January 6, 1997

CLASS II/III GENERAL PURPOSE RESEARCH VESSEL SCIENCE MISSION REQUIREMENTS FOR CENTRAL PACIFIC OPERATING AREA

This report is in response to the Office of Naval Research (ONR) letter dated 7 November 1996 requesting Science Mission Requirements (SMR) for a Class II/III general purpose research vessel. The University-National Oceanographic Laboratory System (UNOLS) Fleet Improvement Committee (FIC), augmented by representatives from the University of Hawaii (UH) and Pacific Ocean research scientists, met in San Francisco on 12-13 December to deliberate on the requirements. A list of attendees is included as **Enclosure 1.**

In response to the ONR letter, Ken Johnson provided the FIC with a charge through his e-mail message dated 14 November 1996 **(Enclosure 2).** In addition, Sujata Millick provided additional guidance in her remarks at the FIC meeting. The FIC working group was instructed that economic issues were relevant, not only for the moneys available for construction but the life cycle cost as integrated into the total UNOLS Fleet operating budget. The instructions to develop SMRs for a Class II/III ship suggest both cost and size constraints. Sujata further explained that when the SMRs are evaluated for design concepts a monohull would not be ruled out.

Brian Taylor presented a revised set of science mission requirements. This revision was in response to the community comments and represented a reduced size/capacity from the first draft provided by UH. Community response overwhelmingly recommended that the ship be built for operations in the central and circum-Pacific including, ice-free high latitudes. These SMRs were again updated by UH based on the deliberation of the FIC working group and are forwarded as **Enclosure 3.** The values used in these SMRs represent UH's interpretation of the FIC work and not necessarily a consensus of the assembled FIC working group.

REQUIREMENTS: The Committee deliberated on 11 requirements that were considered as "drivers" with respect to ship size, design and cost. The requirements considered were: Sea Keeping; Station Keeping; Endurance; Speed; Draft; Range; Science Staff; Science Payload; Lab Space; Deck Space and Hold Space. A detailed discussion of each of these is provided below which constitutes the substance of this report.

REQUIREMENT RANGE: A range of values was established for each of these requirements. The requirement range included the ″Minimum" acceptable, "Desirable" and the "Maximum" considered reasonable for each of the requirements. An attempt was made to keep the "Desirable" within practical cost limits; however, the limited ship design expertise of the working group suggests that a priority system would be necessary to temper excessive enthusiasm. The "Maximum" of the range suggests a goal when it does not compromise other requirements.

The Committee began its discussion of each requirement by reviewing the values reported in existing UNOLS Science Mission Requirements for Class II and Class III monohull research vessels and Class I and III SWATH research vessels (ref: FIC Report "Scientific Mission Requirements for

Oceanographic Research Vessels", Nov. 1989). The minimum acceptable and desirable values were then set.

PRIORITY: A priority system was devised to assist designers with tradeoffs that might be necessary between Minimum and Desirable requirements. High priorities suggest the design should attempt to meet the "Desirable" requirement in the Range. For the lower priorities at least the minimum should be met. To develop the priorities a vote was taken on each of the requirements. The voter had a choice of High, Medium or Low priority. A point value was assigned to each of these with High=3, Medium=2 and Low=1 point. The votes were counted and values tallied. A perfect High, where all present voted for a high priority, would equate to a score of 63 (21 people voted).

It should be noted that the priorities refer only to tradeoffs between Minimum and Desirable values in the requirements. If it is not possible to meet Minimum values, then the priorities will differ dramatically. For example, the ship's range received a relatively low priority ranking of 36. However, the minimum range of 9000 nm was considered to be of very high importance. If it could not be met in an affordable design, then minimum ranges for other factors such as science payload or sea keeping should be lowered first. There was not an extensive discussion of the ranking of Minimum priorities, however, as it was considered to be premature until the constraints of the SMRs on the ship's characteristics were considered by NAVSEA.

