, and recording system available throughout science spaces including vans and key working areas.

Closed-circuit television monitoring and recording of working areas.

Towing: Capable of towing large scientific packages up to 10,000 lbs tension at 6 knots, and 25,000 lbs at 2.5 knots.

Laboratories: Approximately 2,000 sq ft of laboratory space including: Main Lab area (1,000 sq ft) flexible for frequent subdivision providing smaller specialized labs; Hydro lab (200 sq ft) and Wet lab (200 sq ft) both located contiguous to sampling areas; Electronics/Computer lab and associated users space (300 sq ft); climate controlled chamber (100 sq ft), and freezer (100 sq ft).

Labs should be located so that none serve as general passageways. Access between labs should be convenient.

Labs to be fabricated using uncontaminated and "clean" materials and constructed to be maintained as such. Furnishings, HVAC, doors, hatches, cable runs, and fittings to be planned for maximum lab cleanliness.

Fume hoods to be installed permanently in Wet lab and Analytical lab. Main lab shall have provision for temporary installation of fume hoods.

Cabinetry shall be high grade laboratory quality including flexibility through the use of unistruts and deck boltdowns.

Heating, ventilation, and air conditioning (HVAC) appropriate to laboratories, vans, and other science spaces being served. Laboratories shall maintain temperature of 70-75° F, 50% relative humidity, and 9-11 air changes per hour. Filtered air provided to Analytical lab. Each lab area to have a separate electrical circuit on a clean bus with continuous delivery capability of at least 40-volt amperes per square foot of lab deck area. Labs to be furnished with 110 v and 220 v AC. Total estimated laboratory power demand is 75 KVA. Uncontaminated sea water supply to most laboratories, vans, and several key deck areas. Compressed air supply to be clean and oil-free.

Vans: To carry two (2) standardized 8 ft by 20 ft portable deck vans which may be laboratory, berthing, storage, or other specialized use. Hookup provision for power, HVAC, fresh water, uncontaminated sea water, compressed air, drains, communications, data and shipboard monitoring systems. Van should have direct access to ship interior but located in wave sheltered spaces.

Capability to carry up to two (2) additional portable non-standard vans (500 sq ft total) on superstructure and working decks. Supporting connections at several locations around ship including foredeck.

Ship should be capable of loading and offloading vans using own cranes.

Workboats: At least one (1) 16-ft inflatable (or semi-rigid) boat located for ease of launching and recovery.

Usable clear foredeck area to accommodate specialized towers and booms extending beyond bow wave.

All working decks accessible for power, water, air, and data and voice communication ports.

Cranes: A suite of modern cranes to handle heavier and larger equipment than at present: (1) to reach all working deck areas and offload vans and heavy equipment up to 20,000 lbs; (2) articulated to work close to deck and water surface; (3) to handle overside loads up to 5,000 lbs, 30 ft from side and up to 10,000 lbs closer to side; (4) overside cranes to have servo controls and motion compensation; (5) usable as overside cable fairleads for towing at sea.

Ship capable of carrying portable cranes for specialized purposes.

Winches: New generation of oceanographic winch systems providing fine control (0.5 m/min); constant tensioning and constant parameter. Wire monitoring systems with inputs to laboratory panels and shipboard recording systems. Local and remote controls.

Permanently installed general-purpose winches include:

- Two hydrographic-type winches capable of handling 30,000 ft of wire rope or electromechanical cables having diameters from 1/4" to 3/8".

- A heavy winch complex capable of handling 40,000 ft of 9/16" wire/synthetic fibre rope; or 30,000 ft of 0.68" electromechanical cable (up to 10 KVA power transmission) or fiber optics cable. This is envisioned as one winch with multiple storage drums which could be interchanged.

Additional special-purpose winches may be installed temporarily at various locations along working decks. Winch sizes may range up to 30 tons (140 sq ft) and have power demands to 300 hp.

Winch control station(s) located for optimum operator visibility with reliable communications to laboratories and ship control stations.

Overside Handling: Various frames and other handling gear to accommodate wire, cable and free launched arrays. Maximum hoist capacity 30,000 lbs. Matched to work with winch and crane locations but able to be relocated as necessary.

Stern A-frame to have 15-ft minimum horizontal and 25-ft vertical clearance; 12-ft inboard and outboard reaches.

Capability for articulated stern ramp, providing variable configuration ranging from a flush deck to a waterline platform.

Capability to carry additional overside handling rigs along working decks from bow to stern.

Control station(s) to give operator protection and operations monitoring and be located to provide maximum visibility of overside work.

Scientific Mission Requirements for an Intermediate General-purpose Oceanographic Research Ship

March 1989

General:	The ship is to serve as a general-purpose research ship. The primary requirement is a maximum capability commensurate with ship size to support science and engineering operations in all oceans in terms of improved over-side equipment handling, station keeping, towing, and to provide a stable laboratory environment for precision measurements. Other general requirements are for large scientific parties and greater flexibility in use of laboratory/deck spaces than is now available aboard intermediate-size ships.
Size:	The size ultimately is determined by the requirements. However, it is intended that this is to be a class ship to replace the current university research ships having such capabilities as the OCEANUS class (177 ft LOA; 33 ft BEAM; 1015 tons DISP).
Endurance:	Thirty days; providing the ability to transit 15 days at cruising speed and 15 days station work (see station keeping and towing); 8,000 mile total range.
Accommo-dations:	15-20 scientific personnel in two-person staterooms. Expandable to 25 through the use of vans. Science Library-Lounge with conference room capability. Science office.
Speed:	14 knots cruising; 12 knots sustainable through sea state 4. Maximum speed 15 knots. Speed control ± 0.1 knot in 0-6 knot range; and ± 0.2 knot in range 6-14 knots.
Seakeeping:	Maintain science operations in following speeds and sea states: 12 knots cruising through sea state 4 10 knots cruising through sea state 5 6 knots cruising through sea state 6
Station Keeping:	Maintain station and work in sea states up through 5. Dynamic positioning both relative and absolute in 35-knot wind, sea state 5, and 3-knot current in depths to 6,000 m using GPS and bottom transponders. Maximum excursion ± 150 ft.
Ice Strength-ening:	Ability to transit loose pack (3/10 cover Class 1c). Not intended for icebreaking or close pack work.
Deck Working Area:	Spacious stern working area - 1,500 sq ft minimum with contiguous waist work area along one side 8 x 80 ft minimum to allow piston coring. Provide for deck loading up to 1,200 lbs/sq ft and an aggregate total of 60 tons. Heavy-duty holddowns on 2-ft centers. Highly flexible to accommodate large and heavy equipment. Removable bulwarks. Dry working deck but not greater than 6-8 ft above waterline.

