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DIVING SUBMARINE USS DOLPHIN (AGSS-555) (U)

Ad Hoc Committee
author

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PROPOSED ACOUSTIC AND OCEANOGRAPHIC PROGRAM FOR THE DEEP-DIVING SUBMARINE USS DOLPHIN (AGSS-555) [redacted]

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PROPOSED ACOUSTIC AND OCEANOGRAPHIC PROGRAM FOR THE DEEP-DIVING SUBMARINE USS DOLPHIN (AGSS-555)

INTRODUCTION

This memorandum is intended as a supplement to NEL Letter Report No. 081[1] (see list of references, p. 28), which discussed a proposed "Sonar Suit" and research program for the deep-diving submarine USS DOLPHIN (AGSS-555). The keel for this submarine has been laid and operations are estimated to start in the fall of 1964. The DOLPHIN will operate to depths of 4000 feet with a limited crew and payload. The characteristics are described in reference 1.

Somewhat more detailed programs are presented here for Phase II, Acoustic and Oceanographic Research. The best available estimates of sizes, weights, and power requirements are given for the several equipments which are proposed for the programs. It is to be noted that acoustic and oceanographic research go hand-in-hand and that the two parts of Phase II are a matter of relative emphasis. The first part, Acoustic Research, requires supporting oceanographic research; the second part, Oceanographic Research, will utilize some acoustic methods.

Each author estimated on the basis of his specialized experience how the AGSS-555 could be best used to serve U.S. Navy research in the period estimated in reference 1 to start in March 1965. It is to be noted that while this is a little more than two years distant, the weights, volumes, and power requirements are needed now. All of the committee members have cooperated in the final review of this Technical Memorandum.

Authors of the various sections were:

Acoustic Research Program:	M. A. Pedersen
Sea-Floor Research Program:	Dr. E. L. Hamilton
Proposed Research in Physical Oceanography:	O. S. Lee
Biological Oceanography:	Dr. E. H. Barham
Other Proposed Physical Measurements:	K. V. Mackenzie
Introduction and Conclusions:	R. L. Waldie and K. V. Mackenzie

This paper should not be construed as a formal report. It is hoped that the information provided here will be useful and pertinent in the present planning stage of the program. The program described here is intended to complement, not replace, the NEL bathyscaph program.

ACOUSTIC RESEARCH PROGRAM

Introduction

An acoustic research program for the USS DOLPHIN (AGSS-555) has been adequately outlined in section 8 of reference 1. Our purpose here is to expand this outline somewhat by indicating in more detail the importance of a few specific experiments. We shall confine the discussion here to experiments for which the USS DOLPHIN is particularly suited, i.e., experiments which cannot be done as well by other techniques presently available.

Acoustic Fields for Deep Sources

In order to assess the sonar capability of deep diving vehicles, it is necessary to study the dependence of propagation loss on source depth. Theoretical work has progressed satisfactorily and is described in reference 2 but experimental work has lagged due to the inability to accumulate data at an adequate rate. Experimental work in the past has consisted of lowering or towing from surface ships. Work with lowered sources has been confined to a very limited sampling of the acoustic field at discrete ranges. Work with towed sources suffers from the difficulty of controlling the depth and the orientation of sources.

There are several pertinent experiments for which the USS DOLPHIN is well adapted. The first consists of transmitting pulsed CW from the USS DOLPHIN and receiving on hydrophones suspended at various depths from a surface ship. The USS DOLPHIN would close range (on the receiving ship) at a fixed depth of interest. This type of run would then be conducted repeatedly for as many source depths as desired. With a suitable pulse repetition rate and closing speed, practically continuous coverage in range could be achieved. For example, at a speed of 5 knots and a rate of 8 pulses per minute, data points could be obtained every 21 yards over a range interval of as long as 80 miles in a single run.

A modified procedure is for the USS DOLPHIN to change depth fairly rapidly while closing range slowly. This procedure permits a rapid probing of the depth structure of the acoustic field over a rather limited range interval. The experimental data for such a test are not too meaningful alone, since range and depth are varying simultaneously. However, such experimental data may be used to verify theoretical computation in the form of propagation loss contours in the range-depth plane.[2]

The Gertrude Alpha transducer, operating at 3 kc appears satisfactory for the experiments just discussed. It would be advantageous to have lower frequency sources aboard the USS DOLPHIN but size and weight limitations seem to preclude adequate source levels. This drawback can be overcome by reversing the roles of the USS DOLPHIN and the surface ship in the experiments just discussed. The USS DOLPHIN can receive on a calibrated hydrophone and record on magnetic tape, while changing range or depth at a speed compatible with sufficiently low noise levels. The surface ship can cyclically transmit pulses at a variety of frequencies from sources at at selected depths. In this manner one may examine the receiver depth, source depth, and range structure as a function of frequency without the necessity of huge low-frequency sources aboard the USS DOLPHIN.