CLASS II/III MONOHULLS AND SWATH SMR VALUES - To provide a perspective of the SMRs recommended, the SMR values from previous FIC reports of Class II and Class III monohull and SWATH vessels has been included where available.

DISCUSSION, RANGE AND PRIORITY OF EACH REQUIREMENT

1. SEA KEEPING (on station) was the only requirement with a perfect high priority score. A maximum range was not considered applicable and not included. Discussion followed that working in Sea States of 6 and 7 were paramount if this vessel was to have improved characteristics over existing research vessels. A concern for survivability was expressed. Design requirements must include survivability through Sea State 9.

The Minimum values were derived from the Circular of Requirements (COR) for the AGOR 23 (THOMPSON) class, while the Desirable values were based on the COR for the TAGOS-19 SWATH surveillance ships that have been built by the Navy.

The AGOR 23 COR did not include a Heave value, and the Committee suggested a value of six feet. THOMPSON was reported to meet the requirements of the minimum values. The UNOLS FIC report, "Preliminary Design for Medium Endurance General Purpose Oceanographic Research Vessel," suggests that a smaller vessel with a broad beam and shallow draft can also meet the Minimum requirements. A SWATH design is likely to be necessary to meet the Desirable requirements.

Published SMRs for:

Class II		Class III	
Monohull:	SWATH:	Monohull:	SWATH:
NA	NA	NA	NA

REQUIREMENT	MINIMUM	DESIRABLE	MAXIMUM
SEA KEEPING	Sea State 6	Sea State 7	NA
Pitch	4 degrees	3 degrees	NA
Roll	8 degrees	6 degrees	NA
Heave	6 ft.	4 ft.	NA
Vertical Accel.	0.4 g	0.09 g	NA
Horizontal Accel.	0.2 g	0.11 g	NA

Priority score: 63 (H=21/M=0/L=0)

2. DECK SPACE DISTRIBUTION was discussed in general terms and considered a function of the hull form. The requirement was considered significantly important and as a minimum, 2,000 square feet of space should be available. However, the priority for the space was assigned on the basis of configuration, rather than square footage. The deck space must be arranged to allow easy handling of oceanographic gear, and to facilitate typical oceanographic operations such as itemized below.

Published SMRs for:

Class II		Class III	
Monohull:	SWATH:	Monohull:	SWATH:
NA	NA	NA	NA

Priority score: 58 (H=16/M=5/L=0)

3. STATION KEEPING was considered a high priority and related to the ability of the vessel to remain on station with dynamic positioning. The dynamic positioning parameters were considered as +/- 50 meters deviation with +/- 5 degrees on the most favorable heading. It was agreed that the desire for station keeping in higher sea states would necessitate an increase in air gap between the main ship's body and the sea. Survivability through Sea State 9 would be required.

The desirable value for operations in Sea State 7 would significantly expand routine operations into the high latitudes during winter months. Station keeping in Sea State 7 would likely require a SWATH design.

Published SMRs for:

Class II		Class III	
Monohull:	SWATH:	Monohull:	SWATH:
SS-5	SS-6	SS-5	SS-5

REQUIREMENT	MINIMUM	DESIRABLE	MAXIMUM
STATION KEEPING	Sea State 6	Sea State 7	Sea State 7

Priority score: 57 (H=15/M=6/L=0)

4. SCIENCE PAYLOAD is discussed as it relates to that variable load that a science party can bring aboard. This may include vans, moorings (including anchors, floats, cable and instrumentation), ROVs, coring equipment and mission specific scientific gear. The minimum of 60 tons was driven by the weight of a typical set of mooring arrays that would be carried on a NOAA TOGA/TAO cruise. Science outfitting requirements such as winches, cranes and A-frames will be driven by the overall science mission requirements and the load of this non-itinerant equipment is not included in the Science Payload discussed here as there are a variety of options available for outfitting this equipment that will control its weight.

