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Woods Hole Oceanographic Institution

Required oceanographic
instrument suit for
oceanographic survey
vessels.

1930

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41
.G6
1961

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1961

REQUIRED

OCEANOGRAPHIC INSTRUMENT SUIT

FOR

OCEANOGRAPHIC SURVEY VESSELS

Prepared by a Special Working Group of representatives of the Bureau of Commercial Fisheries, U. S. Coast and Geodetic Survey, and the U. S. Navy Hydrographic Office, headed by Captain C. N. G. Hendrix, U. S. Navy.

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Bostwick H. Ketchum

PREFACE

In recent conferences and discussions, an attempt has been made to determine the oceanographic instrumentation needs of oceanographic survey vessels. Although the resulting instrument and system descriptions contained herein have been particularly oriented toward outfitting oceanographic survey vessels, a number of these instruments and systems are considered to have additional application to both basic and applied research investigations.

These descriptions are presented in the combined form of both performance and general engineering specifications. This has been done intentionally, in order to stimulate the needed and desired new thinking and fresh approach that must be applied to oceanographic instrumentation. The engineering specifications have been presented primarily for information and not to restrict or channel thought on how any given problem may best be solved. Likewise, the performance specifications have been presented as guideline goals, to be improved where possible. Should the state-of-the-art prevent the attainment of one or more of the goals set forth, it may be necessary to consider interim solutions. However, interim instruments or instrument systems will have to be individually evaluated on: (1) the inherent merit of the method employed, (2) the degree to which the proposal attains the stipulated goal, (3) its relationship in time to the achievement of the desired goal, and (4) development and production model costs.

The priorities, which have been tentatively assigned to the instruments and instrument systems described herein, have been dictated primarily by the urgency of the requirement for the information that the particular instrument or system can provide. Unit and development costs, the current state-of-the-art, and the estimated time period required to perfect a particular instrument or system have not entered into the setting of these priorities. Furthermore, these priorities will not prevent the procurement of a fully-developed, low-priority instrument merely because all of the higher priority instruments have not yet come into being.

A general requirement for all instruments and instrument systems, excluding those whose sole function is the collection of various samples, is that the data which they collect must be able to be read directly into the Master Shipboard Data Logging and Processing System. This requirement remains regardless of whether the information is internally recorded within the instrument or system vehicle or whether the instrument or system transmits or telemeters the data directly to the survey vessel. In this connection, the final data output of the Master Shipboard Data Logging and Processing System must be in proper form for direct inclusion in the archives of the National Oceanographic Data Center.

Modular construction, both of sensors and of consoles, has been particularly specified in these instruments and instrument systems. This has been done primarily to facilitate field maintenance and repair; however, it also allows for the different lengths of time that may be required to develop any given sensor. Additional factors, which have prompted specification of this mode of construction, are:

1. Higher resolutions and accuracies are more economically attained with a group of modular sensors, each interchangeable and covering a different sensing range;
2. A greater demand may be generated for a particular sensor than the overall demand indicated in these descriptions for the total instrument or systems;
3. Standardization will afford the widest possible sensor application and market, inasmuch as many of these sensors are to be utilized in more than one of the described instruments and instrument systems;
4. Interchangeable, modular sensors will permit many companies, who may have neither the interest nor the capability to contract for an entire system, to devote their specialized talents to development of a particular sensor. This is expected to be especially true of companies having a specialized chemical analysis capability.

In conjunction with this policy of modular construction, vehicles or capsules proposed as components of the described instruments or instrument systems must be capable of accommodating the standardized sensors and their associated recording or transmitting units in the groupings stipulated in the accompanying instrument descriptions.

Although projected estimates of the numbers which may be utilized have been presented for each instrument or system, in order to acquaint industry with the possible extent of the market, these numbers are obviously a function of: (1) the unit cost of production models, (2) opportune breakthroughs in the state-of-the-art, (3) budgetary considerations of the various agencies that may comprise the market, and (4) the individual requirements of segments of the national oceanographic community other than those concerned principally with survey operations.

The following are additional general requirements which inherently apply to all oceanographic instruments or instrument systems:

1. Provision must be included for rapid, accurate, shipboard calibration.
2. Wherever electronic components are utilized, long electronic life must be a basic factor in their design. In this regard, military specifications, especially those written for existing specialized projects, are

not always adequate criteria.

Operation and maintenance of both individual instruments and instrument systems must not be so complicated as to require extensive, specialized training for their use.

4. Instrument and instrument system power requirements must not necessitate elaborate voltage and frequency controls.

5. Possibly the least understood and, yet, the most important is the fact that all of these instruments and instrument systems must be especially designed to be used at sea. Their construction and operation must be reliable, accurate, and compatible with the shipboard and marine environment which can be very severe on occasions.

Inasmuch as all of the described instruments and instrument systems are to be designed for use aboard oceanographic survey vessels, the following general background information is provided regarding ship characteristics:

1. <u>U. S. Navy</u>	<u>Length</u>	<u>Beam</u>	<u>Draft</u>	<u>Displacement</u>
a. AGS 30 and 50	310 feet	41 feet	14 feet	2,800 tons
b. AGS 18 Class	221 feet	32 feet	10 feet	1,221 tons
c. AGOR SCB 185 Class	208 feet	37 feet	15 feet	1,387 tons
2. <u>U. S. Coast and Geodetic Survey</u>				
a. Class I Ships	300 feet	48 feet	20 feet	3,100 tons
b. Class II Ships	210 feet	40 feet	15 feet	1,300 tons
c. Class III Ships	150 feet	30 feet	10 feet	750 tons
3. <u>Bureau of Commercial Fisheries</u>				
a. Coastal vessels	40 feet (various)	(various)		150 tons (approx.)
	to			
	75 feet			
b. Short-range, offshore vessels	75 feet (various)	(various)		600 tons (approx.)
	to			
	125 feet			
c. Extended-range, ocean vessels	125 feet (various)	(various)		1,000 tons (approx.)
	to			
	200 feet			

The estimated numbers of instruments and instrument systems contained in the descriptions have been based upon the following considerations: (1) That, from the TENOC Report, NASCO Report, and personal communications, the following oceanographic ships exist and/or are proposed for future construction, and (2) that some of the proposed ships will replace some of the older, existing ships.

1. U. S. Coast and Geodetic Survey

- 5 Existing Class I hydrographic ships
- 10 Existing Class II and III hydrographic ships
- 8 Proposed Class I oceanographic ships
- 2 Proposed Class II oceanographic ships
- 7 Proposed Class III oceanographic ships

2. U. S. Navy Hydrographic Office

- 2 Existing oceanographic ships (AGS 30, 50)
- 4 Existing inshore oceanographic ships (AGS 18 Class)
- 2 Existing large hydrographic ships (AGS 15, 16)
- 3 Proposed oceanographic ships (AGOR SCB 185)
- 7 Proposed hydrographic ships (AGS SCB 214)
- 4 Proposed hydrographic ships (AGS SCB 193)
- 5 Proposed AGC (3,000 tons)

3. Bureau of Commercial Fisheries

- 27 Existing oceanographic-type research vessels, including chartered vessels.
- 16 Proposed coastal vessels
- 12 Proposed short-range, offshore vessels
- 3 Proposed extended-range, ocean vessels, including 1 submarine

4. U. S. Navy Research Laboratories

- 4 Existing research vessels (EPCE type)
- 3 Proposed oceanographic ships (AGOR SCB 185)
- 1 Proposed VC-2 conversion

5. Scientific Community

a. Lamont Geophysical Observatory

- 1 Existing 750-ton oceanographic vessel (VEMA)
- 2 Proposed oceanographic ships (AGOR SCB 185)

b. University of Washington

- 1 Existing 300-ton oceanographic vessel (BROWN BEAR)
- 1 Proposed oceanographic ship (AGOR SCB 185)

c. Scripps Institution of Oceanography

- 1 Existing 2,100-ton oceanographic ship (ARGO)
- 2 Existing 900-ton oceanographic vessels (HORIZON and BAIRD)
- 1 Existing 550-ton oceanographic vessel (HUGH SMITH)*
- 1 Existing 400-ton oceanographic vessel (STRANGER)
- 2 Existing 200-ton oceanographic vessels (ORCA and PAOLINA T)
- 2 Proposed oceanographic ships (AGOR SCB 185)
- 1 Proposed AGC (3,000 tons)

*On loan from Bureau of Commercial Fisheries, Honolulu.

d. Oregon State College

- 1 Existing oceanographic vessel (ACONA)
- 1 Proposed oceanographic ship (AGOR SCB 185)

e. University of Miami

- 1 Existing 135-ton oceanographic vessel (GERDA)
- 1 Proposed oceanographic ship (AGOR SCB 185)

f. Hudson Laboratories

- 1 Existing 2,800-ton oceanographic ship (GIBBS)
- 1 Existing 750-ton oceanographic vessel (ALLEGHENY)
- 1 Proposed AGC (3,000 tons)

g. Woods Hole Oceanographic Institution

- 1 Existing 3,100-ton oceanographic ship (CHAIN)
- 1 Existing 565-ton oceanographic vessel (ATLANTIS)
- 2 Existing 300-ton oceanographic vessels (CRAWFORD and BEAR)
- 2 Proposed oceanographic ships (AGOR SCB 185)

h. Agricultural and Mechanical College of Texas

- 1 Existing 400-ton oceanographic vessel (HILDAGO)
- 1 Proposed oceanographic ship (AGOR SCB 185)

i. University of Southern California

- 1 Existing 580-ton oceanographic vessel (VELERO IV)

In addition, New York University, Chesapeake Bay Institute, and Narragansett Marine Laboratory, as well as some of the above institutions have various smaller vessels that are equipped for oceanographic data collection and could possibly use some of the described instruments, or portions thereof.