Sea State	*Description*	*Height*	
		Feet	*Meters*
0----------	Calm-glassy	0	0
1----------	Calm-rippled	0 to 0.5	0 to 0.1
2----------	Smooth-wavelets	0.5 to 1.5	0.1 to 0.5
3----------	Slight	1.5 to 4	0.5 to 1.25
4----------	Moderate	4 to 8	1.25 to 2.5
5----------	Rough	8 to 13	2.5 to 4
6----------	Very rough	13 to 20	4 to 6
7----------	High	20 to 30	6 to 9
8----------	Very high	30 to 45	9 to 14
9----------	Phenomenal	Over 45	Over 14

	Selected vessels should be equipped with "dynamic positioning" capability to maintain the ship on station or on a trackline to the stationkeeping specifications under automatic control and appropriate navigational reference.
Internal Communi-cations:	Internal communication system providing high-quality voice communications throughout all science spaces and working areas.
	Data transmission, monitoring, and recording system available throughout science spaces including vans and key working areas.
	Closed-circuit television monitoring and recording of all working areas including subsurface performance of equipment and its handling.
	Monitors for all ship control, environmental parameters, science and overside equipment performance to be available in all, or most, science spaces.
External communi-cations:	Reliable voice channels for continuous communications to shore stations (including home laboratories), other ships, board, and aircraft. This includes satellite, VHF, and UHF.
	Facsimile communications to transmit high-speed graphics and hard-copy text on regular schedules.
	High-speed data communications (56 K Baud) links to shore labs and other ships on a continuous basis.
Satellite Monitoring:	Carry transponding and receiving equipment including antenna to interrogate and receive satellite readouts of environmental remote sensing.
Ship Control:	Chief requirement is maximum visibility of deck work areas during science operations and especially during deployment and retrieval of equipment. This would envision a bridge-pilot house with unobstructed stern visibility.
	The functions, communications, and layout of the ship control station should be carefully designed to enhance the interaction of ship and science operations. For example, ship course, speed, altitude, and positioning will often be integrated with scientific operations requiring control to be exercised from a laboratory area.

Vans:	To carry four standardized 8 ft by 20 ft portable vans which may be laboratory, berthing, storage, or other specialized use. Hookup provision for power, HVAC, fresh water uncontaminated sea water, compressed air, drains, communications, data and shipboard monitoring systems. Van access direct to ship interior. Provision to carry up to four additional portable non-standard vans (600 sq ft total) on superstructure and working decks. Supporting connections at several locations around ship including foredeck. Ship should be capable of loading and offloading vans using own cranes.
Workboats:	At least one and preferably two 16-ft inflatable (or semi-rigid) boats located for ease of launching and recovery. A scientific work boat 25-30 ft LOA specially fitted out for supplemental operations at sea including collecting, instrumentation, and wide angle signal measurements. 12-hour endurance including both manned accommodations and automated operation. "Clean" construction. To be carried as a one of four-van options above.
Science storage:	Total of 15,000 cubic ft of scientific storage accessible to labs by elevator and weatherdeck hatch(es). Half to include suitable shelving, racks, and tie downs; remainder open hold.
Acoustical Systems:	Ship to be as acoustically quiet as practicable in the choice of all shipboard systems and their location and installation. Design target is operationally quiet noise levels at 12 knots cruising in sea state 5 at the following frequency ranges: • 4 hz - 500 hz seismic • 3 kHz - 50 kHz echo sounding and acoustic navigation • 75 kHz - 300 kHz Doppler Current profiling Ship to have 12 kHz, 3.5 kHz echo sounding systems and provision for additional systems. Phased array, multibeam precision echo sounding system (equivalent to "Sea Beam") Transducers appropriate to dynamic positioning system. Transducer wells (20") located forward and aft. Large pressurized sea chest (4 ft x 8 ft) to be located at optimum acoustic location for at-sea installation and servicing of transducers and transponders.
Multichannel Seismics:	All vessels shall have the capibility to carry out multichannel seismic profiling (MCS) surveys using large sound sources (airguns) and long streamers (3-6 km).
Navigation/ Positioning	Global Positioning System (GPS) with appropriate interfaces to data systems and ship control processors for automatic computer steering and speed control.

Portable shelters available to winch work areas for instrument adjustments and repairs. Winch control station(s) located for optimum operator visibility with reliable communications to laboratories and ship control stations.

Overside Handling: Various frames and other handling gear to accommodate wire cable and free launched arrays. Matched to work with winch and crane locations but able to be relocated as necessary.

Stern A-frame to have 20-ft minimum horizontal and 30-ft vertical clearance; 15-ft inboard and outboard reaches.

Provision to carry additional overside handling rigs along working decks from bow to stern.

Control station(s) to give operator protection and operations monitoring and be located to provide maximum visibility of overside work.

Towing: Capable of towing large scientific packages up to 10,000 lbs tension at 6 knots and 25,000 lbs at 2.5 knots.