Published SMRs for:

Class II		Class III	
Monohull:	SWATH:	Monohull:	SWATH:
90 tons	100 tons	60 tons	50 tons

ELEMENT	MINIMUM	DESIRABLE	MAXIMUM
SCIENCE PAYLOAD	60 tons	100 tons	120 tons

Priority score: 47 (H=7/M=12/L=2)

5. LENGTH/BEAM/DRAFT were discussed with a consensus that only harbor draft was a limiting factor for the working group to provide a recommendation. The Panama Canal limitation of 104-foot maximum beam was considered a given requirement. Harbor draft could determine which harbors would be available for this vessel. A SWATH design with variable draft would solve this problem, but it could also compromise some of the other features desired of the vessel. Consensus was not reached on the maximum draft. The majority agreed on 24 feet, however, a significant minority argued that this was not practical and would provide significant operational limitations. It was noted that draft can be a limiting value of range.

Published SMRs for:

Class II		Class III	
Monohull:	SWATH:	Monohull:	SWATH:
NA	NA	NA	NA

REQUIREMENT	MINIMUM	DESIRABLE	MAXIMUM
Draft	NA	20 ft.	24 ft

Priority score: 46 (H=7/M=11/L=3)

6. LABORATORY SPACE is considered as the sum of all internal laboratories. The spatial distribution of these spaces is important and should be a topic of study after basic hull forms are determined. The desired lab space requirements correlate to the desired science staff requirements. The formula used in determining the lab space is:

(number of scientists x 100 sq. ft) + 500 sq. ft

This formula was derived from the experience of the group that multi-disciplinary cruises on the current generation of intermediate vessels were regularly running out of laboratory space, and this trend was likely to continue as science operations become more complex.

Although specific layouts of the laboratories were not considered, they should be convenient to the main working deck and the success of the AGOR 23 design suggests that the labs should all be on one deck if possible.

Published SMRs for:

Class II		Class III	
Monohull:	SWATH:	Monohull:	SWATH:
3000 sq ft	4000 sq ft	2000 sq ft	2000 sq ft

ELEMENT	MINIMUM	DESIRABLE	MAXIMUM
LAB SPACE	2500 sq. ft	3000 sq. ft	3500 sq. ft

Priority score: 44 (H=6/M=11/L=4)

7. SCIENCE STAFF size is a major driver in ship utility, as evidenced by the success of R/V SEWARD JOHNSON. The minimum science party size was set by the number of science berths available on WECOMA. It was recognized that multi-disciplinary cruises will require even more science personnel, which set the desirable value at 25. The science staff is only a portion of the berthing requirement of a vessel. Because the crew size will be influenced by the U.S. Coast Guard requirements of an "inspected vessel", the working group decided to only address the science staff requirements. The group agreed that the crew size should be the minimum possible and serviceable consistent with USCG requirements.

Published SMRs for:

Class II		Class III	
Monohull:	SWATH:	Monohull:	SWATH:
20-25	30-35	15-20	20

REQUIREMENT	MINIMUM	DESIRABLE	MAXIMUM
SCIENCE STAFF (berths)	20	25	30

Priority score: 41 (H=1/M=18/L=2)

8. SPEED (CRUISING) was discussed and a number of issues were identified. Work in the central Pacific will necessarily involve many long transits. Although high speeds are desirable for transit they must be tempered by the cost and the range of the ship. Higher speeds can also be a detriment with respect to some science systems. The potential speed attainable in a SLICE design may differ significantly with a SWATH design or monohull. Sea state was a consideration in the recommended speed range.

Published SMRs for:

Class II		Class III	
Monohull:	SWATH:	Monohull:	SWATH:
14 kts	15 kts	14 kts @ SS4	12 kts @ SS4

REQUIREMENT	MINIMUM	DESIRABLE	MAXIMUM
SPEED (Cruising)	10kts @ SS 6	15kts @ SS 6	17kts @ SS 6

Note: 20kts for the maximum speed value is recommended by SOEST. A full consensus has not been reached.

Priority score: 39 (H=5/M=8/L=8)

9. ENDURANCE was considered that period of time a ship could be at sea without re-supplying food. Although fuel can be an element of endurance, the fuel limitations were considered more critical in the ship's range which is discussed below. The food endurance recommended probably parallels the endurance of science personnel.