INDIVIDUAL INSTRUMENTS/EQUIPMENTS AND INSTRUMENT SYSTEMS FOR
OCEANOGRAPHIC SURVEY VESSELS

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HYDROGRAPHIC PRECISION SCANNING ECHO SOUNDER

Sketch:

(To be provided)

Primary Use:

For use on oceanographic survey ships in conducting underway precision developmental (detailed) types of bathymetric surveys in deep oceanic areas. This instrument is needed to obtain a high resolution, stabilized, echo-sounding picture, including an automatically plotted contoured chart of the sea floor topography, extending a certain distance (about 2 miles in 4,000 fathoms of water) perpendicular to and on each side of the ship's track.

Requirements and Specifications:

a. To perform reliably at ship's speeds of 0 to 18 knots and in sea states 0 through 5.

b. Operating Depth Range:

- (1) Automatic contour plotting (sweep width) 0 to 6,500 fathoms.
- (2) Single-ping and regular echo-gram recording operation 0 to 6,500 fathoms.

c. Recording Accuracy: 1 fathom over full range of each scale.

d. Transducer(s):

- (1) Type: narrow beam, 1° to 3° , at the 10 db point.
- (2) Array: multiple series of transducers faired in to ship's hull, electronically stabilized, and so installed as to scan the sea floor for a specified distance on either side of the ship's track.
- (3) Transducer(s) should be located at a point along ship's hull so as to have minimum cavitation interference.
- (4) Should be capable of scanning up to 30° on either side of ship's track.
- (5) Should incorporate a feature for "plug-in" of a portable/towed transducer.

e. Stabilizer:

- (1) Maximum stabilization angle of 60° .

- (2) Constant stabilization to $1/2^\circ$ of arc from the vertical.
- (3) Minimum lag in stabilization action, easy accessibility for maintenance.
- (4) Alarm system to detect malfunctions.

f. Receiver - transmitter:

- (1) Frequency: 10 - 18 KC
- (2) Transmission: Pulsed CW emission and reception.
- (3) Frequency Control: Precise intermediate frequency (IF).
- (4) Scale Range: Several and concurrently shifted.
- (5) Phasing: Automatic phase detection.
- (6) Pinging: Single or continuous.
- (7) Output: Output suitable for audible depth indication and use with an external precision recorder.

g. Recording:

(1) Data Display: To present travel-time data to a display which automatically connects horizontal and vertical components and displays data from successive sweeps as contours at pre-selected intervals varying between 5 - 100 fathoms.

(2) Data Recording: Output data to be compatible to present and planned data reduction methods.

(3) Must record continuous bottom profiles in addition to plotting "contours".

(4) "Alternate" Recorder:

- (a) Paper Width: 18"
- (b) Time Accuracy: 1 part/million
- (c) Paper Speeds: 24 and 72 inches/hour and also geared to own ship's speed for various chart scales.
- (d) Marking area of recorder paper to have accessibility for ease of immediate reading of trace.
- (e) Adjustable for setting correction for ship's draft.
- (f) Provision for a gating circuit.
- (g) Means for a numerical depth print-out.
- (h) Means for changing vertical scale of recording.
- (i) Automatic depth phase recording on trace.
- (j) A reflectivity meter should be built into the system to provide a continuous recording of the reflectivity of the sea floor.

Potential Users and Estimated Number of Units Which They May Require:

- a. U. S. Navy (hydrographic-oceanographic survey ships, basic research ships, and applied research ships). - 19 to 25
- b. U. S. Coast and Geodetic Survey - 2 to 6
- c. Certain activities of scientific community - 10 to 15

d. Bureau of Commercial Fisheries - 2

Total: 33 to 48

Recommendation Where System Should Be Researched and Developed:

U. S. Industry.

Relative Importance to U. S. National Oceanographic Program:

Individual Instrument priority 1.

CURRENT METER FOR CONDUCTING COASTAL AND OCEANIC SUBSURFACE
CURRENT SURVEYS

Sketch:

(To be provided)

Primary Use:

This is a precision instrument to be utilized on oceanographic survey vessels for conducting subsurface current studies and surveys in coastal and oceanic areas with the ship anchored or "lying-to". It must measure and record precisely the direction and speed of the subsurface currents.

Requirements and Specifications:

- a. To perform reliably and accurately on survey ships which are anchored or "lying-to".
- b. To be operable in depths varying from 0 to 6,500 fathoms with no adverse effects thereto due to hydrostatic pressure.
- c. To be so designed as to be utilized individually or in multiple groupings on one cast.
- d. To be so designed that the adverse effects of platforms and sensor motions (horizontal and vertical accelerations) are eliminated or minimized considerably.
- e. To be designed to include four (4) interchangeable, modular depth sensor units: (1) 0-600 feet, (2) 0-6,000 feet, (3) 0-15,000 feet, (4) 0-39,000 feet.
- f. Depth accuracy for each module to be $\pm 1\frac{1}{4}\%$ of full scale.
- g. Current range and accuracy:
 - (1) Speed: 0.05 kt - 8.0 kts; ± 0.05 kt accuracy at readout
 - (2) Direction: 000-360°; $\pm 10^\circ$ accuracy at readout
 - (3) Instrument output should be linear with respect to the current measured over full range of interest.
 - (4) Time response: 95% response to speed step-function from zero to 1 knot in 1 second or less.

h. In designing this instrument, consideration shall be given to utilizing this instrument on other than research or survey ships, i.e., on ships conducting special current studies such as certain fleet units, commercial auxiliaries, oil exploration activities and the like.

i. Shipboard monitoring components:

(1) Computer/recorder capable of averaging current over varying time intervals as well as providing instantaneous values.

(2) Visual analog and digital tape readout.

(3) Electric or electronic sensor signals must be such as to permit the Master Shipboard Data Logging and Processing System to accomplish (1) and (2) above where this data logging and processing system is installed. Where this system is not installed, separate computing and recording equipment must be available to accomplish (1) and (2) above.

Potential Users and Estimated Number of Units Which They May Require:

a. U. S. Navy (basic research, applied research, hydrographic-oceanographic survey ships) - 50 to 250

b. U. S. Coast and Geodetic Survey - 15 to 30

c. Certain activities of the scientific community - 20 to 40

d. Bureau of Commercial Fisheries - 15 to 50

Total: 100 to 370

Recommendation Where Instrument Should Be Researched and Developed:

U. S. Industry.

Relative Importance to U. S. National Oceanographic Program:

Individual instrument priority 2.

SHIPBOARD WAVE METER

Sketch:

(To be provided)

Primary Use:

This instrument will be utilized on oceanographic survey ships to measure and record the wave spectra in the oceanic areas for general survey and other purposes.

Requirements and Specifications:

a. For use on board oceanographic survey ships in oceanic areas with ship "lying-to" or underway at slow speed (0-3 knots).

b. It is desirable that this instrument operate without the necessity of immersing any sensors in the water, in order to reduce danger of deterioration of sensors or damage to the instrument.

c. The instrument will be capable of being operated from inside a shipboard laboratory and will require no work on deck, except for preliminary calibrations and rigging the instrument for operation. There is to be no requirement to work on deck while measurements are being taken.

d. The instrument should be so designed as to require minimum installation on the ship. In particular there shall be no requirement for ship dry dock availability to install the gear. It is highly desirable that the instrument be capable of being moved from one ship to another with a minimum of effort.

e. In high waves considerable spray is to be expected. The instrument is to be so designed to withstand and minimize the effect of the spray. The instrument should be able to withstand total immersion.

f. Amplitude: The instrument is to be capable of measuring the relative displacement of the sea surface from mean sea level with an allowable error of not more than $\pm 5\%$. It must be able to do this continuously with minimum phase lag and small time constant.

g. Wave Height Range: The instrument must be able to sense displacements from mean sea level of ± 20 feet, giving a total wave height of 40 feet. Resolution should be such that wave heights of $\frac{1}{2}$ foot or greater will be measured.

h. Period-Length: The instrument should be capable of sensing all variations in relative sea surface height which have periods between 2 and 25 seconds. In terms of lengths, waves of from 20 to 2,500 feet should be sensed by the instrument. Should the sensor use as its operating principle one which averages readings over a small area of sea surface, the area involved should be less than 5 feet in diameter.

i. Duration: The instrument should be capable of measuring the relative height of the sea surface as a continuing function of time. Although measurements of $\frac{1}{2}$ hour duration will be required ordinarily, special problems will require records of many hours duration.

j. Recording and Analysis:

(1) Visible: A visible, strip chart record of wave height, as function of time, is required. This recording should be normalized, and should be of such a scale as to permit manual digitizing to the accuracy of the instrument at $\frac{1}{2}$ second intervals.