Advantages of having source and receiver at both the USS DOLPHIN and surface ship will be discussed later under echo-ranging tests.

There has been recent interest in the acoustic field for source depths between the bottom-limited depth and the ocean bottom. The USS DOLPHIN cannot investigate this region in low latitudes such as off the California Coast where bottom-limiting occurs at about 10,000 feet. However, such conditions can be investigated by the USS DOLPHIN at higher latitudes during the winter months where surface sound velocities are low.

A somewhat more specialized but related set of experiments involves transmission at or near the axis of minimum velocity (SOFAR channel propagation). We are interested in experimentally checking the adequacy (or inadequacy) of ray theory in this situation and also the applicability of normal mode theory. This axial type of propagation has also been utilized in the past by both NEL and USL to measure attenuation or absorption of sound. This former work has been limited because of inadequate sampling in range.

Echo Ranging Tests

Let us first call attention to the desirability of having a source and receiver at the target ship in controlled echo-ranging experiments. This has been a standard procedure in early Lorad tests. The transmission from the target source is used at the echo-ranging ship to determine bearing and whether propagation loss will permit active detection. The receiver aboard the target measures propagation loss at the echo-ranging frequency, which is necessary in calculating target strengths. Thus in an experiment of this type we not only determine the echo-ranging capability of a system but also we obtain measurements of propagation loss at two frequencies and target strength at one frequency. These additional measurements are extremely useful in pointing up discrepancies or explaining why echo-ranging performances are good or poor. Another advantage of two-way transmission is that fairly accurate ranges may be obtained by the method discussed on page 6 of reference 3. This is a fairly simple backup procedure in case ranges cannot be obtained due to failure or unavailability of clocked pulses or the acoustic transponder. This procedure applies for both propagation loss tests and echo-ranging tests.

Two types of echo-ranging tests can be considered - those for which the USS DOLPHIN is the source and those for which it is a target.

Basic experiments with the USS DOLPHIN as a source are of somewhat limited interest because of the high frequency involved. In addition to items discussed in section 8 of reference 1, we might mention the determination of target strength of "belly-aspect" submarines. Some investigators have reported unusually high target strengths for submarines when "viewed" from below. This would be a simple task for the USS DOLPHIN to determine with her active system.

Basic experiments with the USS DOLPHIN as a target are of somewhat more interest. In addition to testing the ability of concealment by sea canyons or sea mounts as suggested in section 8 of reference 1, we are interested in the capabilities of the AN/SQS-26 or Lorad sonars in detecting deep submarines in the open unobstructed ocean. We are also interested in the accurate localization of the target in terms of range, bearing, and depth. Localization requirements for a long-range, fire-control sonar are quite stringent. Work has been done with the Lorad system on the range and and bearing accuracy for near-surface targets. The addition of a depth variable complicates the problem considerably and an early experimental start on the problem is in order. One of the difficulties to be worked out is the position control against which the sonar is to be checked, i.e., how will the exact position of the target either absolute or relative to the source be determined.

Reverberation Measurements

Because of equipment restrictions, reverberation measurements aboard the USS DOLPHIN will be confined to ranges generally less than 5 kyd. The most important measurements will be reverberation from the scattering layers. Past measurements with vertical beams have looked through the scattering layers. With a horizontal beam aboard the USS DOLPHIN one can look along the layers. An appropriate experimental procedure would be to change depth slowly and attempt to correlate changes in reverberation level with visual observations and biological sampling measurements. An alternative procedure would be to change range, while holding a constant depth, to determine variability and whether the reverberation is discrete or uniform.

A deep diving vessel, with a narrow beam sonar, which can be trained and tilted, could be used to make a more detailed study of surface reflection and surface reverberation. There are several sonar systems under consideration which look upward at the surface. Thus such measurements would have general importance as well as determining the effectiveness of the USS DOLPHIN against surface targets.

