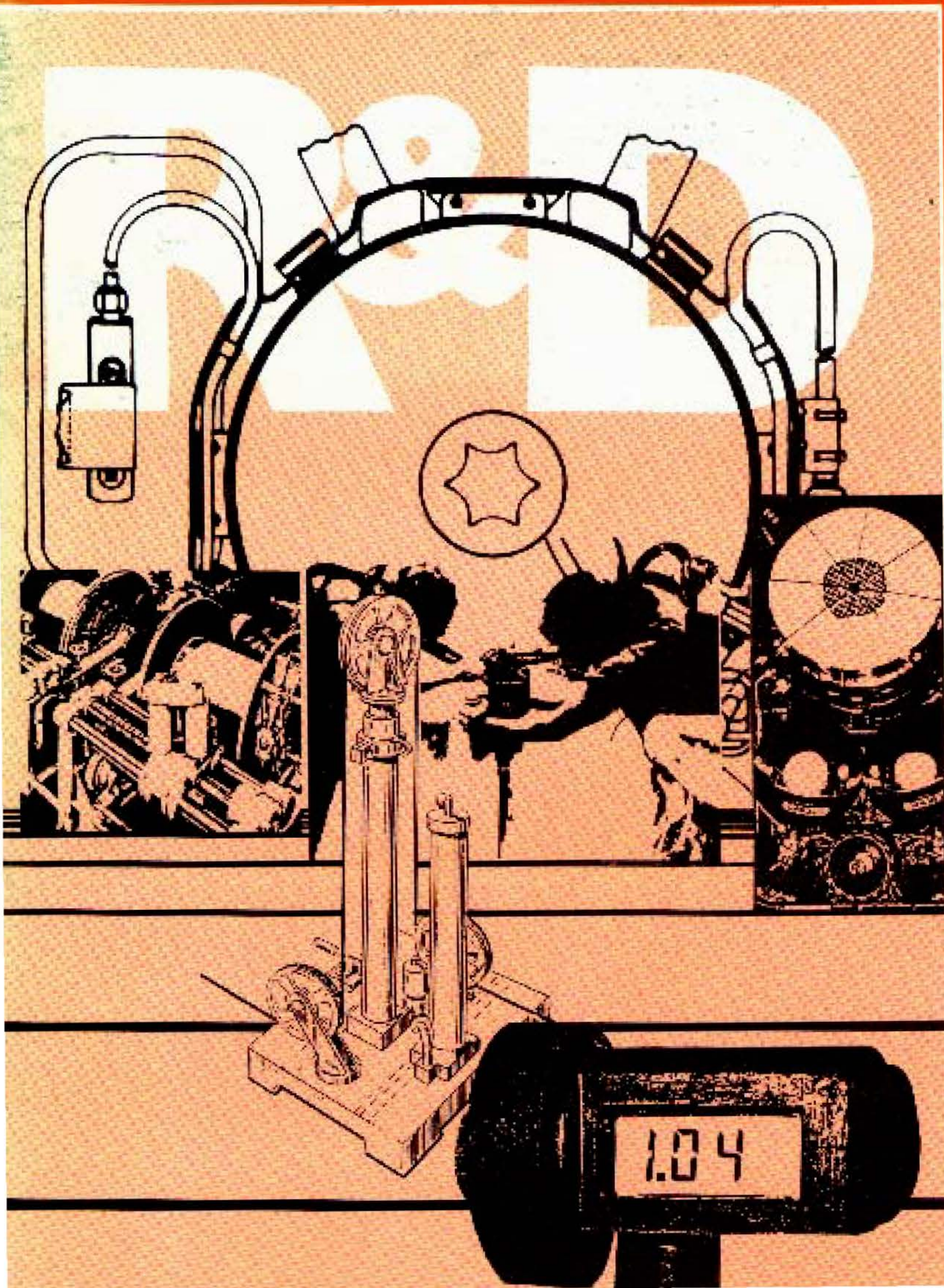
FACEPLATE

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



Research and Development:

MK 16 UBA
Diver Tools
MK 14 CCSDS
Ram Tensioner
Ultrasonic Hull Inspection
Tow Machine Training System

Summer 1983
Volume 14, No. 2

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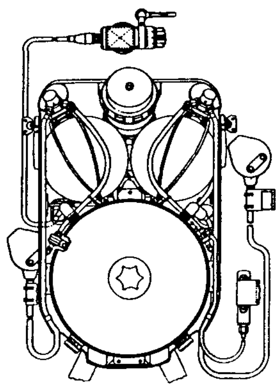

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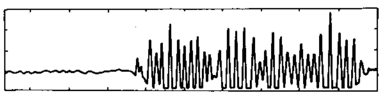

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FACEPLATE is published quarterly by the Supervisor of Diving to bring the latest and most informative news available to the Navy diving and salvage community. Articles are presented as information only, and should not be construed as regulations, orders or directives. Discussions or illustrations of commercial products do not imply endorsement by the Supervisor of Diving or the U.S. Navy.

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SOUNDINGS

Change of Command at NCEL

CAPT James D. Falk, CEC, USN will relieve CAPT James H. Osborn, CEC, USN as Commanding Officer of the Naval Civil Engineering Laboratory (NCEL) in Port Hueneme, California on 19 August 1983.

CAPT Osborn, a graduate of the U.S. Naval Academy in Annapolis, is retiring from the Navy after 24 years of service. Before his two-year tenure at NCEL, he served in a variety of posts, including Assistant Commander for Research and Development Testing and Evaluation at the Naval Facilities Engineering Command, Designated Saturation Diving Officer of Aquanauts in the Sealab III program and posts at the Naval Air Station in Coronado, the Office of the Chief of Naval Material and as Resident Officer in Charge of Construction, Long Binh, Vietnam.

CAPT James D. Falk

CAPT Falk, also a U.S. Naval Academy graduate, is coming to NCEL from Naval Facilities Engineering Command. His 23 years of naval experience include assignment at the Naval Station Roosevelt Roads, the staff of the Chief of Naval Education and Training and the Atlantic Division Naval Facilities Command, Norfolk, Virginia.

Hydraulic Cable Puller System

A hydraulic cable puller system has been designed by NCEL to replace the system of purchase tackles in use over the years to perform retractions of stranded ships and conduct heavy lifts.

The system consists of a hydraulic power supply, cable puller control console and cable puller. The system is simpler than its forerunner, allowing for reduced rigging time, reduced deck hazards and positive load control. It can pull more than one leg of beach gear simultaneously.

The hydraulic cable puller system is designed to pull in and pay out 1-5/8 inch diameter wire rope at tensions up to 100,000 pounds and withstand the forces and conditions found in salvage scenarios.

Mobile Diving and Salvage Unit TWO (MDSU TWO) is currently conducting salvage training with the Service Squadron Eight ships using the hydraulic puller system. The puller is in the process of being distributed to all ARS, ATS ships and T-ATF portable salvage gear allowances.

LCDR David McCampbell

USS BOLSTER (ARS-38) Change of Command

LCDR David McCampbell relieved LCDR John Speer as Commanding Officer of USS BOLSTER (ARS-38) at Todd Shipyard in Long Beach, California on 1 July 1983. LCDR Speer's next tour of duty will be in Pearl Harbor, Hawaii, where he will assume command of the USS BRUNSWICK (ATS-3).

LCDR McCampbell comes to BOLSTER from the MLSF/Salvage Office (OP-375) on the staff of the Chief of Naval Operations. Before that assignment, he was the first Executive Officer at the Naval Diving and Salvage Training Center in Panama City, Florida. His previous naval experience includes assignments as Operations Officer of USS RATHBURNE (FF-1057); Diving Officer/Production and Planning Officer, Ship Repair Department, U.S. Naval Station at Guantanamo Bay, Cuba; Executive Officer of USS PRESERVER (ARS-8) and Electronics Material Officer/Navigator on USS MCKEAN (DD-784). LCDR McCampbell was graduated from the U.S. Naval Academy in 1970 and is a native of Eustis, Florida.

