SMALL POWER DEEP OCEAN

• Port Hueneme, Calif.

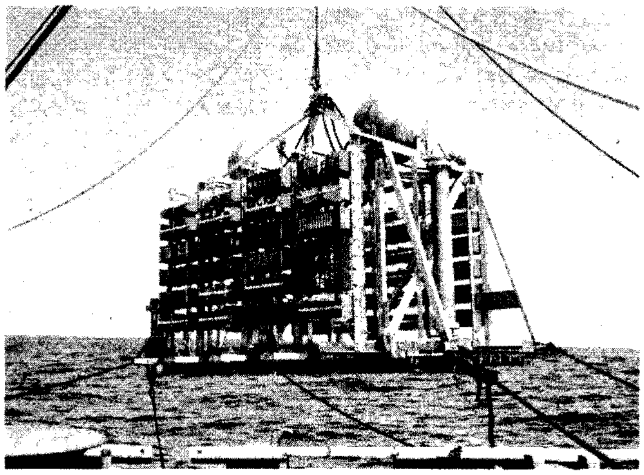
SUMMARY

Oceanographic instrumentation is providing useful data in deep ocean engineering research programs. Automation promises to simplify and reduce costs in many deep ocean engineering oprations. A brief outline is given of the work of the U.S. Naval Civil Engineering Laboratory with small power sources for instrumentation and automated equipment.

Because the limitations imposed by chemical battery power on long-term data collection have been found to be significant, an alternative power source is needed. The possibility of using nuclear energy to generate power at the very low levels required may offer an economical solution to the problem.

The Naval Civil Engineering Laboratory will conduct a test and evaluation program for radioisotope power sources. Work will commence when the first devices are received, in early February, 1967.

The ocean holds a fascination for thousands of scientists and engineers who are endeavoring to unlock the many secrets of earth's last frontier. Recently, the scope of oceanography as a science has been broadened to encompass the engineering aspects. The U.S. Navy has found new uses for data once used only in studies connected with fisheries and in basic biological research. Data on water chemistry, sea floor sediments, sea floor topography and microrelief, and microorganisms are used to support work in the field of antisubmarine warfare and will be needed if any program of engineering in the deep ocean is to be successful.



A submersible Test Unit is lowered at emplacement site.

The Deep Ocean Engineering Program

The U.S. Naval Civil Engineering Laboratory has completed a portion of a comprehensive text—"Engineering Manual for Underwater Construction." While this represents only a documentation of state-of-the-art engineering operations, it will be updated as new information becomes available.

One very important area in which NCEL has already made a considerable contribution to the state-of-the-art concerns the performance of construction materials exposed to the deep ocean environments at various depths and for various periods. Included in the materials are metals, plastics, wood and concrete. Chemical, physical, and biological effects are studied.

The success of the study is dependent upon the ability to emplace and retrieve large quantities of specimens. For this purpose a vehicle called a Submersible Test Unit (STU) is used. A typical STU is shown in Figure 1.

Since 1961, six such vehicles have been emplaced and retrieved. They have been located off the coast of southern California at the positions indicated in Figure 2 at depths from 2,300 to 6,700 feet. The rigging complex used is shown in Figure 3 and is designed to provide several additional or "backup" methods to the primary means of retrieval.