SEA-FLOOR STUDIES RESEARCH PROGRAM

Physical Measurements

Any deep submersible intended for research involving the sea floor should have the following advantages over work done from the surface: (1) direct viewing of the water-sediment interface, (2) sampling and making measurements with respect to what one is able to see, rather than blindly, and (3) doing away with the need for long electrical and supporting cables, and permitting the use of more involved experimental equipment. With these factors in mind, it is essential that any submersible designed for research involving the sea floor have a port, or ports, together with proper lighting, to view the sea floor from within the submersible and to take photographs when desired. Closed-circuit television is a poor substitute for such direct viewing. Secondly, the means to raise and lower equipment outside the hull, and to take selective samples of the sea floor sediments, rocks and minerals are necessary.

1. As far as design parameters are concerned (for marine geology), the raising and lowering winch should be capable of lifting approximately 300 pounds. The view port should observe the area of the bottom below the winch, and two shielded 4-conductor lead-throughs should be provided for outside instrumentation.

2. Devices to measure the sediment, sound speed and attenuation, temperature, strength, density, etc., will be in the form of probes and small packages of various shapes. These devices can be attached to the winch line either prior to going to sea, or at the surface at the point of dive; such attachment is probably most feasibly done by SCUBA divers. If attachment is done at the dock, the divers could secure the device from swinging by a quick-release bracket secured to the hull, which could be released by divers, prior to the dive. It is, of course, impossible at the present time to forecast the exact dimensions of such devices; however, from experience with similar devices used with the bathyscaph TRIESTE, the following shapes and sizes (and other requirements) would be probable:

(a) High-power-short-pulse acoustic-reflection device: size approximately 1 x 1 x 3 feet; weight less than 200 pounds; brackets or bolts needed for securing to hull; transducers could be actuated by batteries if desirable.

(b) Sound velocity and attenuation, density, thermal properties: these properties would require devices in the form of single or multiple probes. If single, a probe 3 to 6 feet in length and one to four inches in diameter are probably outside size limits; if multiple, probes 3 to 6 feet long through a rack 3 to 6 feet in length; approximate weights less than 300 pounds.

(c) Shear-strength measurements: a device approximately 2 cubic feet in volume; to be attached to the winch line.

(d) A remote-control arm would be useful, but in view of the probable lack of maneuverability of the craft just above the bottom, is less a requirement than the winch and view port.

Measurements Supplemented by Visual Observation

Contingent on the ability to see the sea floor and to take samples and measurements (as above), then the following program in marine geology could be implemented by the use of the proposed submersible.

1. Topography of the sea floor

Many features of sea-floor relief are too small to be properly delineated by an echo sounder, and too big to be photographed from lowered cameras from the surface. Many of these features are of importance to the Navy in bottom-bounce sonar studies and *in-situ* investigations when placing equipment on the sea floor. Examples are: gullies and channels and other medium-scale relief, topographic detail of the upper part of the continental slope (where a deep-running submarine would first encounter the sea floor in approaching the continental shelf), topographic detail of seamounts where it might be desirable to place equipment, and relief of the continental shelves in general.

2. Sedimentary processes

Information on the transportation, accumulation, thickness and distribution of sediments on the sea floor is important to the Navy's programs in underwater acoustics to placing of bottomed weapons and equipment on the sea floor, and to mapping of the sea floor. Examples of studies are: factors influencing the stability of slopes in regard to slumping, or other failures, the mass movements of sediments down gullies and canyons, the influence of deep currents on the bottom, and the relationships between sedimentary processes and topography.

3. Mass physical properties of sediments

Provide information on the mass physical properties of sediments, especially those important in the transmission of sound such as the speed and attenuation of sound, density, porosity, and those important in the studies of the bearing capacity and slope stabilities of sea floor sediments. Examples of such projects are: probes inserted into the sea floor to measure the speed and attenuation of sound, the density and thermal properties of sediments; shear testing in-situ by using the vane-shear technique (a small vane inserted into the sediments and torque applied to cause the sediments to fail in shear). The means to take selective samples of the sea floor are necessary in this type of program (such as with a remotely-controlled arm).

4. Acoustic-reflection studies of the upper layers of sediments

Provide information on (a) the thicknesses of sediments over acoustic reflection boundaries within the sea floor; (b) the shape of the sediment and rock layers, and; (c) the acoustic properties of the layers. This information is important in bottom-bounce sonar studies, and in site investigations when it is desirable to place equipment on the sea floor. Example of this type of work: use of a high-power short-pulse equipment such as the Marine Sonoprobe now in operation at the Navy Electronics Laboratory from both the TRIESTE (planned), and from surface ship in shallow water. *Much greater detail is possible if the device is operated from a submersible running just above the sea floor.*

PROPOSED RESEARCH IN PHYSICAL OCEANOGRAPHY

In physical oceanography two categories of research programs are proposed. These categories are determined by the methods of sampling which in turn determines the methods that must be used to analyze the data.