(2) In addition to visual recording, the wave data must be amenable to spectrum analysis on board ship.

(3) Electric or electronic sensor signals must be such as to permit the Master Shipboard Data Logging and Processing System to accomplish (1) and (2) above where this data logging and processing system is installed. Where this system is not installed, separate computing and recording equipment must be available to accomplish (1) and (2) above.

Potential Users and Estimated Number of Units Which They May Require:

a. U. S. Navy (basic research, applied research, and oceanographic survey ships) - 20 to 30

b. U. S. Coast and Geodetic Survey - 10 to 15

c. Certain activities of the scientific community - 10 to 15

d. U. S. Air Force Ocean Range Vessels - 6 to 8

e. Bureau of Commercial Fisheries - 2

f. U. S. Coast Guard - 15 to 30

Total: 63 to 100

Recommendation Where Instrument Should Be Researched and Developed:

U. S. Industry.

Relative Importance of Interest to U. S. National Oceanographic Program:

Individual instrument priority 3.

MULTI-PURPOSE, CONSTANT TENSION, HEAVY-DUTY OCEANOGRAPHIC WINCH

Sketch:

(To be provided)

Primary Use:

This winch will be used primarily to handle the majority of oceanographic instruments and will be utilized in most of the oceanographic survey operations. Some of these major types of operations include:

- a. Conducting "ocean-station" operations with ship "lying-to", in oceanic areas, during which a multiple number of instruments and sensors will be lowered to interim or maximum depth.
- b. Conducting deep or shallow ocean-floor dredging with either light or heavy loads.
- c. Conducting "bottom coring" operations.
- d. Conducting "towed operations", at varying speeds, utilizing various oceanographic instruments either singly or in multiple groupings.

Requirements and Specifications:

- a. To be utilized for underway and stopped ("lying-to") operations.
- b. To perform reliably at slow ship speeds (0-3 knots) under heavy deep-sea dredging loads and at high ship speeds (10-15 knots) under light trawling or towing loads.
- c. Cable Reels:
 - (1) Should be designed so as to facilitate rapid removal and change of cable reels.
 - (2) The "non-conducting" wire reel should have a capacity equivalent to 40,000 feet of 5/16 inch wire.
 - (3) The "conducting" wire reel should be constructed of non-ferromagnetic material to reduce eddy losses and to minimize noise.
 - (4) The "conducting" wire reels shall be capable of providing a number of electrical pick-offs, varying from 1 to 12.
 - (5) The "conducting" wire reel shall have a capacity equivalent to 40,000 feet of 0.3 inch diameter "conducting" cable.
- d. The design shall incorporate a "winding machine" feature for controlled laying of the cable on the storage reel during in-haul. This feature must be adjustable to accommodate wire and cable sizes varying

from 0.1 to 0.9 inch diameter.

e. There shall be a provision for constant tension control, i.e., fine control of the load's vertical motion. This constant tension should be $\pm 2\%$ or better of the load at any given instant. This feature should be readily removable or by-passed when not required. A cable load indicator must also be included.

f. It shall incorporate controlled torque for shockless stopping and starting.

g. It shall be capable of ascent-descent rates of up to 150 meters/minute.

h. The operating depth range of this equipment shall be 0 to 6,500 fathoms (0 to 39,000 feet.)

i. It shall be capable of performing with an in-haul dynamic load of 8,000 lbs, and of withstanding a "break-load" of 20,000 lbs.

j. It shall include an emergency retrieval system.

k. Although the largest and the highest priority winch is described here, it should be the basis of a series of standard-type, varying-sized winches.

Potential Users and Estimated Number of Units Which They May Require:

a. U. S. Navy (basic research, applied research, and oceanographic survey ships) - 15 to 30

b. U. S. Coast and Geodetic Survey - 6 to 15

c. Certain activities within the scientific community - 10 to 20

d. Bureau of Commercial Fisheries - 2

Total: 33 to 67

Recommendation Where Instrument Should Be Researched and Developed:

U. S. Industry.

Relative Importance to U. S. National Oceanographic Program:

Individual instrument/equipment priority 4.

SUB-SEA FLOOR STRATA PROFILER

Sketch:

(To be provided)

Primary Use:

To be utilized by oceanographic survey ships in determining the types, characteristics, and discontinuities in the upper layer sediments which cover the sea floor. In those oceanic areas where the sediment carpet is thin, it will be utilized to provide pertinent information concerning the basement rock structure.

Requirements and Specifications:

a. To perform reliably on oceanographic survey ships with the ship stopped ("lying-to") or underway at ship speeds of 0-10 knots.

b. The instrument shall be designed to perform reliably in ocean areas varying in depth from 0 to 6,500 fathoms. Within this depth of water range, it shall be capable of penetrating sediments to at least 2,000 feet in depth.

c. The transducer(s):

(1) Shall include a fixed active transducer (or other sound source) attached to the ship's hull, and/or

(2) It shall have an active streamlined transducer (or other sound source) capable of being towed at a depth suitable for maximum sediment penetration.

d. Recorder:

(1) Shall afford maximum accessability for immediate reading and marking of traces.

(2) In addition to a selection of fixed recorder paper speeds, it shall provide variable paper speeds to conform to own ship's speed.

(3) It shall permit direct navigational position data on the trace.

(4) This recorder shall be located with and controlled by the Master Shipboard Data Logging and Processing system wherever that system is available.

Potential Users and Estimated Number of Units Which They May Require:

a. U. S. Navy (basic research, applied research, and oceanographic survey ships) - 20 to 30

b. U. S. Coast and Geodetic Survey - 10 to 15

c. Certain activities within the scientific community - 15 to 30

Total: 45 to 75

Recommendation Where Instrument Should Be Researched and Developed;

U. S. Industry and the Scientific Community.

Relative Importance to U. S. National Oceanographic Program:

Individual instrument/equipment priority 5.

SMALL CRAFT, SHALLOW WATER ECHO SOUNDING INSTRUMENT

Sketch:

(To be provided)

Primary Use:

To be portable and to be utilized primarily by those small craft carried on board oceanographic survey ships for the purpose of conducting detailed, controlled shallow water bathymetric surveys in continental shelf areas and rivers throughout the world.

Requirements and Specifications:

a. To be portable and utilized primarily in those small boats and launches which are carried on board oceanographic survey ships.

b. To perform reliably at boat/launch speeds of 0-12 knots and in water depths of 0-250 fathoms, with an accuracy at readout of ± 0.5 fathom (3 feet) or better over the entire operating range.

c. Power Supply:

- (1) Should be capable of both AC and DC operation.
- (2) Should be equipped with a frequency meter and voltage regulator.

d. Transducer(s):

To include two (2) transducers of different frequency ranges, for the purpose of obtaining fine resolution of bottom detail as well as reliable performance under severe environmental conditions. These transducers are to be enclosed within the same streamlined housing.

e. This system should include a streamlined housing for the dual transducer plus a streamlined sword-arm for supporting the transducer housing assembly. The transducer housing, the sword-arm, and associated support arms should be streamlined, light weight, of simple design, rugged, and easy to rig and unrig. Additionally, the entire assembly should be designed to permit installation on either side of the small craft/launch, at the bow or stern, and with a capability of positioning the transducer housing at any depth between 2-10 feet below the surface of the water.

f. Recording:

(1) To provide a graphic recording of the bottom, in feet and in fathoms.

(2) Scales:

- (a) 0-100 feet
- (b) 0-600 feet
- (c) 0-1,500 feet

(3) Recorder design should emphasize ruggedness, simplicity, compactness, ease of maintenance, and ease of annotating the recording trace.

g. The transducer housing and sword-arm should be designed so that they can readily and easily be shipped and unshipped by two men. The same applies to the power pack-recording unit.

Potential Users and Estimated Number of Units Which They May Require:

a. U. S. Navy (basic research, applied research, and hydrographic-oceanographic survey ships) - 20 to 40

b. U. S. Coast and Geodetic Survey - 15 to 30

c. Certain activities within Scientific Community - 10 to 20

d. U. S. Coast Guard - 10 to 20

e. U. S. Navy (Bureau of Ships) - Unknown

f. Bureau of Commercial Fisheries - 10 to 30

Total: 65 to 140

Recommendations Where Instrument Should Be Researched and Developed:

U. S. Industry.

Relative Importance to U. S. National Oceanographic Program:

Individual instrument/equipment priority 6.

SURFACE SHIP AND SUBMARINE GRAVITY METER FOR SURVEY USE

Sketch:

(To be provided)

Primary Use:

This is a precision instrument designed for survey use. It will permit the continuous measurement of gravity profiles from surface ships and submarines.

Specifications and Requirements:

- a. This is primarily an underway instrument and should perform with accuracy and reliability for ship's speeds between 0 and 15 knots.
- b. It should also perform effectively in sea states 0 through 5 and under the influence of long-period swells.
- c. It must be capable of measuring over an overall range of 7,000 milligals without resetting; this range to cover 977 to 984 gals.
- d. Individual readings must be accurate to ± 2 milligals over the entire operating range.
- e. It must have a zero or a constant drift rate (not to exceed 5 milligals) over periods of at least one month, and have automatic input of corrections to readout.
- f. It must be rugged, easy to maintain, and of such size and weight as to permit installation aboard surface ships and submarines.
- g. It must be capable of making automatic corrections for horizontal accelerations, and must not be adversely affected by the average horizontal or vertical accelerations of the vessel.
- h. It must eliminate secondary vertical effects.
- i. Its readout must be compatible with Master Shipboard Data Logging and Processing System inputs, where navigational and other related data can be added to gravity data.