Laboratories: Approximately 3,000 sq ft of laboratory space including: Main lab area (1,500 sq ft) flexible for frequent subdivision providing smaller specialized labs; Hydro lab (200 sq ft) and Wet lab (300 sq ft) both located contiguous to sampling areas; Bio-Chem Analytical lab (200 sq ft); Electronics/Computer lab and associated users space (500 sq ft); Darkroom (100 sq ft); climate controlled chamber (100 sq ft), and freezer (100 sq ft).

Labs should be located so that none serve as general passageways. Access between labs should be convenient. Labs, offices, and storage to be served by a man-rated elevator having clear inside dimensions of approximately 3 ft by 4 ft.

Labs to be fabricated using uncontaminated and "clean" materials and constructed to be maintained as such. Furnishings, HVAC, doors, hatches, cable runs, and fittings to be planned for maximum lab cleanliness.

Fume hoods to be installed permanently in Wet lab and Analytical lab. Main lab shall have provision for temporary installation of fume hoods.

Cabinetry shall be high-grade laboratory quality including flexibility through the use of unistruts and deck boltdowns.

Heating, ventilation, and air conditioning (HVAC) appropriate to laboratories, vans, and other science spaces being served. Laboratories shall maintain temperature of 70-75° F, 50% relative humidity, and 9-11 air changes per hour. Filtered air provided to Analytical lab. Each lab area to have a separate electrical circuit on a clean bus with continuous delivery capability of at least 40-volt amperes per square foot of lab deck area. Labs to be furnished with 110 v and 220 v AC. Total estimated laboratory power demand is 100 KVA. Uncontaminated sea water supply to most laboratories, vans, and several key deck areas. Compressed air supply to be clean and oil-free.

Maintain a precision trackline while towing at speeds as low as 0.5 kts with a heading deviation up to 45° from the prescribed trackline using GPS or bottom navigation as reference. (See navigation and positioning.) Speed control along track should be maintained ± 0.1 knot (averaged over one-minute intervals).

Trackline requirements should be met 95% of time considering range of sea states specified.

Ice Strengthening: None. Not intended for icebreaking or work in pack ice.

Deck Working Area: Spacious; 4,000 sq ft minimum with work areas along all sides; bow and stern; and center well. Provide for deck loading up to 1,500 lbs/sq ft and an aggregate total of 100 tons.

Oversize holddowns on 2-ft centers. Highly flexible to accommodate large and heavy equipment. Removable bulwarks and/or railings.

All working decks accessible for power, water, air, and data and voice communication ports.

Centerwell: Approximately 15 ft x 30 ft centerwell accessible form working deck and interior deck.

Cranes: A suite of modern cranes to handle heavier and larger equipment than at present: (1) to reach all working deck areas and offload vans and heavy equipment up to 20,000 lbs; (2) articulated to work close to deck and water surface; (3) to handle overside loads up to 5,000 lbs, 30 ft from side and up to 10,000 lbs closer to side; (4) overside cranes to have servo controls and motion compensation; (5) usable as overside cable fairleads at sea.

Ship capable of carrying portable cranes for specialized purposes.

Winches: New generation of oceanographic winch systems providing fine control (0.5 m/min); constant tensioning and constant parameter. Wire monitoring systems with inputs to laboratory panels and shipboard recording system. Local and remote controls.

Permanently installed general-purpose winches include:

- Two winches capable of handling 30,000 ft of wire rope or electromechanical cables having diameters from 1/4" to 3/8".

- A winch complex capable of handling 40,000 ft of 9/16" trawling or coring wire and 30,000 ft of 0.68" electromechanical cable (up to 10 KVA power transmission and fiber optics). This could be two separate winches or one winch with two storage drums.

Additional special-purpose winches may be installed temporarily at various locations along working decks. Winch sizes may range up to 40 tons (140 sq ft) and have power demands to 300 hp.

Scientific Mission Requirements for Large High-performance, General-purpose Oceanographic Research Ship, Small Waterplane Area Twin Hull (SWATH)

November 1989

General: The ship is to serve as a large general-purpose research ship. The overriding required characteristic is that the ship provide the most stable environment possible in order to allow both overside and laboratory work to proceed in greater capacity and in higher sea states than is now possible. Other general requirements are larger scientific parties, reliability, flexibility, cleanliness, vibration- and noise-free, and an overall upgrading of quality for doing science and engineering at sea.

Size: The size ultimately is determined by the requirements.

Endurance: Fifty days; providing the ability to transit 24 days at cruising speed and 24 days station work (see station keeping and towing); 10,000 mile total range.

Accommodations: 30 scientific personnel in two-person staterooms. Expandable to 40 under reduced endurance conditions, through the use of vans. Science library-lounge with conference capability. Science office.

Speed: 13 knots cruising; sustainable in sea state 6. Speed control ± 0.1 knot in 0-6 knot range; and ± 0.2 knot in range 6-15 knots.

Maintain science operations in following speeds and sea states:

15 knots cruising through sea state 6
10 knots cruising through sea state 7

Seakeeping: To provide exceptionally stable seakeeping capabilities. Design targets for at-rest condition in the following sea states are:

	Sea State (Sig. Wave Height)	
	SS-4 (6.9 ft)	SS-5 (12 ft)
Pitch (ampl)	2.0 degrees	3.0 degrees
Roll (ampl)	2.5 degrees	4.0 degrees
Heave (ampl)	1.7 ft	3.0 ft
Vert. Accel.	0.06 g	0.09 g
Horiz. Accel.	0.06 g	0.11 g

Station Keeping: Allow normal station and deck work through SS 6 and limited work through SS 7.

Maneuverability that would assure relative positioning at best heading in 30-knot winds and SS 5 and 1 1/2-kt current ± 150 ft maximum excursion from a point or trackline, and maintain ± 5 degree heading.