1. Continuous Time Series Observations of Physical Parameters at Fixed Points in Space near 4000 Feet

The objective of this type of experiment is to determine (a) the variance spectrum of fluctuation of physical parameters and (b) coherence of fluctuations in these physical parameters over space.

a. Time series observations of fluctuation of temperature near the bottom.

Observations of temperature are required at a minimum of six levels within 30 to 300 feet of the bottom at four thousand feet depth. Continuous observations for the duration of the maximum length of time that this vessel can stay on the bottom at greatest diving depth are required.

The temperature transducers will have various spacings in the vertical direction for different experiments. The temperature transducers and the conductors can be constructed with positive buoyancy so that the unit will rise toward the surface as it is payed out from the wet winch.

Six temperature transducers located at the bow and stern of the submarine are required for the study of coherence of fluctuation over space. Both sets of transducers can be operated from the same winch by using a series of sheaves as pivot points for the cable leading from the bow to the stern.

Recording of the output from each of the thermistors will be made inside the hull. The transducers located on the outside of the hull weigh approximately 10 pounds in water and occupy about 1 cubic foot. The winch occupies about 1 cubic foot and weighs approximately 150 pounds in water. Inside the hull about 2 cubic feet of air space is required for recorders which weigh about 100 pounds. Power required is about 500 watts. Twelve leads through hull are required.

Methods of analysis are presently available to study the variance spectrum of temperature fluctuation from these data and to study the coherence of temperature fluctuations. Serial observations over depth permit study of variance spectra by mode of oscillation.

b. Study of time series observations of temperature within the sediment

Observation of temperature in the sediment are to be made at one to six different levels depending on the type of sediment. Continous observations for as long a period of time as possible are desirable since serial observations in the vertical are required at only one location, the transducers can be located directly under the wet winch. A suitable method of driving the temperature transducers into the sediment can be devised by using dead weight or a mechanical vibrator with much less dead weight.

Provided that each observation period can be as long as 24 hours, the time series observations will permit the computation of the spectra of temperature fluctuation within the sediment for comparison with spectra of temperature fluctuation within the water mass. The data from serial observations in the vertical will permit the computation of heat exchange between sediment and water.

The equipment outside the hull will occupy about 1 cubic foot and weigh approximately 100 pounds. The equipment inside the hull will weigh approximately 75 pounds and occupy 2 cubic feet. 100 watts of power are required.

c. Investigation into continuous observations of salinity near the bottom at 4000 feet

Salinometers (devices for measuring salintiy other than by titration) have been developed for laboratory use, but none has been developed to accurately measure salinity in-situ from a surface vessel. Presently a salinometer is under development for use in the bathyscaph TRIESTE. If this equipment is successful, a similar model can be constructed for the AGSS-555. The salinometer could be used to produce continuous profiles of salinity while diving and time series observations of salinity at fixed points while at rest on the bottom.

For studies of spectra and coherence of salinity fluctuation, two salinometers with sea elements located on the bow and stern are required. Spectra of these data can be compared with the spectra of temperature fluctuation. According to theory, these two spectra are related but this has not been verified by direct observation especially in deep water.

Inside the hull recording equipment will occupy 2 cubic feet and weigh approximately 50 pounds. Twelve electrical leads through the hull and 200 watts of power are required.

d. Time series of measurements of currents near the bottom

Ripples on the bottom show that currents exist at great depth, but little is known about them. Time series measurement of currents while the vessel rests on the bottom for periods is required for an adequate study of the phenomenon. Computation of coherence of fluctuation over space requires that observations be made at three or more levels to study the velocity profile near the bottom. Such data are of interest in the study of origin of temperature fluctuation near different types of bottom topography such as submarine canyons, seamounts, etc.

A minimum of three current meters are required. Mounting of the current meters outside the hull will vary depending on whether the study is concerned with horizontal changes or vertical changes. For studies of horizontal changes, one current meter located at the bow, stern, and midship is needed. Investigation of vertical changes can be accomplished by using buoyed members extended from the wet winch.

Equipment outside the hull will occupy approximately 1 cubic foot and weigh about 80 pounds. Equipment inside will occupy 2 cubic feet and weigh approximately 75 pounds. Sixteen electrical leads through the hull are required. Power requirement is 100 watts.