USS BOLSTER, which just completed a homeport change from Pearl Harbor, Hawaii to Long Beach, California and transferred to the Naval Reserve force on 1 June 1983, is undergoing overhaul in Todd Shipyard.

Fourth Annual Pacific Salvage Symposium

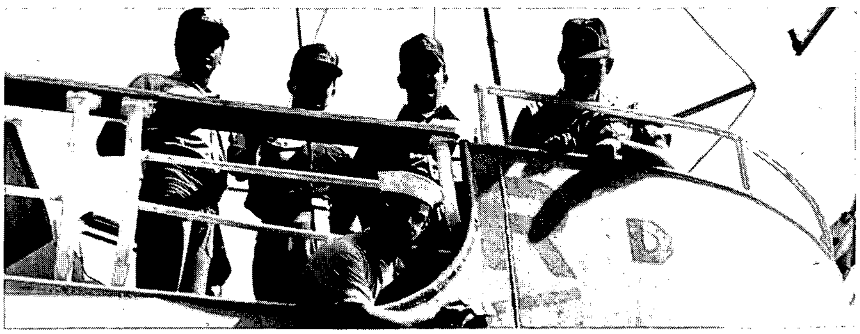
More than 60 naval officers from the diving and salvage community attended the Fourth Annual Pacific Salvage Symposium, hosted by Commander Service Squadron FIVE, CDR A.G. Campbell, in Pearl Harbor, Hawaii on 24–25 March 1983. Representatives came from as far as Panama City, Florida and Washington, D.C., as well as from numerous fleet and shore activities, located in the Pearl Harbor area.

The symposium was designed to give participants an opportunity to exchange information on diving and salvage. It also provided the diving and salvage community with pertinent and timely information on many issues of concern, such as technical improvements, training and funding.

The symposium was opened by CDR Campbell. Other speakers included RADM Wyatt, Fleet Maintenance Officer, CINCPACFLT; CAPT Maclin, Supervisor of Salvage and LCDR R. Wells, NAVMILPERSCOM. Presentations covered such diverse topics as readiness for combat in the fleet, the Towing and Salvage Study of 1979, salvage and towing operations funding, Naval Diving and Salvage Training Center curriculum and 1140 community notes.

Attendees were divided into five work-study groups which examined such topics as salvage plans, micro-computers, demolition pay for divers and heavy bow lift equipment. Recommendations on 16 different issues were generated by these work-study groups and will be sent up through the chain of command.

The attendees' consensus was that the symposium was a valuable learning experience. It is hoped that future symposiums will provide the vehicle through which progress in diving and salvage can continue into the 21st century.



The USS RECOVERY and crew members.

USS RECOVERY (ARS-43) Wins Retention Excellence Award

The USS RECOVERY (ARS-43), after 12 consecutive months on the Commander of Naval Surface Fleet Atlantic (COMNAVSURFLANT) retention Superstars listing, was recently identified as Surface Fleet Atlantic's top retention performer. In recognition of this distinction, the ship has received its second Retention Award. RECOVERY's successful retention program has been recognized with several other awards in recent years, including the CINCLANTFLT Golden Anchor Award, the COMNAVSURFLANT Retention Star Award and Commander Service Group TWO's Retentional Excellence Award.

RECOVERY has also recently celebrated her 37th birthday. The ship's crew commemorated the 15 May 1946 birthday with traditional festivities amid the Sardinian Archipelagos. The 37-year-old RECOVERY is the Navy's fifth oldest diving and salvage ship.

The hundred sailors and 8 officers of RECOVERY are proud of the ship's history. Since the day she was launched, RECOVERY has provided salvage and rescue services to 34 countries. The 2000-ton, 213-foot ship has towed 53 vessels, raised 10 aircraft and four ships and floated several vessels off land.

