FACEPLATE

The Official Magazine for the Divers and Salvors of the United States Navy

DEEP DIVE

NMRI Hyperbaric Center

Fall 1984
Volume 15 No. 3

FACEPLATE

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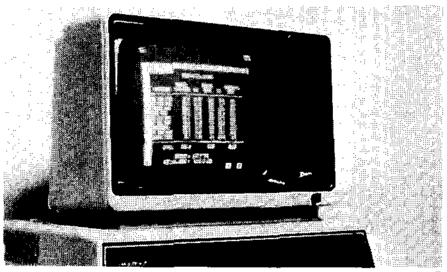
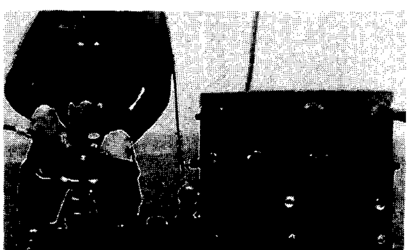


page 8

page 16



page 24

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SOUNDINGS


Photo by PH3 Joan M. Zopf

USN Diver on Exchange with Royal Navy

Ensign Victoria Cassano, MC, USN, recently spent two months on exchange service with the Royal Navy. As part of her training in underwater medicine she studied at the Institute of Naval Medicine in Alverstoke, England. She also spent time aboard the MV SEAFORTH CLANSMAN, a commercial DSV chartered by the Royal Navy. Aboard the CLANSMAN, she became familiar with Royal Navy saturation diving procedures, and completed a shallow water bell dive.

SEAL in Space

Navy LCDR William M. Shepherd, the 34-year-old Commanding Officer of Special Boat Unit 20 (SBU/20), recently learned that NASA has admitted a SEAL to its Space Shuttle Program.

LCDR Shepherd, of Babylon, New York, is the first Naval non-aviation astronaut-candidate to be selected by NASA.

A unit of Special Warfare Group Two, SBU/20's mission is to train boat crews to support SEALs (Sea-Air Land). "I imagine," Shepherd said, "that's something most aviators don't understand. What is a SEAL doing in the middle of the space program?"

LCDR Shepherd said NASA believes a SEAL will fit into the space program well. As naval combat swimmers, SEALs work in an environment which is the closest approximation on earth to the state of weightlessness.

Other qualities possessed by SEALs that would be useful to the astronaut program are excellent physical condition, manual dexterity, self-determination, the ability to do detailed tasks alone or with a team, and the ability to work under adverse conditions.

Aviation has been a long-time interest of LCDR Shepherd. He studied Aeronautical Engineering because he thought he was going to be a pilot, but his eyesight wasn't quite good enough.

This prompted him to become a SEAL. He completed graduate studies at MIT and holds a Masters Degree in Mechanical Engineering and a degree in Ocean Engineering. He served as a platoon officer with Underwater Demolition Team *Eleven*, SEAL Team *One* and SEAL Team *Two*. On 10 May 1983, LCDR Shepherd assumed command of SBU 20.

Shepherd reported to the Johnson Space Center in Houston 2 July 1984 for a year of intensive training as a Mission Specialist.

"What the people at NASA are looking for are individuals who know something about the way the real world works and can take a problem and solve it whether it is with a computer, a piece of machinery or a system," Shepherd said.

It may be three to four years before he makes his first shuttle flight, but LCDR Shepherd feels very fortunate to be a participant in the Space Program.

MK1 MOD 0 DIVERS MASK COMMUNICATIONS

Alternate microphone and earphones have been approved for use with the MK1 Mask. The new communication set has been listed in NAVSEAINST 9597.1A, but the items are listed with *outdated* part numbers. The items are manufactured by Diving Systems International and have new part numbers, as follows:

Earphone, right	515-005
Earphone, left	515-006
Microphone	515-009
Communication Set (1 Microphone and 2 Earphones)	515-030

Microphones and earphones originally furnished with the MK1 Mask are still available and approved for use.

USS SAMUEL ELIOT MORRISON (FFG-13)
Auxiliary Propulsion Unit Change

On 16 March 1984, the first waterborne auxiliary propulsion unit (APU) change was completed by the Navy on the USS SAMUEL ELIOT MORRISON. NAVSEA Supervisor of Salvage and Diving personnel, SIMA Mayport divers, Mayport Naval Station and a Master Ship Repair contractor, collaborated to change the APU and replace the three power cables in the ship's support column, meeting the ship's schedule for deployment.

The MORRISON arrived in port unable to raise its partially extended APU. Immediate attention was needed to return the ship to working order in time for deployment. The Supervisor of Shipbuilding, Conversion and Repair, USN, Jacksonville (SUPSHIPJAX) was tasked with the repairs and, unable to locate a drydock, arranged for emergency repairs with a commercial contractor. Workers began to remove the APU and cap the support column, leaving the ship with one working APU. However, they soon discovered that the three power cables in the support column had been damaged beyond repair and required replacement.

SIMA divers were tasked to assess the feasibility of waterborne replacement of the APU and the three cables, with the assistance of a NAVSEA diving engineer. SIMA personnel and the diving engineer found no damage to the support column or mating flange, and determined that a waterborne replacement was possible. They specified that job completion would require a cofferdam; a fixture bolted to the support column, capable of holding the 6,000 pound APU; and a plug for the support column, to maintain the ship's watertight integrity during cable removal and installation. NAVSEA provided an interim change-out procedure.

The replacement operation began 14 March 1984 and was completed three days later. As this procedure had never been tested, thorough planning was essential. Fitting the cofferdam and the cables, placing the clamps around the APU shaft, measuring and manufacturing wire straps to position the APU and other tasks all required great care. Flanges, vents and a vacuum pump were necessary to compensate for the pressure difference between the APU column and the ship. Extreme precision was required to match the unit with the flange and power cables once the unit was in the water. It was especially important that the power cables remain dry during installation and connection to the APU. Careful planning resulted in a smooth operation.

Throughout the operation, divers noted any changes made in NAVSEA's interim procedure. These were incorporated into a final standard procedure for waterborne APU changes.

After all work was completed and tools were returned to the surface, the APU was tested in accordance with the Technical Manual for Operation and Maintenance. It met all manufacturer's specifications. This successful waterborne job resulted in savings to the Government of approximately $90,000.

PERSONNEL INVOLVED:

SIMA MAYPORT DIVERS:

BMCM (MDV) W.B. Austin
BMC (DV) T.I. Rodgers
BMC (DV) E.F. Smith
GMCI (DV) G.A. Young
HT1 (DV) R.G. Garon
TM1 (DV) T.E. Stevenson
PN1 (DV) M.F. Matin
STS2 (DV) M. Hertzberg
HT2 (DV) J.H. Bailey
BT2 (DV) C.C. Lowery
HT2 (DV) F.M. Fogg
BT2 (DV) D.J. Merkel
BM3 (DV) K.D. Flesher
MR3 (DV) R.D. Gassaway
MMFN (DV) K.J. Kowalski
PERSONNEL FROM SIMA SHOP 11

NAVSEA SUPPORT

E.P. Lindberg (Project Engineer, diver)
M. Dean (Design Engineer)
C. Mallder (Operations Support)

SUPSHIP JAX

H. James
Smokey
Breakfield

DOD Supply Systems Assets of Carpenter Stoppers/Wire Rope Bridles

The Ships Parts Control Center is reporting little demand for carpenter stoppers due to a past shortage of carpenter stopper/bridles in the stock room.

The DOD Supply System has the following assets of carpenter stoppers/wire rope bridles ready for issue:

5/8	**inch carpenter stopper**	**1 H-2040-00-102-4064**
1-5/8	**inch carpenter stopper**	**1 H-2040-00-102-4066**
1-5/8	**inch bridle**	**1 H-2040-00-102-4071**
2	**inch carpenter stopper**	**1 H-2040-00-136-5131**
2-1/4	**inch carpenter stopper**	**1 H-2040-00-102-4067**
2-1/2	**inch carpenter stopper**	**1 H-2040-00-102-4068**

Carpenter stopper/wire rope bridles currently being purchased by the DOD supply system are as follows:

7/8	**inch carpenter stopper estimated delivery date (EDD) from contractor 84327**	**1 H-2040-00-102-4065**
1-1/4	**inch carpenter stopper EDD 84327**	**1 H-5120-00-260-5478**
1-1/4	**inch bridle EDD 85087**	**1 H-3940-00-377-5675**
2	**inch bridle EDD 85068**	**1 H-2040-00-132-5096**

NAVSEA Supervisor of Salvage is working with the DOD Supply System to procure wire rope bridles for stock for 5/8 inch, 7/8 inch, 2¼ and 2½ inch carpenter stoppers.

Recompression Chamber Certified with No Material Deficiencies

Mr. A.P. Ianuzzi, representing the Naval Facilities Engineering Command (NAVFACENGCOM), recently conducted an initial, on-site certification survey of the recompression chamber facility at the Naval Civil Engineering Laboratory (NCEL), Port Hueneme, California.

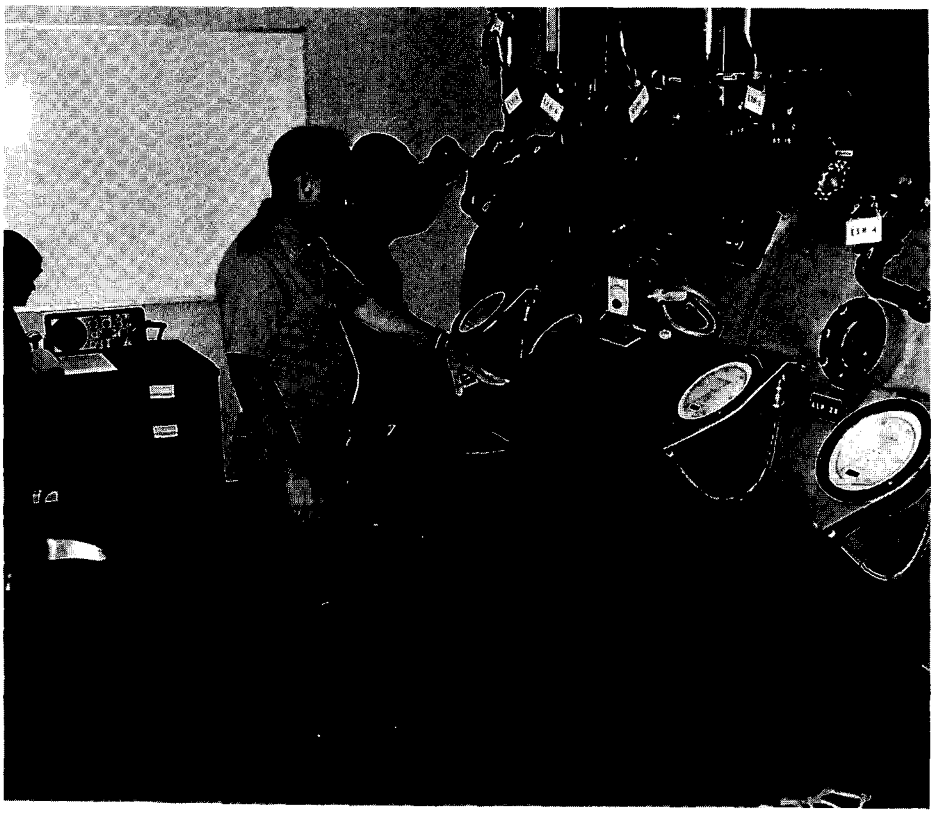
The survey was accomplished in two phases: (1) A review of all paperwork and comparison to the installed system and (2) an operational exercise of the system in both normal and emergency conditions. The system met or exceeded all operational standards set by NAVMAT P9290 (System Certification Procedures and Criteria Manual) and the U.S. Navy Diving Manual.

The Design Division of NCEL developed the system under the guidance of the Diving Officer and the Master Diver. Before ordering any material, a design review was performed by the Chesapeake Division, NAVFACENGCOM, Hyperbaric Division, to ensure compliance with DM 39, Hyperbaric Facility Manual (the NAVFACENGCOM design manual for new facility construction).

Components were ordered in August 1981 and most were received by August 1982.

Evaluation of the chamber's hull, manufactured by Dixie in 1956, proved a major challenge. Minimal documentation about the hull was available from 1956 until it was placed in storage in 1973. Because reconstruction of the missing documentation was virtually impossible, a complete survey of the hull was conducted to ascertain its present condition. An ultrasonic thickness tester was used to provide a profile of hull thickness. These records were reviewed by the Certification Authority structural engineer and found to be satisfactory.

NCEL's Ocean Operations Division and Diving Locker personnel began construction of the facility in the fall of 1982. Two steelworker divers were trained in certified silver brazing procedures for copper-nickel and stainless steel pipe. They brazed all copper-nickel low pressure pipe joints with the assistance of the other Diving Locker personnel. Mr. Phil Kling of the NCEL's weld shop assisted in the construction of the stainless steel high pressure piping system. Divers also cleaned the entire system, including the oxygen piping which had to be cleaned to a high tolerance using a solution analyzed by the NCEL's Environmental Protection Division. Except for assistance, the entire facility was constructed by Diving Locker personnel under the supervision of the Diving Officer, Master Diver and Maintenance Chief.



A surface supplied diving system (SSDS) for an installed open-test tank was also included as a separate system in the construction effort. The open-test tank system allows NCEL's engineers to evaluate equipment in a simulated ocean environment prior to costly at-sea testing. Because the open-tank system was certified separately, and two stop valves were installed in the tank system supply, work can be performed on the open-tank SSDS without affecting the chamber. Both the chamber and open-tank SSDS use the same primary and secondary air sources. A unique feature of the system is that the chamber may be aligned by operational procedure separately from the SSDS; however, aligning the SSDS by OP automatically places the chamber on line.

The successful outcome of the certification survey proves that with proper planning, a positive attitude and constructive supervision, a hyperbaric or diving system can be built (with the exception of cleaning solution analysis) by any diving locker. NCEL is fortunate to have the in-house analysis capability.

The certification was granted effective 25 December 1983; a welcome Christmas present for the personnel who worked so hard to make the NCEL Recompression Chamber a reality.

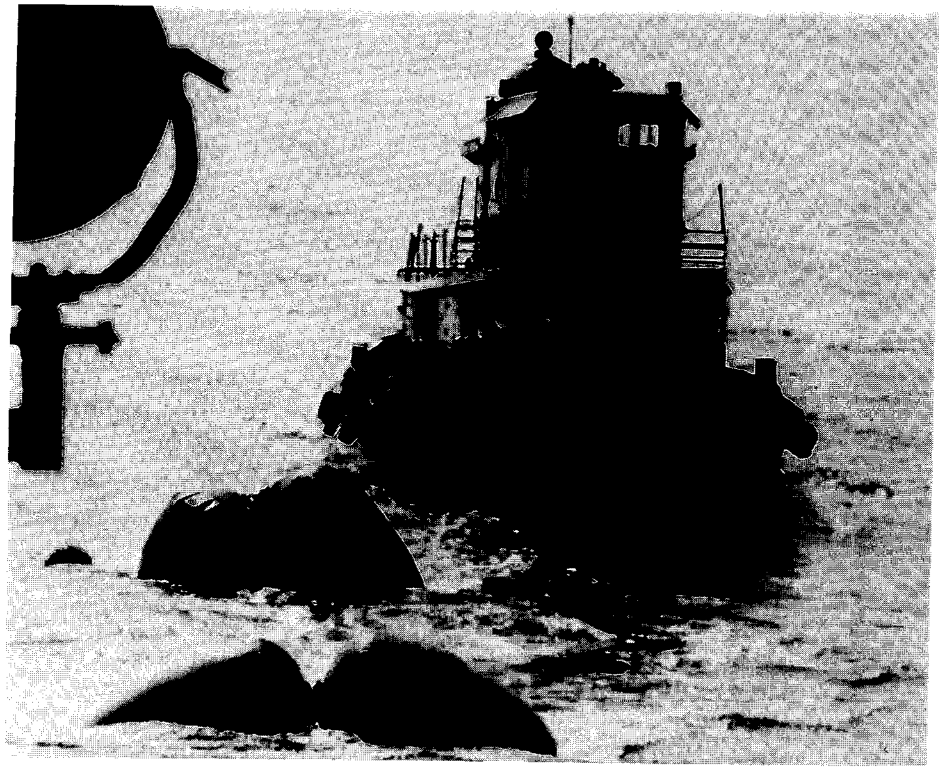
Personnel involved in the certification effort:

LCDR G.S. Guthrie, CEC, USN, Diving Officer
CUCM(MDV) C.R. Cope, Master Diver
CMC(DV) D.M., Forster, Maintenance Chief
BU1(DV) J.P. Wright
SW2(DV) J.W. Little
SW2(DV) K.L. Platt
EO3(DV) J.F. Butterfield

Many other divers who have since been transferred were involved in the effort in the early stages. Among them, SW1(DV) G.L. Sparks and SW(DV) F.K. Valdez, are most notable. They accomplished all the copper-nickel brazing which consisted of over three hundred weld joints.