Fluctuation in sound velocity as measured by sound velocimeters can be used in conjunction with these measurements and others involving time series measurement.

Space and weight requirements inside and outside the hull are doubled and the number of hull penetrations for leads is increased by eight.

2. Sampling of the Ocean Environment at Different Points and at Different Times

A different type of analysis is required for this type of study and the investigation is to be emphasized at depths ranging from about 3700 to 4000 feet.

a. Study of physical and chemical properties of the vertical water column while diving and ascending.

Measurements include continuous recording of temperature, salinity and turbidity.

The temperature measurements require two electrical leads through the hull at the bow of the vessel and 300 watts of electrical power. The space and weight occupied on the outside of the hull of these experiments are less than ten pounds and less than a quarter of a cubic foot.

For salinity experiments, six electrical leads through the hull are required with less than a hundred pounds of weight and one cubic foot outside the hull. Inside, 100 pounds weight and two cubic feet are required.

Six electrical leads through the hull are required for turbidity experiments.* Requirements outside the hull are one hundred pounds and one cubic foot. Inside, the equipment weighs one hundred pounds and occupies two cubic feet.

b. Studies of the variation of salinity and oxygen within a small grid.

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* All leads to transducers should be designed for 18 gage wire. Power lines to the wet winch will probably require a larger size.

Very little variation is expected but this has not been verified. Sampling within the small grid while underway requires the installation of a water tap by penetrating the hull. There are no requirements for space and weight on the outside of the hull, but about 8 cubic feet and 500 pounds of weight are required inside the hull.

BIOLOGICAL OCEANOGRAPHY

Carrying out biological oceanographic investigations from any deep submersible vehicle will usually involve two basic operations: (1) observation of the environment and (2) sampling of the environment.

Possible methods of implementing these two objectives are discussed below.

Observation

The various methods in order of desirability are:

1. Direct observation through a viewing port. This can be accomplished by inserting plastic cones similar in nature to that used on the bathyscaph TRIESTE into the skin of the hull. A mechanical eyelid could be developed to protect the port against accidental damage. The location of such a port should be in an area where the passage of the vessel through the water has had the least opportunity to disrupt the environment. It should also be associated with the sampling devices so that their operation can be monitored.

2. Direct observation through a lens system. This would involve a smaller aperture in the hull of the submarine, and may be just as effective as a viewing port. Such systems might also be used to cover blind spots and, in conjunction with magnifying systems, used for close inspection of the sea floor.

3. Indirect observation by means of underwater television cameras. Regardless of picture quality (and this is not only a function of the instrumental limitations, but is related to clarity of the water) UWTV is never as satisfactory for observations as the human eye. Further, operation of present commercial closed circuit TV in the underwater environment for long periods of time involves a good deal of maintenance. Therefore, this method would be less desirable than the two previously discussed techniques. UWTV could however be a valuable addition to these other observational methods.

4. Indirect observation by still and motion cameras. This is a highly desirable supplement to the direct methods, but cannot substitute for them.

Regardless of the mode of observation, proper illumination is highly necessary for adequate results. This involves not only intensity of light, but the orientation of the light beam in relation to the viewing axis as well since some organisms are more readily observed when using side or back lighting. This may involve placing lights at the ends of booms. To minimize avoidance behavior by large active organisms, use of light of various wave lengths, particularly in the red region, should be considered.

Sampling

Depending on the nature of the problem, various types of techniques are necessary. For example, in some cases, discreet, rapidly obtained volumes of water must be taken in series either on command or at predetermined times and depths. Such samples are necessary for filtration of particulate matter which may affect the transmission of light or sound, or for conventional chemical analysis. In most cases, one-liter samples should be adequate. For some of the newer biochemical techniques, as much as 50 liters may be necessary.

Another method that must be considered is that of handling relatively small filtered samples of a minimum of 5 liters. At the present various kinds of devices such as the Michele plankton sampler[4] have been under development at NEL which if perfected could readily serve this purpose. Water drawn from the submarine's cooling system or a through-hull tap* may be adequate for some purposes.

In other cases filtration *in-situ* of a relatively large volume of water is necessary to trap small nektonic forms and the larger types of zooplankton. This involves nets of various dimensions and ideally some sort of a selective sampling device associated with it. A modified cod-end sampling

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* Dr. E. C. LaFond collected plankton samples from the USS SKATE (SS (N) 578) on her under-ice polar crossing by this method.

device[5] is under consideration at the present time to serve this function for the TRIESTE program.