Sea State	*Description*	*Height*	
		Feet	*Meters*
0----------	Calm-glassy	0	0
1----------	Calm-rippled	0 to 0.5	0 to 0.1
2----------	Smooth-wavelets	0.5 to 1.5	0.1 to 0.5
3----------	Slight	1.5 to 4	0.5 to 1.25
4----------	Moderate	4 to 8	1.25 to 2.5
5----------	Rough	8 to 13	2.5 to 4
6----------	Very rough	13 to 20	4 to 6
7----------	High	20 to 30	6 to 9
8----------	Very high	30 to 45	9 to 14
9----------	Phenomenal	Over 45	Over 14

Selected vessels shall have compressors capable of generating 2000 SCFM of air at 2500 psi permanently installed. The compressors and assciated high-pressure plumbing should be installed in or adjoining below-deck machinery spaces.

Refer to the appendix on special characteristics of equipment and capabilities for geological and geophysical investigations.

Navigation/ Positioning: Global positioning System (GPS) with appropriate interfaces to data systems and ship control processors.

Selected vessels should be equipped with "dynamic positioning" capability to maintain the ship on station or on a trackline to the stationkeeping specifications under automatic control and appropriate navigational reference.

Internal Communi-cations: Internal communication system providing high-quality voice communications throughout all science spaces and working areas.

Data transmission, monitoring, and recording system available throughout science spaces including vans and key working areas.

Closed-circuit television monitoring and recording of all working areas including subsurface performance of equipment and its handling.

Monitors for all ship control, environmental parameters, science and overside equipment performance to be available in all, or most, science spaces.

External communi-cations: Reliable voice channels for continuous communications to shore stations (including home laboratories), other ships, boats, and aircraft. This includes satellite, VHF, and UHF.

Facsimile communications to transmit high-speed graphics and hard-copy text on regular schedules.

High-speed data communications (56 K Baud) links to shore labs and other ships on a continuous basis.

Satellite Monitoring: Carry transponding and receiving equipment including antenna to interrogate and receive satellite readouts of environmental remote sensing.

Ship Control: Chief requirement is maximum visibility of deck work areas during science operations and especially during deployment and retrieval of equipment. This would envision a bridge-pilot house very nearly amidship and with unobstructed stern visibility.

The functions, communications, and layout of the ship control station should be carefully designed to enhance the interaction of ship and science operations. For example, ship course, speed, attitude, and positioning will often be integrated with scientific operations requirement control to be exercised from a laboratory area.

Vans: To carry two standardized 8 ft by 20 ft portable vans which may be laboratory, berthing, storage, or other specialized use. Hookup provision for power, HVAC, freshwater uncontaminated sea water, compressed air, drains, communications, data and shipboard monitoring systems. Van access direct to ship interior.

Provision to carry up to three additional portable non-standard vans (500 sq ft total) on superstructure and working decks. Supporting connections at several locations around ship including foredeck.

Ship should be capable of loading and offloading vans using own cranes.

Workboats: At least one and preferably two 16-ft inflatable (or semi-rigid) boats located for ease of launching and recovery.

A scientific work boat 25-30 ft LOA specially fitted out for supplemental operations at sea including collecting, instrumentation, and wide angle signal measurement. 12-hour endurance including both manned accommodations and automated operation. "Clean" construction. To be carried as a one of two-van options above.

Science storage: Total of 15,000 cubic ft of scientific storage accessible to labs by interior and weatherdeck hatch(es). Half to include suitable shelving, racks, and tie downs; remainder open hold.

Acoustical Systems: Ship to be as acoustically quiet as practicable in the choice of all shipboard systems and their location and installation. Design target is operationally quiet noise levels at 12 knots cruising in sea state 5 at the following frequency ranges:

- 4 hz - 500 hz seismic
- 3 kHz - 50 kHz echo sounding and acoustic navigation
- 75 kHz - 300 kHz Doppler Current profiling

Ship to have 12 kHz, 3.5 kHz echo sounding systems and provision for additional systems.

Phased array, multibeam precision echo sounding system (equivalent to "Sea Beam").

Transducers appropriate to dynamic positioning system.

Transducer wells (20") one located forward and one aft. Large pressurized sea chest (4 ft x 8 ft) to be located at optimum acoustic location for at-sea installation and servicing of transducers and transponders.

Multichannel Seismic: All vessels shall have the capability to carry out multichannel seismic profiling (MCS) surveys using large sound sources (airguns) and long streamers (3-6 km).

Overside Handling: Various frames and other handling gear to accommodate wire, cable and free launched arrays. Matched to work with winch and crane locations but able to be relocated as necessary. Stern A-frame to have 15-ft minimum horizontal and 25-ft vertical clearance; 12-ft inboard and outboard reaches; safe working loads up to 40 tons.

Able to handle, deploy and retrieve very long, large-diameter piston corer up to 50 m length, 15 tons weight and 60 tons pullout tension.

Provision to carry additional overside handling rigs along working decks from bow to stern. (See also "Multichannel Seismics")

Control station(s) to give operator protection and operations monitoring and be located to provide maximum visibility of overside work.

Towing: Capable of towing large scientific packages up to 10,000 lb. tension at 6 knots, and 25,000 lbs at 2.5 knots in sea state 5, 35-knot wind, and 3-knot current.

Laboratories: Approximately 3,000 sq ft of laboratory space including: Main Lab area (1,400 sq ft) flexible for frequent subdivision providing smaller specialized labs; Hydro lab (300 sq ft) and Wet lab (300 sq ft) both located contiguous to sampling areas; Bio-Chem Analytical lab (300 sq ft); Electronics/Computer lab and associated users space (500 sq ft); climate controlled chamber (100 sq ft); and freezer (100 sq ft).

Labs should be located so that none serve as general passageways. Access between labs should be convenient.

Labs to be fabricated using uncontaminated and "clean" materials and constructed to be maintained as such. Furnishings, HVAC, doors, hatches, cable runs, and fittings to be planned for maximum lab cleanliness.

Fume hoods to be installed permanently in Wet lab and Analytical lab. Main lab shall have provision for temporary installation of fume hoods.

Cabinetry shall be high-grade laboratory quality including flexibility through the use of unistruts and deck boltdowns.