Pontoons Assist Sterngate Salvage by USS RECOVERY

By LT J.W. Archer, USN
USS RECOVERY



Recovery divers prepare to enter the water after locating the Sterngate.

While conducting amphibious exercises off the coast of Morehead City, North Carolina, an LPD lost a 33-ton sterngate. An EOD team participating in the exercises located the sterngate in 45 feet of cold, murky water. Commander Service Squadron EIGHT (CSR-8), Little Creek, Virginia, was tasked with the sterngate salvage.

CSR-8 assigned the salvage job to the USS RECOVERY (ARS-43). Within eight hours of notification, necessary equipment was assembled and the RECOVERY was underway for Morehead City. Prior to departure, six 8.4-ton salvage pontoons and six one-inch wire pennants, all from the ESSM Pool at Cheatham Annex, and one 125 CFM compressor from MDSU-2 at Little Creek were onloaded.

The pontoons were especially important in this operation. Each weighed 750 pounds and when fully inflated had a seven-foot diameter and a height of 10 feet. Each had the capability of buoyantly lifting 8.4 tons and were fitted with steel eyes on each end so that two or more pontoons could be connected in a series. To inflate the pontoons, quick-disconnect nipples were removed and replaced with standard MK V divers air fittings. Swan hose (divers air hose) was then attached for inflation.

On site, RECOVERY settled into a three-point moor with her stern close to the sunken sterngate. Personnel conducted exploratory dives and pre-lift rigging operations. They connected three pontoons in tandem and lowered them into the water. At 45 feet the lowest pontoon achieved negative buoyancy and was wired to the sterngate. Team members attached a hauling line to the second pontoon, led it through a block on the sterngate and back to the ship. The pontoon was lowered to the bottom. The crew inflated the pontoons by connecting swan hose to each and pumping air from the compressor on the ship. Forward and after tow bridles were then rigged.

The ship remoored 50 feet ahead of the buoyed site following pre-lift preparations. The compressors pumped air into the pontoons and, with the help of an assist tug, the sterngate was raised.

The RECOVERY pulled and the assist tug acted as a rudder and brake during the tow back to Morehead City. The tide was ebbing and the vessels faced a four- to five-knot opposing current as they approached Morehead City inlet. With the opposing current and tidal rips, the partially submerged tow began to slue across the channel and could not have been controlled without a steering tug astern. The strong currents continued for the remainder of the operation. Even alongside the pier, RECOVERY maintained a one-third ahead bell until all mooring lines were secured.

At the pier, divers assisted the pier crane crew in preparing for the lift. Within minutes, the twisted and warped sterngate was raised and placed on the pier. Approximately 90 minutes afterward, the sterngate was stripped of all salvage gear, and the RECOVERY was detached and returned home.

View from the SUPERVISOR OF DIVING

By CDR Raymond Swanson

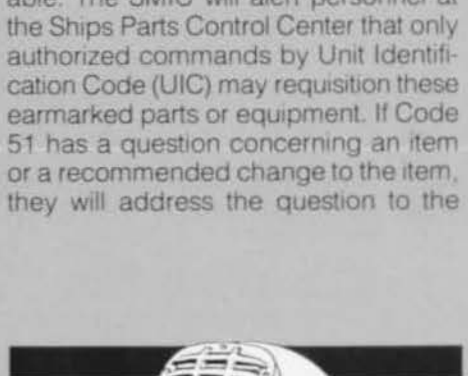
One of the most frustrating problems frequently encountered is a lack of logistic support for our diving equipment. For example, how many times have you tried to get a part in a timely fashion and either could not get the part or received the wrong part? Our office has been working to resolve this problem and has made substantial progress which you should begin to notice during the next year.

As a first step, two people have been assigned full time at Ships Parts Control Center (SPCC) to handle the supply of diving equipment. In the past, supply matters were dealt with on a "catch-as-catch-can" basis. This method can no longer satisfy the increasing demand for diving equipment which is often technically complex.

Many of you may have already met Mr. Arnold, Program Manager of the Diving Support Section (Code 51) at Ships Parts Control Center. Mr. Arnold has been traveling to various commands to gain a better understanding of diving and salvage equipment and related supply problems. In the future, this background, along with his knowledge of the supply system, should prove invaluable to our community.

Mr. Arnold is available to assist all Navy divers with equipment related supply problems. He can be reached at Code 51 by commercial telephone number (717) 790-5511 or by autovon 430-5511.

As a second step, diving equipment has recently been assigned a Special Material Identification Code (SMIC). In the past, part of the problem has been the manner in which the supply system handled procurement of spare parts for diving equipment. There was no way of indicating that diving equipment required special attention or that substitutes, even though they might conform to form and function, were unacceptable. The SMIC will alert personnel at the Ships Parts Control Center that only authorized commands by Unit Identification Code (UIC) may requisition these earmarked parts or equipment. If Code 51 has a question concerning an item or a recommended change to the item, they will address the question to the NAVSEA (OOC) for resolution.



Along similar lines, the first Configuration Control Board (CCB) meeting for the MK 12 Surface Supplied Diving System (SSDS) was held in September. This meeting marked the initiation of a new program to facilitate and ensure that there is an orderly method for making configuration changes to the MK 12 Surface Supported Diving System. All changes will be based upon safety, cost, technical merit and benefit to the community vice one activity. The board is chaired by the Supervisor of Diving and assisted by members from NAVSEA Systems Certification Authority, the Navy Experimental Diving Unit, the Naval Coastal Systems Center, the Naval Surface Weapons Center and, on an as required basis, by Fleet personnel. Most board members are engineers as well as divers so that the technical aspects of the proposed design change can be explored fully.

As we get some of the bugs worked out, additional equipment will be brought under the configuration management umbrella. We are presently working on the MK 1 Divers' Mask and the MK 16 UBA. These will be followed by the ROPER Cart, the FADS I and FADS II. Eventually, all diving life support equipment will be under configuration management.

You are probably wondering what this program will do for you—the diver. Well, primarily, it will increase your safety by ensuring that your equipment meets all the appropriate standards and certification criteria. The program will also permit you to submit your ideas for equipment improvement and provide a more expeditious and uniform method for adopting changes. Finally, it will enhance the availability of spare parts in the supply system.

Diving Accidents

Last year, Navy divers performed 93,026 dives with a total of 192 mishaps or accidents. This is an accident rate of one accident for every 485 dives or 0.2 percent. Is this a good record? Can we reduce the number of accidents? Let's examine these statistics in more detail.

Ninety-five of the accidents were due to barotrauma or ear squeeze, as it is more commonly called. As divers, we can reduce this figure significantly since the rate of descent is usually controlled by us. On many occasions we push too hard to get down to a job. Why? Sometimes we do it so we will not look "bad" to our fellow divers; sometimes it is done because of a strong desire to get the job done. Whatever the reason, the unfortunate result is an accident that forces us to remain out of the water for one to three weeks. In the worst case, the diver is out of commission for two to three months if the ear drum is broken. What this really means is that your usefulness to the Navy as a diver has been diminished significantly.

The next highest cause of accidents is decompression sickness. Fifty-five cases were reported of which seventeen, the highest amount for one type of equipment, were for open circuit SCUBA. This is frightening because open circuit SCUBA dives are not decompression dives. How does this happen? Easy. We overstay our bottom times and then quicken our ascent to make up extra time. Some of us get by with it; others, not as fortunate, become part of this statistic. Several other incidents were apparently caused by using a bottom time for decompression that was less than the actual bottom time of the dive.

Decompression sickness can be reduced by the proper selection of decompression schedules. By paying closer attention to the guidance provided in the U.S. Navy Diving Manual for strenuous and extremely cold dives, the proper schedule can be selected.

If we can reduce accidents in these two areas to zero, the accident rate will be 0.04 percent, or one accident out of every 2219 dives. Much better than one out of every 485 dives isn't it? Work on it so you will not be part of these statistics.

Equipment Development

Several issues of FACEPLATE have been published since I last gave an update on diving equipment programs. These programs continue to make progress. The *Standard Navy Diving Boat* is nearing completion at the Naval Ocean Systems Center in San Diego. Changes have been made to give more room for storage in the forward section of the boat. The divers' console has been reduced in size and relocated to provide an unobstructed view while piloting the boat; the pilot house has been reduced in size to provide more work space on the stern. A fold-up stage has been added to the stern to accommodate SCUBA divers and a diving ladder can be used from the stern and the port or starboard locations. The design is now set and TECHEVAL and OPEVAL are scheduled for midsummer 1985.

The *ROPER Cart* is located at the Naval Surface Weapons Center, Dahlgren, Va. It is being strengthened to make the trailer more roadworthy, the piping system is being modularized to facilitate maintenance and a SCUBA charging station is being added. A preproduction model will be available around September and deliveries will begin in 1986.

Testing on the *MK 12 Mixed Gas Recirculator* First Article at the Navy Experimental Diving Unit is scheduled to end this December. If all is satisfactory, production will begin on 120 recirculators. Delivery of the equipment is scheduled for May 1985.

As the official magazine for the U.S. Navy diving and salvage community, FACEPLATE publishes information concerning the latest equipment, techniques and procedures as well as other newsworthy events.

For this purpose to be best served — and for you to be best informed — it is imperative that the magazine receive articles from all Fleet and shore-based activities. Without such support, FACEPLATE cannot adequately fulfill its mission.

Some suggested areas of interest include salvage operations where divers employed special techniques or completed a particularly difficult job, research and development of diving equipment, training programs in diving and underwater ships husbandry. Articles submitted for publication must be unclassified.

Although this office assumes the privilege of limited editorial license, significant changes to manuscript text will not be made without prior consent. Material considered unworthy of publication will be returned to the originator.

FACEPLATE's accounts of people, programs and operations become a part of the historical record of U.S. Navy diving and salvage. You can be part of it.

Point of contact at NAVSEA OOC is CDR Raymond Swanson (SEA OOC-3) at AUTOVON 227-7606/7/8 or commercial (202) 697-7606/7/8.

LET'S HEAR FROM YOU!

Computer-Assisted Salvage:

AN UPDATE

By LT Todd J. Peltzer, USN
Staffing and Salvage Officer, COMSERVRON 5

LT Neil E. Hansen, USN
Diving and Salvage Officer, MOBDIVSALVU 1

Photographs by
CWO3 Peter Mularchuk, USN
Chief Engineer
USS BEAUFORT (ATS 2)

The ocean's surface boils black under the harsh glare of floodlights from USS BEAUFORT and USS BRUNSWICK; tension mounts as all eyes stare intently at the foaming patch of water. Will she rise from the bottom? No one can be sure, but the divers who labored so long to make her ready, rigging literally miles of salvage hose, are confident she will.

The salvage officers are also confident: they've selected this dewatering sequence from hundreds of possibilities, rehearsing the most likely alternatives electronically with a micro-computer.

"She's moving!" cries the sailor watching the pneumofathometer. At last, a dark form breaks the surface, and soon BLUEGILL (AGSS-242) is afloat once more after nearly 13 years on the ocean floor. There is much work still to be done, but the salvors can take pride in the success of their salvage plan.

The successful raising, and subsequent disposal, of BLUEGILL in October-November 1983 (see FACEPLATE, Summer 1984) was a tribute to the skill and dedication of those involved. A key element in this salvage operation, which must not be overlooked, is the micro-computer role in developing the salvage plan.

Hardware Selected

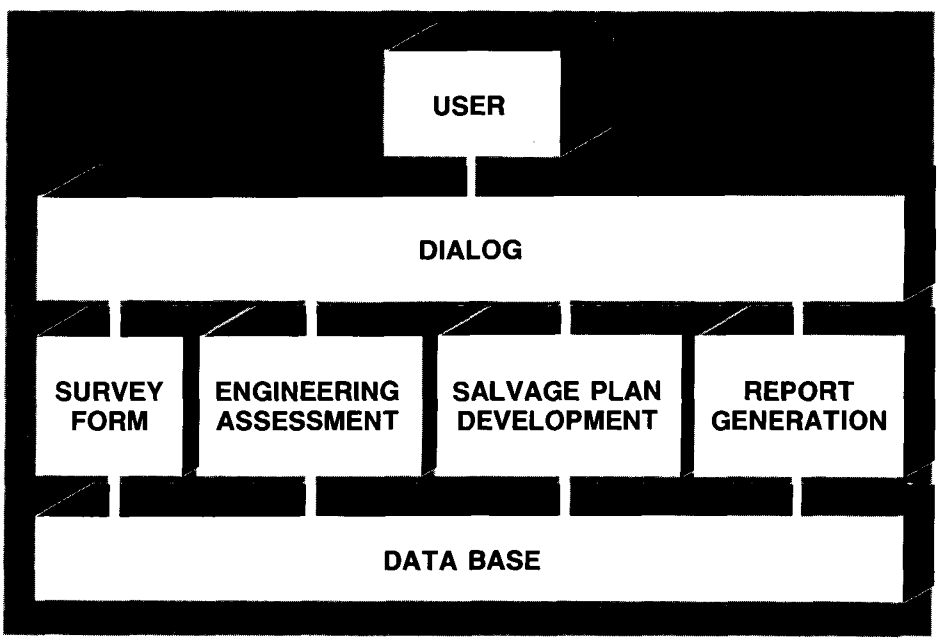
In summer 1982, the first article on the subject, "Computer-Assisted Salvage" by LCDR John P. Speer, appeared in FACEPLATE. Since then, considerable progress has been made in computer-assisted salvage at COMSERVRON 5.

An important step in bringing SERVRON 5 into the computer age was the purchase of a Zenith/HeathKit Model Z-100 desktop micro-computer in March 1983. Navy personnel conducted an informal survey of available computers and the Zenith was chosen for its excellent capabilities and relatively low cost.

The Navy and Air Force entered into a joint contract with Zenith Data Systems to provide Z-120 micro-computers for both services, significantly lowering their cost. Taking advantage of this contract, with funds provided by COMNAVSURFPAC, CONSERVRON 5 bought several micro-computers for its units, and by January 1984 all SERVRON 5 units had received a Z-120.

Despite its unassuming appearance, the Z-100 (and its cousin, the Z-120) is a powerful computer. At the heart of the Z-100 lie dual 8-bit and 16-bit microprocessors, making it possible to run both 8-bit and 16-bit based software. The large memory capacity of the Z-100 is another important feature. Configured with 128 kilo bytes of Random Access Memory (RAM) (the Z-120 has 192K RAM), it may be expanded to 704K RAM by installing additional memory circuit boards. (See inset on page 12 for a brief description of some common computer terms.) By comparison, the popular Commodore 64 micro-computer is limited to 64K RAM.

Figure 1. Salvage Decision Support System Architecture



Concept Developed

Salvage work is by nature an evolutionary process. As no two salvage operations are ever the same, no rigid computer model can be created to handle the many complex decisions that must be made during the course of a single operation. A practical computer-assisted salvage system requires, in addition to computer hardware, software that truly aids the salvor in making decisions. The concept for such a system can be characterized as a decision support system.