Potential Users and Estimated Number of Units Which They May Require:

- a. U. S. Navy (hydrographic-oceanographic survey and applied research vessels) - 10 to 20
- b. U. S. Coast and Geodetic Survey vessels - 2 to 3
- c. U. S. Air Force (ocean range vessels) - 6 to 8
- d. Scientific Community - 6 to 15

Total: 24 to 46

Recommendation Where Instrument Should Be Researched and Developed:

U. S. Industry.

Relative Importance to U. S. National Oceanographic Program:

Individual instrument/equipment priority 7.

MARINE ELECTRON RESONANCE MAGNETOMETER

Sketch:

(To be provided)

Primary Use:

To be utilized on oceanographic survey ships for the purpose of obtaining continuous profiles of the earth's total magnetic intensity.

Requirements and Specifications:

a. To be designed primarily for underway operations and secondarily for stopped operations.

b. To perform reliably at ship's speeds of 0-15 knots in sea states of 0 through 5.

c. To be designed with emphasis on simplicity, ruggedness, compactness, and minimum maintenance requirements.

d. To be designed primarily for survey type of operations with primary emphasis on installation in the survey surface ship, but with consideration of and possible application to survey use from aircraft.

e. Sensors:

<u>Data</u>	<u>Range</u>	<u>Accuracy</u>
(1) Total magnetic intensity	20,000-100,000 gammas	± 0.01 gamma
(2) Depth of sensor below surface of water	Underway Mode:	$\pm \frac{1}{4}\%$ full scale
	0 - 1,000 feet	
	Lying-to Mode:	$\pm \frac{1}{4}\%$ full scale
	0 - 6,500 fathoms	

The depth sensor modules should be interchangeable.

f. Data recording and Read-out:

(1) Visual analog at the instrument.

(2) Data from this instrument must be an input into the Master Shipboard Data Logging and Processing System.

Potential Users and Estimated Number of Units Which They May Require:

- a. U. S. Navy (basic research, applied research, hydrographic-oceanographic survey ships) - 20 to 40
- b. U. S. Coast and Geodetic Survey - 10 to 20
- c. Certain activities within Scientific Community - 10 to 20
- d. National Aeronautics and Space Agency - Unknown

Total: 40 to 80

Recommendation Where Instrument Should Be Researched and Developed:

U. S. Industry.

Relative Importance to U. S. National Oceanographic Program:

Individual instrument/equipment priority 8.

SELF-CONTAINED, DEEP-DIVING OCEANOGRAPHIC SENSING INSTRUMENT

Sketch:

(To be provided)

Primary Use:

This instrument shall be designed for utilization from oceanographic survey ships to allow the measurement and recording of certain key oceanographic data simultaneously with other underway or stopped operations. Emphasis shall be placed on simplicity and rapidity of data collection.

Requirements and Specifications:

- a. For use on oceanographic survey ships with ship stopped ("lying-to"). It may also be utilized in multiple drops, all positioned and later retrieved by one underway vessel, within a given area.
- b. To be designed as a "free" descent/ascent deep-diving instrument, capable of performing reliably to depths of 6,500 fathoms.
- c. The instrument should be designed to sink to any pre-programmed depth, at a uniform rate compatible with the time response of attached sensors, recording certain key data during the descent. Upon reaching the pre-specified depth, a mechanism or weight would be released allowing the instrument to rise uniformly to the surface, recording the data during the ascent. It would then be retrieved by maneuvering the ship and hoisting it on board.
- d. The vehicle shall be so designed that it is compact, light weight and easy to handle on board ship and in the water. It shall incorporate a provision to aid in the vehicle's location upon surfacing, day or night.
- e. The following modular data sensors shall be included: (1) temperature, (2) salinity, (3) sound velocity, (4) oxygen, (5) depth.
- f. The sensor ranges and accuracies desired are:

<u>Sensor</u>	<u>Range</u>	<u>Accuracy</u>
(1) temperature	-2° to +35°C	±0.02°C
(2) salinity (two interchangeable modules)	0 to 25°/oo 25 to 45°/oo	±0.01°/oo ±0.01°/oo
(3) sound velocity	4,500 to 5,500 feet per second	±1.0 foot per second absolute at readout

(4) oxygen	0 to 10 milliliter/liter	± 0.1 milliliter/liter
(5) depth (four inter-changeable modules)	0 to 600 feet	$\pm 0.25\%$ of full range
	0 to 6,000 feet	for each module
	0 to 15,000 feet	
	0 to 39,000 feet	

g. The sensor time responses desired are:

- (1) temperature: 95% response to a step function of 0.02°C in 1 second.
- (2) salinity: 95% response to a step function of $0.01^{\circ}/\text{oo}$ in 1 second.
- (3) sound velocity: 95% response to a step function of 1.0 foot per second in 1 second.
- (4) oxygen: 95% response to a step function of 0.1 milliliter per liter in 1 second.
- (5) depth: 95% response to a step function of 1 fathom (6 feet) in 1 second.

h. Recording:

(1) Within the instrument, there shall be continuous analog recording of all five variables simultaneously on magnetic tape.

(2) On deck, after the instrument has been retrieved, this data must be capable of immediate, direct input into the Master Shipboard Data Logging and Processing System.

Potential Users and Estimated Number of Units Which They May Require:

- a. U. S. Navy (basic research, applied research and oceanographic survey ships) - 20 to 40
- b. U. S. Coast and Geodetic Survey - 10 to 200
- c. Certain activities within the scientific community - 10 to 20
- d. Bureau of Commercial Fisheries - 30 to 100

Total: 70 to 360

Recommendation Where Instrument Should Be Researched and Developed:

U. S. Industry.

Relative Importance to U. S. National Oceanographic Program:

Individual instrument priority 9.

SURFACE NAVIGATION AND BUOY LOCATION TRANSPONDER

Sketch:

(To be provided)

Primary Use:

To be utilized on oceanographic survey ships during miscellaneous oceanographic operations for three purposes: (1) To permit seaward extension of existing shore navigation control stations in certain areas designated for specific survey assignments (hydrographic-oceanographic), (2) To aid in the location and "homing in" on deep-sea anchored buoys and/or other devices, and (3) To provide a system for establishing reference grids in extended ocean areas lacking electronic navigational aids for conducting special research and/or survey operations.

Requirements and Specifications:

a. Buoy-Mounted Transceiver Unit:

(1) Transceiver unit to be mountable on various size buoys and at a sufficient height above the surface of the water so as to permit maximum range performance.

(2) To consist of a low-powered transceiver unit which would be activated by the servicing ship's interrogation pulse and then transmit a signal back automatically on the same frequency. The transceiver should be transistorized, compact, light-weight, rugged, and provide for reliable unattended operation.

(3) Transceiver should be designed so that it can be activated, if possible, by existing survey/research surface ship's radar/radio systems and also by existing aircraft systems which might be utilized in oceanographic investigations and surveys. In brief, it should be capable of being attuned to and broadcast back on a pre-selected frequency band.

(4) Transceiver unit should contain its own power supply and this should have an assured 6-12 month life unattended, in this intermittent type of interrogation.

(5) Transceiver unit to shut down automatically when interrogation has ceased.

(6) Transceiver to perform reliably at ranges varying from 10-50 miles.

b. Shipboard/Airborne Transceiver Unit:

(1) The instrument to be designed for operation from either an

oceanographic research/survey ship or from an aircraft (scientific or military).

(2) For reasons of flexibility and economy, existing radar/radio systems as now installed in research/survey ships and scientific/military aircraft should be utilized, if feasible, for the shipboard/airborne transceiver unit.

Potential Users and Estimated Number of Units Which They May Require:

a. U. S. Navy (basic research, applied research, and hydrographic-oceanographic survey ships) - 20 to 200

b. U. S. Coast and Geodetic Survey - 10 to 20

c. Certain activities within Scientific Community - 10 to 20

d. U. S. Coast Guard - 10 to 20

e. Bureau of Commercial Fisheries - 10 to 100

Total: 60 to 360

Recommendation Where Instrument Should Be Researched and Developed:

U. S. Industry.

Relative Importance to U. S. National Oceanographic Program:

Individual instrument/equipment priority 10.

SHIPBOARD DYE DETECTOR PROBE FOR OCEANOGRAPHIC INVESTIGATIONS

Sketch:

(To be provided)

Primary Use:

To be utilized on oceanographic survey ships for the direct detection and evaluation (quantitative) of certain dyes which are used in tagging water masses for the purposes of studying diffusion, turbulence, and ocean circulation.