Heating, ventilation, and air conditioning (HVAC) appropriate to laboratories, vans, and other science spaces being served. Laboratories shall maintain temperature of 70-75° F, 50% relative humidity, and 9-11 air changes per hour. Filtered air provided to Analytical lab. Each lab area to have a separate electrical circuit on a clean bus with continuous delivery capability of at least 40-volt amperes per square foot of lab deck area. Labs to be furnished with 110 v and 220 v AC. Total estimated laboratory power demand is 75 KVA. Uncontaminated sea water supply to most laboratories, vans, and several key deck areas. Compressed air supply to be clean and oil-free.

Trackline requirements should be met 95% of time considering range of sea states specified.

Ice Strengthening: ABS Classification 1C. Able to transit very loose pack. Not intended for icebreaking or close pack work.

Deck Working Area: Spacious fantail area - 2,000 sq ft minimum with contiguous waist work area along one side 12 x 40 ft minimum. Provide for deck loading up to 1,200 lbs/sq ft and an aggregate total of 90 tons.

Oversize holddowns on 2-ft centers. Highly flexible to accommodate large and heavy equipment. Removable bulwarks. Dry working deck but not greater than 6-8 ft above waterline.

Usable clear foredeck area to accommodate specialized towers and booms extending beyond bow wave.

All working decks accessible for power, water, air, and data and voice communication ports.

Cranes: A suite of modern cranes to handle heavier and larger equipment than at present: (1) to reach all working deck areas and offload vans and heavy equipment up to 20,000 lbs; (2) articulated to work close to deck and water surface; (3) to handle overside loads up to 5,000 lbs, 30 ft from side and up to 10,000 lbs closer to side; (4) overside cranes to have servo controls and motion compensation; (5) usable as overside cable fairleads at sea.

Ship to be capable of carrying portable cranes for specialized purposes such as deploying and towing side scanning sonars, photo and video devices, remotely operated vehicles (ROV's), and paravaned MCS air gun arrays.

Winches: New generation of oceanographic winch systems providing fine control (0.5 m/min); constant tensioning and constant parameter. Wire monitoring systems with inputs to laboratory panels an shipboard recording systems. Local and remote controls.

Permanently installed general-purpose winches include:

- Two winches capable of handling 30,000 ft of wire rope or electromechanical cables having diameters from 1/4" to 3/8".

- A winch complex capable of handling 40,000 ft of 9/16" trawling or coring wire and 30,000 ft of 0.68" electromechanical cable (up to 10 KVA power transmission and fiber optics). This could be two separate winches or one winch with two storage drums.

Additional special-purpose winches may be installed temporarily at various locations along working decks. Winch sizes may range up to 40 tons (140 sq ft) and have power demands to 300 hp. (See also "Multichannel Seismics")

Winch control station(s) located for optimum operator visibility with reliable communications to laboratories and ship control stations.

Scientific Mission Requirements for Large Medium-endurance, General-purpose Oceanographic Research Ship

March 1989

General: The ship is to serve as a medium to large general-purpose research ship. The primary requirement is a maximum capability commensurate with ship size to support science and engineering operations at sea in terms of overside equipment handling, laboratory qualities, and a clean, vibration-free, and stable environment for precision measurements.

Selected vessels may be designated for additional or enhanced capabilities in a particular field such as Multichannel Seismics Profiling or Submersible Handling. Any added performance requirement, however, shall not reduce or supplant the general-purpose performance requirements.

Size: The size ultimately is determined by the requirements. However, it is intended that this is a class ship to be a direct replacement of the current large university research ships such as the AGOR-3 Class (210 ft LOA).

Endurance: Fifty days; providing the ability to transit 24 days at cruising speed and 24 days station work (see stationkeeping and towing); 12,000 mile range at cruising speed.

Accommodations: 20-25 scientific personnel in two-person staterooms. Expandable to 30 through the use of vans. Science library-lounge with conference capability. Science office.

Speed: 14 knots cruising; sustainable through sea state 4. Speed control ± 0.1 knot in 0-6 knot range; and ± 0.2 knot in range 6-14 knots.

Seakeeping: Maintain science operations in following speeds and sea states:

14 knots cruising through sea state 4
12 knots cruising through sea state 5
8 knots cruising through sea state 6
6 knots cruising through sea state 7

Station Keeping: Allow normal station and deck work in sea states through SS 5 and limited work through SS 6.

Maneuverability that would assure relative positioning at best heading in 35-knot winds and SS 5 and 2-kt current ± 150 ft maximum excursion from a point or trackline, and maintain ± 5 degree heading.

Maintain a precision trackline while towing at speeds as low as 0.5 kts with a heading deviation up to 45° from the prescribed trackline using GPS or bottom navigation as reference. (See navigation and positioning.) Speed control along track should be maintained ± 0.1 knot (averaged over one-minute intervals).

Ship Control: Chief requirement is maximum visibility of deck work areas during science operations and especially during deployment and retrieval of equipment. This would envision a bridge-pilot house very nearly amidships and with unobstructed stern visibility.

The functions, communications, and layout of the ship control station should be carefully designed to enhance the interaction of ship and science operations. For example, ship course, speed, attitude, and positioning will often be integrated with scientific operations requiring control to be exercised from a laboratory area.

Sea State		*Height*	
	Description	*Feet*	*Meters*
0----------	Calm-glassy	0	0
1----------	Calm-rippled	0 to 0.5	0 to 0.1
2----------	Smooth-wavelets	0.5 to 1.5	0.1 to 0.5
3----------	Slight	1.5 to 4	0.5 to 1.25
4----------	Moderate	4 to 8	1.25 to 2.5
5----------	Rough	8 to 13	2.5 to 4
6----------	Very rough	13 to 20	4 to 6
7----------	High	20 to 30	6 to 9
8----------	Very high	30 to 45	9 to 14
9----------	Phenomenal	Over 45	Over 14

Transducer wells (20") one located forward and two athwartships. Large pressurized sea chest (4 ft x 8 ft) to be located at optimum acoustic location for at-sea installation and servicing of transducers and transponders.