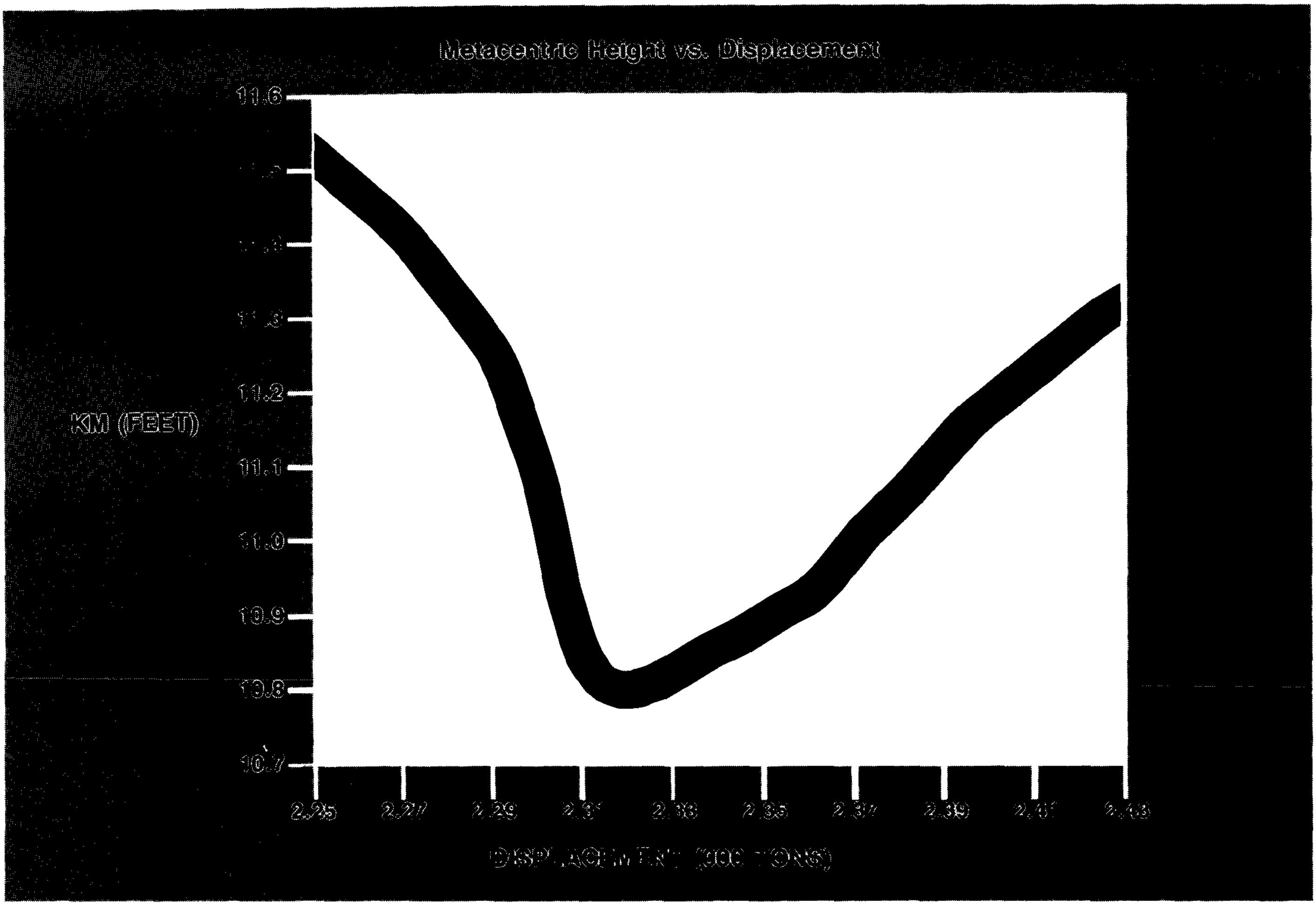
Much of the early conceptual development for a Salvage Decision Support System (SDSS) was done by CDR A. G. Campbell during his tenure as Commander, Service Squadron Five. The purpose of the SDSS is to give the on-scene commander a variety of tools to aid in the decision-making process, aid in making the best use of available resources and help produce the reports required both during and after an operation.

As conceived, the SDSS will include the following: (1) a Z-120 micro-computer, (2) a ship characteristics data base and (3) a modular software package.

The data base for the SDSS will first consist of hull offset files for those ship classes designed by NAVSEA. The files will be made compatible with the eventual SDSS software, and will be stored on a set of 5 1/4 inch floppy disks to be carried on every salvage ship. This will give the salvor enough information to make elementary buoyancy and stability calculations. Eventually, a more detailed data base will include weight and moment information, tank capacities and compartment volumes, hull-scantlings, *etc.*

The modular structure of the SDSS software, consisting of four basic components along with the data base, is shown in Figure 1. A "dialog" element will be designed to lead the salvor through various options in defining and solving the salvage problem.

Figure 2: Graph of Metacentric Height vs. Displacement for ex-BLUEGILL



A survey form component will give a series of message formats designed to obtain vital information from a stricken vessel. These may be tailored to suit the class of ship and the particular circumstances. The information gained will provide data for the second component.

The heart of the SDSS, an engineering assessment component, will take a ship's hull characteristics from the data base and combine it with information from the survey component. This will supply information to determine the stability and strength of the stricken vessel. The on-scene commander will be able to evaluate the effects of salvage efforts on a real-time basis. He can anticipate potential problems and have confidence in the course of action selected.

A salvage plan development component will produce a formal plan which may be sent to inform the chain of command. It will help the on-scene commander make best use of his resources to accomplish a salvage mission in the shortest possible time.

The system includes a report generation component to help compile daily situation reports and the final post salvage report. Collecting data from all three of the other SDSS components, it will document the many changes to the initial salvage plan, along with supply data and other statistics on the salvage operation.

Software Explored

The Ship Hull Characteristics Program (SHCP), described in the Summer 1982 article, was originally considered for the engineering component of the Salvage Decision Support System. A powerful program, SHCP provided detailed buoyancy and stability information during the salvage of USNS CHAUVENET in May 1982 and the salvage of two Korean Navy ships in March 1983.

However, SHCP was designed for use on large main frame computers. Written in FORTRAN (FORmula TRANSlation), it requires a thorough understanding of FORTRAN procedures and formats and requires computer programming experience.

The introduction of Lotus Development Corporation's 1,2,3 (TM) software for the Zenith system in Summer 1983 offered a different approach.

Lotus 1, 2, 3 is an electronic spreadsheet program with integrated graphics and data base management features. It offers the user tremendous computational power without requiring programming experience. Simple command menus and an extensive help function make Lotus 1,2,3 very easy to use, or user friendly. A built-in capability to automate any series of keystrokes or commands, using keyboard macros, gives the user an elementary programming language.

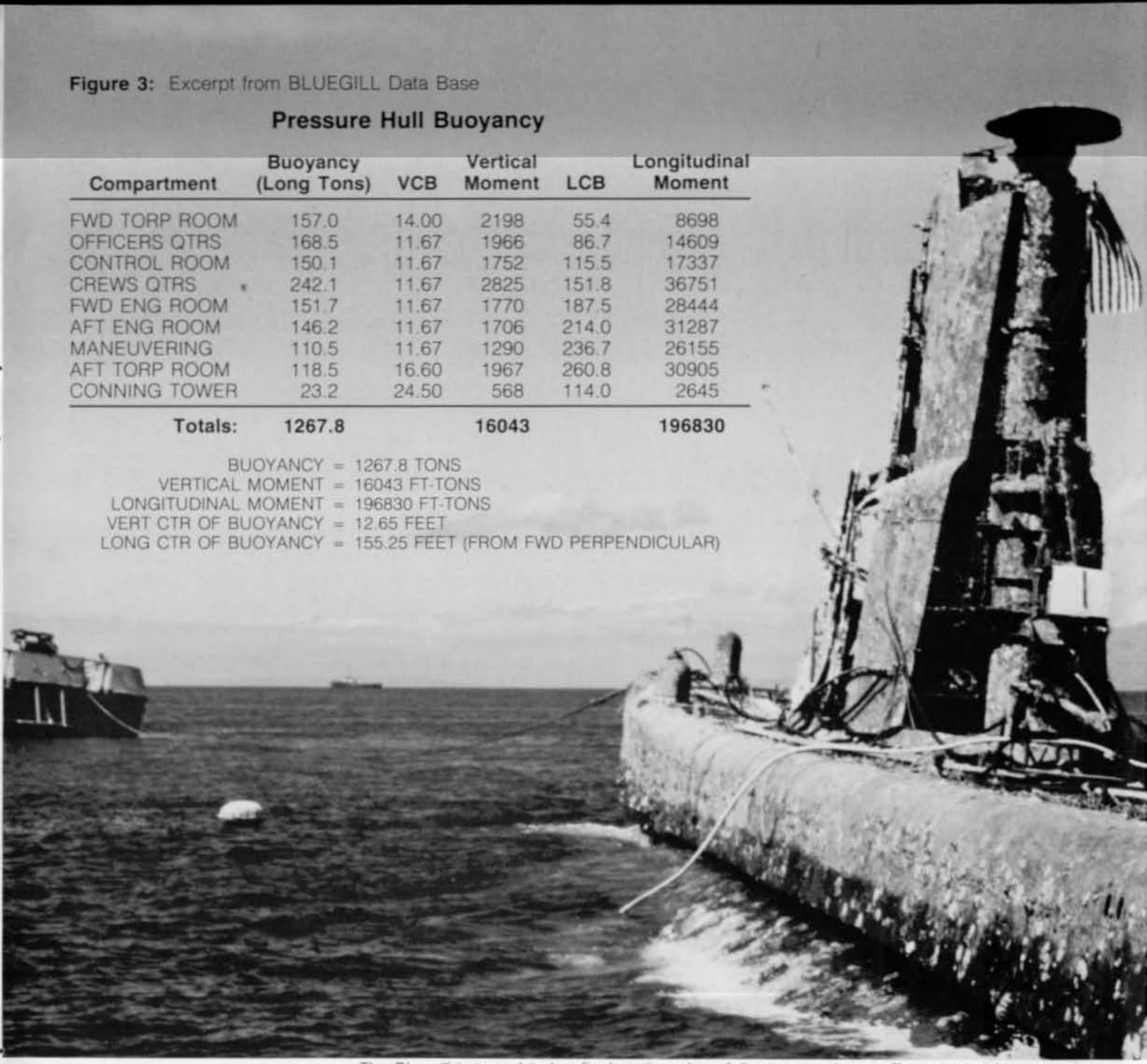
Graphics are another exciting feature of this sophisticated software. With a few keystrokes, it is possible to create a variety of graphs and charts, enabling the salvor to visualize data more clearly. Figure 2, for example, shows a graph of metacentric height versus displacement for BLUEGILL.

Figure 3: Excerpt from BLUEGILL Data Base

Pressure Hull Buoyancy

Compartment	Buoyancy (Long Tons)	VCB	Vertical Moment	LCB	Longitudinal Moment
FWD TORP ROOM	157.0	14.00	2198	55.4	8698
OFFICERS QTRS	168.5	11.67	1966	86.7	14609
CONTROL ROOM	150.1	11.67	1752	115.5	17337
CREWS QTRS	242.1	11.67	2825	151.8	36751
FWD ENG ROOM	151.7	11.67	1770	187.5	28444
AFT ENG ROOM	146.2	11.67	1706	214.0	31287
MANEUVERING	110.5	11.67	1290	236.7	26155
AFT TORP ROOM	118.5	16.60	1967	260.8	30905
CONNING TOWER	23.2	24.50	568	114.0	2645
Totals:	**1267.8**		**16043**		**196830**

BUOYANCY = 1267.8 TONS
VERTICAL MOMENT = 16043 FT-TONS
LONGITUDINAL MOMENT = 196830 FT-TONS
VERT CTR OF BUOYANCY = 12.65 FEET
LONG CTR OF BUOYANCY = 155.25 FEET (FROM FWD PERPENDICULAR)



The Bluegill is towed to her final resting place following a salvage effort assisted by computers.

"Raise the Bluegill!"

PACSUBSALVEX '83, the salvage of BLUEGILL, gave a unique opportunity to test the potential of the Z-100/Lotus 1,2,3 combination in a salvage environment.

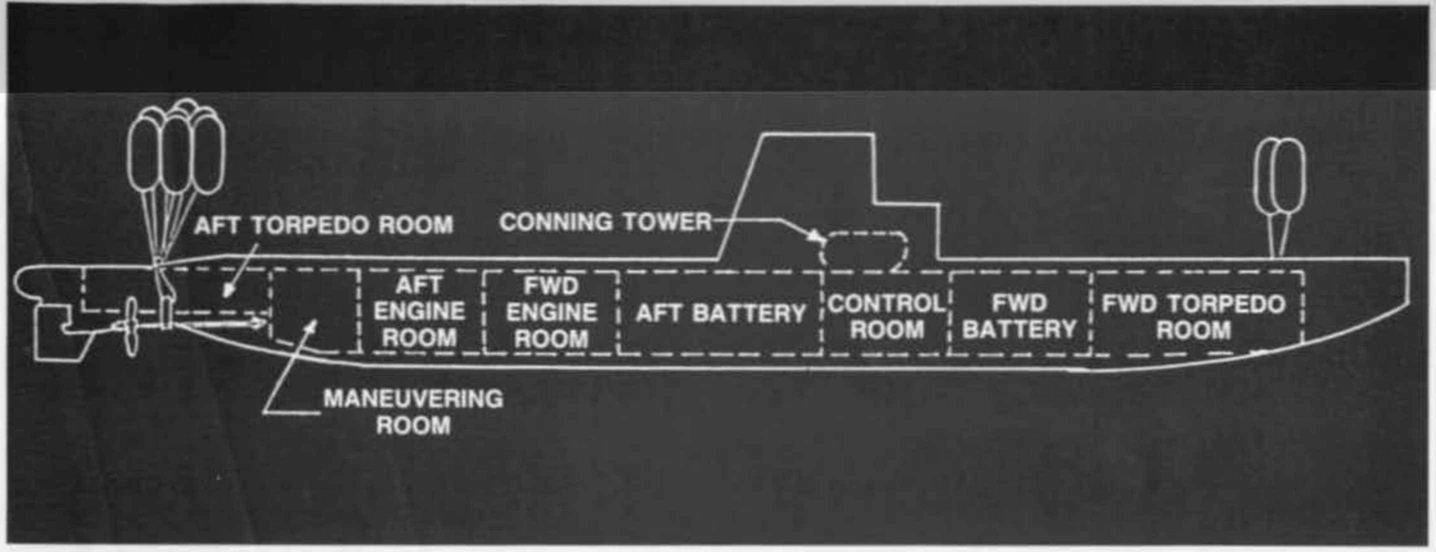
Originally, salvage plans called for BLUEGILL to be raised from her 130-foot depth in several stages, using the combined heavy bow lift capabilities of USS BEAUFORT and USS BRUNSWICK to bring her, step by step, into shallower water. Once the submarine was in approximately 40 feet of water, compressed air to dewater her pressure hull and ballast tanks would be used to bring her to the surface.

This initial plan was discarded, however, for a bolder and simpler approach: BLUEGILL would be raised using only her own buoyancy augmented by nine 8.4 ton lift capacity salvage pontoons.

While divers worked to prepare BLUEGILL for raising, the Z-100 installed on BRUNSWICK began proving its usefulness. Working with information obtained from Philadelphia Naval Shipyard, salvage engineers used Lotus 1,2,3 to develop a buoyancy and stability data base for BLUEGILL. The spreadsheet format lent itself readily to this application. Figure 3 shows an excerpt from this data base.

Engineers created a mathematical model to simulate the effects of dewatering on pressure hull compartments, ballast tanks and inflating salvage pontoons. Various combinations and sequences were examined. Lotus 1,2,3's keyboard macros made it possible to automate this model, greatly reducing the time required to evaluate a given sequence. What would have taken weeks to compute by hand, Lotus 1,2,3 was able to do in a matter of hours.