Requirements and Specifications:

- a. To be utilized by oceanographic survey ships when stopped ("lying-to") and when underway.
- b. Instrument design should stress simplicity, ruggedness, and light weight in construction.
- c. The sensor (dye) should have its wave length sensitivity peaked to correspond to the wave length of rhodamine type dyes. This will reduce the effect of spurious, natural background fluorescence.
- d. To be utilized in coastal and oceanic areas and in water depths of 0-6,500 fathoms.
- e. Sensors, range and accuracy:

<u>Sensor</u>	<u>Range</u>	<u>Accuracy</u>
(1) Depth	0-6,500 fathoms	$\pm 1\%$ full scale of each module
NOTE: Depth modules: 0-600 feet, 0-1,000 feet, 0-6,000 feet, 0-39,000 feet		
(2) Rhodamine	500 parts/million to .01 parts/billion	$\pm .01$ part/billion
(3) Time response: (a) <u>Depth</u> : 95% response to a step function of 1 fathom (6 feet) in 1 second at mid-range.		
(b) <u>Rhodamine dye concentration</u> : 95% response to a step function of 0.1 part per billion in 1 second.		

f. Recording and Readout:

- (1) To provide for visual analog.
- (2) The data sensed by this instrument is to be an in-input into the "Master" Shipboard Data Logging and Processing System.

Potential Users and Estimated Number of Units Which They May Require:

a. U. S. Navy (applied research, basic research, and oceanographic survey ships) - 20 to 40

b. U. S. Coast and Geodetic Survey - 10 to 20

c. Certain activities within Scientific Community - 10 to 20

d. Bureau of Commercial Fisheries - 2 to 14

e. Atomic Energy Commission - 10 to 20

Total: 52 to 114

Recommendation Where Instrument Should Be Researched and Developed:

U. S. Industry.

Relative Importance to U. S. National Oceanographic Program:

Individual instrument/equipment priority 11.

DEEP SEA PLANKTON SAMPLER

Sketch:

(To be provided)

Primary Use:

This is an instrument designed for "underway" operations from an oceanographic survey ship at moderate speeds. Its purpose is to permit quantitative sampling of a variety of sizes of plankton, at selected depths.

Requirements and Specifications:

- a. To be designed for "underway" operation and to perform reliably at ship speeds of 0-15 knots and at operating depths of 0 to 6,000 feet.
- b. Net opening to be adjusted prior to lowering in water.
- c. Net to be designed so as to be opened and/or closed on signal from the ship.
- d. Net screen (mesh) size must be capable of being adjusted remotely from the ship, with an end view of achieving a minimum of six (6) screen changes per cast.
- e. Water volume flow through net to be measured to an accuracy of ± 1 percent.
- f. This instrument should provide for attaching standard modular temperature and depth sensors to the net frame to measure and continuously transmit this data to a recorder topside. The characteristics of such standard sensors should be:

(1) Depth Sensor:

0-6,000 feet; $\pm 1\%$ of full range
Time response: 95% response to a step function of 6 feet in 1 second.

(2) Temperature:

-2° to +35°C; $\pm 0.1^\circ\text{C}$
Time response: 95% response to a step function of 1°C in 1 second.

g. Data Read-out:

(1) Proper form and type for direct input into the Master Shipboard Data Logging and Processing System.

Potential Users and Estimated Number of Units Which They May Require:

a. U. S. Navy (oceanographic survey ships, basic research ships, and applied research ships) - 19 to 22

b. Certain activities of scientific community - 12 to 20

c. U. S. Coast and Geodetic Survey - 8

d. Bureau of Commercial Fisheries - 2 to 20

Total: 41 to 70

Recommendation Where Instrument Should Be Researched and Developed:

U. S. Industry.

Relative Importance to U. S. National Oceanographic Program:

Individual instrument/equipment priority 12.

SHIPBOARD GAMMA RAY DETECTOR OF NUCLEAR WASTE IN THE SEA

Sketch:

(To be provided)

Primary Use:

To be utilized on oceanographic survey ships for identifying and measuring abnormal gamma ray concentrations in the ocean areas, such as would result from nuclear powered vessel refuse and special concentrations from other sources, such as nuclear waste dumping grounds and experimental nuclear tests conducted at sea.

Requirements and Specifications:

a. To perform reliably in depths of water varying from 0-6,500 fathoms, in both coastal and oceanic regions.

b. Sampling operation to be conducted with the ship stopped ("lying-to") and when underway.

c. Sensor module should contain, for example, a pressure protected 6" X 9" sodium iodide or plastic scintillating crystal with its associated photomultipliers and pre-amplifiers. It should also include:

(1) A device for indicating the depth of the module with an accuracy of $\pm 1\%$ full range.

(2) A discriminator analyzer element to discriminate gamma ray photon energy. The range of this element should be not less than 100 energy categories (channels).

(3) A counting rate range selective from extreme sensitivity downward by at least 5 orders of magnitude and to incorporate the following:

(a) Should measure environmental gamma ray radiation in the ocean.

(b) Should incorporate a multi-range system for special circumstances.

(c) Should range from below the natural background of the ocean to 5 orders of magnitude higher gamma intensities.

(4) Accessory equipment for analyzing a liquid or solid sample on shipboard, including a well-shielded scintillating crystal and electronic equipment connecting this to the shipboard pulse analyzer.

d. Shipboard Recording and Data Readout:

(1) The data from this system should be one of the "in-puts" into the Master Shipboard Data Logging and Processing System.

(2) This should include: (a) a multi-channel pulse height analyzer with direct dial readout, (b) visual analog readout and magnetic tape recording, (c) background storage and direct subtraction accessory.

Potential Users and Estimated Number of Units Which They May Require:

a. U. S. Navy (basic research, applied research, and oceanographic survey ships) - 20 to 40

b. U. S. Coast and Geodetic Survey - 10 to 20

c. Certain activities within Scientific Community - 10 to 20

d. Bureau of Commercial Fisheries - 2 to 8

e. Atomic Energy Commission - 10 to 20

Total: 52 to 108

Recommendation Where Instrument Should Be Researched and Developed:

U. S. Industry.

Relative Importance to U. S. National Oceanographic Program:

Individual instrument/equipment priority 13.

OCEANOGRAPHIC RADIOACTIVE WATER SAMPLER

Sketch:

(To be provided)

Primary Use:

To be utilized on oceanographic survey ships for the purpose of collecting sea water samples in order to trace and investigate radioactivity background and anomalies.

Requirements and Specifications:

- a. To be utilized when the ship is stopped ("lying-to").
- b. The sampler and associated gear to be constructed of non-contaminating material.
- c. The sampler to contain a plastic liner of about 15 gallon capacity.
- d. The sampler must be of a non-contaminating type which can be opened and closed at any desired depth by remote operation from shipboard. This may or may not require the need for the sampler to withstand hydrostatic pressure.
- e. To be designed so that one to two men can conduct the sampling operation, utilizing standard hydrographic wire and equipment.
- f. To be designed to permit operation in multiples of four or more samplers per cast.
- g. The system must include approximately 15-gallon size shipping containers for shipment of samples to laboratories for analysis and also include spare plastic liners to replace those which are used.
- h. Analysis of water samples to be performed either on shipboard, if facilities are available, or at shoreside laboratories.
- i. This 15-gallon size sampler is the first and highest priority of a series of sampler sizes, which should increase by an order of two, three and/or four.

Potential Users and Estimated Number of Units Which They May Require:

a. U. S. Navy (basic research, applied research, survey ships) - 20 to 40

b. U. S. Coast and Geodetic Survey - 10 to 20

c. Certain activities within Scientific Community - 10 to 20

d. Bureau of Commercial Fisheries - 2 to 10

e. Atomic Energy Commission - 20 to 40

Total: 62 to 130

Recommendation Where Instrument Should Be Researched and Developed:

U. S. Industry.

Relative Importance to U. S. National Oceanographic Program.

Individual instrument/equipment priority 14.

UNDERWATER CAMERA

Sketch:

(To be provided)

Primary Use:

To be utilized on oceanographic survey ships for the purpose of obtaining close-up photographs, both single-frame and stereo, of the detailed topography of the sea floor. It will also be employed for photogrammetric mapping of the sea floor.

Requirements and Specifications:

- a. To be utilized primarily for stopped ("lying-to") operations but also for slow-speed operations with ship underway at 0-5 knots.
- b. To be operable in coastal and oceanic waters, at depths of 0-6,500 fathoms.
- c. Film capacity: Approximately 100 to 150 feet of 70mm film.
- d. Photographic distance:
 - (1) Single-frame photographs: should accept object distances of 2-30 feet.
 - (2) Stereo photographs: should accommodate close (2 feet) and long (35-50 feet) object distances.
- e. The camera instrument must include, or have attached thereto, a device which measures and indicates at all times to an observer on deck the precise height of the camera unit above the sea floor.
- f. A deep-water, synchronized illuminating device must be incorporated in this instrument in order to light adequately the photographic field.
- g. The instrument must incorporate variable, pre-programmed shutter operation to provide for both continuous and time-series studies.
- h. The camera unit must be capable of taking both horizontal and vertical underwater photographs.

i. The camera and its associated devices should provide and photograph the following minimum supporting information in the corner of each frame: (1) date/time, (2) location, (3) camera attitude, and (4) camera direction.

j. In addition, a turbidity meter shall be incorporated into the system for on-deck indication of operational photographic conditions and/or for general environmental knowledge.