In April 1963 RECOVERY was the first ship on scene picking up debris and oil samples from the THRESHER disaster. RECOVERY supported NASA for seven Mercury and Apollo missions, including three manned launches. She has accomplished 72,000 nautical miles of oceanographic survey and conducted special operations in the Arctic.

From 5 January 1983 through late June, RECOVERY was tasked with providing diving, salvage and towing services to the Sixth Fleet in the Mediterranean. She is attached to Commander Service Squadron EIGHT and homeported at the Naval Amphibious Base in Little Creek, Virginia.

CDR John Sedlak, Jr.

Naval School, Explosive Ordnance Disposal Change of Command

CDR John Sedlak, Jr. relieved CDR James C. Blanton as Commanding Officer of the Naval School, Explosive Ordnance Disposal (EOD) in ceremonies at the school on 8 July 1983. A recent graduate of the Defense Systems Management College, CDR Sedlak has just completed a tour of duty at Naval Sea Systems Command in Washington, D.C.

CDR Sedlak has served in a variety of assignments since he joined the Navy in 1965, including tours as Officer in Charge, EOD

Mobile Unit ONE Detachment, China Lake; Commanding Officer, EOD Mobile Unit ONE and several posts at the Naval School, EOD.

He also served as Officer in Charge, EOD Mobile Unit Pacific Team 40, Da Nang, Republic of Vietnam and Executive Officer of the EOD Training and Evaluation Unit, Pacific.

A native of Cleveland, Ohio, CDR Sedlak attended U.S. Naval Officers Candidate School in Newport, Rhode Island, and also received training at the Underwater Swimmers School, Key West, Florida and Naval School, EOD in Indian Head, Maryland.

CDR Blanton leaves the school to serve at the Industrial College Armed Forces at Fort McNair, Washington, D.C.

UCT TWO Wins Meritorious Unit Commendation

Underwater Construction Team (UCT TWO), Port Hueneme, California was awarded the Meritorious Unit Commendation on 23 March 1983. The award was given for the unit's extraordinary achievement between 25 January and 5 November 1982.

During the 1982 deployment UCT TWO successfully completed projects at twelve diverse sites throughout the Pacific and Indian Oceans, including McMurdo Station, Antarctica; Fairway Rock, Alaska; Diego Garcia, British Indian Ocean Territory; Kauai, Hawaii and San Diego, California.

The 37 Seabees of UCT TWO logged 1900 hours of underwater time on a wide range of projects, including installation of magnetic sensors, bridge repairs and hydrographic survey.

The award is the third received by UCT TWO since its inception as a unit nine years ago. It was presented by CAPT Frederick G. Kelley, Commanding Officer, Naval Construction Battalion Center, Port Hueneme, California, on behalf of the Secretary of the Navy. The Team Officer in Charge, LCDR Troy K. Pyles, accepted for UCT TWO.

CAPT Esau Addresses NDSTC Graduating Class

CAPT Anthony C. Esau, Chief Staff Officer of COMSUBRON SIX in Norfolk, Virginia, was the honored guest speaker at the Naval Diving and Salvage Training Center's (NDSTC) First Class Diver graduation ceremonies last winter.

During his speech, CAPT Esau noted that NDSTC was the diving center of the world and that students there profit greatly from the team concept of the center's training program.

The team concept is a mechanism through which five instructors with diverse experience are selected to oversee a class from the first day of training until graduation. In addition to technical training, they monitor, motivate and counsel their students.

CAPT Esau was Commanding Officer of the Navy School of Diving and Salvage in Washington, D.C. When the school moved to its present location in Panama City, Florida, CAPT Esau played a key role in designing and conceiving NDSTC as it is today.

The graduating class consisted of 13 students. BM2 David Jones was the honor graduate with a grade point average of 94.4.

AGA Divator Full Face Mask Maintenance Notice

The Naval Safety Center has recently described a potential problem with the AGA Divator 324 (EFCOM SPM-1) Full Face Mask demand regulator safety pressure assembly.