Figure 4: BLUEGILL Pressure Hull Arrangement



These calculations led to the decision to raise BLUEGILL in three stages. First, the stern would be raised to within 50 feet of the surface using seven salvage pontoons, rigged aft on 50-foot pendants. Ballast tanks would be blown as required. Second, the bow would be raised to the surface in a single step using two salvage pontoons rigged to forward and ballast tanks as necessary. Finally, the remaining ballast tanks would be blown to raise the stern to the surface.

Using the micro-computer, the salvors developed a dewatering sequence to support this plan. After dewatering the pressure hull, buoyancy would be added in relatively small increments to reduce chances of an uncontrolled ascent. Individual salvage pontoons would be alternately inflated and deflated while ballast tanks were dewatered in sequence. This procedure proved cumbersome and time consuming. Rapid backflooding of the pressure hull, estimated at 30 tons per hour, caused this attempt to fail.

Experience from this first attempt indicated a faster, less cautious dewatering sequence was not only feasible, but desirable. Using the computer a new sequence was developed, which kept the hull pressurized to minimize backflooding.

This plan involved a certain amount of risk. If BLUEGILL's stern continued to ascend past 50 feet during the first phase, the internal pressure could spring hatches open, flooding the pressure hull and causing her to sink back to the bottom. Although this possibility could not be discounted entirely, the extensive calculations made with Lotus 1,2,3 and the Z-100 gave the salvors great confidence that BLUEGILL would be raised in a controlled manner.

Using this knowledge, the salvors made final preparations and at 1451 hours on 5 November the salvage manifold valves were opened. The salvage pontoons were inflated, then air replaced water in Fuel Ballast Tank 4, the Safety Tank, Main Ballast Tank 2 and finally Main Ballast Tank 6. Computer calculations showed this combination would lift BLUEGILL's stern from the bottom.

The inflated stern pontoons surfaced. BLUEGILL's stern now lay suspended 50 feet below the surface, confirming the computer's prediction. After inflating the two pontoons at the bow and blowing the Bow Buoyancy Tank, BLUEGILL's bow broke the surface again as the computer had indicated.

BLUEGILL's journey to her final resting place had its tense moments, but after a 23-mile trip at the end of USS BEAUFORT's tow wire she was cast free and the compressors keeping her afloat were silenced. At about 1800 hours on 6 November BLUEGILL's form slipped beneath the waters of the Pacific for the last time.

A Powerful Ally

We are still a long way from realizing the full potential of the micro-computer in a salvage role, but it has proved a powerful ally to the salvor. COMSERVRON 5 will continue to pursue the goal of integrating the silicon chip technology of the micro-computer with the wire-and-chain technology of the salvor.

For further information on Navy computer-assisted salvage efforts, contact LT Peltzer at Service Squadron 5, Pearl Harbor, Hawaii, telephone 808-471-9084.

Here is a brief explanation of some common terms associated with computers:

BIT
A single piece of information: 0 or 1, ON or OFF.

BYTE
Eight bits; a "kilo byte" is 1024 bytes (2 raised to the 10th power). Usually abbreviated "K", as in 192K".

FLOPPY DISK
A flexible plastic disk with a magnetic coating on which information can be recorded, much as sound is recorded on a magnetic tape.

FORTRAN
A high level computer language developed for scientific and engineering applications.

RAM
Random Access Memory. The useable internal memory of a computer, so named because the computer has access to each memory location directly.

SOFTWARE
The detailed instructions, or programs, that govern the operation of a computer.

Ship Husbandry Modifications Improve Fleet Readiness

By LTJG Bev Abbott, USN
MOBDIVSALVU 1

Devine Marine Services Commercial Diving Company (MSCD), under a diving services contract with NAVSEA (OCC), developed and manufactured a cofferdam for SPRUANCE Class ships. First used in July 1983, the cofferdam is a significant contribution to ship husbandry, permitting difficult underwater repairs on ships with hull designs particularly prone to leaks.

One area of constant concern in ship husbandry is the repair of shaft seals. Performing repairs to a shaft seal or to the portion of the shaft inside the ship requires a dry working environment. This is usually provided by a shaft wrap. The wrap consists of a base or bulk substance and a caulking compound, such as binsky, for sealing. A diver must seal the shaft from the outside of the ship so that repairs may be made inside without danger of flooding.

The configuration of the ship's hull, shaft and fairwater often make this difficult. On certain ships leakage is a problem for shaft wraps. For example, the two shafts of the SPRUANCE class destroyer leave the ship's hull at different angles, creating a different stern tube barrel structure for each shaft. The starboard shaft exits the stern tube barrel half exposed and extends at a narrow angle through a section cut from the diaper plates. The shaft does not clear the ship's after hull lines until approximately 8 feet aft of the stern tube barrel.

The cofferdam developed by MSCD was designed to overcome these problems and was first used on USS O'BRIEN (DD-975) in the fall of 1983. Divers from Mobile Diving and Salvage Unit ONE Detachment, San Diego, installed the cofferdam and have since repeated the successful procedure on other ships of the SPRUANCE class.

The cofferdam consists of four elements: the coffin-shaped body, a pair of U bolts, a top after face insert piece and a forward cover extension piece. The installation procedure used by MOBDIVSALVU ONE DET requires only two divers. After thorough cleaning of all contact surfaces on the hull, personnel lower the cofferdam into the water with a light crane or hoist, or launch it from a platform with safety lines attached. Care must be exercised when launching the cofferdam to ensure that neither the wood nor gaskets are damaged. Two equal weights are attached, one at each end of the unit. These allow the body to float level with a slight positive buoyancy, enabling two divers to maneuver the body into place with ease. The positive buoyancy holds the body against the shaft while the divers secure it.

Personnel seal the cofferdam by caulking around the shaft and on the sides and ends of the body. They patch the after vent holes in the ship's diaper plates, and dewater the cofferdam and stern tube with an eductor and the plumbing which accompanies the cofferdam body.

Another device manufactured by the MSCD is used for the SPRUANCE class port shaft, which leaves the ship's hull at a greater angle than the starboard shaft. The uni-seal consists of two halves which fit around the shaft, enclosing the after end of the stern tube barrel and forming a seal with expanding gaskets. Like the cofferdam, the uni-seal has its own plumbing for dewatering the stern tube.

The potential for a problem exists in the sealing process. The base must be solid enough to prevent its being sucked in when the unit is dewatered. Line, with caulking material placed solidly around it, can be used for this purpose.

The cofferdam and uni-seal developed for use on the SPRUANCE class ships are examples of the diving industry's ability to adapt to the Navy's needs. With the use of the sealing devices, ship repairs can be accomplished without drydocking.

SURFACE SHIP

Sonar Dome Repair

By Roy Manstan
Naval Underwater Systems Center

The Naval Underwater Systems Center consists of a Newport, Rhode Island Laboratory, a New London, Connecticut Laboratory and several detachments where specific test and evaluation tasks are performed. Since the Center is involved in both underwater weapons development and underwater acoustics research, it is often necessary to provide qualified individuals to perform underwater research, development, testing and evaluation (RDT&E).

The Center maintains teams of divers at both principal laboratories for this purpose. The divers at NUSC's two locations perform very different functions. At Newport, a group of Range Support Divers assists with weapons testing and development at the test range in Narragansett Bay. NUSC divers help to deploy, monitor and retrieve torpedoes and all other underwater equipment. They study new hardware or changes in existing hardware.

At New London, underwater tasks are performed by the NUSC/NL Scientific Diving Team. These divers are unique to the Navy because their primary training is in engineering, either electrical or mechanical. They learned to dive at Navy dive school and are qualified as SCUBA divers. Only about 15 percent of their time is spent in the water. These volunteer divers support laboratory work by installing equipment, tracing cables and testing and repairing surface ship and submarine sonar domes.

Although the NUSC/NL divers provide technical assistance for many underwater acoustics research projects, they work primarily on surface ship sonar domes, maintaining their effectiveness for a ship's Anti-Submarine Warfare (ASW) function.

Sonar Domes

In recent years, much emphasis has been placed on the surface ship sonar domes, which include both the bow dome configuration (AN/SQS-26 and AN/SQS-53 sonar systems) and the keel mounted dome (AN/SQS-23 and AN/SQS-56 sonar systems). A sonar dome consists of two components. First, the steel supporting structure is an integral part of the ship's hull. Attached to this supporting framework is the Sonar Dome Rubber Window (SDRW). Built from a layered composite of rubber plies reinforced with wire, it is similar in construction to a steel belted radial tire. The SDRW is clamped in place at the point where the curvature of the SDRW matches the curvature of the steel support. With these two components properly mated, the sonar dome presents a smooth, hydrodynamically clean surface. Because the SDRW is nearly acoustically transparent it functions as a "window" for the sonar.

If the dome is damaged, excessive flow noise and cavitation will degrade sonar performance and thereby significantly affect a ship's ASW mission. Any problem must be corrected as quickly as possible, minimally altering the ship's operational schedule. Maintaining the SDRW in optimal condition is as important to sonar performance as is the proper functioning of the electronic components within the ship. It requires efficient, accurate and reliable pierside repairs.

NUSC/NL Develops Repair Procedures

NUSC/NL is responsible for evaluating and upgrading the repair procedures and materials currently in use, including the development of new repair techniques, hardware, and materials that will improve the overall efficiency of pierside repairs, and allow them whenever and wherever possible. Such procedures can eliminate any need for immediate dry docking, or at least permit postponing major repairs until a scheduled docking occurs.

These objectives are being pursued through experimentation at the New London Laboratory and actual waterborne repairs by Navy dive teams assigned ship husbandry duties. Some of these repairs have required fast response to ship problems on a worldwide basis.

A series of tests was begun in October 1983, when a full-size sonar dome, mounted in its shipping fixture, was suspended on pontoons and moored pierside at the New London Laboratory. Throughout the following winter, this SDRW was used as a test platform to evaluate the materials and procedures necessary for cold water repairs.

A major problem associated with cold water is the excessive cure time for the underwater epoxy used to make SDRW repairs. Using this test platform, a great deal of insight was obtained regarding the behavior of the repair materials in cold water. Two systems were developed and tested for heating the repair area to accelerate the cure time. These systems are being reviewed and hopefully will be available for field use during the winter.

NUSC/NL has also been involved in the Non-Destructive Evaluation (NDE) of SDRWs. These investigations have included using a technique for pierside radiographic inspection of critical areas on the SDRW. With this procedure, similar to an X-ray, the wire ply strength members embedded within the rubber window can be viewed in detail. If failures in these wires are found, the SDRW can be repaired or replaced prior to deployment.

Most of the work performed at NUSC/NL will eventually be incorporated into the Sonar Dome Repair section of the Ship Husbandry course currently under development by NAVSEA OOC. It is important that Navy divers trained in ship husbandry be thoroughly familiar with sonar dome construction so that accurate damage reports can be made. A high level of quality control must be maintained during the repair process in order to guarantee reliable functioning of the dome. Proper sonar dome maintenance is crucial given the importance of the SDRW in the ship's overall ASW capability.

NMRI Hyperbaric Center:
Research Biomedicine of the 1,000-FOOT Saturation Dive

By LT A. Grimmig, CEC, USN
Maureen A. Darmody, Editor
Naval Medical Research Institute

Photos by HT2(DV) Mark Faram

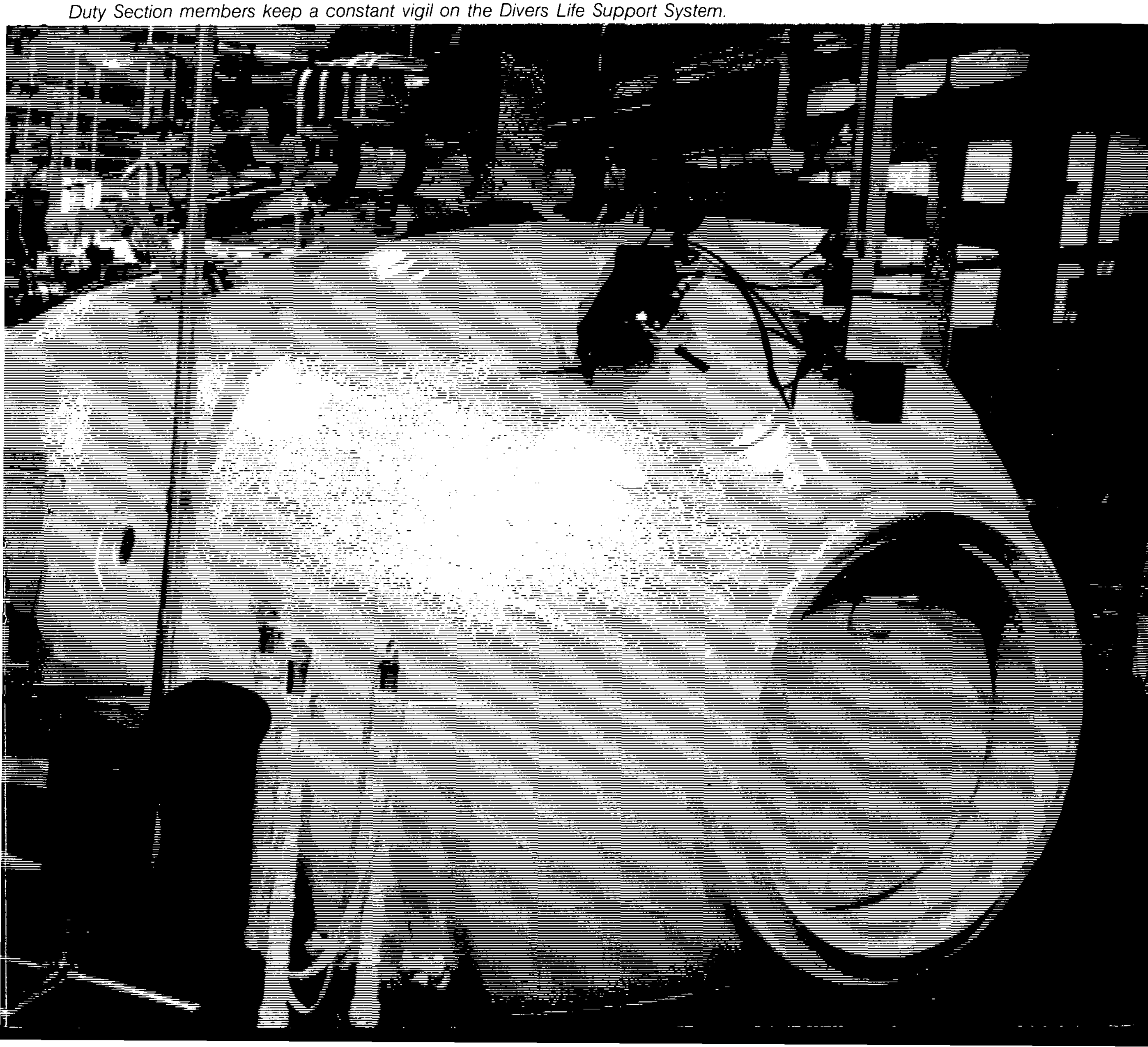
5 September 1984 was a significant day in history. The day the space shuttle Discovery was returning from its maiden voyage in space, the Naval Medical Research Institute's (NMRI) Hyperbaric Medicine Program Center was making its first deep saturation dive to 1,000 feet in the Man-Rated Chamber Complex (MRCC).