Published SMRs for:

Class II		Class III	
Monohull:	SWATH:	Monohull:	SWATH:
50 days	45 days	30 days	30 days

REQUIREMENT	MINIMUM	DESIRABLE	MAXIMUM
ENDURANCE	40 days	50 days	50 days

Priority score: 37 (H=0/M=16/L=5)

10. CRUISING RANGE and speed are elements that have a direct relationship to the size and thus, the cost of the vessel. Increasing the range of the vessel will require greater fuel carrying capacity and as a result will impact the weight of the ship. The ranges recommended below resulted from the fact that the operating area for this vessel is considered to be the Pacific Ocean. A cruise from Hawaii to Easter Island and return would require a minimum range of 8K nm, as would some cruises to service TOGA/TAO arrays. These cruises set the minimum desirable range.

Published SMRs for:

Class II		Class III	
Monohull:	SWATH:	Monohull:	SWATH:
12K	12K	8K	6K

REQUIREMENT	MINIMUM	DESIRABLE	MAXIMUM
CRUISING RANGE (nm)	9K	10K	10K

Priority score: 36 (H=6/M=3/L=12)

11. SCIENTIFIC HOLD SPACE will be a function of expeditionary planning. More is considered better; however, staging in outports is an alternative to a large hold capacity. As a minimum the ship should have sufficient hold space to accommodate a second cruise.

Published SMRs for:

Class II		Class III	
Monohull:	SWATH:	Monohull:	SWATH:
15K	20K	10K	5K

ELEMENT	MINIMUM	DESIRABLE	MAXIMUM
SCIENTIFIC HOLD	10K cubic ft	15K cubic ft	NA

Priority score: 30 (H=0/M=9/L=12)

SCIENCE OPERATIONS: The working group discussed a possible array of science operations envisioned by this ship. Below is a list of operations suggested. The list is not considered to be all inclusive but should be the subject of further discussion.

1. ROVs
2. Mooring Deployment & Recovery
3. Free-Fall Instrument Deployment & Recovery
4. Hydrography
5. Seasoar Towing
   MOCNESS & other nets
6. Deep Towing
7. Multi-Beam Bathymetry
8. Ocean Bottom Observatories (Borehole Re-entry)

9. Coring - Piston, Box
10. Cable-Laying - Lightweight Electro-Fibre Cables
11. Atmospheric Observations
    Lidars, Radars, Sodars, Balloons
    Chemical Sampling (Space Distribution Issue)
12. Satellite Receiving & Telecommunication (Deck layout superstructure obstructions)
13. Seismic Streamers, Towed Arrays
14. Hull-Mounted Sampling Systems/Sensors (ADCPs, seawater sampling)

RECOMMENDATION: It is recommended that the design of this vessel will be an evolutionary process that may require large changes in some of the SMRs outlined above. To facilitate this process it is recommended that a FIC ad hoc committee be formed to work with ONR/NAVSEA in the further development of these science mission requirements. It is envisioned that this committee be made up of seagoing scientists and be limited to three in number.

ENCLOSURE 1

FLEET IMPROVEMENT COMMITTEE MEETING
DECEMBER 12-13, 1996

PARTICIPANTS

Fleet Improvement Committee:

Chris Mooers, FIC Chair
Larry Atkinson
Tom Crowley
Eric Firing
Bill Smethie
Suzanne Strom
Bess Ward
Tom Weingartner
Joe Coburn (ex-officio)

UNOLS:

Ken Johnson, Chair
Jack Bash, UNOLS Office
Annette DeSilva, UNOLS Office

Invited Participants:

Mark Brzezinski, UCSB
Curt Collins, NPS
Doug Hammond, USC
Bruce Howe, UW/APL
Bob Knox, SIO
Russ McDuff, UW
Chris Measures, UH
Hugh Milburn, PMEL
John Orcutt, SIO
Brian Taylor , UH

Federal Agency Representatives:

Don Heinrichs, NSF
Sujata Millick, ONR

Observers:

Barry Raleigh, UH
Bob Wall, UNOLS Council

ENCLOSURE 2

From johnson@mlml.calstate.edu Fri Nov 15 08:40:39 1996
Date: Thu, 14 Nov 96 18:19:26 EST
To: unols@gsosun1.gso.uri.edu
From: johnson@mlml.calstate.edu (Kenneth S. Johnson)
Subject: FIC meeting letter

Dear Colleague

I have received a letter (enclosed) from Fred Saalfeld at ONR regarding the construction of the University Operated, Navy owned research ship that is included in the 1997 budget. The letter states that the requirements for the vessel will be developed by ONR with input from UNOLS and the University of Hawaii. They have requested that UNOLS convene a group to develop mission requirements for a Class II/III general purpose research vessel. ONR will then review the requirements and forward them to Naval Sea Systems Command to conduct an assessment of vessel designs, including SWATH, SLICE and monohull designs, that could accommodate the requirements within the amount of money that is budgeted ($45M). Once the design assessment is completed NAVSEA will issue an RFP for vessel construction and ONR will begin operator selection.

UNOLS is to report to ONR by January 27, 1997. The timeline to respond is therefore very short. We have scheduled a meeting of the Fleet Improvement Committee to begin developing the SMR's on December 12 and 13 in San Francisco before the AGU meeting. Representatives from West Coast universities and laboratories with seagoing experience in the Pacific have been invited to the meeting to present their input on the SMR's required for a Central Pacific vessel. We have focused on the Pacific because the MOANA WAVE is nearing retirement and there is a clear need for a vessel to operate in the Central Pacific. Although the SMR's should be developed with the science mission as the critical element, ONR has directed UNOLS to focus on Class II/III size vessels.

The SMR's produced by this group will then be passed to the UNOLS Council for approval. The Council is scheduled to meet in mid-January, 1997.

Development of this research vessel is an excellent opportunity for the science community, and I am looking forward to all of your input.

Sincerely yours,
Kenneth S. Johnson
UNOLS Chair

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ENCLOSURE 3

REVISED SCIENTIFIC MISSION REQUIREMENTS FOR OCEANOGRAPHIC RESEARCH SWATH SHIP TO REPLACE R/V MOANA WAVE (SOEST, 12/26/96)

General: The ship is to serve as a general-purpose research vessel, primarily for operations in the central and circum-Pacific. The overriding requirement is that the ship provide the most stable environment possible in order to allow both overside and laboratory work to proceed in greater capacity, at higher speeds, and in higher sea states than is now possible. Other general requirements are for larger scientific parties, less vibration and noise, and greater flexibility in the use of lab/deck spaces than is now available aboard intermediate-size research ships.

Size: The size is ultimately determined by the requirements. Available information indicates that these will result in a vessel of about 200 ft LOA and 3000 long tons total displacement. The maximum beam encompassing the lower hulls shall be no greater than 104 feet, to allow passage through the Panama Canal, and the maximum draft in port shall be no greater than 24 feet.

Speed: Minimum 15 knot cruising speed in sea state 6, 10 knots in sea state 7, with speed control +-0.1 knot in 0-6 knot range and +-0.2 knot in 6-15 knot range. The highest possible speeds consistent with fuel economy are desirable (for transit and multi-narrow beam swath mapping). Diesel-electric/SCR propulsion is envisioned, with the diesel generators above the water line for noise/vibration suppression.

Seakeeping: The ship shall be designed to provide exceptionally stable seakeeping capabilities. A tandem-strut SWATH or SLICE design is envisaged. Design targets for the at rest (dead in the water) condition for any orientation of the ship in sea state 6 (significant wave height 3D 17 ft) are:

	Minimum	Desirable
Pitch (ampl.)	4 degrees	3 degrees
Roll (ampl.)	8 degrees	6 degrees
Heave (ampl)	6 feet	4 feet
Vert. Accel.	0.4 g	0.1 g
Horiz. Accel.	0.2 g	0.1 g

Endurance: Fifty days; providing the ability to transit 25 days at cruising speed and 25 days station work (see station keeping and towing); 10,000 nautical mile total range at cruising speed with 15% fuel reserve.