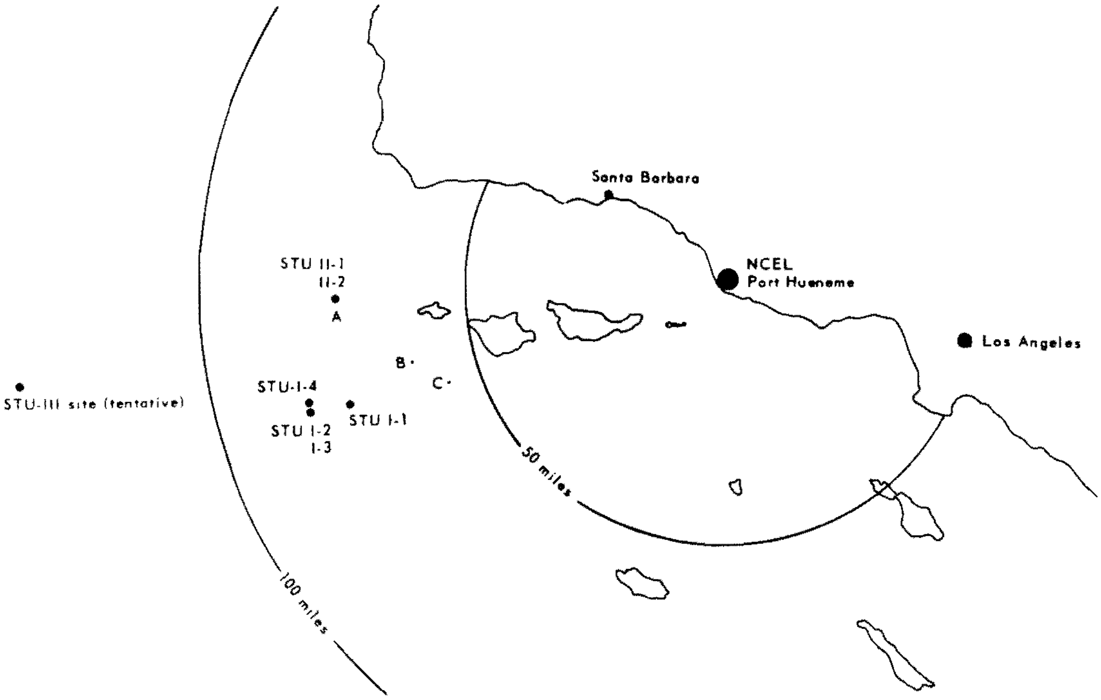
Radio navigation is used to position the ship at the site: in case of failure, a system of acoustic navigation is employed that makes use of the STU system's pingers.

An acoustic command release is located just above the concrete sinker at the lower end of the riser. When the release is actuated, the buoys supporting the instrumentation can surface and be retrieved. In case of a failure, a second acoustic release designed to operate with a different coded command can be actuated. When the release link separates, a 500-foot length of rope connected in parallel with the release is pulled from its bale by the upper riser buoy. When the buoy surfaces it can easily be retrieved. If both acoustic command releases fail, retrieval may be effected by grappling for the buoyant lift line. This has been done successfully using the type of grapnel shown in Figure 4. If the lift line is severed (this has occurred) it is necessary to grapple for the bottom-laid grappling wire using the same techniques employed for retrieving transoceanic telephone cables for repair.

Instrumentation For STU

The instrumentation operated with the STU systems consists of current recorders, temperature recorders, acoustic pingers, and acoustic command releases. Their power requirements are presented in Table 1. Other devices similar to these have comparable power requirements. The current recorders are commercial versions of those de-

SOURCES IN RESEARCH



STU sites off the California Coast, near the Channel Islands.

TABLE 1
Power Requirements For Undersea Devices

Instrumentation	Average Minimum	Average Maximum	Remarks
Current recorders	40 mw	100 mw	Limitation on storage of recorded data
Temperature recorders	20 mw	50 mw	Limitation on storage of recorded data
Acoustic pingers	500 mw	5 w	NCEL pinger has requirement of 1 watt, maximum
Acoustic command releases	60 uw	10 mw	Requirement of 18 watts for less than 0.5 second at time of release

signed by Dr. W. Richardson of Woods Hole Oceanographic Institution. Figure 5 shows one of the instruments. A Savonius rotor is used to sense current speed, a vane to sense direction and a magnetic compass for north reference. Each sensor output is in digital form (Gray binary) and is displayed on a light stage for intermittent recording on photographic film using a fiber optic transmission system. Over 9,000 data intervals can be recorded. The data interval is usually one minute in duration.

Temperature is recorded by means of a Bourdon-tube-driven stylus scribing a waxed chart. The chart advances periodically according to a preset program. Up to 9,000 data intervals of one minute duration can be recorded.