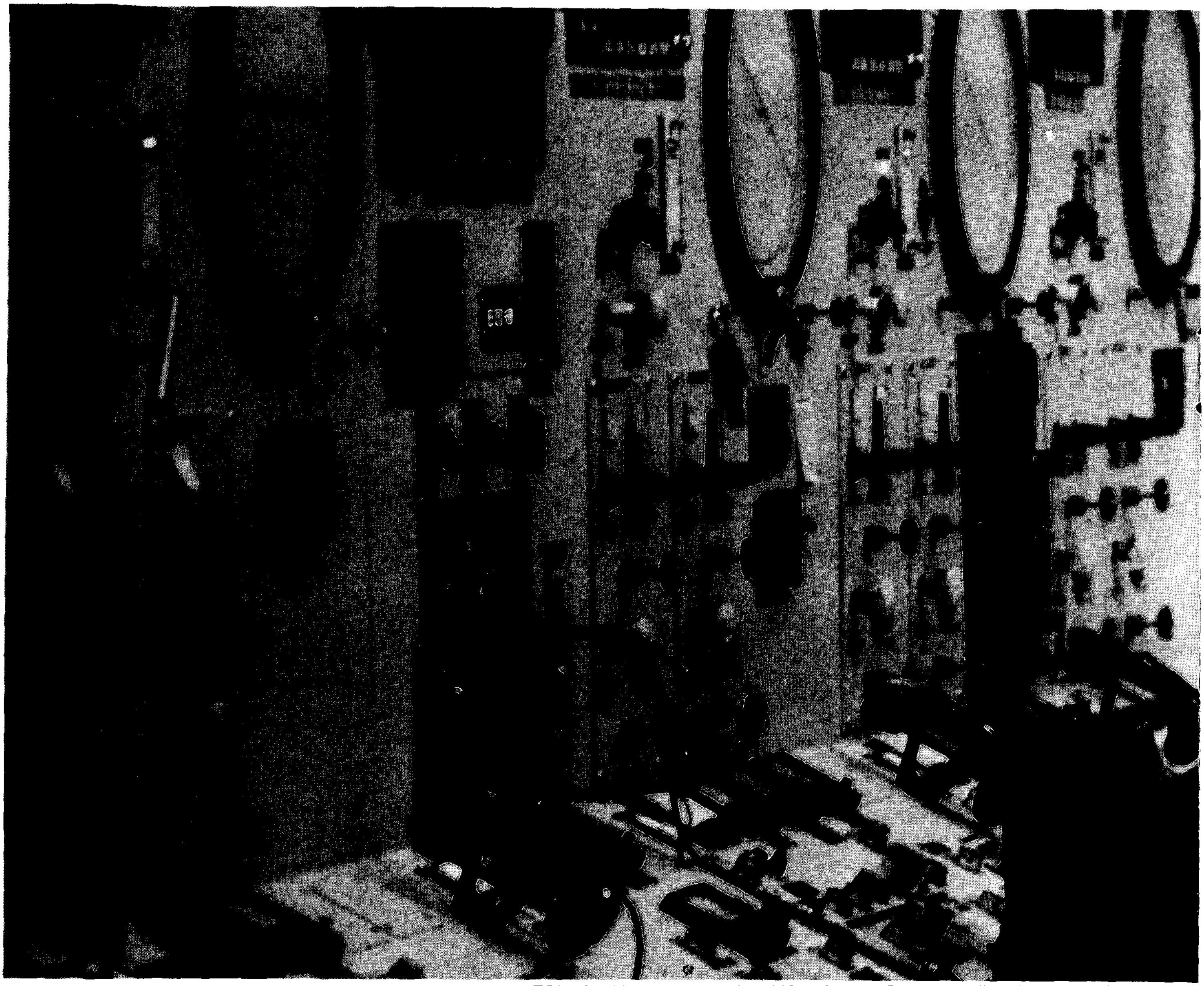
At 0900 four Navy saturation divers at the Hyperbaric Medicine Program Center (HMPC), Naval Medical Research Institute (NMRI), in Bethesda, Maryland, began an eagerly awaited odyssey, the first manned 1,000-foot saturation dive in the Center's hyperbaric chamber complex. Researchers at HMPC believed that information gained from the dive would have important applications to established Navy standards for fleetwide surface supported "bounce" diving and saturation diving operations.

One-thousand foot saturation dives are not new to the Navy's Diving Program. The Navy Experimental Diving Unit (NEDU) has conducted deep saturation dives routinely since 1968. However, NMRI's first 1,000-foot dive is significant because it initiated the HMPC Man-Rated Chamber Complex, the most advanced hyperbaric facility entirely dedicated to hyperbaric medicine research. This Complex, commissioned three years ago, has as its mission the researching of biomedicine affecting Fleet divers.

There are some important differences between the chamber complexes at NMRI and NEDU, although they have the same design. Because NEDU studies equipment and the effects of equipment on divers, its facility is much larger, permitting evaluation of units as large as submersibles. Researchers at NMRI conduct biomedical diving studies, learn the physical parameters

Duty Section members keep a constant vigil on the Divers Life Support System.





HTCM (MDV) David Debolt, NMRI's Master Diver, middle, checks on dive

of the body at depth and the effects on physical functions of the ocean environment. This biomedical data is then used at NEDU to develop and test equipment. Therefore, the new NMRI complex will provide valuable information to both organizations.

NMRI's Chamber Complex

NMRI's complex, 56 feet in length, is composed of five chambers labeled A, I, D, R and O. The A chamber, formerly intended for experiments with animals, has been redesigned for human studies. The I chamber is an interim facility, used to move personnel from the surface to depths. Wet dives will be conducted in the D chamber, although none were accomplished during the September series. A 4,160-gallon wet pot is attached to this chamber. R is a living chamber. During the 1,000-foot dive, participants lived in both R and A chambers, giving them the maximum possible space in this relatively small facility. The O Chamber, at the end of the complex, is an elevator providing access to other chambers from the surface. The A and I chambers can be pressurized to 1,500 psi, and R, D and O to 1,000 psi.

Since its commissioning three years ago, HMPC's mission at NMRI has been to solve the physiological problems facing the U.S. Navy's conventional saturation diving Fleet. HMPC conducts biomedical diving research and development to study the processes underlying safe decompression, investigates cardiovascular and respiratory performance, conducts cold stress studies, determines the limits and mechanisms of oxygen toxicity, studies the High Pressure Nervous Syndrome and develops improved treatment procedures for decompression sickness and air embolism.

The 1,000-foot dive was a culmination of years of effort to advance knowledge in these areas. The first phase of this effort was begun in early 1984 when HMPC personnel insulated the entire chamber complex, modified the atmosphere conditioning systems and conducted 30-foot, 200-foot and 300-foot saturation dives to prepare the complex for the 1,000-foot dive. This was an operational series designed to determine the operational capabilities of the

progress while Don Chandler, HMPC Deputy Director, right, looks on.

complex. Solving problems as they arose helped personnel in understanding the system's capabilities. In addition to studies of complex functioning, two research protocols were pursued during the 200, 300 and 1,000-foot dives. Tests were completed on the effects of varying inspired oxygen concentrations on cardiovascular performance, and to determine if breathing cold helium-oxygen gas mixtures adversely affects lung function.

The cardiovascular and cold water experiments are important because the stresses experienced by divers in the chamber are common to divers in the Fleet. There are differing views regarding the effect of breathing cold gas mixtures and further study in this chamber complex may yield data to clarify this issue and improve lung functioning in the undersea environment.

The hyperbaric operations team conducted a full range of operational tests to document the capabilities of the MRCC during manned diving operations. These tests were conducted in the research chamber, the two living quarters chambers, and the wetpot of the MCRR. In one test, the team determined the operating capability of the recently developed atmosphere conditioning system loops designed to maintain temperature and humidity at preset levels. The team also performed operational tests to examine atmosphere contamination, gas analysis capabilities and habitability of the MRCC. These operational tests were divided into two basic categories: engineering and gas analysis. The engineering tests included: monitoring of temperature stratification, measurements of plenum pressure and the efficiency of the CO_2 scrubbers, monitoring of the cooling and heating of the wetpot, testing of the efficiency of the helium speech unscramblers, measurements of sound levels in the chamber under hyperbaric pressure and testing of medical instrumentation. The latter equipment consisted of EKG leads, an audiometer, pressure transducers, temperature probes and thermistors.

Gas analysis tests included: measurements of gas stratification, monitoring of response time needed for gas switching in the built-in breathing system, measurements of response time of gas analysis instruments, testing of the capability of the mixmaker to deliver acceptable breathing gases directly to divers, measurement of inert gases such as nitrogen, measurement of carbon monoxide, analysis of particulate matter and analysis of trace contaminants.

The data collected from all operational tests will be critical for planning future saturation diving operations that involve longer bottom times and deeper depths. In addition, the dive afforded hyperbaric operations personnel the opportunity to test new MRCC operating and emergency procedures and provided appropriate program center personnel with an opportunity to conduct watch stander training and qualification.

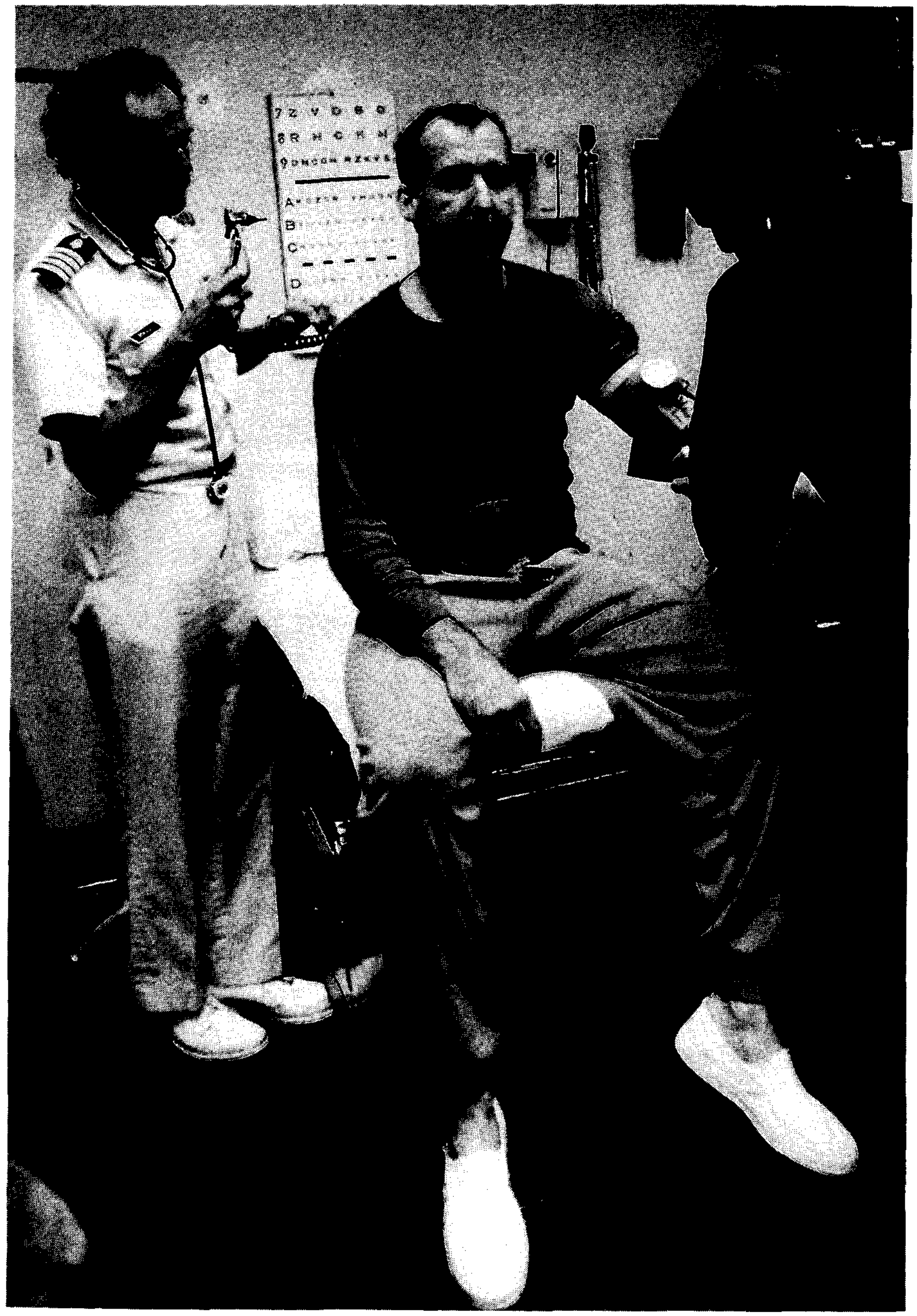
While the hyperbaric operations team conducted operational studies, the research team conducted numerous tests to obtain data on biomedical criteria for manned underwater work.

Biomedicine of Manned Underwater Work

One objective of the research team was to determine the effects of ambient pressure and PO_2 on the beat-to-beat fluctuations in resting heart rate and on changes in cardiac output. Researchers tested the hypothesis that an elevated oxygen partial pressure may be beneficial to cardiovascular function and exercise tolerance at deep depths, in part because it facilitates faster repayment of the oxygen debt incurred during exercise.

Another objective was to assess the changes in the kinetics of the heart rate changes during submaximal exercise at depth. The kinetics of changes in heart rate and cardiac output during and after exercise should provide useful information about the adequacy of the cardiovascular response to exercise at depth and could help define safe limits for the intensity of workloads in different diving situations. This is important because little information is available concerning cardiovascular kinetics during exercise at great depths. Previous studies have focused almost exclusively on steady state values of cardiovascular response.

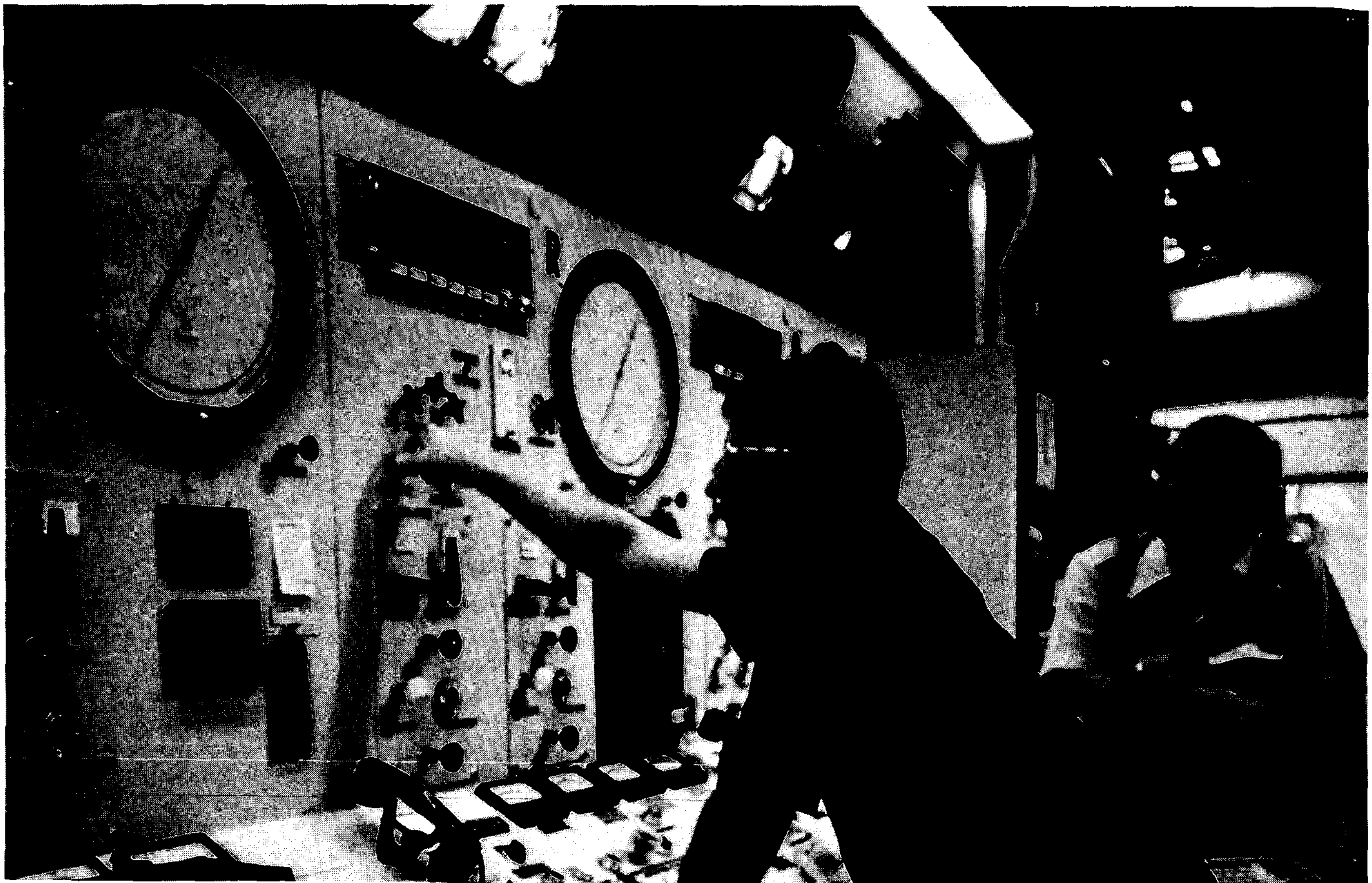
Yet another objective of the research team was to determine the rate at which the skeletal muscle fibers in the forearm tire under hyperbaric conditions. The results may contribute to standards for both the type and duration of work that divers can perform safely underwater. In addition, the research team made temporal measurements of fluid intake and urine formation in the dive subjects because the balance of body fluids is an additional factor that influences cardiovascular function and exercise tolerance in the diving environment. These measurements may provide a valuable index of the optimum balance of body fluids.