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

Accommodations: 25 scientific personnel (plus ship's crew) in 11 two-person staterooms and 3 single-person staterooms. Science library-lounge with conference capability (~250 sq ft). Science office (~150 sq ft). Provide general access restrooms, wash facilities and exercise room.

Station Keeping: Allow normal station and deck work through sea state 6, limited work through sea state 7, and survivability through sea state 9. Assure relative positioning at best heading in 35 knot winds, 2 knot current, and sea state 6, within +- 5 degrees of heading and +- 150 ft maximum excursion from a point or trackline. Maintain a precision trackline while towing at speeds as low as 0.5 knots with a heading deviation up to 45 degrees 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 the time considering the range of sea states specified. Maintain maneuverability while working with over the side lines and gear - i.e. be able to keep gear out of the props.

Towing: Capable of towing scientific packages up to a total tension of 10,000 pounds at 10 knots, 12,000 pounds at 8 knots, and 25,000 pounds at 2.5 knots.

Working Configuration: Minimum 3,500 sq ft open working deck area, with minimum contiguous work areas of 25 ft along full width of stern and 20 x 50 ft along bow, both as close to sea level as possible to facilitate access to the sea surface. Provide for working deck loading up to 1,200 lbs/sq ft and an aggregate total of 100 tons of installed systems (A-frames, cranes, winches, hydraulics, work boats, etc.) plus at least 60 tons (and preferably 100 tons) of itinerant payload (vans, deployable vehicles, scientific equipment, and additional cranes, supplies, etc.). Install one-inch bolt-down fittings on 2-ft centers grid pattern to accommodate portable equipment. Provide removable bulwarks and railings, with the lower hulls and screws not protruding beyond upper hulls. All working decks accessible for power, water, air, and data and voice communication ports.

Cranes: A suite of cranes (1) articulated to work close to deck and water surface, (2) able to lift a max of 20 tons, service the entire usable deck space, and lift 10 tons at the limit of their working areas, (3) overside cranes to have servo controls, to be usable as overside cable fairleads at sea, and at least one to be positioned to lift 10 tons from an adjacent dock/pier. Ship to be capable of carrying portable cranes for specialized purposes such as deploying and towing special instruments

Winches: Oceanographic winch systems with fine control (0.5m/min); constant tensioning. Local and remote controls. Wire monitoring systems with inputs to laboratory panels and digital shipboard recording systems. Permanently installed general-purpose winches shall include:

- Two winches capable of handling 30,000 ft of wire rope or electromechanical/fiber optic 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 is envisioned as one winch with multiple storage drums that can be interchanged.

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

Overside Handling: A versatile combination of frames, booms, 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. Permanently installed general-purpose systems shall include:

- Stern A-frame, mounted on lowest (lab) deck without overhead, to have 20 ft minimum horizontal, and 30 ft vertical, inside clearance, with 15 ft inboard and outboard reaches; safe working load up to 30 tons.
- Capability to install 20 ft pivoted booms on aft corners of lower deck.
- Climate controlled control stations to give operator protection and operations monitoring and to be located for maximum visibility of overside work.

Laboratories: At least 2,500 sq ft (preferably 3,000 sq ft) of laboratory space including the following (minimum area): Main lab (1,000 sq ft); Wet lab (300 sq ft) located contiguous to sampling areas; Bio-chem Analytical lab (200 sq ft); Electronics/Computer lab and associated users space (500 sq ft, sub dividable); Dry lab (200 sq ft) located proximal to forward meteorological tower; 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, storage, and all main deck levels to be served by man-rated freight elevator having clear inside dimensions of at least 4 ft by 6 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 shall be permanently installed in the Wet and Analytical labs. Cabinetry shall be high-grade laboratory quality (not metal). Flexible lab configurations shall be aided by the use of bulkhead unistruts, deck holddowns, and bench tops that can secure a surface of easily replaceable plywood (that can be drilled and nailed into at will). Provide heating, ventilation, and air conditioning (HVAC) appropriate to labs, vans, and other science spaces being served. Labs shall maintain temperature of