Multichannel Seismics: All vessels shall have the capability to carry out multichannel seismic profiling (MCS) surveys using large sound sources (airguns) and longstreamers (3-6 km).

Selected vessels shall have compressors capable of generating 2000 SCFM of air at 2500 psi permanently installed. The compressors and associated high-pressure plumbing should be installed in or adjoining below-deck machinery spaces.

Refer to the appendix on special characteristics of equipment and capabilities for geological and geophysical investigations.

Navigation/ Positioning: Global Positioning System (GPS) with appropriate interfaces to data systems and ship control processors.

Short baseline acoustic navigation system.

Selected vessels should be equipped with "dynamic positioning" capability to maintain the ship on station or on a trackline to the stationkeeping specifications under automatic control and appropriate navigational reference.

Internal Communi-cations: Internal communication system providing high-quality voice communications throughout all science spaces and working areas.

Data transmission, monitoring and recording system available throughout science spaces including vans and key working areas.

Closed-circuit television monitoring and recording of all working areas including subsurface performance of equipment and its handling.

Monitors for all ship control, environmental parameters, science and overside equipment performance to be available in all, or most, science spaces.

External Communi-cations: Reliable voice channels for continuous communications to shore stations (including home laboratories), other ships, boats, and aircraft. This includes satellite, VHF, and UHF.

Facsimile communications to transmit high-speed graphics and hard-copy text on regular schedules.

High-speed data communications (56K Baud) links to shore labs and other ships on a continuous basis.

Satellite Monitoring: Carry transponding and receiving equipment including antenna to interrogate and receive satellite readouts of environmental remote sensing.

Heating, ventilation, and air conditioning (HVAC) appropriate to laboratories, vans, and other science spaces being served. Laboratories shall maintain temperature of 70-75° F, 50% relative humidity, and 9-11 air changes per hour. Filtered air provided to Analytical lab. Each lab area to have a separate electrical circuit on a clean but with continuous delivery capability of at least 40-volt amperes per square foot of lab deck area. Labs to be furnished with 110 v and 220 v AC. Total estimated laboratory power demand is 100 KVA.

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

Vans: To carry four standardized 8 ft by 20 ft portable vans which may be laboratory, berthing, storage, or other specialized use. Hookup provision for power, HVAC, fresh water uncontaminated sea water, compressed air, drains, communications, data and shipboard monitoring systems. Van access direct to ship interior.

Provision to carry up to four additional portable non-standard vans (600 sq ft total) on super-structure and working decks. Supporting connections at several locations around ship including foredeck.

Ship should be capable of loading and offloading vans using own cranes.

Workboats: At least one and preferably two 16-ft inflatable (or semi-rigid) boats located for ease of launching and recovery.

A scientific work boat 25 - 30 ft LOA specially fitted out for supplemental operation at sea including collecting, instrumentation, and wide-angle signal measurement. 12-hour endurance including both manned accommodations and automated operation. "Clean" construction. To be carried as a one of four-van options above.

Science Storage: Total of 20,000 cubic ft of scientific storage accessible to labs by elevator and weatherdeck hatch(es). Half to include suitable shelving, racks, and tie downs; remainder open hold.

Acoustical Systems: Ship to be as acoustically quiet as practicable in the choice of all shipboard systems and their location and installation. Design target is operationally quiet noise levels at 12 knots cruising in sea state 5 at the following frequency ranges:

- 4 hz - 500 hz seismic
- 3 kHz - 500 kHz echo sounding and acoustic navigation
- 75 kHz - 300 kHz Doppler Current profiling

Ship to have 12 kHz, 3.5 kHz echo sounding systems and provision for additional systems.

Phased array, very wide multibeam precision echo sounding system (equivalent to "Sea Beam").

Transducers appropriate to dynamic positioning system.

Portable shelters available to winch work areas for instrument adjustments and repairs. Winch control station(s) located for optimum operator visibility with reliable communications to laboratories and ship control stations.

Overside Handling: Various frames and other handling gear and more versatile than present to accommodate wire, cable and free launched arrays. Matched to work with winch and crane locations but able to be relocated as necessary.

Stern A-frame to have 20-ft minimum horizontal and 30-ft vertical clearance; 15-ft inboard and outboard reaches; safe working load up to 60 tons.

Able to handle, deploy and retrieve very long, large-diameter piston corer up to 50 m length, 15 tons weight and 60 tons pullout tension. Variable configurations ranging from a flush deck to a waterline platform.

Provision to carry additional overside handling rigs along working decks from bow to stern. (See also Multichannel Seismics)

Control station(s) to give operator protection and operations monitoring and be located to provide maximum visibility of overside work.

Towing: Capable of towing large scientific packages up to 10,000 lbs tension at 6-knots and 25,000 lbs at 2.5 knots in sea state 5, 35-knot wind, and 3-knot current.

Laboratories: Approximately 4,000 sq ft of laboratory space including: Main Lab area (2,000 sq ft) flexible for frequent subdivision providing smaller specialized labs; Hydro lab (300 sq ft) and Wet lab (400 sq ft) both located contiguous to sampling areas; Bio-Chem Analytical lab (300 sq ft); Electronics/Computer lab and associated users space (600 sq ft); Darkroom (150 sq ft); climate-controlled chamber (100 sq ft), and freezer (100 sq ft).

Labs should be located so that none serve as general passageways. Access between labs should be convenient. Labs, offices, and storage to be served by a man-rated elevator having clear inside dimensions of approximately 3 ft by 4 ft.

Labs to be fabricated using uncontaminated and "clean" materials and constructed to be maintained as such. Furnishings, HVAC, doors, hatches, cable runs, and fittings to be planned for maximum lab cleanliness.

Fume hoods to be installed permanently in Wet lab and Analytical lab. Main lab shall have provision for temporary installation of fume hoods.