Both current and temperature recorders are self-contained, battery-powered instruments. Battery failures have limited the amount of useful data collected. However, several six-month period recordings have been obtained.

The temperature and current recorder housings are similar in construction, both being cylindrical pressure cases whose end closures are held in place by stainless steel tie rods as shown in Figure 5. Both instruments are designed to support a tensile load of up to 7,000 pounds across the bails. Even when supported in the manner shown in Figure 6, wherein virtually no load is applied to the ends, failures have occurred due to crevice corrosion at the tie rod nuts. In some cases this has resulted in loss of the instrument. A simple remedy which eliminates this problem is to apply silicone rubber caulking compound to the contact areas to eliminate voids where stagnant water can be trapped.

The pingers used in STU systems were designed to fulfill a need which could not be satisfied from commercial sources. Each pinger is designed to operate at a different frequency within the 12-kc band, which can be received on a standard Navy fathometer (AN/UQN-1). Different frequencies are used for identification. The circuit design

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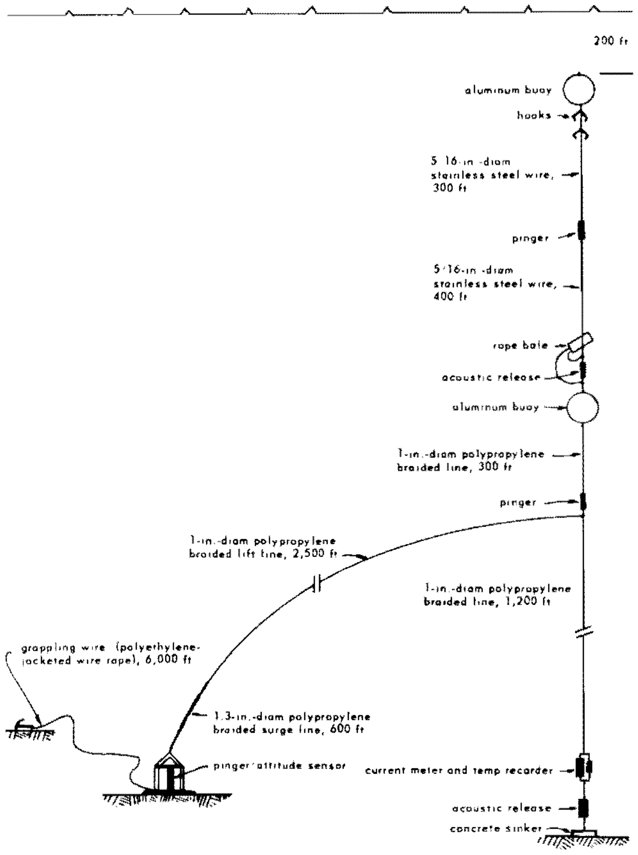


Installation diagram of STU 11-2 system as installed.

allows for setting the pulse rate within a 9- to 11-second range, thereby preventing masking of one pinger by another when the two are in close proximity. A long pulse length, about 50 milliseconds, is used because a sound of this persistency can be detected above the ambient noise, even in sea states up to five. The housings of 6066 T-6 aluminum alloy are satisfactory for depths to 15,000 feet.

The acoustic release systems (Figure 7) were designed and fabricated for use in the STU systems. Physically, the system consists of two separate units, an acoustic command receiver, and a release link. Figure 8 contains a block diagram illustrating system operation and logic. The release is activated on receipt of a three-tone code within the band between 14-kc and 16-kc. Incorrect signals, even when combined with correct signals, cannot effect release. Snodgrass has conducted an evaluation of the devices and found them to be reliable at a range of two or three nautical miles. Release is accomplished by the device illustrated in Figure 9. It consists of two stainless steel cylinders, grooved on the inner face and bonded with amorphous sulfur to a thermite-filled heater. The heater is activated by an initiator (squib) which is electrically fired by the firing relay. The heater melts the bonding sulfur allowing the two stainless steel tubes to separate. Difficulties have been experienced with these release links. They are susceptible to failure from torsional loading. Modification is still needed to overcome this problem. However, any explosive bolt, latching mechanism, or device having similar requirements could be used.