70-75 B0F, 50% relative humidity, and 9-11 air changes per hour, with individual HVAC controls in each lab. Provide filtered air to analytical labs and compressed gas bottle racks. Each lab area shall have a separate electrical circuit on a clean bus with continuous delivery capability of at least 40-volt amperes per sq ft of lab deck area. Labs shall be furnished with 110 v and 220 v AC. Total estimated lab power demand is 100 KVA. Provide uncontaminated sea water supply and clean compressed air supply, free of oil, to most labs, vans, and several key deck areas. Provide 20 ft tower (with sampling platform, power, gas and electro-optical data lines) atop forward super-structure for aerosol, gas and rain sampling, optical measurements, and meteorological observations.

Vans: To carry three standardized 8 ft by 20 ft vans which may be lab, 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 three additional portable non-standard vans (450 sq ft total) on working decks. Supporting connections at several locations around ship including lower fantail and foredeck (see working configuration). Ship should be capable of loading and offloading vans using own cranes.

Workboats: At least one 19-ft inflatable (or semi-rigid) boat 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 one of three van options above.

Science Storage: Total of 15,000 cubic ft of scientific storage accessible to labs by freight elevator and weatherdeck hatch(es). Half to include suitable shelving, racks, and tie downs; remainder open. Chemical reagent storage in suitable location.

Acoustical Systems: Ship to be as acoustically quiet as practicable in the choice of all shipboard systems, their location and installation. Hulls, transducer wells and bow thruster should be designed to minimize the presence of bubble layers in front of the transducers (e.g., bow thruster on different pontoon/pod than transducers). Design target is operationally quiet noise levels at 15 knots cruising in sea state 5 (and preferably, at higher speeds and sea state 6) 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 (1) 12 kHz and 3.5 kHz echo sounding systems and provision for additional systems, (2) acoustic Doppler current profiler systems operating at about 150 kHz and 75 kHz, together with some system (acoustic or otherwise) for measuring currents in the 0-20 m depth range (shallower than presently usable ADCP data), (3) phased array, multi-narrow beam precision echo sounding system (equivalent to "SeaBeam 2100" or "Simrad EM" series or better) - this requires pontoons/pods at least 25 ft wide, (4) transducers appropriate for dynamic positioning system, (5) transducer wells (20") located forward and aft, (6) large pressurized sea chest (4 ft x 8 ft) located at optimum acoustic position for at-sea installation and servicing of transducers and transponders.

Environmental Systems: Ship to have (1) underway standard meteorological sampling (from tower on forward superstructure) - this could be satisfied with the "IMET" system plus an optical raingauge, (2) continuous seawater sampling system, including intake from the nose of one pontoon, proximal measurement of temperature and salinity (using a "Sea-Bird SBE-21" thermosalinograph or equivalent), two pumps (centrifugal, 150 litre/min) and two separate supply lines (1" fiberglass pipe and 1-1/2" polypropylene tubing) to deliver water to the hydro and wet labs and the following instruments: flow-though fluorometer, nutrient analyser, transmissometer, and CO2/O/pH/H2O2 meters, (3) deployable bow boom or other system for air-sea interface sampling, (4) facility to attach additional sensors and through-hull data links (e.g., to measure turbulence) to the nose of the pontoon without acoustic systems.

Geophysical Systems: Ship to have (1) gravity meter installed as near as possible to the center of motion, (2) shipboard (not towed) 3-component magnetometer system, (3) compressors capable of generating 500 scfm at 2500 psi, with high-pressure plumbing connecting to large sound sources (airguns) and their deployment systems; with the ability to expand the sound source capacity to 2000 scfm at 2500 psi by the addition of compressors in vans, (4) the capability to carry out multichannel seismic profiling surveys using these sound sources and long streamers (3-6 km).

