

APPENDIX XI

REVISED SCIENTIFIC MISSION REQUIREMENTS FOR OCEANOGRAPHIC RESEARCH SWATH SHIP TO REPLACE R/V MOANA WAVE (12/10/96)

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 reliability, flexibility, cleanliness, minimal vibration and noise, and an overall upgrading of quality for doing science and engineering at sea.

Size: The size is ultimately determined by the requirements. It seems likely that these will result in a vessel of about 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. Design targets for the at rest (dead in the water) condition for any orientation of the ship in the following sea states (and significant wave heights) are:

	SS-4 (7 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 feet	3.0 feet
Vert. Accel.	0.06 g	0.09 g
Horiz. Accel.	0.06 g	0.11 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.

IceStrengthening: None: Not intended for ice breaking 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 and wash facilities.

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 5, 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 5,000 sq. ft open working deck area, with minimum contiguous work areas of 25 ft along full width of stem and 20 x 50 ft along bow, both as close to sea level as possible to facilitate access to the sea surface. Provide for deck loading up to 1,200 lbs/sq ft and an aggregate total of up to 150 tons of installed systems (A-frames, cranes, winches, hydraulics, work boats, etc.) plus 50 tons of variable payload (vans, deployable vehicles, scientific equipment, and additional cranes, supplies, etc.). Install oversize holddowns on 2-ft centers as a highly flexible means to accommodate large and heavy 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 (0.5rpm/min), both local and remote, and 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 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.

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:

- Stem 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 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°F, 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

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 other-wise) 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-through 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 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 oversight 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 from a laboratory area.

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