Chemical Batteries As Power Sources

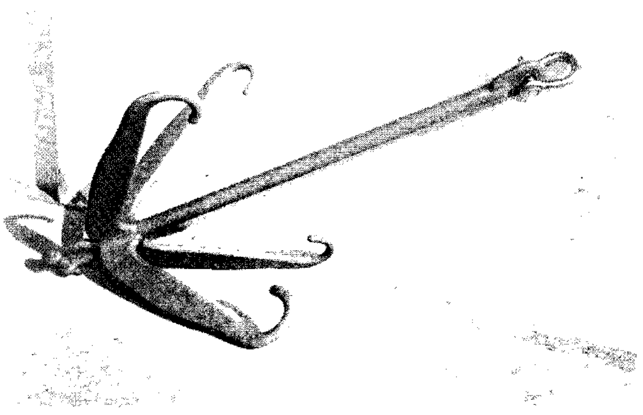
The modern 1.5-volt chemical cell has remarkable reliability. However, there are very few applications in oceanography which require the use of only a single cell. Multicell batteries reduce reliability because, although failure of a single cell might not cause a critical loss of power, other cells may be drained by the failed cell causing failure of the power source. Use of isolating diodes between parallel strings of cells is one remedy, but this cannot be done when groups of cells are prepackaged.

In each of NCEL's pingers, for example, fifty No. 6 railroad industrial cells have been used. They are arranged in five parallel strings isolated by diodes. Each string consists of ten cells in series. Theoretically, at least, there is sufficient stored power for in excess of two and one-half years of continuous pinger operation. Few survive even one year, and most often, there are one or two cell case leakages (followed by power failure) after only six months' service.

Nuclear Batteries As Power Sources

What alternative to chemical cells is available? The Atomic Energy Commission has contracted for studies to be made concerning the requirements for milliwatt power sources of from 150 milliwatts to one watt. Following these studies, it is intended that some representative "nuclear batteries" be built and tested.

It is speculated that if a high degree of reliability can be achieved with nuclear batteries, they will be an economical source of power even though initial cost may be much higher than conventional and less reliable batteries. Also, where very long term unattended power is required (over two years) the only alternative to nuclear power is the regular service and replacement of the power source. Service and repair operations at sea are expensive and can cost up to $3,000 per day just for ship rental. Thus the expected expenditure of $4,000 to $5,000 for immediate production of a 100-milliwatt nuclear battery with a minimum reliable life of five years may well be economically advantageous.



NCEL designed grapnel.

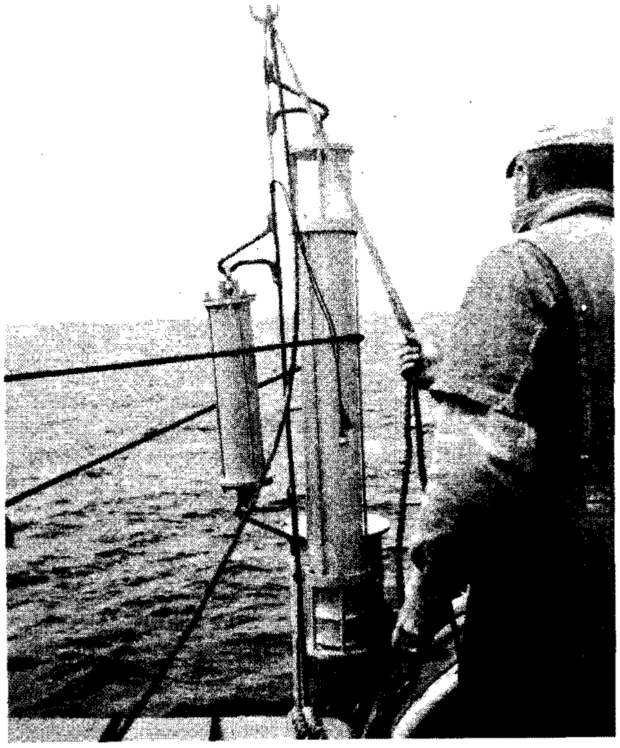
In terms of safety, there does not appear to be any problem if full shielding is utilized for the particular isotope employed. Already, successful special-use devices have been built using Pu 238 fuel (SNAP 15A). Shielding has been minimal since Pu 238 does not emit neutrons or gamma radiation. For undersea use, the only major difference would be the size of shield for the isotope, Sr^{90} which probably will be employed.