Subsequent investigation by the Naval Experimental Diving Unit (NEDU) determined that the problem was related to incorrect maintenance procedures. While not directly affecting diver safety, incorrect maintenance procedures involving the safety pressure diaphragm assembly of the subject mask can eliminate the overpressure function of the mask, thereby reducing comfort and creating a continuous free flow condition.

The AGA demand valve is designed quite differently from a conventional down-stream second stage (*i.e.* U.S. Divers Conshelf XIV). Consequently, when performing maintenance on the demand regulator in the AGA Divator Full Face Mask, it is imperative to follow exactly the procedures described in the maintenance manual.

The AGA regulator incorporates a unique safety pressure feature which maintains the pressure inside the mask slightly over ambient. The safety pressure diaphragm assembly (AGA part no. 331-190-234) is a delicate mechanism. It will give reasonable service when handled with the care normally given life support equipment. Disassembly and assembly must be conducted exactly as described in the AGA maintenance manual to prevent damage and to insure proper operation.

New APL's Available

Allowance Parts Lists (APL's) have been established for the following diver equipment. Copies of these APL's may be obtained by contacting the Navy Ship Parts Control Center (SPCC) at Autovon 430-3194 or by writing SPCC, Mechanicsburg, PA, P.O. Box 2020, zip code 17055. Address all correspondence to "APL Distribution":

Allowance Parts List Numbers

Suitcase Filter-Console
APL Number: D39540329
Technical Manual Number: S9592-AF-MMM-010/5020805

EFCOM Acoustic Through Water Communicator—Model SC100M
APL Number: D39510043
NIIN: LL Q716164 DS 7HH 1925

AGA Full Face Mask — Model SPM-01
APL Number: D39510043
NIIN: LL Q716165 DS 7HD 1925

RIX Scuba Charging Compressor, 5SCFM 3000 PSIG — Model 1S3B-6, Type SA-6G
APL Number: D39540343

View from the SUPERVISOR OF DIVING

By LCDR Ray Swanson

As Supervisor of Diving for the past year I have gained a broader perspective on the strengths and weaknesses of the Navy diving community. Our greatest strength lies within our high degree of skill and "can do" spirit. In order to continue to build on this strength and to help each of you perform the physically and increasingly technical demanding work required in our underwater world, we must: improve our understanding of the diving community's structure; continually upgrade diving equipment and procedures and improve communications within our community.

Administrative Structure

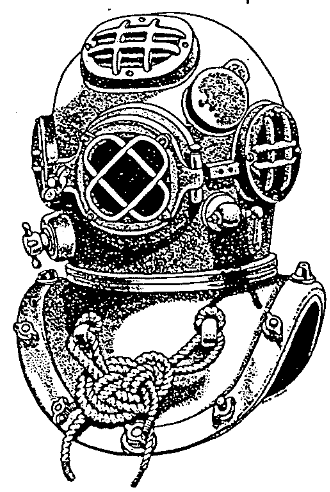
Many divers lack a basic understanding of how NAVSEA OOC, the Office of the Director of Ocean Engineering, Supervisor of Salvage and Diving is organized. Code OOC1 handles financial and contractual matters, interfacing with the larger Financial (SEA 01) and Contractual (SEA 02) offices of NAVSEA. Code OOC2 is responsible for salvage operations, pollution abatement, underwater tools and the associated R&D and engineering functions to support this mission. Code OOC3, my code as Supervisor of Diving, is responsible for the research and development, design, test and evaluation and acquisition of all diving equipment and the procedures by which we dive. Code OOC4 is the System Certification Authority (SCA) for diving systems. It is separate from OOC3 to avoid any possible conflict of interest.

The heads of the four codes report directly to the Director of Ocean Engineering.

Equipment Development

Several new diving systems and pieces of equipment are now in various stages of development. All equipment must pass rigorous testing and evaluation before it is distributed for use in the fleet to insure that it will advance our diving and salvage capability and be efficient and safe to use.