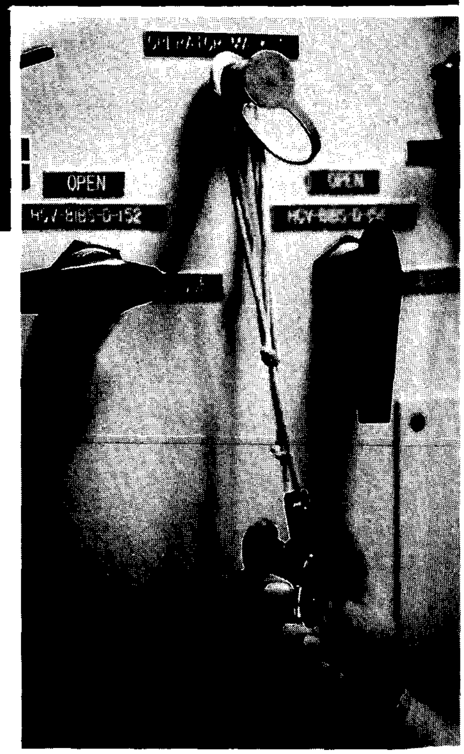


Capt. Mark Bradley and HM1(DV) Frank Mecocci give HT1(DV) "Corky" Light his post-dive physical.

In a separate area of study, the research team tested some proposed breathing gas temperatures in an effort to understand problems incurred when divers inhale cold gas. The inhalation of cold gas is a common problem in deep or cold water diving. It is known that cold gas can reduce body core temperature, but there are few studies on the effects of cold gas on pulmonary functions in diving. Anecdotal reports by divers describe detrimental effects of cold gas inhalation, such as a choking sensation accompanied by difficulty in breathing, and copious secretions of mucous in the airways. Thus, research on cold gas inhalation also needs to address the area of pulmonary function.

The most common solution proposed for dealing with the effects of breathing cold gas is to heat the breathing gas. The beneficial effects of this solution could backfire, however, if the heated





IC1(DV) Jay Barber, bottom left, monitors communications between the divers and the surface. HMCS(DV) Wayne Shirtz, in large photo, adds oxygen to the divers' breathing mixture as Mr. "Chips" Hurley looks on.

A constant watch on depth and time is essential to any dive operation.

gas induces hyperthermia, a dangerous rise in body core temperature. The optimum breathing gas temperature for deep saturation dives is not yet known, but the solution must understandably balance the physiological concerns of both body core temperature and pulmonary function. The research team hopes the results of this study will make a significant contribution to standards for inspired gas temperatures in deep saturation diving.

To train for the 1,000-foot saturation dive, all members of the dive team as well as standby divers participated in a physical fitness training program for a period of approximately two months before the dive. This program included general strength and endurance training, and specific physical fitness training for bicycle pedaling and handgrip performance, both part of the experimental test protocol.

Before the start of the saturation dive, all experimental procedures were performed on each diver to obtain control data. The same procedures were repeated during each full day at 500 and 750 fsw, respectively, in the compression phase. Experiments were then continued on the first full day after reaching the target depth of 1,000 fsw. After the dive team surfaced, experimental procedures were again repeated to obtain postdive data.

The dive profile spanned a period of 27 days to complete the entire cycle of compression and decompression. The chart below details the compression phase of the dive:


MS2 Steve Sheckells, left, prepares food for consumption at depth by divers.

COMPRESSION SCHEDULE

Start Depth (fsw)	Stop Depth (fsw)	Travel Rate (fsw/min)	Breathing Gas
surface	22	15	air
22	22	stop:1 h	
22	300	3	helium-oxygen
300	300	stop:24 h	
300	500	3	helium-oxygen
500	500	stop:2.5 days	
500	750	2	helium-oxygen
750	750	stop:2.5 days	
750	1,000	1	helium-oxygen

The profile specified five days of bottom time at 1,000 fsw, allowing time for all operational and experimental procedures to be completed at this depth. After that interval, decompression began. This phase followed the standard saturation decompression rates cited in the U.S. Navy Diving Manual.

No single person is responsible for the success of the dive series; many made significant contributions. HMPC's saturation debut could not have been accomplished without the dedication and perseverance of its military and civilian personnel. Endless hours of training, repairs and systems alterations were invested into the preparations for the 1,000-foot dive. Through the relentless vigil of around-the-clock watches, ensuring the safety of the dive team inside the chamber for 25 days, the topside personnel remained alert and steadfast in their commitment to the success of the mission.

HT1 (DV) D.J. Woodworth, ENC (DV) D.D. Thornton, HT1 (DV) C. Light and HMC (DV) W. Liggett made up the dive team.

Two additional teams, the research team and the hyperbaric operations team, comprised the team triad that made this debut dive possible. The research team conducted the aspects of the dive protocol dealing with medical research. Members collected biomedical data concerning the effects of deep diving on man and analyzed the results. The operations team consisted of the Center's Hyperbaric Operations branch from which were assigned designated watch station and watch supervisory personnel. This team conducted the operational tests during the dive.

NMRI will continue its biomedical research with the Man-Rated Chamber Complex. Improved understanding of the operational capabilities of the Complex as a sophisticated facility for biomedical research, combined with the application of this research to equipment, should assure improved operational capability for the Navy divers.

What is next on the research agenda of HMPC? In the immediate future, 125 nonsaturation air dives are planned this calendar year to further the Center's studies on air decompression. Two shallow saturation dives to 150 feet are planned early in 1985, and another 1,000-foot deep saturation dive is slated for the late spring of 1985. This brisk research pace should greatly advance HMPC's contribution to the solution of diving problems in the Fleet.

NEDU REPORTS

Evaluation of Commercially Available Underwater Communicators for Use with the MK I MOD O and MK 12 SSDS in the Air Mode

LT Susan Trukken, USN;
Jerry D. Pelton, Equipment Specialist
NEDU Report 9-84

ABSTRACT:

In March and April 1984, the Navy Experimental Diving Unit tested four, three diver, four wire, helium speech unscrambler (HSU) capable commercial underwater communicators. The goal was to recommend one or more of the following commercial communicators for Navy approval for use in the air mode only:

a. EPCOM HSU-1500
b. HELLE Model 3315
c. HYDROCOM
d. AMCOM III Model 2830H

Only the HYDROCOM, manufactured by Hydro-Products, satisfied required communication intelligibility using the Modified Rhyme Test (MRT) as the evaluation criteria during shallow manned in-water testing. Human engineering aspects were satisfactory. The HYDROCOM unit suffered no material failures during testing.

The Hydro-Products, HYDROCOM UDC 225 is considered to be a reliable and effective means of communication for surface supported diving operations.

Operating and Maintenance Guidelines for the Kinergetics Environmental Control System (Carbon Dioxide Scrubber Model DH-10 and Heat Exchanger Model CCU-01)

CDR Henry J. C. Schwartz, MC, USNR
NEDU Report 14-84

ABSTRACT:

An environmental control system consisting of the Kinergetics, Inc. (6029 Resada Boulevard, Tarzana, CA 91356) Carbon Dioxide Scrubber Model DH-10 and Heat Exchanger model CCU-01 has been previously evaluated as suitable for installation in standard U.S. Navy two-lock aluminum recompression chambers. A method of measuring chamber carbon dioxide concentration, such as chemical detection tubes, must be used to determine when to change carbon dioxide absorbent canisters. For planning purposes, predicted canister durations for the scrubber under specified conditions of 3 occupants or less, 75°F (24°C) internal temperature, and no external ventilation or breathing apparatus overboard dump are 3.5 hours at 30 Feet of Sea Water (FSW), 1.5 hours at 60 FSW, and 1.0 hour at 165 FSW. The heat exchanger requires a minimum of 2 gallons per minute of water or water/propylene glycol mixture, chilled to a maximum temperature at the chamber ranging from 82°f (28°C) for an ambient air temperature of 86°F (30°C), to 36°F (2°C) for an ambient air temperature of 110°F (43°C), in order to keep the chamber internal temperature below 85°F (30°C). In the future NAVSEA is considering outfitting selected chambers with this system.

Evaluation of the Kerie Cable Thermal Arc Cutting Equipment

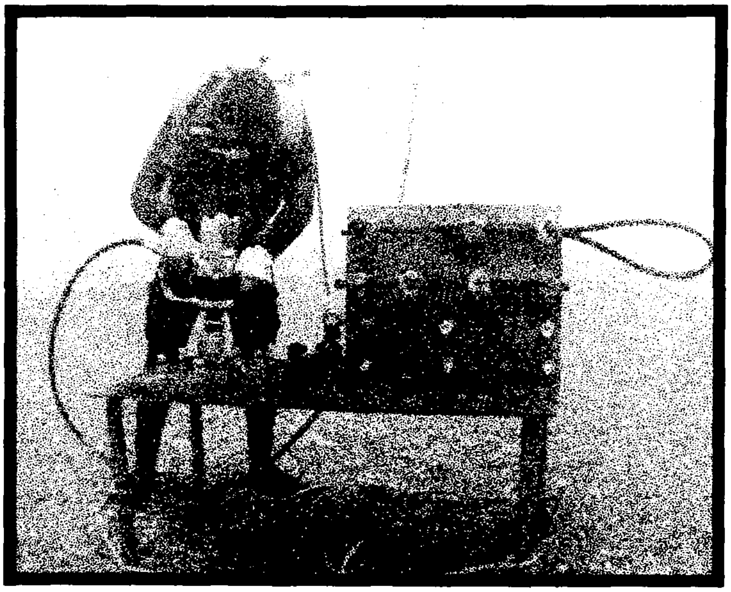
LT Susan Trukken, USN
NEDU Report 7-84

ABSTRACT:

From 16-26 April 1984, the Navy Experimental Diving Unit conducted testing on the CLUCAS Underwater Kerie Cable thermal cutting equipment at 'A' dock, Pearl Harbor, Hawaii. The purpose of this testing was to verify Navy procedures for set up, use and maintenance; evaluate diver and equipment hazards; identify proper procedural corrections for identical hazards; and provide a recommendation for training procedures.

The Kerie Cable has similar hazards as other cutting equipment with acceptable safety margins. The procedures established proved to be effective and safe. The Fleet will require only minimal training for safe and effective cutting. The CLUCAS Underwater Kerie Cable thermal cutting equipment is considered to be reliable, safe and an effective means of underwater thermal cutting.

NCEL DEVELOPS NEW TOOLS FOR DIVERS



Diver operates prototype seawater hydraulic impact wrench in NCEL's shallow-water test tank.

By Jerry Thomas
Naval Civil Engineering Laboratory

In the near future, Navy divers will work faster and safer, at greater depths and with more freedom of movement.

All classifications of divers (construction, maintenance, repair, rescue, salvage and saturation) will benefit from new tools, techniques and power systems, appreciably improving the Navy's underwater capabilities.

For example, saturation divers will be capable of working efficiently at 850-foot depths using a bottom-resting tool system. The self-contained package will feature five interchangeable heads which can be connected to a universal power handle. The system will use hydraulic fluids which contain 50 percent water and 50 percent additives to improve viscosity, lubricity and corrosion inhibition.

This major deep-diver capability, in final stages of development, is part of an extensive Diver Tools Program at the Naval Civil Engineering Laboratory (NCEL), Port Hueneme, California.

For almost 20 years the Laboratory has been improving diver tools with expanded applications and greater reliability, reducing maintenance requirements and time, and developing new tools, techniques and power sources. Divers will be able to perform more complex tasks with greater ease and versatility and increased efficiency.

Sponsored by the Naval Sea Systems Command and the Naval Facilities Engineering Command, the NCEL program includes two major areas of development: Technology and Hardware.

Technology Development includes the areas of seawater hydraulic components and new processes for conducting underwater work. NCEL's hardware developers concentrate on underwater construction systems, saturation diver tools and electrical safety.

Underwater Construction Systems development includes a multi-function tool system, grout dispenser, emergency diver recall system, a cable tracking system, underwater work repair manual and geotechnical tools. A lightweight oil hydraulic power supply to be mounted on an inflatable boat is scheduled for test this year by Navy Underwater Construction Teams (UCTs).

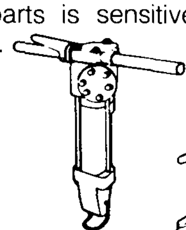
Multi-Function Tool System

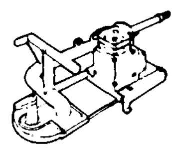
New developments in underwater tool systems incorporate the latest technology. For example, NCEL's recently developed seawater hydraulic motor is being adapted to the multi-function tool system. This system consists of a seawater power source and four seawater hydraulic tools: rock drill, rotary impact wrench and drill, high speed rotary abrasive disc, and portable bandsaw. The multi-function tool system also features design innovations never used previously by UCTs. The tools are designed specifically for underwater construction and are not simply modifications of tools originally designed for use on land. In addition, the system is powered by pressurized seawater instead of pressurized oil. Seawater hydraulics is the newest advancement in power tools, providing a safe, clean and convenient source of working fluid. The system should be available to Navy divers by FY 1986.

Following are brief descriptions of components in the multi-function tool system.

Seawater Power Supply—This full-duty 30 horsepower power source is driven by diesel and is capable of delivering 2,000 pounds per square inch of seawater at flow rates of up to 14 gallons per minute. Skid-mounted on a trailer, the unit features a 50-foot inlet lift and can power two tools at the same time.

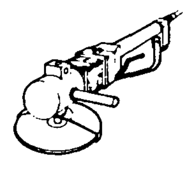
Rock Drill—This tool incorporates an interchangeable nose piece for light and heavy duty drilling. As a light duty drill, the tool, powered by seawater hydraulics, produces holes 1/4 to 1 1/2 inches in diameter. It can be operated to depths of 190 feet, drilling 3/4 inch diameter holes in granite at a rate of 3 to 4 inches per minute. Using the heavy duty drill, divers can drill holes up to 3 1/2 inches in diameter. The tool can be used at greater depths because none of the parts is sensitive to ambient pressure.

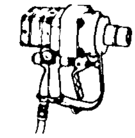




Portable Bandsaw—Previously, it took a team of divers, using a hand hacksaw, four to eight hours to cut through a double-armored 3 1/2 inch diameter cable. With the portable hydraulic bandsaw developed by NCEL, divers can cut the cable in less than a minute.

High Speed Rotary Abrasive Disc—Featuring an interchangeable arbor, this versatile tool can be adapted as an abrasive saw, grinding wheel, or cleaning brush. It also cuts steel, aluminum, bolts, rebar, cable and 1 1/4-inch synthetic lines, all underwater. A safety guard minimizes viscous drag.