SNAP 7D supplies power for a weather station floating in the Gulf of Mexico. It produces 60 watts, has a design life of ten years, and weighs 4,600 pounds, most of which consists of shield weight. SNAP 7E, a 6.5-watt device, is

Richardson recording current meter.

NCEL acoustic command release. Hydrophone is at top, thermal release at lower end.

supplying power for an acoustic beacon on the floor of the Atlantic. It has a design life of ten years, but again has the disadvantage of high weight, about 6,000 pounds. SNAP 7F has been used to operate a navigation warning device on an off-shore oil rig. It produces 60 watts, has a design life of ten years, and weighs 4,600 pounds. This series all use Sr^{90} fuel and therefore heavy shielding is necessary. However, SNAP 21, presently under construction, although fueled by Sr^{90} will produce ten watts and weigh only about 500 pounds because a more efficient shielding material has been chosen.

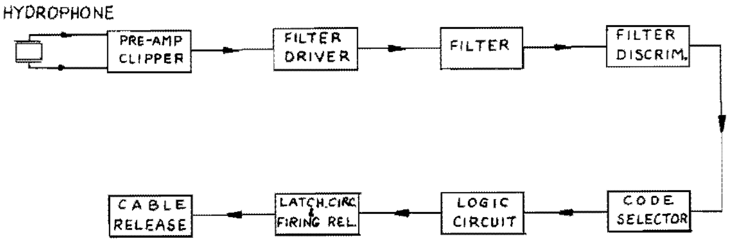


Current and temperature recorders attached to tie-rod support. There is no load across instruments.

Under their RIPPLE program the British have been operating two demonstration model Sr^{90} fueled devices for navigation marker lights for a year. Design life is ten years. Each of these devices has an output of about 30 milliwatts.

The Radioisotope Power Sources Test

Responsibility for the provision of radioisotope devices to all branches of the Navy has recently been assigned to the Naval Facilities Engineering Command. The Command has requested NCEL to conduct a program of test and evaluation of devices which show potential for use in ocean engineering operations. The program is divided in two parts: thorough test of each device under laboratory conditions simulating the undersea environment and an in-service evaluation during which the performance of the



Block diagram of acoustic command release underwater unit.

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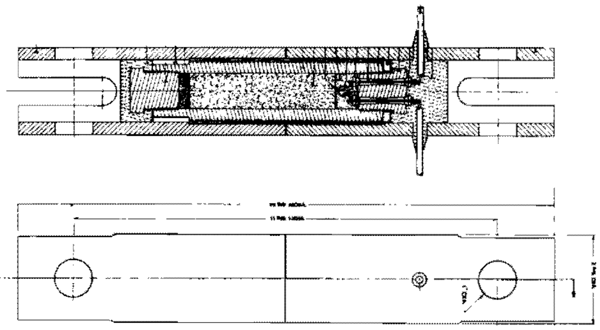
power source is monitored by remote, indirect means. For example, a radioisotope device is used to power a pinger, the acoustic signal can be used to transmit information about the performance of the power source. Three devices are presently under construction for use in the program. In addition it is intended that RIPPLE III and LCG-25 will be evaluated. Table 2 contains details of the first devices.



Thermal release device.