There have been rumors that the **MK 12 Mixed Gas Recirculator** is due in fleet some time this year. However, the contract for the MK 12 Recirculator has just been awarded. Now, the contractor will develop a preproduction model which must satisfactorily pass a first article test before full production



begins. This process takes a minimum of 20 months.

The several certified prototypes of the system at NDSTC will be used exclusively for training. An accident aboard the USS GRAYBACK last year cost the lives of five divers. As a result, certification procedures are becoming more comprehensive and strictly enforced, precluding loan of the prototypes previously held by NDSTC for use by other commands. Do not look for the recirculators before March 1985. In the interim, every effort will be made to improve upon this date.

The **ROPER cart** has completed prototype testing. This cart provides divers with a portable HP air system capable of supporting surface supplied diving. The system contains sufficient air to sustain two divers at 40 feet for four hours in the open circuit mode and for six hours in the demand mode. The first of 14 production units will be shipped to the fleet in 1985.

Diver **Portable Recompression Chambers** (PRC) are being sent to various activities. Procurement will be completed in 1983 and 16 units are expected to be outfitted. The PRC is an emergency means of transporting a stricken diver to a conventional chamber. It functions in the semi-closed circuit mode, conserving air supplied from SCUBA clyinders. Training activities will receive the first units during fiscal year 1983 and selected fleet activities will receive a predetermined allowance approximately 12-18 months after contract award.

Another project is the **Standard Diving Boat,** a 50 foot mike boat hull with a removable Diving System Module. The purpose is to separate the weight of the diving boat into two units, each of which can be handled by a destroyer/submarine tender or a repair ship. In this way, the diving boat can deploy with the ships. Interest has been expressed by several OPNAV sponsors for a total of 13 boats.

The **MK 14 Closed Circuit Saturation Diving System** and **MK16 Underwater Breathing Apparatus** are two major advances in Navy diving equipment. They are discussed in separate articles in this issue.

We are attempting to streamline the supply system for diving gear. This should provide a system which is more responsive to you, the user, while reducing costs. In the present economic climate, none of us can afford the luxury of unnecessary duplication of effort or equipment. The money saved will be used to upgrade other systems. We are also trying to standardize communication equipment and umbilicals.

MK 16

Underwater Breathing Apparatus:

MK 16 with MK 4 life jacket. Note the secondary display in the jacket pouch and lead shot non-magnetic weight belt.

an advance for EOD Divers

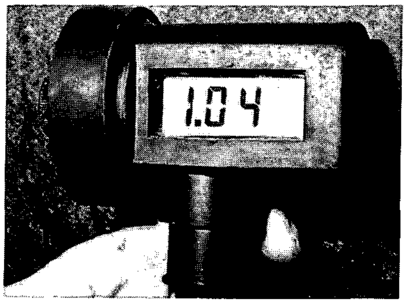
By LCDR Ralph E. Darling
MK 16 Project Engineer

The MK 16 Underwater Breathing Apparatus, scheduled for distribution in fiscal year 1984, is the result of years of effort by Navy personnel from several units supported by more than 75 Navy and Army test divers during operational evaluation.

The MK 16 is a nonmagnetic, acoustically quiet, closed circuit, mixed gas underwater breathing apparatus, born of a complete redesign of its military predecessor, the MK 15 and its commercial counterpart, the CCR-1000. The MK 16's primary application is in mine counter-measure diving. Because the rig is nonmagnetic and acoustically quiet, it is reliable for divers working to render safe, recover or dispose of influence (magnetically or acoustically) detonated mines.

Despite the recent discussion and rumor in the fleet that the MK 16 is only a nonmagnetic version of the MK 15, the new apparatus resembles the MK 15 only in outward appearance. Both the MK 16 and MK 15 are operationally based on maintaining a constant partial pressure of oxygen (PO_2) through the breathing loop; but the MK 16 is a significant advance over the MK 15 and is without a doubt the most advanced SCUBA rig in the world today. (Some key physical and functional characteristics of the MK 16 are shown in the table on page 9.)