Rotary Impact Wrench and Drill—Providing maximum torque of at least 400 foot-pounds to tighten 5/8-inch bolts, the tool can be used to drill holes into wood and metal from 1/4 inch to 1 inch in diameter. Weighing 15 pounds, it can be operated in forward or reverse directions using commercially available impact sockets and drill bits. Flow range is four to ten gpm and the pressure range is 500-1500 psi. For more information on the multi-function tool system, contact Wayne Tausig, NCEL, Code L43, (805) 982-5553.

In other areas of the Hardware Development, staff members at NCEL's Seafloor Engineering Division have been working on additional tools for underwater work.

Geotechnical Tools

The Laboratory has developed six diver tools to obtain reliable geotechnical data. They are designed for SCUBA divers up to a depth limit of 130 feet. The tools will be available this year and will enable UCTs to gather in-site data and samples for laboratory testing. Data and test results will be instrumental in the design and installation of a variety of sea-floor facilities.

Following are some examples of recently developed geotechnical tools.

Impact Corer—Approximately 4 feet long and weighing 17 pounds, the tool takes a relatively undisturbed soil sample 1 1/2 inches in diameter and 30 inches long.

Miniature Standard Penetration Tester—The tool gives an indication of the density of sandy (cohesionless) soils. Weighing 17 pounds, the tester with a cone-shaped bottom has a 20-inch shaft marked in 3-inch increments. The number of blows from a cylindrical drop hammer needed to penetrate the soil is counted to indicate soil density.

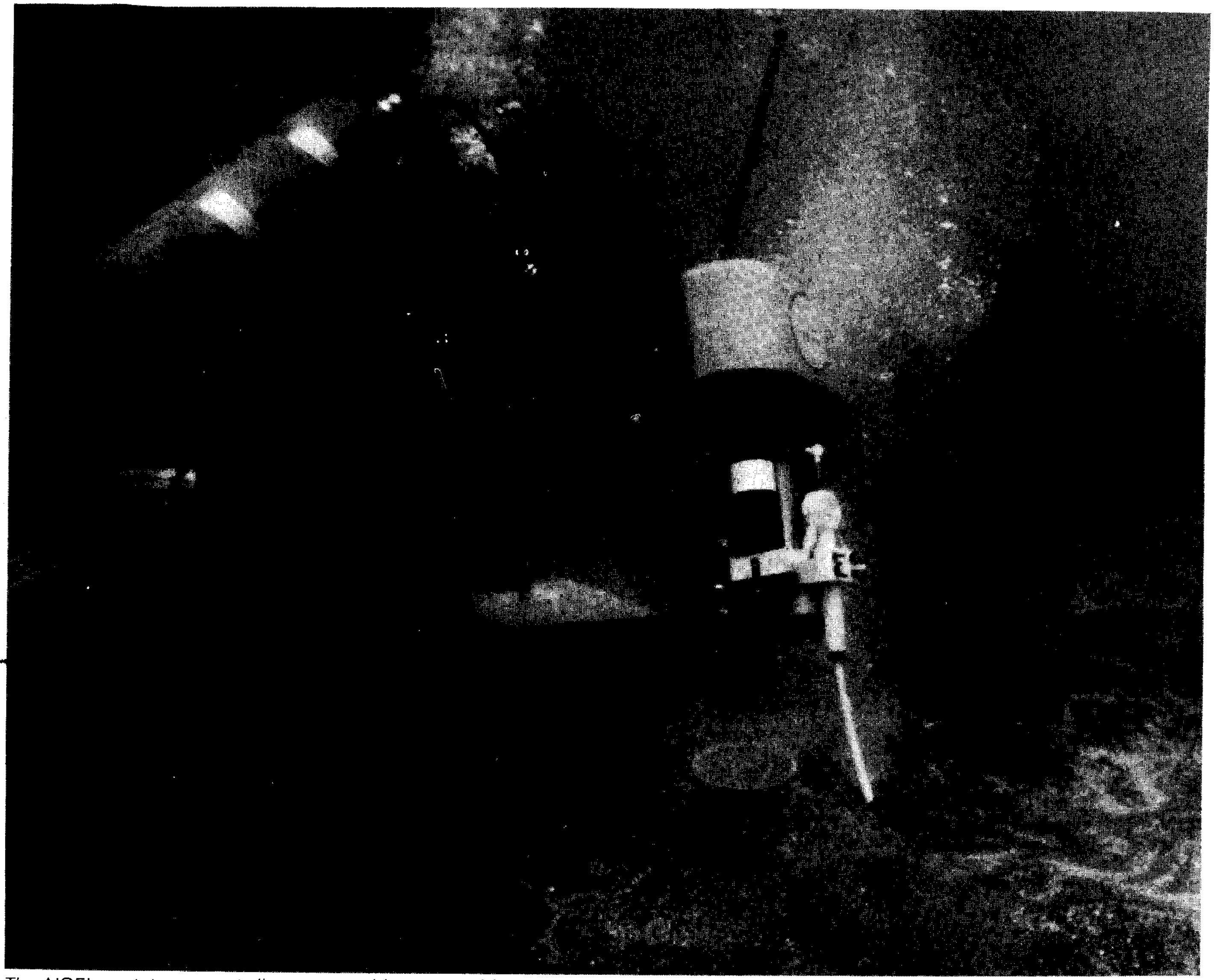
Vane Shear—Attached to the bottom of a shaft marked in 6-inch increments, this four-bladed vane determines the shear strength of clay cohesive soils. A torque wrench at the top of the shaft has a memory marker to record the highest torque achieved. Torque readings are used in an established geotechnical equation to obtain in-site shear strength.

Rock Classifier—This instrument measures a rock's compressive strength. The tool, a "Schmidt Hammer" rebound rock classifier, is enclosed in an underwater housing. The diver must find or clear a small spot, about 1-inch in diameter, on the rock's surface and then press the classifier's plunger against the rock until the internal hammer rebounds. Ten readings are needed before an average can be determined.

Jet Probe—Driven by a water pump, the probe determines the depth of bedrock, or other hard layers, within the 10-foot soil depth limit of the tool. By observing the sediment being washed out, the diver may determine the type of soil (clay or sand) and whether any layers exist.

Vacuum Corer—The tool uses the same water pump that drives the jet probe. Water is pumped through an eductor to create suction in a hose-connected core tube. The suction aids in obtaining a longer soil sample than is possible with the impact corer. These samples are useful for visual analysis, grain sizing and angularity. Corer tubes up to 10 feet in length are used.

Prototypes of the above tools have performed well on several projects when tested by NCEL divers, and the tests have provided worthwhile geotechnical data. NCEL's contact for the geotechnical tools program is Barbara Johnson, Code L42, (805) 982-4362.



The NCEL prototype grout dispenser tool is operated by a diver in 40-feet deep water off the Southern California coast.

More New Tools and Techniques

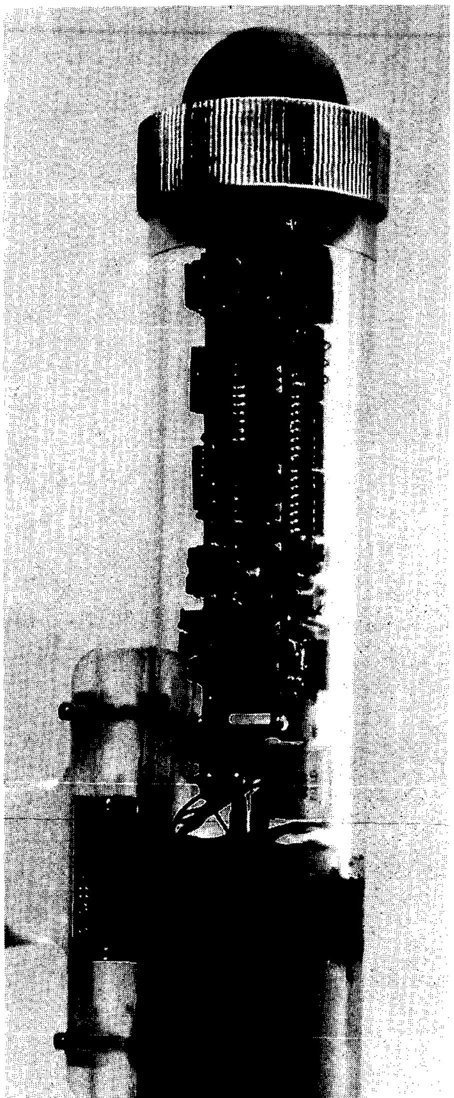
Engineers in NCEL's Ocean Systems Division have developed the following:

Grout Dispenser—This tool provides the diver with improved capability to mix and dispense two-part epoxies from disposable cartridges simultaneously. Developed for installation of rebar anchor bolts in soft, porous coral, the diver-operated dispenser is simple and safe to operate and increases grouting rates. Holding capacities in excess of 40,000 pounds can be achieved for rebar grouted with epoxy in concrete block. For further information, contact Hugh Thomson, NCEL, Code L42, (805) 982-5429.

Emergency Diver Recall System—The Benthos Diver Signaling System has been modified, yielding an emergency diver call system suitable for Navy divers. The battery-operated device transmits voice and alarm signals directly through the water. An underwater transducer is connected to the audio control unit by a 25-foot shielded, waterproof cable. The alarm signal can be heard at recall distances of more than 300 yards in open water and harbor environments.

Cable Tracking System—This device locates and tracks buried and surface laid submarine cables, using a diver probe, a surface signal injector, and a submersible signal injector. The hand-held electronic probe detects the presence of a 25-hertz magnetic field. Depending upon the strength of the impressed signal, the probe can track the cable's exact location from a distance of several hundred feet. The tracking tone is impressed by either the surface or submersible signal injectors. NCEL's contact is Hugh Thomson, Code L42, (805) 982-5429.

Underwater Work Repair Techniques Manual—The manual was developed to increase the effectiveness of UCTs and help divers to plan and perform future operations. Information in the manual, available this year, is based upon UCT's experiences and applicable commercial practices. Although primarily designed to provide general information, it does contain specific details on selected subjects. The publication covers work techniques, operational procedures and



With the NCEL-developed tool, divers can inspect underwater equipment and detect the presence of electrical leakage.

Divers prepare to test hydraulic rock drill powered by a lightweight oil-hydraulic power supply driven by an outboard motor.

assists (by examples) in planning and estimating resources and time. For copies or more information, contact Stanley Black, NCEL, Code L43P3, (805) 982-4826.

Lightweight Oil Hydraulic Power Supply—With this power source, divers can operate hydraulic tools from an inflatable boat. The supply consists of hydraulic components (pumps, filters, valves, *etc.)* attached to a 35 hp outboard motor which can be mounted on the transom of the boat. Power source controls are located inside the boat. NCEL's contact is Stanley Black, Code L43P3, (805) 982-4826.

Diver Electrical Safety Systems—Personnel in this program are developing safe electrical power transmission systems for Navy divers. The use of electrical power underwater requires an improved ground fault detection system. The recently developed detection and shutdown system will remove all power from the transmission line in less than 10 milliseconds if the insulation resistance of the load current drops below 50,000 ohms. Systems have been tested for use with 120 Vac single-phase, and 220 Vac three-phase equipment, at power levels up to 25 kw. In addition, an underwater electric field detector has been developed to allow divers to survey equipment, not protected by a ground fault system, for potentially hazardous leakage currents. NCEL's contact is Lee Tucker, Code L43, (805) 982-5256.

Saturation Diver Tools Package Program—Participating in a program with the Naval Ocean Systems Center, Hawaii, NCEL is developing a completely self-contained tool package, increasing the saturation diver's working capabilities to depths of 1,000 feet. Assisting with the diver's missions of submarine rescue, deep-ocean salvage, and deep-ocean recovery, the tool package was developed with five basic subsystems: a silver-zinc battery pack to provide primary power to the package, a submersible electric DC motor, an hydraulic converter unit, an electronic monitoring system and the tool system itself. The package features special design precautions to protect against accidental hydraulic fluid contamination from the tools into the diving system. The battery pack contains 40 cells (60 volts) and provides a total power delivery of 350 amp-hours. For more information, contact Wayne Tausig, NCEL, Code L43, (805) 982-5553.

As divers work at increased depths and take on more complex tasks, their needs for new tools grow and change.

The equipment being developed by NCEL engineers is designed to help divers do their work safely and efficiently. These tools will aid in underwater construction and repairs and in gathering data for undersea research. The equipment described above illustrates NCEL's commitment to advancement and excellence, both within their organization and for Navy divers and salvors.

Navy Saturation Divers Collect
MARINE SNOW
for Ocean Science

By CDR J.K. "Otto" Orzech, USNR-R
Scripps Institution of Oceanography

Editor's Note: CDR Orzech and Jonathan Trent are doctoral candidates at Scripps Institution of Oceanography. Both have contributed to the research described in this article. CDR Orzech is studying bioluminescence and the effects of marine snow on optical properties in the sea. Mr. Trent is studying the composition of marine snow and its role in the oceanic food chain.

Have you ever gone diving in the ocean and found the water cluttered with millions of small particles? While diving at night, have you been amazed at all the strands of junk visible in the beam of your light? This is not pollution, but naturally occurring aggregations (or collections) of organic particles known as marine snow.

Typically less than an inch in its longest dimension, marine snow was first named in the 1950s by submersible divers who observed blizzards of these particles in the beams of their floodlights. Marine snow has since been observed in many places throughout the world's oceans and is thought to be an important part of the food chain.

Marine snow is formed when organic material produced in the upper waters is joined together. Many of these particles sink, transferring food and energy from one layer of the sea to another, ultimately stopping on the bottom sediments. Understanding this natural system of food distribution is important to biological oceanographers.

These particles are extremely fragile and scientists who study them must use SCUBA and delicately collect specimens by hand in syringes. Otherwise, the aggregations would break up and blend with the surrounding water. Open-ocean research using SCUBA has been limited to the upper 100 feet of the sea which has left many scientists with the obvious question: "What's happening deeper?"

Elk River Divers Assist Researchers

U.S. Navy saturation divers from the Diver Training Vessel ELK RIVER (IX-501) collected marine snow at depths as great as 850 feet during the recertification of the Deep Diving System MK 2 MOD O in May and June 1981 (see FACEPLATE Summer 1981). This effort was the start of an ongoing cooperative research program between the Submarine Development Group ONE and the Scripps Institution of Oceanography in La Jolla, California.

Samples of marine snow and surrounding water were collected in 20-cc and 50-cc syringes. Three marine snow particles were collected in each 20-cc syringe with as little surrounding water as possible, and 50-cc of surrounding water were collected in the larger syringes. Each diver gathered approximately ten samples of snow and ten of surrounding water, placing all of them in a plastic bucket attached to the outside of the diving capsule. These were transported to the surface. The entire operation took less than 60 minutes of diving time at each depth. The samples were available as soon as the capsule surfaced and were processed within hours of collection.

In addition to collecting marine snow and surrounding water at all depths, the divers were asked to make observations of gelatinous (jelly-like) animals that inhabit the sea. Since many of these animals produce bioluminescence (or biological light), observations were made under Personnel Transfer Capsule (PTC) floodlamps and in total darkness. During the saturation dives, SCUBA divers collected samples and made observations in the near-surface waters for comparative analyses.

The ELK RIVER moored approximately one mile east of San Clemente Island where the water depth was about 1,000 feet, and the first saturation dive began on 12 May 1981. The divers made an excursion to 250 feet where they successfully collected marine snow, and later the same day, they collected samples at 450 feet. On 15 May the divers took samples at 650 and 850 feet.

The divers saw marine snow in great abundance at all depths and were treated to the sight of large chains of jelly-like animals known as "salps" and "siphonophores." At 850 feet, a saturation diver reported the following:

> **"Upon (my) entering the water, . . . all exterior (PTC) lights went out. The first thing I noticed was the beautiful colors and the great concentration of particles in the water. I had locked out at 850 feet before, but never experienced the total darkness or the translucent colors that appeared when the floodlights were secured. The color appeared to be 'cold steel blue' and 'fluorescent orange.' The best way to describe the luminescence would be (as) a worn out fluorescent light bulb that does not have enough remaining gas to completely light the bulb, but has enough to pulsate back and forth in the tube. The average length (of the strands) was 15 to 25 feet, with some strands as long as 40 feet. It was really a great light show with these longer strands. At all excursion depths with flood lights on, I noticed small shrimp (or what appeared to be shrimp) jumping on the PTC platform, like bugs around a yard light. When we lost external floodlights the second time, it appeared (that) these tiny shrimp (1/4 inch) moved to the luminous strands and attached themselves. The current was quite strong and I was amazed at the way the strands corkscrewed and appeared not to be moving with the smaller particles . . ."**

The saturation divers completed their shipboard decompression on 24 May.

