MARINE TECHNOLOGY

Undersea Hardware Still Untrustworthy

Men adjust to the strange habitat beneath the sea, but their equipment, so far, isn't good enough to allow useful work.

Lack of reliable hardware and adequate communications are frustrating progress in the Navy's program to learn how man can do useful work for long periods on the ocean floor.

"I cannot tell you one piece of equipment that is reliable for deep-ocean work," says Capt. W. M. Nicholson, director of the Navy's deep submergence systems project. "There is a general lack of reliability throughout the field," agrees Capt. T. K. Treadwell, deputy commander of the U.S. Navy's Oceanographic Office. The Navy's man-in-the-sea program, underwater equivalent to America's man-in-space effort, "has a history of unhappy experiences with respect to immersed items of hardware," says Capt. George F. Bond, medical officer of the project.

Experience of aquanauts, who spent from 11 to 30 days confined in Sealabs 1 and 2 offshore from California, demonstrated that man could make the physiological adjustment, Bond told a recent technical conference at Cocoa Beach, Fla., but what doesn't exist is hardware to get useful work done.

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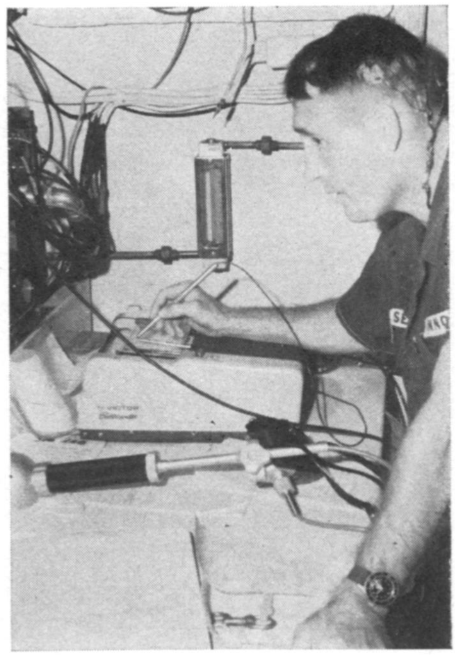

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Sealab 2 men lived underseas for weeks, but working is another story.

Two basic factors have been the source of most hardware-development problems: the increased pressure at great depths and the use of helium as the inert gas component in the artificial atmosphere that aquanauts breathe. A helium-oxygen mixture was chosen for the Sealabs because nitrogen has a narcotic—and possibly fatal—effect on humans under high-pressure conditions.

Helium at sea level has six times the thermal conductivity of air, and the ratio increases at increased depths and pressures. Electronic gear, heat-sensitive in any environment, is partially or totally disabled in a high-pressure helium-oxygen atmosphere, Bond says.

For example, during the Sealab 2 experiment, a high voltage line chafed through and started arcing from outside the underwater laboratory toward the lab. Circuit breakers, designed to operate in the thermal conductivity of air, did not work and it was only through heroic measures that all electrical circuits were broken and a possible tragedy averted.

Also, the helium atmosphere did not permit the heating elements of heaters and stoves inside the Sealabs to turn red. As a result, aquanauts suffered burns when they touched the coils.

The thermal conductive properties of helium required that the Sealab be heated to temperatures in excess of 85 degrees F. to insure shirt-sleeve comfort. The inert gas also saturates any gas-filled cell, and, given time, will exert all its bizarre physical properties inside something such as a TV camera.

Voice communications from diver-to-habitat, diver-to-surface, and diver-to-diver "cannot presently be achieved with available equipment," the medical specialist says. In fact, he adds, "it is quite possible that conventional modes of underwater voice communication must be abandoned altogether."

Astronaut-aquanaut Scott Carpenter, who orbited the earth three times in the Mercury 7 space capsule and spent a month 210 feet underwater in Sealab 2, reeled off a list of communications difficulties at a recent New York meeting of the Institute of Electrical and Electronics Engineers.

The biggest deepsea communications problem, says Carpenter, comes from the fact that sound travels faster in high-pressure helium than in earth's normal atmosphere. Voices, as a result, have a high-pitched "Donald Duck" sound, often to such an extent that speech is completely useless.

Voice communications with the surface from Sealab 2, in fact, would have been a waste of time without some unscrambling device to restore the pitch to its normal level. The solution was a device that electronically reproduced the high frequency curve of helium speech as a proportional curve of a lower frequency. But the equipment is complicated, and awkward for use between aquanauts themselves.

With obvious misgivings, Carpenter suggests that an alternative might be a surgically-implanted artificial voice box, designed to produce lower sounds than a human larynx. "But I hope you can spare us the need for that," he says.

A much simpler device, currently being produced in several commercial versions, is the speech compressor, a modified tape recorder that can lower the pitch of a voice as it is played back without changing the speed (SN: 4/1). The lowering is done mechanically, without the need for special electronics, but the equipment is bulky and heavy and would be unsuitable for man-to-man communications since it introduces a time delay.

Still another possibility is the bone-conduction microphone, mounted directly against the skull to measure vibrations through the bones of the head. It is possible that bone conduc-

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Trying to do any useful work underwater is still a primitive process at best.

tion may not be affected by helium pressure, Carpenter believes, and a bone mike would have the advantage of not requiring a large face mask as conventional microphones sometimes do. The large amount of space enclosed by the mask could allow a dangerous amount of exhaled carbon dioxide to accumulate; sometimes, Carpenter says, enough to cause death.

The Navy has experimented with bone-conduction mikes mounted on the forehead, but with inadequate hardware.

Helium poses another communications difficulty besides intelligibility. It is difficult in such an atmosphere to tell from which direction a sound is coming. The reason is that the increased speed of sound shortens the time difference between a sound's arrival at a person's two ears.

This lack of directionality poses a hazard for men traveling underwater. The porpoise has a built-in sonar-like "pinging" system, Carpenter points out, and unless someone comes up with a fail-safe, lightweight device that can do the same job for man, he half-jokingly asserts that "we might have to use porpoises as a backup system."

Another underwater communications problem that needs solving is the noise of bubbles being exhaled from self-contained diving lungs. "This can completely mask any communication with a free swimmer," Carpenter says.

Among items which the Navy says do not exist are adequate lighting devices, tools, swimmer propulsion devices and thermal-protective garments that will keep divers warm.

Following the Sealab II project in which he spent 30 days at the bottom of the sea off La Jolla, Calif., Carpenter contrasted the equipment used with that available for space flights.

The difference can be expressed in millions of dollars and thousands of man-hours of time, he observed. An astronaut has special systems designed for him; he is constantly watched and monitored by a worldwide network of tracking stations; fleets of ships and squadrons of airplanes stand ready to dash to the rescue when he surfaces.

Aquanauts, on the other hand, have had to use off-the-shelf equipment, often adapting it themselves for use in the sea. Funds are available only in a dribble compared to the torrent of dollars that supports the space program.

This, Carpenter suggests, will have to change before man can become at home in the sea. Carpenter and five eight-man teams of aquanauts will continue their experiments in the next Sealab test, now set for October. The teams will rotate between the surface and Sealab 3, 430 feet down off San Clemente, Calif.