Cabinetry shall be high-grade laboratory quality including flexibility through the use of unistruts and deck boltdowns.

Trackline requirements should be met 95% of time considering range of specified sea states.

Ice Strengthening: ABS Ice Classification 1A. Able to transit loose pack. Not intended for icebreaking or close pack work. Protection against encounters with growlers and other glacial ice difficult to detect.

Deck Working Area: Spacious fantail area - 3,000 sq ft minimum with contiguous work area along one side 12 x 50 ft minimum. Provide for deck loading up to 1,500 lbs/sq ft and an aggregate total of 100 tons.

Oversize holddowns on 2-ft centers. Highly flexible to accommodate large and heavy equipment. Removable bulwarks. Dry working deck but not greater than 7-10 ft above waterline.

Usable clear foredeck area to accommodate specialized towers and booms extending beyond bow wave.

All working decks accessible for power, water, air, and data and voice communication ports.

Cranes: A suite of modern cranes to handle heavier and larger equipment than at present: (1) to reach all working deck areas and offload vans and heavy equipment up to 20,000 lbs; (2) articulated to work close to deck and water surface; (3) to handle overside loads up to 5,000 lbs, 30 ft from side and up to 10,000 lbs closer to side; (4) overside cranes to have servo controls and motion compensation; (5) usable as overside cable fairleads at sea.

Ship to be capable of carrying portable cranes for specialized purposes such as deploying and towing side scanning sonars, photo and video devices, remotely operated vehicles (ROV's), and paravaned MCS air gun arrays.

Winches: New generation of oceanographic winch systems providing fine control (0.5 m/min); constant tensioning and constant parameter. Wire monitoring systems with inputs to laboratory panels and shipboard recording systems. Local and remote controls.

Permanently installed general purpose winches include:
- Two winches capable of handling 30,000 ft of wire rope or electromechanical cables having diameters from 1/4" to 3/8".

- A winch complex capable of handling 40,000 ft of 9/16" trawling or coring wire and 30,000 ft of 0.68" electromechanical cable (up to 10 KVA power transmission and fiber optics). This could be two separate winches or one winch with two storage drums.

Additional special purpose winches may be installed temporarily at various locations along working decks. Winch sizes may range up to 40 tons (140 sq ft) and have power demands to 300 hp. (See also Multichannel Seismics)

Scientific Mission Requirements for Large High-endurance, General-purpose Oceanographic Research Ship

March 1989

General: The ship is to serve as a large general-purpose, multi-discipline oceanographic research ship. The primary requirement is for a high-endurance vessel capable of worldwide cruising (except in close pack ice) and able to provide both overside and laboratory work to proceed in greater capacity and in higher sea states than is now available. Other general requirements are larger scientific parties, reliability, flexibility, cleanliness, vibration and noise free, and an overall upgrading of quality for doing science and engineering at sea.

Selected vessels may be designed for additional or enhanced capabilities in a particular field, such as Multichannel Seismics Profiling or Ice Worthiness. Any added performance requirement, however, shall not reduce or supplant the general-purpose performance requirements.

Size: The size ultimately is determined by the requirements. It seems likely that these will result in a vessel larger than present academic ships. However, the LOA should not exceed 300 ft.

Endurance: Sixty days; providing the ability to transit to the most remote area and work 3-4 weeks on station. 15,000 mile range at cruising speed.

Accommodations: 30-35 scientific personnel in two-person staterooms. Expandable to 40 through the use of vans. Science library-lounge with conference capability. Science office.

Speed: 15 knots cruising; sustainable through sea state 4. Speed control ± 0.1 knot in 0-6 knot range; and ± 0.2 knot in range 6-15 knots.

Seakeeping: Maintain science operations in following speeds and sea states:

15 knots cruising through sea state 4
13 knots cruising through sea state 5
8 knots cruising through sea state 6
6 knots cruising through sea state 7

Station Keeping: Allow normal station and deck work in sea states through SS 5 and limited work through SS 7.

Maneuverability that would assure relative positioning at best heading in 35-knot winds and SS 5 and 2 kt current ± 150 ft maximum excursion from a point or trackline, and maintain ± 5 degree heading.

Maintain a precision trackline while towing at speeds as low as 0.5 kts with a heading deviation up to 45° from the prescribed trackline using GPS or bottom navigation as reference. (See navigation and positioning.) Speed control along track should be maintained ± 0.1 knot (averaged over one-minute intervals).