Potential Users and Estimated Number of Units Which They May Require:

a. U. S. Navy (basic research, applied research, and oceanographic survey ships) - 20 to 40

b. U. S. Coast and Geodetic Survey - 10 to 20

c. Certain activities within Scientific Community - 10 to 20

d. Bureau of Commercial Fisheries - 2 to 8

Total: 42 to 88

Recommendation Where Instrument Should Be Researched and Developed:

U. S. Industry.

Relative Importance to U. S. National Oceanographic Program:

Individual instrument/equipment priority 15.

SEA FLOOR SAMPLING SYSTEM

Sketch:

(To be provided)

Primary Use:

This is primarily a series of interchangeable bottom sampling devices designed for utilization by oceanographic survey ships in the collection of various samples of the sea floor.

Specifications and Requirements:

- a. The system shall be designed for utilization by oceanographic survey ships "lying-to" and/or underway with slight "head-way" on.
- b. The system shall be operable in water depths varying from 0-6,500 fathoms.
- c. The system shall include, but not be restricted to, the following interchangeable sampling devices: (1) small "grab" samplers, (2) short corers (0-15 feet), (3) long corers (0-100 feet), (4) light-weight dredge, (5) heavy-weight dredge, (6) long "in-situ" sampling device, (7) large volume interface sediment sampler (capacity 1 cubic foot), (8) short "in-situ" sampling device.
- d. The "in-situ" sampling devices indicated above shall be capable of obtaining an undisturbed sample of the water/bottom interface, including retention of ambient pressure at sampling depths of 1 to 20 feet for the long and up to 6 inches for the short "in-situ" devices
- e. Although certain types of corers and samplers now exist, they are considered to be in need of improvement and consequently, new and radical scientific and engineering techniques are needed to develop an overall improved Sea Floor Sampling System.
- f. The various attachments associated with this system, if tended by a wire, shall be so designed that they can be used with the Multi-Purpose Heavy Duty Oceanographic Winch described separately in this Oceanographic Survey Ship instrument system.

Potential Users and Estimated Number of Units Which They May Require:

- a. U. S. Navy (for oceanographic survey ships, basic research ships, and applied research ships) - 19 to 22

- b. Certain activities within the scientific community - 12 to 20
- c. U. S. Coast and Geodetic Survey - 8 to 15
- d. Bureau of Commercial Fisheries - 2

Total: 41 to 59

Recommendation Where System Should Be Researched and Developed:

U. S. Industry.

Relative Importance to U. S. National Oceanographic Program:

Individual Instrument/Equipment Priority - 16

SEA FLOOR GEOTHERMAL PROBE

Sketch:

(To be provided)

Primary Use:

To be utilized on oceanographic survey ships, with the ship stopped ("lying-to"), to measure the heat-flow characteristics and values across and within the sea floor sediments.

Requirements and Specifications:

- a. To be utilized during stopped ("lying-to") operations.
- b. To perform reliably and accurately in water depths of 0 to 6,500 fathoms.
- c. Instrument should be simple in design and construction, rugged, and easy to transfer from one ship to another for re-installation. Modular sensors could be attached to the long and short sediment corers of the Sea Floor Sampling System.

d. Data to be measured:

<u>Data</u>	<u>Range</u>	<u>Accuracy</u>
Heat Flow	0 to 10 micro cal/cm ² /sec	±0.05 micro cal/cm ² /sec
Temperature gradient	0 to 0.6°C/meter	±0.001°C/meter
Temperature	0 to 5°C (0 to 20 feet)	±0.001°C
	0 to 10°C (0 to 100 feet)	±0.001°C
Depth of probe (corer) in sea floor	0 to 20 feet	±0.1 foot (or measured mechanically or visually on core barrel)
	0 to 100 feet	

e. Data Recording and Readout:

Data to be displayed and recorded on Master Shipboard Data Logging and Processing System; or, if more practicable, recorded internally at the probe.

Potential Users and Estimated Number of Units They May Require:

a. U. S. Navy (applied research, basic research, and oceanographic survey ships) - 20 to 30

b. U. S. Coast and Geodetic Survey - 10 to 15

c. Certain activities within Scientific Community - 10 to 20

Total: 40 to 65

Recommendation Where Instrument Should Be Researched and Developed:

U. S. Industry.

Relative Importance to U. S. National Oceanographic Program:

Individual instrument priority 17.

SHIPBOARD OCEANOGRAPHIC SURVEY SYSTEM

Sketch:

(To be provided)

Primary Use:

To be utilized on oceanographic survey ships incorporating the most up-to-date techniques for collection, storage, reduction, and possible transmission of oceanographic data.

Requirements and Specifications:

a. For utilization on oceanographic survey ships with the ship in any of the following modes of operation: (1) stopped ("lying-to"), (2) at anchor and (3) underway at slow speeds (0-3 knots).

b. To perform efficiently, effectively, and safely in sea states of 0 through 5.

c. To be operable in water depths of 0-6,500 fathoms.

d. To be able to simultaneously accommodate any or all of the sensor modules listed in sub-paragraph e. following.

e. Sensor - Range - Accuracy:

<u>Sensor</u>	<u>Range</u>	<u>Accuracy</u>
(1) <u>Depth</u> (4 modules)	0-600 feet 0-2,400 feet 0-6,000 feet 0-39,000 feet	$\pm 0.25\%$ of full scale for each range
(2) <u>Temperature</u>	-2° to $+35^{\circ}\text{C}$	$\pm 0.01^{\circ}\text{C}$
(3) <u>Sound Velocity</u>	4,500-5,500 feet/sec	± 1.0 foot/sec absolute at readout
(4) <u>Light Absorption</u>	0-100%	$\pm 1.0\%$
(5) <u>Density</u>	1.00000-1.08000	± 0.00001
(6) <u>Subsurface Currents</u>	0-8 kts 0-360 $^{\circ}$	± 0.1 kt or better $\pm 10^{\circ}$
(7) <u>In-Situ, Modular Ion Analyzer</u>		
(a) Oxygen	0-10 milliliters/ liter	± 0.1 milliliter/liter

(b) Salinity (two interchangeable modules)	0-25 ⁰ /oo 25-45 ⁰ /oo	±0.01 ⁰ /oo ±0.01 ⁰ /oo
(c) Nitrate-Nitrogen	0-50 microgram atoms/ liter	±0.1 microgram atoms/ liter
(d) Phosphate-Phosphorus	0-5 microgram atoms/ liter	±0.01 microgram atoms/ liter
(e) Silicates	0-200 microgram atoms/liter	±0.1 microgram atoms/ liter
(8) Total Magnetic Intensity	20,000-100,000 gammas	±0.1 gamma

Note: Sensor Time Response: All sensors should have a 95% response to a step function in a period of 1 second.

(f) Recording and Readout:

The system shall be designed so that the above data will be read directly into the Master Shipboard Data Logging and Processing System either continuously (time-series) and/or intermittently.

(g) If multi-conductor electric cable is employed, this cable and the various sensors associated with this system shall be compatible and useable in conjunction with the Multi-Purpose Constant Tension, Heavy Duty Oceanographic Winch, described elsewhere.

(h) Sensors shall be constructed in modular form, with simplicity so that they can be easily repaired and/or replaced at sea.

Potential Users and Estimated Number of Units Which They May Require:

a. U. S. Navy (basic research, applied research, and oceanographic survey ships) - 20 to 40

b. U. S. Coast and Geodetic Survey - 10 to 20

c. Certain activities within Scientific Community - 10 to 20

d. Bureau of Commercial Fisheries - 2 to 10

e. U. S. Coast Guard - 10 to 20

Total: 52 to 110

Recommendation Where Instrument Should Be Researched and Developed:

U. S. Industry.

Relative Importance to U. S. National Oceanographic Program:

Instrument System priority 1.

PRECISION NAVIGATIONAL CONTROL SYSTEM
FOR OCEANOGRAPHIC SURVEY OPERATIONS

Sketch:

(To be provided)

Primary Use:

To be utilized by oceanographic survey ships for obtaining precise navigational positioning incidental to routine oceanographic surveys and/or special oceanographic investigations.

Requirements and Specifications:

a. To be utilized on oceanographic survey ships in the conduct of routine oceanographic surveys and special oceanographic investigations.

b. To be utilized in both coastal and oceanic operations, day and night, and to have an all-weather capability.

c. The system operation must be reliable, i.e., have an on-the-air time in excess of 95% and signals must be free of any ambiguity.

d. To be readily adaptable to automatic plotting of position on a plotting sheet.

e. To be designed to support a dual-range operational capability as follows:

- (1) Short range (0-200 miles); accuracy ± 50 feet
- (2) Long range (0-5,000 miles); accuracy $\pm \frac{1}{2}$ -1 mile.

f. Shipboard system to be designed emphasizing modular construction, compactness, ruggedness, and ease and simplicity of operation and maintenance. In any case, ship's crew should be able to operate and service the system at sea without extensive specialized training. If feasible, both short and long range systems should be incorporated into one console.

g. "Position" information obtained from both of these systems must be capable of being read automatically into the Master Shipboard Data Logging and Processing System simultaneously and in conjunction with any environmental data.

h. Provision also shall be made for direct "read-in" of "position" information from both the short and long range system into the Hydrographic Precision Scanning Echo Sounder System.

i. Geographic Coverage:

This system(s) must be world-wide, ocean-wide; however, the short range system coverage may be limited by shore station site availability.