TABLE 2

Test Qty.	Device	Supplier	Output (watts)	Fuel	Thermoelectric System
2	NUMEC	Nuclear Materials Equip. Corp.	0.1	Sr^{90}	Thermocouples
1	Westinghouse Compact	Westinghouse	5	Sr^{90}	Lead telluride
1	RIPPLE III	A.E.R.E. Gt. Britain	0.7	Sr^{90}	Bismuth telluride
1	LCG-25	Martin Co.	25.	Sr^{90}	Lead telluride

It is difficult to decide on the most economical way to utilize radioisotope power for oceanographic instruments. Groups of instruments might well be supplied by a single power source, or each might be powered independently. Various "plug-in" power conditioners might be available so that output voltage can be made compatible with the particular instrument to be used. Many trade-offs are possible; however it does not seem economically desirable to make radioisotope power sources with as many capacities and voltages as are available in chemical batteries. The contemplated standardization of oceanographic instrumentation may provide some solutions to the problems created by the varied power requirements.

LONG BINH SEEN AS NUMBER TWO PRIORITY

• Saigon

It's going to be the next big one for the U.S. Navy's Facilities Engineering Command and its prime contractor in Vietnam, RMK-BRJ.

Put five Levittowns together, install all the facilities that grace a city of over 50,000 people and you've got an idea of the mammoth job that's shaping up twenty kilometers from Saigon.

"Long Binh will be comparable in size to Cam Ranh Bay," says Brig. Gen. Daniel A. Raymond of the U.S. Army Corps of Engineers and MACV Director of Construction, who recently gave the go-ahead for the giant building effort.

"Everybody recognizes that Newport is the top priority in the country," adds RMK-BRJ General Manager Jim Lilly. "But the No. 2 priority is Long Binh."

The 16,000-acre stretch of rolling land that is the object of these superlatives was earmarked last year as the cantonment area to house most of the military personnel now residing in Saigon and Cholon.

The site was selected after it became obvious to military authorities that the influx of American troops was straining Saigon's facilities to the seams. With this in mind, USARV and 1st Log Command headquarters moved out to Long Binh last year to form the advance wave of the rising tide to come.

At present there are already some 20,000 troops in the cantonment area. Army engineers and regular GIs have been busy since last spring turning up the ground for the hundreds of barracks that now dot Long Binh.

But most of the permanent structures—the facilities that will make a home out of the Long Binh house—will be built by RMK-BRJ. The 40% of the overall construction officials estimate the joint venture will do, is expected to tally out to a $180 million project.

Although RMK-BRJ has been on the site since last summer, the big push awaited approval of designs and construction studies before it could really get going several weeks ago. Much of RMK-BRJ's construction activity there is now focused on building a camp to house the hundreds of American and Third National supervisors, part of a total construction force that may go as high as 10,000 workers.

"The big thing is to mobilize as fast as we know how," explains Navy ROICC (Resident-Officer-In-Charge-of-Construction) Lt. Cmdr. Barry Carle, of Milton Mass., who prior to his Long Binh assignment was the U.S. Navy's officer in charge of construction at Newport.

At Long Binh, Carle faces a novel departure from his previous building stints. "At Newport, we were headed for one goal," he says. "Everything we did there was related to this single object. But here we're putting together thousands of housing units and utilities for different customers. Everything is extremely diversified."

Because of the great amount of skilled labor required in the type of construction at Long Binh, Project Manager Keays is adamant that only the best craftsmen and supervisors are admitted to the site's ranks.

The construction of 3,200 individual buildings of all kinds—messhalls, living quarters, evacuation hospitals, post headquarters, cantonment and service buildings, etc. —will take an awful lot of plain old elbow grease.

The building compounds are to be laced with a total of almost 135 miles of road, plus the usual facilities found in a cantonment area, such as a POL system for the heliport and a 5,000-acre ammo storage area.

A dredge is slated to start working at the site shortly, ready to pump thousands of yards of fill into the area. The statistics are truly staggering: over three million cubic yards of laterite will be used for base material; over one million sacks of cement will be poured over the slabs alone.

RMK-BRJ is now readying a huge equipment yard to house the hundreds of pieces of heavy duty machinery that are daily clanking into the camp from all over Vietnam.

Although it's hard to set a completion date for the widely-ramified construction to take place at Long Binh, it is expected that many of the military personnel now living in Vietnam's capital will have moved out to Long Binh by Spring.