Since most EOD diving has involved open circuit SCUBA and semi-closed circuit SCUBA (MK 6), decompression dives have been conducted only rarely in these applications. With the introduction of the MK 16 it is **anticipated** that decompression diving will become the rule rather than the exception. The rig contains enough gas for a total dive time of approximately six hours, which exceeds current EOD mission requirements. Dives of long duration will only be conducted in water warm enough to support the required CO_2 cannister life. Procedures for conducting MK 16 in-water decompression dives are being evaluated at the Navy Experimental Diving Unit (NEDU).



The percentage of primary battery power reading on secondary display.

The efficiency with which the MK 16's cannister scrubs CO_2 is closely related to water temperature, depth and diluent gas used. Cannister duration data extrapolated from technical evaluation and first article test data at NEDU showed that the cannister operated effectively within a range of 96 minutes in 29°F water to 290 minutes in 70°F water. A chart in the Operation and Maintenance (O&M) Manual will aid the diving supervisor plan his dives based on time and water temperature.

In addition, the method used to pack the CO_2 cannister with sodasorb is critical to the scrubbing process and proper operation of the MK 16. It will be carefully taught in MK 16 training. If sodasorb is not packed properly, CO_2 may channel, or flow irregularly, through the sodasorb. This reduces sodasorb's scrubbing efficiency by as much as 50 percent. To insure adequate packing, the cannister must hold between 7.75 and 8.00 pounds of sodasorb. A scale for weighing the cannister is included in the tool kit.

The oxygen sensors used in the MK 16 have a warranted shelf life of one year plus additional operational life of one year from the date the sensor is placed in service. They are not interchangeable with MK 15 sensors.

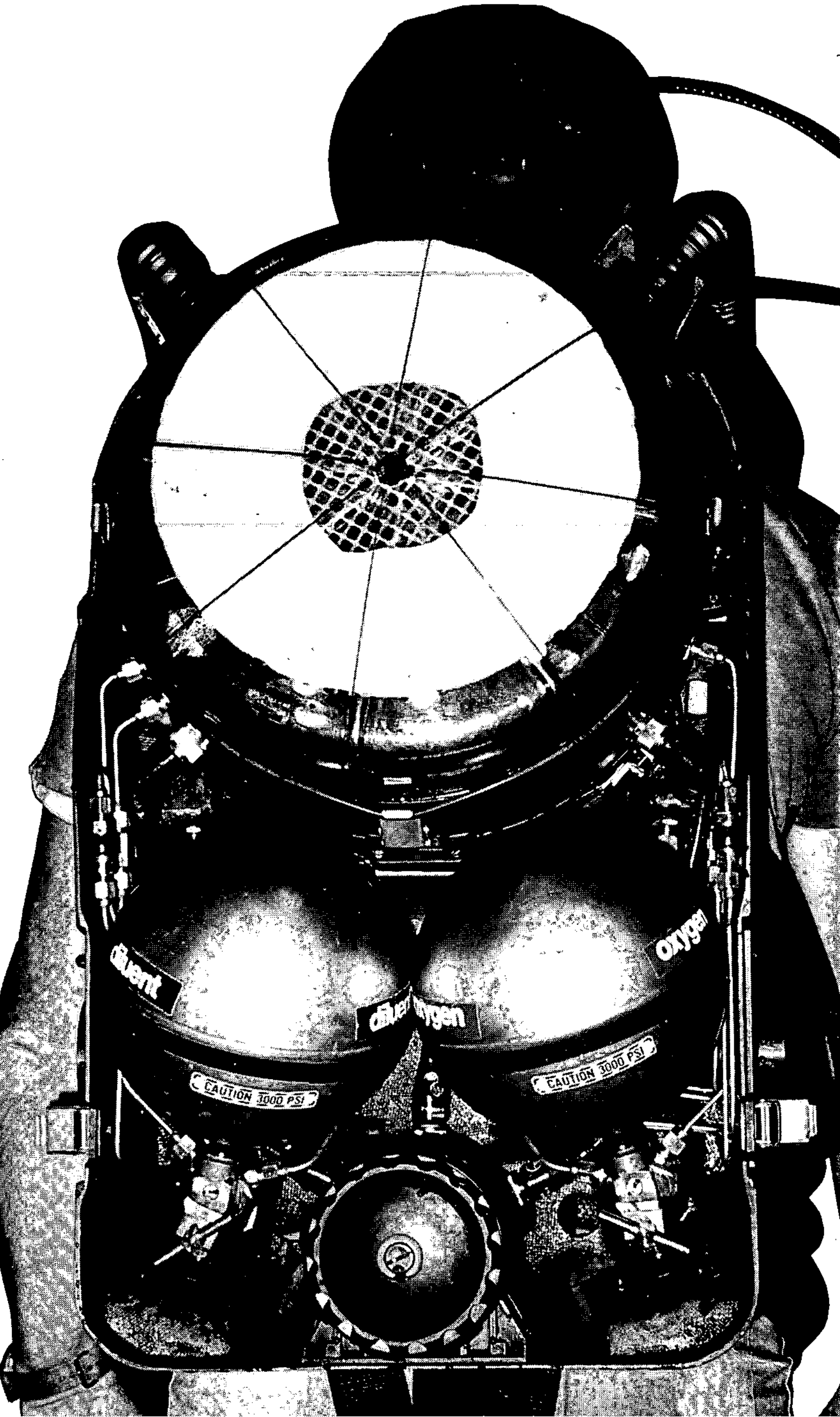
The sensors are individually packed in small glass jars to allow for visual inspection for leakage of the electrolytic solution from inside the sensor. This storage system increases the working life of the sensors. The sensors function essentially as batteries: when exposed to oxygen an electrolytic reaction occurs in the sensor, which results in current flow proportional to the oxygen concentration. This reaction will occur as long as the sensor is exposed to a source of oxygen. Removing the source of oxygen essentially puts the sensor to sleep. The internal volume of the MK 16's storage jars is so small that the sensor will consume all of the oxygen in the jar in only 48 hours—the internal electrolytic reaction will then cease. Thus, if the MK 16 rig is used infrequently, the sensors' operational life can be extended by removing them from the rig and returning them to their storage jars.