Potential Users and Estimated Number of Shipboard Units Which They May Require:

a. U. S. Navy (basic research, applied research, hydrographic- oceanographic survey ships) - 20 to 40

b. U. S. Coast and Geodetic Survey - 10 to 20

c. Certain activities within Scientific Community - 10 to 20

d. Bureau of Commercial Fisheries - 10 to 15

e. U. S. Coast Guard - 10 to 20

Total: 60 to 115

Recommendation Where Instrument Should Be Researched and Developed:

U. S. Industry.

Relative Importance to U. S. National Oceanographic Program:

Instrument system priority 2.

MASTER OCEANOGRAPHIC SHIPBOARD DATA LOGGING AND PROCESSING SYSTEM

Sketch:

(To be provided)

Primary Use:

To be utilized on oceanographic survey ships. In view of the many ships scheduled to be employed in ocean-wide research and survey programs, it is imperative that the maximum quantity of data possible be processed on board ship. This data processing system, through being sufficiently versatile to handle a variety of data inputs, should provide the required on-board data analyzing, logging, processing, and storage capability. This system will expedite the availability of "smoothed" field data for utilization by either the scientific leader or survey party chief "in the field" in order to achieve optimum results.

Requirements and Specifications:

- a. To be utilized and perform reliably under the following modes of survey type of operations: (1) ship stopped ("lying-to"), (2) ship anchored, and (3) ship underway at speeds 0-18 knots.
- b. System to function reliably in sea states 0 through 5.
- c. The system should employ solid state circuitry wherever possible to reduce size, weight, and heat generation.
- d. It should be versatile enough to record information from a large variety of sensors and transducers, in both digital and analog form, and to include such key information as time, position, course, speed, ship, cruise number on all data records.
- e. It should employ modular construction, plug-board system programming, and stored program system control.
- f. It should incorporate, but not be limited to, the following major components to achieve the above:
 - (1) A multi-channel high quality analog magnetic tape recorder having modular read-write electronics for direct and FM recording.

(2) Input commutators:

(a) A 100 channel simple sequential commutator having a variable sampling rate up to 100 samples per second. This commutator also should have a switching mode wherein sequential groups of 10 channels can be selected.

(b) A multi-channel simultaneous sample hold and multiplex commutator having a variable sampling rate up to 12,000 per second.

(c) A commutator control unit to permit combined or independent use of the two commutators.

(3) Analog to digital converters:

(a) A 12 bit bipolar A-D converter having a variable sampling rate up to 12,000 samples per second. (Small aperture, 50 microsecs).

(b) A 12 bit bipolar voltage to frequency type A-D converter having a variable sampling period in the range of 10 msec to 1 sec.

(4) A small scale digital computer having the following characteristics: (1) 12 microsecond add time, (2) 4,096 words of random access memory, (3) Two independent serial by word input/output channels at least one of which can be used in an automatic buffer mode at a word rate of 60 KC, (4) At least one on-line digital magnetic tape unit, (5) Punched paper tape input/output at not less than 110 characters per second, and (6) An on-line monitoring typewriter.

(5) A system programming board having the following characteristics: (1) 500 audio frequency jacks, (2) A removable 1,000 hole plug board.

(6) A 30 by 30 inch combined digital-analog X-Y plotter with punched paper tape input.

(7) Several independent analog displays units to monitor while recording.

(8) 250 inches of standard 19 inch rack for mounting special instrumentation. Racks are to be equipped with power outlets and signal lines running to system programming board.

(9) Air conditioning and humidity control.

Potential Users and Estimated Number of Units Which They May Require:

a. U. S. Navy (basic research, applied research, and oceanographic survey ships) - 20 to 25

b. U. S. Coast and Geodetic Survey - 5 to 8

- c. Bureau of Commercial Fisheries - 2
- d. Certain activities within Scientific Community - 2 to 6
- e. U. S. Coast Guard - 5 to 10

Total: 34 to 51

Recommendation Where System Should Be Researched and Developed:

U. S. Industry.

Relative Importance to U. S. National Oceanographic Program:

Instrument System priority 3.

TOWED SUBSURFACE INSTRUMENT SYSTEM

Sketch:

(To be provided)

Primary Use:

This device is designed for utilization on oceanographic survey ships for underway operations to obtain horizontal profiles of certain key oceanographic variables. It is to be a streamlined, compact platform to which will be attached modular sensors and other special miniaturized instruments capable of being towed submerged at moderate speeds.

Requirements and Specifications:

a. The platform with associated instruments shall be capable of being towed from an oceanographic survey ship at any constant depth within a depth range of 0-2,000 feet at any ship's speed ranging from 3 to 15 knots. In addition, a feature should be incorporated in the vehicle design to permit continuous, controlled variation of the platform's depth over the entire operating depth range or any increment thereof.

b. The towing wire angle shall not exceed 25° from the vertical.

c. The platform and associated instruments shall be compact, streamlined, and not excessively heavy or bulky in order to allow rapid and adequate deck stowage and/or to permit smooth entry into or hoisting out of the water.

d. The following sensors shall be included:

<u>Sensor</u>	<u>Range</u>	<u>Accuracy</u>
Temperature	-2 to $+35^{\circ}\text{C}$	$\pm 0.01^{\circ}\text{C}$
Salinity (two interchangeable modules)	0 to $25^{\circ}/\text{oo}$ 25 to $45^{\circ}/\text{oo}$	$\pm 0.01^{\circ}/\text{oo}$ $\pm 0.01^{\circ}/\text{oo}$
Sound Velocity	4,500 to 5,500 feet/second	± 1 foot/sec absolute at readout
Depth (two interchangeable modules)	0 to 600 feet 0 to 2,000 feet	$\pm 0.25\%$ of full scale

Sensor Time Response: All sensors, except depth, should have a 95% response to a step function in a period of 1 second. The depth sensor should have a 95% response to a step function of 1 fathom (6 feet) in a period of 1 second.

e. Data Recording and Readout:

Temperature, salinity, sound velocity and depth data shall be transmitted from the sensors into the Master Shipboard Data Logging and Processing System.

f. This platform should be able to be rigged from and towed by the Multi-purpose, Constant Tension, Heavy Duty Oceanographic Winch where it is available.

g. If this unit can be mass-produced cheaply, it may have widespread commercial fishing application.

Potential Users and Estimated Number of Units Which They May Require:

a. U. S. Navy (basic research, applied research, and oceanographic survey ships) - 20 to 30

b. U. S. Coast and Geodetic Survey vessels - 10 to 15

c. Bureau of Commercial Fisheries vessels - 2 to 20

d. Certain activities within the scientific community - 10 to 20

Total: 42 to 85

Recommendation Where Equipment Should Be Researched and Developed:

U. S. Industry.

Relative Importance to U. S. National Oceanographic Program:

Instrument System priority 4.

AIR-SEA SURFACE INTERFACE ENVIRONMENTAL DATA RECORDING SYSTEM

Sketch:

(To be provided)

Primary Use:

To be utilized by oceanographic survey ship primarily for underway operations, and secondarily for stopped operations, to sample and record the key environmental data found at and/or near the air-sea interface.

Requirements and Specifications:

a. To be designed and constructed primarily for underway operations at ship's speeds of 0-15 knots.

b. A strict requirement is that the sensors be designed and located so as to measure the environment immediately at the interface or as close thereto as possible, without being adversely affected by own ship's motion and air turbulence over the ship projections as the ship moves through the water.

c. Sensors: Ranges and Accuracies:

<u>Sensor</u>	<u>Range</u>	<u>Accuracy</u>
Sea surface Temperature	-2° to +35°C	±0.1°C
Sea surface salinity	0 to 25°/oo	±0.01°/oo
(two interchangeable modules)	25 to 45°/oo	±0.01°/oo
Sea surface oxygen	0 to 10 milliliters/liter	±0.1 milliliter/liter
Air temperature	-40° to +70°C	±0.01°C
Relative humidity	0 to 100%	±5%
or	or	or
Dew point	-40 to +50°C	±0.1°C
Barometric pressure	950 to 1,050 millibars	±0.1 millibar
Wind speed and direction	Speed: 0 to 200 knots Direction: 0 to 360°	Speed: ±0.5 knots Direction: ±5°
Indident radiation	0 to 40 Langleys/minute	±5% overall range
Reflected radiation	0 to 100 (U.S. Weather Bureau special scale)	±5% overall range

The system should include provision for a towed, submerged, constant depth device to measure wave spectra and transmit this data to the Master Shipboard Data Logging and Processing System for correlation with other recorded data.

Sensor Time Response: All sensors should afford a 95% response to a step function in a period of 1 second.

d. Recording and Readout:

Above data must be a direct and immediate input into the Master Shipboard Data Logging and Processing System, on a continuous and/or intermittent recording basis.

Potential Users and Estimated Number of Units Which They May Require:

- a. U. S. Navy (basic research, applied research, and oceanographic survey ships) - 20 to 30
- b. U. S. Coast and Geodetic Survey - 10 to 15
- c. Certain activities within Scientific Community - 10 to 20
- d. Bureau of Commercial Fisheries - 2 to 8
- e. U. S. Weather Bureau - 10 to 20

Total: 52 to 93

Recommendation Where Instrument Should Be Researched and Developed:

U. S. Industry.

Relative Importance to U. S. National Oceanographic Program:

Instrument System priority 5.