The second saturation dive team reached San Clemente Island on 2 June 1981, and an excursion was made to 250 feet on the first day. Dives to 450 and 650 feet were made the second day, and to 850 feet on the third day. The divers again reported marine snow at all depths and samples were collected without difficulty. Decompression was completed on 12 June, concluding the recertification demonstration for the dive and a remarkable sampling program for the scientists.

Starting in November 1981, saturation diving students from the U.S. Naval School of Deep Diving Systems have been collecting marine snow for the scientists as part of their training dives on ELK RIVER. To date, four classes have collected samples during their saturation lock outs at 190 feet. This program has contributed significantly to our knowledge of the composition and properties of marine snow.

Marine Snow Gathered by Divers on the PIGEON

The USS PIGEON (ASR-21) recently conducted a recertification program for its Deep Diving System MK 2 Mod 1. On 14 June 1983, the PIGEON laid a four-point moor in 850 feet of water off Carlsbad, California. PIGEON divers successfully collected samples and made observations for the Scripps scientists at 200 and 450 feet on 15 and 16 June. On 17 June, they entered the water at 790 feet and made an excursion to the bottom at 850 feet.

When the samples arrived at the surface, half were sent immediately to the Scripps Institution of Oceanography for processing by a doctoral candidate who is studying the composition of marine snow and its role in the marine food chain. The other half of the samples remained on board the PIGEON where they were analyzed for their emitted light (bioluminescence).

The second PIGEON deep dive began on 29 June 1983. The mooring that had been laid for the previous dive was again utilized. On 2 July, two divers locked out at 200 feet and successfully sampled marine snow. The Fourth of July was an unforgettable day for the divers who marked the holiday with a lock out at 450 feet. The next day, the certification demonstration dive was completed as PIGEON divers entered the water at 790 feet and made an excursion to the bottom at 850 feet. Marine snow was collected at all lock out depths, and sediment samples were taken at the bottom.

Scientifically, the dives were a splendid achievement! The oceanographers have been studying the samples under the microscope and evaluating the data for many months. The samples of marine snow taken by U.S. Navy saturation divers deeper than 100 feet have been of special interest to the scientists since so few specimens have ever been collected at these depths.

Bioluminescence

The Office of Naval Research has an interest in bioluminescence and has sponsored the investigation of marine snow as an emitter of light in the sea. Bioluminescence is produced by bacteria and many other microorganisms associated with marine snow. It is a significant environmental characteristic of the seas in which the Fleet now operates, particularly in the Western Pacific Ocean and in the Indian Ocean. Prior to this cooperative program between scientists and Navy divers, no one had examined marine snow as a source of bioluminescence. This research has further indicated that the formation and degradation of the marine snow affects the optical properties of the sea, such as light scattering. It is hoped that a more fundamental understanding of these phenomena will aid in successful Fleet operations.

The U.S. Navy deep-diving systems have proven to be valuable tools in oceanographic research and we are planning more work in the near future with PIGEON. We thank the divers who did the sampling as well as the many others who assisted this program in so many ways. We acknowledge the support and assistance received from the Commander, Submarine Development Group ONE; the officers and men of the D.T.V. ELK RIVER, the U.S.S. PIGEON, and the U.S. Naval School of Deep Diving Systems; the Office of Naval Research; and the Foundation for Ocean Research.

Naval Medical Resear

By Don Chandler, Maureen Darmody and Ellen Hughes,
NMRI

CAPT Mark Bradley, MC, USN,
Scientific Advisor

Editors Note: The following are brief descriptions of research currently underway at the Hyperbaric Medicine Program Center (HMPC), Naval Medical Research Institute (NMRI). Personnel at NMRI want divers to know about their work to make the undersea environment less hazardous. If you would like more information on these studies, contact Don Chandler, or Maureen Darmody at HMPC, NMRI, Bethesda, Maryland 20814, telephone (301) 295-5866.

Death by Diving — Can the Risk Be Lowered?

Research by CAPT Mark E. Bradley, MC, USN and SURG CDR David R. Leitch, former Exchange Royal Navy Officer, HMPC

Nearly an hour after a diver embarked on a 300-foot dive, he panicked, saying, "I have to get out of here." He began climbing the ascent line, was brought directly to the surface without the required decompression, and died. In another instance, a diver making a 460-foot dive ignored the advice of topside personnel to slow down his operations when they observed he was overworking. He died of anoxia, a lack of sufficient oxygen. These accounts are examples of recorded deep-dive fatalities which have in common an inexplicable thread of diver unconsciousness or erratic behavior.

Can similar fatalities be prevented in the future? Yes, says a researcher at the Hyperbaric Medicine Program Center (HMPC), Naval Medical Research Institute (NMRI). He studied fatal accidents in commercial diving in the Gulf of Mexico (1968-1975) and in the British sector of the North Sea (1971-1978) to determine causes of fatalities. He found that often these accidents are caused by an interaction of many different factors rather than just one. The injured diver's behavioral and physiological characteristics and environmental conditions are just two possible influences on diver fatalities. We can, however, control some of these problems.

The most significant "host" factor (personal characteristic) seems to be a diver's poor judgment or panic, appearing in 20 to 40 percent of recreational diving deaths in the United States. In the opening story, for example, poor judgment and panic is obvious in the diver who insisted on ignoring established protocol and warning signals upon returning to the surface.

The researcher explains that, "During the period between 1965 to 1975, lack of experience was cited as a contributing factor in about 25 percent of the U.S. Navy's fatal diving accidents." Through improved and more thorough training, divers will acquire necessary skills and expertise and thereby decrease their risk of accidents.

Among the many environmental factors involved in fatal diving accidents, human error and equipment failure are the most important. By using safe operating and emergency procedures and improving the selection, operation, and maintenance of equipment, divers can often prevent accidents. For example, when a former Exchange Royal Navy Officer at the HMPC investigated the causes of unconsciousness, respiratory distress and related diving problems, he found they are less likely to occur when the expired oxygen concentration is 1.3 ATA or less in N_2-O_2 and He-O_2 breathing mixtures.

While researchers at the HMPC continue their investigative work, we can all help prevent fatalities by making sure diving gear is in excellent working condition and by following all diving regulations and protocols. Remember, water is a hostile environment where safety is of the utmost importance.

MEDICAL ADVANCES FOR DIVERS

Pregnancy and Diving:

Research by LCDR Sara C. Gilman, MSC, USN and Associates

In a landmark decision in 1974, the U.S. Navy began to admit eligible women to its diver training program. A number of candidates have since qualified as operational divers. The new, lightweight MK XII diving gear used by the Fleet should increase the number of women who enter and complete diver training in the future. Moreover, approximately 435,000 women in this country are currently certified as civilian sport divers, according to statistics obtained by the Professional Association of Diving Instructors in California. The rate of increase in civilian certifications sought by women was 30 percent in 1983 alone, an exceptional year for sport diving.

In light of the increased numbers of women divers, it is important to take a closer look at possible adverse effects of diving on pregnancy.

Researchers at the HMPC are pursuing this issue by studying the effects of fetal develoment in female hamsters. During early pregnancy the hamsters are exposed to non-decompression dives and decompression on hyperbaric oxygen. Although it would be presumptuous to reach hard and fast conclusions about humans from hamster studies, Dr. Gilman's research provides a needed warning signal.

The central concern is that women divers are often unaware of their condition during the beginning of the first trimester of pregnancy, and are therefore unable to take precautionary measures. Little has been determined about the safety of diving during pregnancy, which aggravates the problem.

The data indicate that non-decompression dives per se do not induce effects such as low birth weight, birth defects or fetal death. In addition, those hamsters in Dr. Gilman's studies that did contract decompression sickness (DCS) but were treated with hyperbaric oxygen, did not produce abnormal or dead fetuses. The fetuses of pregnant hamsters who suffered from DCS but were not treated did not fare so well, however. Many were born with defects, some quite severe, including incomplete closure of the skull and cleft palate. One pair of fetuses developed as Siamese twins.

Severe birth defects indicate that untreated DCS during early pregnancy may have very harmful effects on fetal development. So far, signs point to DCS as the biggest diving risk for women in the early stages of pregnancy.

What's the next step? These researchers stress that, "It is important that our findings be confirmed in another animal species and in other laboratories." If we can determine the effects of diving on the human fetus, women divers will at least know the risks involved in diving during early pregnancy, whether they are aware of their status as mothers or not. With risk data in hand, Fleet personnel will be able to make informed decisions about appropriate operational procedures for women divers.

Focus of Research on Cold Water Stress Begins to Coalesce

Studies by Dr. Robert Weinberg, HMPC, NMRI and LCDR R.P. Layton, formerly of HMPC, NMRI

The bodily stress that cold water exerts on divers is formidable — enough for Navy requirements to limit the amount of dive time for completion of mission tasks. So pervasive are the effects of prolonged immersion in cold water that the success of Navy diving missions does not hinge merely on the prevention or alleviation of bodily discomfort. Both on-the-job reports by divers and research studies have confirmed that cold water may handicap the diver's physical capabilities and work performance long before he complains of unbearable discomfort.

A HMPC physiologist with a bioengineering background has reviewed recent research efforts in the area of cold water diving stress. He is evaluating the physiological/psychological results of exposure to cold water and identifying areas of research that show promise for improving diver safety. All research on cold water stress stems from the basic assumption that safe diving operations in cold water are only possible if a diver has adequate thermal protection. For engineers to design diving gear that provides adequate thermal protection, however, they must have a basic knowledge of the effects of exposure to cold water on the human body. This is the launch point of much research on thermal protection for divers. He notes, "The need for this information is crucial and immediate, as the frequency of diving in cold water is accelerating for both military and civilian purposes."

Physiologically, what happens to a

Medical Advances for Divers

diver subjected to cold water without adequate thermal protection? When the diver is submerged, the cold water causes the skin temperature to drop as heat is transferred from the warm skin to the cooler water. As heat leaves, the body reacts to cooling by adopting several heat conservation measures. For example, blood circulation is redistributed from the body surface to the body core, minimizing blood flow in the extremities, particularly in the hands and feet. This cooling of the skin allows heat to be conserved in the center of the body. This is a crucial self-preservation mechanism because the core of the body contains vital organs such as the brain, heart, lungs and liver that require constant body temperatures. If body core temperature falls sufficiently, life-threatening hypothermia occurs.

How do the physiological effects of cold water affect a diver's work performance? Dr. Weinberg explains how an individual's work performance is made up of simple sensory and motor skills, such as hand dexterity and reaction time, and more complex perceptual and cognitive abilities, such as memory and problem solving. These are affected progressively in four time stages.

In the first stage when a diver is initially exposed to cold water, he experiences distraction effects for possibly as long as an hour. His ability to pay attention decreases and his general performance in a wide variety of tasks is not as good as it would be in moderate or warm water. In the next stage, the diver's hands and arms become cold and he loses some sensation and mobility in these areas. This peripheral effects stage adversely affects the diver's ability to perform a wide range of tasks involving sensation and psychomotor abilities. If exposure to cold water continues, the diver moves into the third stage of cold exposure called deep body cooling. Although studies have not produced conclusive evidence about this stage, there are some indications that it may degrade perceptual and cognitive performance. It is known that at this stage of cold water exposure, cold stress is just one factor that may adversely affect performance; physical fatigue and mission-induced boredom also appear to have a role in poor performance at this stage. Dysfunction effects characterize the final stage of cold water exposure. At this point, the diver is extremely cold, which may cause him to commit erroneous actions, despite his knowledge or performance of the same tasks in the past.

Clearly, exposure to cold water can have adverse effects on a diver's health and his or her ability to perform work underwater. In discussing valid criteria for designing and testing the thermal protection of diving suits, Dr. Weinberg cites three categories of measurements: heat loss, temperature and metabolic measurements. These help evaluate whether the suit in question is capable of maintaining the thermal limits specified by USN guidelines. The diver's input is another valuable evaluation criteria that should never be overlooked. A complete evaluation must include listening to the diver's comments or reports of cold, discomfort and fatigue, and observation of his condition after use of a particular suit.

In addition to the suggested criteria for the design and evaluation of diving suits, in order to design better diving gear, engineers need more precise and inclusive thermal limits for diving equipment, and better descriptions of performance decrement and physiological changes due to cold water exposure. The most crucial research priority is the need to define physiological responses to net body heat loss and to determine the relationship between this heat loss and performance of complex tasks requiring problem solving, decision making, following procedures and memory.

HMPC is keenly pursuing these studies. During recent years, a researcher there developed a method of measuring body heat exchanges during cold water dives using an array of heat flow sensors. These sensors measure the heat transfer from the skin to the water at different water temperatures and pressures. The transducer system has been evaluated against existing methods of heat measurement and works extremely well. In a study with the transducers, results showed that the body's heat regulation does not change considerably at depth until 4 ATA.

In another keystone study, a former investigator at HMPC found that if a diver does not suffer heat loss greater than that specified by USN guidelines, his major motor and cognitive functions will remain intact. Future studies at HMPC will explore more complex motor and cognitive functions in cold water.

In summary, as researchers at HMPC make inroads in the study of cold water stress, they are paving the way to deeper, safer and more efficient diving operations.

The OLD MASTER

Recently, I reviewed the circumstances of a diving accident and noticed some rather serious material discrepancies, including unauthorized alterations to certified diving equipment and poor maintenance of the equipment. Although these discrepancies did not contribute directly to the actual diving casualty, they certainly stand as a measure of the diver attitude and professionalism at the involved command. Obviously, there still some old diehards in Navy diving who do not recognize that we are in the 1980s and that diving, and diving regulations, have changed.

Diving equipment is now carefully developed and tested during the RDT&E phase; after an operational evaluation, the design of the equipment is frozen and only alterations approved by the Configuration Control Board are permitted. Diver safety is the sole purpose of equipment certification to specific configurations designed to meet our mission needs. As such, a diving activity cannot execute an unapproved alteration to their equipment. Commands with ideas for diving equipment improvements or alterations should formally submit ideas through the proper chain of command. The ideas will be carefully evaluated and, if approved, adopted for use by the entire diving Navy.

The proper maintenance of diving equipment, within the PMS program, ensures that diving equipment will be in an adequate state of readiness at all times. The excuse of being too busy with heavy at-sea deployment, special training, or preparing for inspections is unacceptable. There is no excuse for not keeping diving equipment in top condition; our lives and those of our shipmates depend on it.

Have you ever noticed that when a diving casualty occurs that is investigated within and outside the command, we normally find many violations that in hindsight are so very obvious? It would make much more sense for each of us to have the foresight, before an accident occurs, to create and support a professional Navy diver attitude—one that works within the system. The professional Navy diver keeps the configuration of certified diving equipment and maintains equipment to proper standards. The slogan we learned at diving school, "We Dive the World Over," is a good one. We need to mentally amend it to say ". . .with the best available equipment, maintained and operated to the highest standards."

Navy Salvage Expert Dies at 54

CWO Robert T. Belsher, USN (Ret.), an expert in salvage and towing, died 16 November 1984 at age 54.

CWO Belsher's distinguished 30-year career included service aboard a number of salvage and towing project ships, participation in both SEALAB I and II and command of a Harbor Clearance Team in Vietnam. CWO Belsher's final tour of duty was as an Instructor in Salvage at the Naval School of Diving and Salvage, then located in Washington, D.C.

Following his retirement in 1970, CWO Belsher worked in the salvage industry as a Salvage Master and Senior Salvage Master for Murphy Pacific Marine Salvage and Fred Devine Diving & Salvage, Inc.

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