Wind and Sea Scale for Fully Arisen Sea

Sea state	Description	Wind: Beaufort wind force	Wind: Description	Wind: Range, knots	Wind: Wind velocity, knots†	Sea: Wave height, ft: Average	Sea: Wave height, ft: Significant	Sea: Wave height, ft: Average ⅓ highest	Sea: Significant range of periods, sec	Sea: f_{max}, period of maximum energy of spectrum	Sea: $\bar{T}$ average period	Sea: $\bar{L}$ average wavelength	Sea: Minimum fetch, nmi	Sea: Minimum duration, hr	Sea state
0	Sea like a mirror.	0	Calm	Less than 1	0	0	0	0							0
	Ripples with the appearance of scales are formed, but without foam crests.	1	Light airs	1–3	2	0.05	0.08	0.10	Up to 1.2 sec	0.7	0.5	.10 in.	5	18 min	
1	Small wavelets, still short but more pronounced; crests have a glassy appearance, but do not break.	2	Light breeze	4–6	5	0.18	0.29	0.37	0.4–2.8	2.0	1.4	6.7 ft	8	39 min	1
	Large wavelets, crests begin to break. Foam of glassy appearance. Perhaps scattered white horses.	3	Gentle breeze	7–10	8.5	0.6	1.0	1.2	0.8–5.0	3.4	2.4	20	9.8	1.7 hr	
2					10	0.88	1.4	1.8	1.0–6.0	4	2.9	27	10	2.4	2
					12	1.4	2.2	2.8	1.0–7.0	4.8	3.4	40	18	3.8	
	Small waves, becoming larger; fairly frequent white horses.	4	Moderate breeze	11–16	13.5	1.8	2.9	3.7	1.4–7.6	5.4	3.9	52	24	4.8	
3					14	2.0	3.3	4.2	1.5–7.8	5.6	4.0	59	28	5.2	3
					16	2.9	4.6	5.8	2.0–8.8	6.5	4.6	71	40	6.6	
	Moderate waves, taking a more pronounced long form; many white horses are formed (chance of some spray).	5	Fresh breeze	17–21	18	3.8	6.1	7.8	2.5–10.0	7.2	5.1	90	55	8.3	4
4					19	4.3	6.9	8.7	2.8–10.6	7.7	5.4	99	65	9.2	
					20	5.0	8.0	10	3.0–11.1	8.1	5.7	111	75	10	
5					22	6.4	10	13	3.4–12.2	8.9	6.3	134	100	12	5
	Large waves begin to form: the white foam crests are more extensive everywhere (probably some spray).	6	Strong breeze	22–27	24	7.9	12	16	3.7–13.5	9.7	6.8	160	130	14	
6					24.5	8.2	13	17	3.8–13.6	9.9	7.0	164	140	15	6
					26	9.6	15	20	4.0–14.5	10.5	7.4	188	180	17	
	Sea heaps up and white foam from breaking waves begins to be blown in streaks along the direction of the wind (spindrift begins to be seen).	7	Moderate gale	28–33	28	11	18	23	4.5–15.5	11.3	7.9	212	230	20	
					30	14	22	28	4.7–16.7	12.1	8.6	250	280	23	
					30.5	14	23	29	4.8–17.0	12.4	8.7	258	290	24	
7					32	16	26	33	5.0–17.5	12.9	9.1	285	340	27	7
	Moderately high waves of greater length; edges of crests break into spindrift. The foam is blown in well-marked streaks along the direction of the wind. Spray affects visibility.	8	Fresh gale	34–40	34	19	30	38	5.5–18.5	13.6	9.7	322	420	30	
					36	21	35	44	5.8–19.7	10.3	10.3	363	500	34	
					37	23	37	46.7	6–20.5	14.9	10.5	376	530	37	
					38	25	40	50	6.2–20.8	15.4	10.7	392	600	38	
					40	28	45	58	6.5–21.7	16.1	11.4	444	710	42	
8	High waves. Dense streaks of foam along the direction of the wind. Sea begins to roll. Visibility affected.	9	Strong gale	41–47	42	31	50	64	7–23	17.0	12.0	492	830	47	8
					44	36	58	73	7–24.2	17.7	12.5	534	960	52	
					46	40	64	81	7–25	18.6	13.1	590	1110	57	
	Very high waves with long overhanging crests. The resulting foam is in great patches and is blown in dense white streaks along the direction of the wind. On the whole, the surface of the sea takes a white appearance. The rolling of the sea becomes heavy and shock-like. Visibility is affected.	10	Whole gale*	48–55	48	44	71	90	7.5–26	19.4	13.8	650	1250	63	
					50	49	78	99	7.5–27	20.2	14.3	700	1420	69	
					51.5	52	83	106	8–28.2	20.8	14.7	736	1560	73	
					52	54	87	110	8–28.5	21.0	14.8	750	1610	75	
					54	59	95	121	8–29.5	21.8	15.4	810	1800	81	
9	Exceptionally high waves (small and medium-sized ships might for a long time be lost to view behind the waves). The sea is completely covered with long white patches of foam lying along the direction of the wind. Everywhere the edges of the wave crests are blown into froth. Visibility affected.	11	Storm*	56–63	56	64	103	130	8.5–31	22.6	16.3	910	2100	88	9
					59.5	73	116	148	10–32	24	17.0	985	2500	101	
	Air filled with foam and spray. Sea completely white with driving spray; visibility very seriously affected.	12	Hurricane*	64–71	>64	>80‡	>128‡	>164‡	10–(35)	(26)	(18)	~	~	~	

* For hurricane winds (and often whole gale and storm winds) required durations and fetches are rarely attained. Seas are therefore not fully arisen.
† A heavy box around this value means that the values tabulated are at the center of the Beaufort range.
‡ For such high winds, the seas are confused. The wave crests blow off, and the water and the air mix.
SOURCE: W. A. McEwen and A. H. Lewis, "Encyclopedia of Nautical Knowledge," p. 483, Cornell Maritime Press, Cambridge, Md., 1953. "Manual of Seamanship," pp. 717–718, vol. II, Admiralty, London, H.M. Stationery Office, 1952. Pierson, Neumann, James, "Practical Methods for Observing and Forecasting Ocean Waves," New York University College of Engineering, 1953.

TABLE OF CONTENTS

Preface

One task of the UNOLS Fleet Improvement Committee and its predecessor, the Fleet Replacement Committee, is to formulate the requirements for scientific missions of future UNOLS vessels. These scientific mission requirements constitute the basis for concept designs leading to new construction and for modification plans in the case of mid-life refits or conversions.

The scientific mission requirements given here are for each class ship according to its size or type. They were developed by working groups of practicing, seagoing scientists and have been reviewed and revised by a cross-section of the community. This refinement will continue, and scientific mission requirements for additional classes of vessels will be added to this collection. For these reasons, the collection is provided in a loose-leaf binder.

Because the final design, construction, and outfitting of future new ships will be based on the contents of these requirements, all research ship users are encouraged to consider these contents carefully. Comments should be sent to The UNOLS Fleet Improvement Committee, c/o W. D. Nowlin, Department of Oceanography, Texas A&M University, College Station, TX 77843-3146.

UNOLS Fleet Improvement Committee
November 1989

SCIENTIFIC MISSION REQUIREMENTS FOR OCEANOGRAPHIC RESEARCH VESSELS

A Report of the
UNOLS Fleet Improvement Committee

Prepared as Part of an
Overall Fleet Planning Study