Navigation and Positioning: Ship to have (1) DGPS and P/Y-code GPS, (2) GPS attitude determination to 0.1 degree or better (e.g. "Ashtech 3DF-ADU2" or equivalent), (3) short baseline acoustic navigation system, (4) "dynamic positioning" capability to maintain the ship on station or on trackline to the station keeping specifications under automatic control and appropriate navigational reference.

Internal Communications: Internal communication system providing high-quality voice communications throughout all science spaces and working areas. Optical fiber Ethernet cabling and connections shall connect all science spaces including staterooms, labs, vans, meteorological tower, pontoon nose and key working areas. Data and power cable races shall be kept separate and as far from each other as possible. Provide closed-circuit televison 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 shall be provided in all, or most, science spaces.

External communications: Provide (1) reliable voice channels for continuous communications to shore stations (including home laboratories), other ships, boats, and aircraft; this includes satellite, VHF, and UHF, (2) facsimile communications to transmit high-speed graphics and hard-copy text on regular schedules, (3) 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. Satellite antennas and the GPS-attitude sensor should be positioned with a reasonably clear view of the sky and adequate distance from radar and other ships antennas.

Ship Control: Chief requirement is maximum visibility of deck work areas during science operations and especially during deployment and retrieval of equipment. This may require additional or portable control stations besides the bridge-pilot house. The functions, communications, and layout of the ship control station(s) should be 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 (possibly by computer) from a laboratory or working deck area.

Noise Control: Laboratories, working deck areas, ship control stations and library/conference room must meet Category "A-12" airborne noise criteria. Other spaces (except machinery) must meet "A-3".

Sea State	Description	Height (ft)
0	Calm-glassy	0
1	Calm-rippled	0-0.5
2	Smooth-wavelets	0.5-1.5
3	Slight	1.5-4
4	Moderate	4-8
5	Rough	8-13
6	Very Rough	13-20
7	High	20-30
8	Very high	30-45
9	Phenomenal	Over 45

At its 12-13th Dec 96 meeting, the UNOLS Fleet Improvement Committee, plus invited scientific representatives from Pacific coast marine institutions, considered a set of SMRs submitted by SOEST that was substantially revised (12/10/96) following community wide responses to a draft version (10/24/96).

The further revised SMRs (above) seek to incorporate comments from that meeting and to reflect the consensus view noted in the following table. The meeting participants gave the key SMR design parameters consensus ranges (minimum/desirable/maximum) and then ranked them in order of priority for achieving the desirable (as against minimum) specification.

Parameter	Minimum	Desirable	Max	Vote (hi/med/lo/total)	Notes
Sea Keeping:	SS-6 (17 ft.)	SS-6 (17 ft.)	-	21/0/0/63	
Pitch (ampl.)	4 degrees	3 degrees	-		
Roll (ampl.)	8 degrees	6 degrees	-		
Heave (ampl.)	6 feet	4 feet	-		
Vert. Accel.	0.4 g	0.1 g	-		
Horiz. Accel.	0.2 g	0.1 g	-		
Deck Space:	2000 sq ft	-	-	16/5/0/58	(priority is configuration)
Station Keeping:	SS-6	SS-7	SS-7	15/6/0/51	(+-50m & 5 B0, best heading)
Science Payload:	100/60	100/100	-	7/12/2/47	(installed/ itinerant tons)
Draft (ft):	-	20	24	7/11/3/46	(variable draft desirable)
Lab Space (sq ft):	2,500	3,000	3,500	6/11/4/44	
# Science Staff:	20	25	30	1/18/2/41	
Cruising Speed: (kts in SS-6)	10	15	20	5/8/8/39	(max only if SLICE (higher speeds lose some science systems)
Range (nm)	9,000	10,000	10,000	6/3/12/36	
Endurance (days):	40	50	50	0/16/5/35	
Science Hold (cu ft):	10,000	12,000	15,000	0/9/12/30	