A further need for which there is no present solution, is the desirability of capturing large, rapidly swimming animals with relatively small nets. Various possibilities here might be the use of "lures" such as lights of various wave lengths or sound signals followed by the detonation of a small explosive in front of a net which might then capture the stunned or dead animals.

Sampling of benthic populations can be done by a series of bottom grabs of the Shipek type. Further instrumentation for this purpose can be coordinated with the sea-floor study program.

While it is impossible to specify the exact piece of collecting equipment that may be used, in all probability it will involve selenoid activated valves, gates or articulated parts. Therefore provision for at least four electrical leads through the hull should be anticipated. The gear for sampling pelagic organisms can be relatively light, weighing perhaps no more than 25 pounds in air, bolting rings or threaded studs should be provided at appropriate attachment points. Allowances for 3 cubic feet of internal space and 200 pounds of weight should be considered to be adequate.

Examples of Problems

1. The kinds of organisms responsible for sound scattering are now being studied at NEL. It should be possible to map their populations over large areas of the ocean. This would involve coordination between a surface vessel and the USS DOLPHIN. The extent, nature and depths of scattering would be recorded from the surface while the organisms are being identified and population densities estimated from the submarine. It is anticipated that high resolution sonar techniques would allow computations of target strength of the organisms to be made from the submarine. Enough data should be gathered so that a statistical treatment will permit predictions as to the intensity, frequency dependence, and seasonal variation of scattering throughout the critical areas of the oceans.*

2. Use of the submarine as a platform for a passive, highly directional listening device which would allow the tracking and identification of noise producers.

3. Characterization of large areas of the sea floor in terms of types and numbers of benthic organisms which may affect bottom sound reflections. Coincidental to this, the investigation of the fauna of continental slopes may result in extremely valuable data pertaining to evolutionary theories of invertebrate life. Because of the difficulty of

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*Other studies of the deep scattering layer (DSL) were proposed in the preceding section under "Acoustic Research Program."

sampling this area by conventional trawls, it is the least known of the relatively shallow marine environments.

4. Planting radioactive material in a known location. Repeated visitations of the area and mapping of spread of material through the ecological community and environment.

The above problems are merely outlined briefly to indicate the nature and scope of investigations which could be carried out. In general the obvious advantages of the USS DOLPHIN over a deep submersible of the TRIESTE design is the ability of the former to make long time and/or distance series of observations in relative comfort, and at a lower cost/observation ratio. Ideally program planning should utilize these advantages to the fullest.

OTHER PHYSICAL MEASUREMENTS

The USS DOLPHIN is suitable for other measurements of physical properties, such as the variations of gravity, magnetic field, radioactivity, electromagnetic phenomena, etc., in several diverse areas. The possibility exists that physical or chemical properties not mentioned will become of considerable practical or theoretical interest. The equipments involved in such measurements need not be large, but some weight, volume, and power must be left available for future measuring equipments. An adequate number of electrical lead-throughs in penetrators and arrangements for bolting of equipments must be allowed for future flexibility.

CONCLUSIONS

It is to be emphasized that certain portions of the Sonar Suit outlined in reference 1 will be essential for the safety of the submarine during work in either acoustic or oceanographic research. We believe that the bare minimum of the Sonar Suit that must be retained during oceanographic work is as follows:

AN/BQR-2B/AN/BQS-8 Passive and Active High Resolution Sonar combination

AN/UQC-1 underwater communication, including a Gertrude Alpha transducer to operate at 3 kc as well as two of the UQC-1 type

AN/UQN-1 depth sounder

High-resolution depth sounder

The high-resolution sonar is required for the safety of the vessel when operating near the bottom; the depth sounders are needed for oceanographic work; the passive sonar and some form of underwater communication to surface vessels are needed for the safety of the vessel. The minimum Sonar Suit will obviously have to be taken into consideration in the final design. This Laboratory does not at present have available weight figures for such a minimum sonar suit.

The 12 tons of payload given in Appendix A of reference 1 is in addition to the minimum sonar suit and this 12 tons is for other acoustic and oceanographic research equipments. It should be noted that trim and balance are important and that the location of equipments of specified weight may require compensatory weight adjustments elsewhere. An early decision on equipments to go aboard either permanently or for temporary mounting needs to be evaluated in the overall design stage.

Some changes or additions to the USS DOLPHIN (AGSS-555) design are required for this proposed research program. These include two or more viewing ports and a relatively large number of electrical leads penetrating the pressure hull.

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