MARINE SEISMIC RECEIVING SYSTEM

Sketch:

(To be provided)

Primary Use:

To be utilized on oceanographic survey ships to measure and record the various characteristics of the structure of the sea floor as applicable to acoustical propagation studies of the water volume, the bottom sediments, and the underlying structures.

Requirements and Specifications:

a. To perform reliably on oceanographic survey ships, in sea states of 0 through 5, with ship stopped ("lying-to").

b. To be operable in coastal and oceanic regions, in water depths of 0 to 6,500 fathoms.

c. To be designed so that the equipment is portable, compact, rugged, simple, requiring minimum maintenance, and readily and easily transferable from one ship to another.

d. The receiving hydrophone must be so designed as to permit reliable detection of shots as far as 100 nautical miles away.

e. Receiving hydrophone frequency:

(1) Range: 0 to 10 KCS

(2) Accessory Filters:

(a) Filters to permit the selection of high frequency band (usually greater than 4 KCS) for the resolution of thin-bedded strata.

(b) Filters to permit the selection of low frequency band (usually lower than 500 C.P.S.) for maximum penetration of the sediments.

f. Data recording and readout:

(1) Data to be directly read into the Master Shipboard Data Logging and Processing System.

Potential Users and Estimated Number of Units Which They May Require:

- a. U. S. Navy (basic research, applied research, and oceanographic survey ships) - 20 to 40
- b. U. S. Coast and Geodetic Survey - 10 to 20
- c. Certain activities within Scientific Community - 5 to 10
- d. U. S. Geological Survey - 2 to 4
- e. Commercial oil companies - Unknown

Total: 37 to 74

Recommendation Where Instrument Should be Researched and Developed:

U. S. Industry.

Relative Importance to U. S. National Oceanographic Program:

Instrument System priority 6.

UNDERWATER TELEVISION SYSTEM FOR SEA FLOOR INVESTIGATIONS

Sketch:

(To be provided)

Primary Use:

To be utilized on oceanographic survey ships in coastal and oceanic areas to obtain continuous observations of and to investigate the sea floor topography.

Requirements and Specifications:

- a. To be operable in water depths of 0 to 6,500 fathoms, with the ship stopped ("lying-to") or underway at slow speeds (0 to 5 knots).
- b. The system must include a device for indicating the precise height of the camera above the sea floor.
- c. The design of this system must include a provision for "taping" all of its coverage for re-run at a later time.
- d. The camera carrying unit must contain, or have attached to it, an illuminating device which is capable of adequately lighting the T.V. picture field at all depths and which has a duration of at least two hours of sustained operations.
- e. There must be provision for remote focus and lens control from shipboard.
- f. The camera carrying unit must be streamlined, rugged, compact, and capable of being handled readily and easily on board ship during operations.

Potential Users and Estimated Number of Units Which They May Require:

- a. U. S. Navy (basic research, applied research, and oceanographic survey ships) - 15 to 30
- b. U. S. Coast and Geodetic Survey - 5 to 15
- c. Certain activities within Scientific Community - 5 to 15
- d. Bureau of Commercial Fisheries - 2 to 8

Total: 27 to 68

Recommendation Where Instrument Should Be Researched and Developed:

U. S. Industry

Relative Importance to U. S. National Oceanographic Program:

Instrument System priority 7.

U. S. NAVY HYDROGRAPHIC OFFICE

REQUIREMENTS

FOR

OCEANOGRAPHIC INSTRUMENT SUIT

FOR

SHIPS-OF-OPPORTUNITY

Government-Industry
Oceanographic Instrumentation
Symposium

16-17 August 1961

Bostwick H. H. H.

U. S. NAVY HYDROGRAPHIC OFFICE REQUIREMENTS
FOR
OCEANOGRAPHIC INSTRUMENT SUIT FOR SHIPS-OF-OPPORTUNITY

Sketch:

(To be provided)

Primary Use:

This is a special oceanographic "instrument suit" for utilization on certain "ships-of-opportunity" to collect much needed oceanographic data. These ships-of-opportunity include, but are not restricted to: (1) certain U. S. Navy combatant Fleet units such as aircraft carriers, cruisers, destroyers, amphibious ships, mine sweepers, and submarines, (2) U. S. Navy Radar Picket Ships (YAGR's and DER's), (3) certain U. S. Navy auxiliary units (oilers, refrigerator ships, cargo ships, ice breakers), (4) units of Military Sea Transportation Service, (5) units of U. S. Merchant Marine, (6) U. S. Air Force Ocean Range Vessels, (7) larger units of U. S. Fishing Fleet. The installation and operation of this "instrument suit" on the above-indicated platforms is predicated on a not-to-interfere basis with the ship's primary mission.

Requirements and Specifications:

a. This "instrument suit" is primarily designed for utilization by ships "underway", as during long transits between ports, extended operations in certain geographic areas, and involving special operations related to the primary mission of the ship.

b. This "instrument suit" to perform reliably and accurately, with minimum maintenance, at ship's speeds of 0 to 18 knots and in sea states 0 through 5.

c. This "instrument suit" to be so designed and constructed as to be capable of being installed and removed from one platform to another with minimum expenditure of time, effort and money. In this connection, it should be compact, light weight, rugged and reliable to withstand the severe treatment in shipment to, installation on and removal from the various ship platforms.

d. Components:

(1) AN/UQN type of Sonic Sounding Set to record 0 to 6,000 fathoms.

(2) Precision depth/graphic recorder for utilization with AN/UQN Sonic Sounding Set.

(3) One electronic bathythermograph with associated winch-wire-boom-recorder/readout assembly.

(4) An automatic recording sea-surface temperature probe.

(5) A suit-case size meteorological instrument to record automatically key air-sea interface meteorological data, including total incident and reflected solar radiation.

(6) Towed magnetometer with an all-weather capability.

(7) An "interim" wave height measuring/recording device.

In the design and fabrication of this "instrument suit", consideration shall be given to two different applications: (1) installing all of the above in a small "van" for trans-shipment to and on-deck stowage on the particular ship or (2) integrating certain of the above components into already-existing "instrument suits" of certain ships such as destroyers, etc.

e. Accuracies and Range:

(1) Sonic Sounding Set

Range: 0 to 6,000 fathoms

Accuracy: As in present AN/UQN system

(2) PDR/PGR

Range: 400-fathom incremental presentation of
0 to 6,000-fathom range

Accuracy: 1 part per million (time)

(3) Electronic Bathythermograph

Range: (1) Depth: 0 to 2,500 feet

(2) Temperature: -2° to $+35^{\circ}\text{C}$

Accuracy: (1) Depth: $\pm 0.25\%$ of full range

(2) Temperature: $\pm 0.1^{\circ}\text{C}$

(4) Sea Surface Temperature Recorder

Range: -2° to $+35^{\circ}\text{C}$

Accuracy: $\pm 0.1^{\circ}\text{C}$

(5) Meteorological Suitcase - Type Package

To be determined, but to include: (1) air surface temperature, (2) barometric pressure, (3) relative humidity, (4) surface wind direction and speed, (5) total incident and reflected solar radiation with following ranges and accuracies:

<u>Sensor</u>	<u>Range</u>	<u>Accuracy</u>
Air surface temperature	-40 to $+70^{\circ}\text{C}$	$\pm 0.01^{\circ}\text{C}$
Barometric pressure	950 to 1,050 millibars	± 0.1 millibar
Relative humidity	0 to 100%	$\pm 5\%$
Surface wind: speed	0 to 200 knots	± 0.5 knot
direction	0 to 360°	$\pm 5^{\circ}$
Radiation: incident	0 to 40 Langleys/ minute	$\pm 5\%$ overall range
reflected	0 to 100 (U.S. Weather Bureau special scale)	$\pm 5\%$ overall range

(6) Magnetometer

Range: 20,000 to 100,000 gammas

Accuracy: ± 0.01 gamma

(7) Wave Meter

Range: 0 to 40 feet

Accuracy: ± 0.5 foot

f. Modular construction should be used throughout the system to: (1) facilitate maintenance and repair, and (2) to permit special "tailor-made" assembling of sensors and recorders in order to augment the particular ship's existing instrumentation (such as in the case of Fleet units which are already partially equipped).

g. The recording of all data should be automatic insofar as possible. In addition, data readout and recording should be in such form that it can be a direct input into the archives of the National Oceanographic Data Center.

Potential Users and Estimated Number of Units Which They May Require:

- a. U. S. Navy - 25 to 100
- b. U. S. Air Force Ocean Range Vessels - 4 to 8
- c. MSTs and U. S. Merchant Marine - 25 to 50
- d. U. S. Fishing Fleet - 2 to 5

Total: 56 to 163

Recommendation Where System Should Be Researched and Developed:

U. S. Industry.

Relative Importance to U. S. National Oceanographic Program:

(1) Of intermediate importance and priority as related to the overall U. S. National Oceanographic Program.

(2) Has a potential of increasing in importance as the National Oceanographic Program progresses, and it can be of valuable assistance to the Navy ASWEPS program.