During the eight year process of designing the rig, MK 16 engineers studied all the problem areas identified by fleet users of the MK 15. Special design consideration solved most problems. As a result, the design features incorporated in the MK 16 make it a breed apart from its predecessor. Though MK 15's can be refitted with MK 16 improvements in a few instances, it is not generally an economically sound approach, nor are the changes necessary to support the MK 15's intended mission.

Neither the MK 15 nor the MK 16 were intended as blanket replacements for open circuit SCUBA—they are pieces of precision diving equipment. Though it is possible to use either apparatus to fulfill the role of air SCUBA, for example a 20-minute dive to 30 feet, it is not practical to set up a MK 16 for such a purpose, unless necessary for an application such as detonating a live mine. The rigs are designed to withstand rigorous operational use but not careless abuse. The MK 16 has sophisticated electronic equipment that must be handled with care and common sense.

The O&M Manual contains detailed check sheets for predive

MK 16 with backpack cover removed. Note the plastic center section, hard-mounted gas regulators and bottle valves which fit into the external valve wheel.



Physical and Functional Characteristics of the MK 16

Weight	• approximate dive weight 64 pounds
Mouthbit	• AGA mouthbit for superior diver comfort • breathing hoses of larger bore diameter than the MK 15 for lower breathing resistance
Gas Bottles	• two 21-cubic foot gas bottles • 3000 psi • nonmagnetic
Regulators	• hard mounted • all piping out of the way • no flexible hoses inside backpack • bottle valve slips into a captive valve handwheel mounted to the case • bottle valves can be opened/closed from outside the case with the bulkiest dry suit gloves • regulator holds bottle in place
Battery	• 6 VDC rechargeable gell cell • 13 hours charging time • 24 hours operational life • cost $20.00 each • good for 200 charging/discharging cycles
On-Off Switch	• no on-off switch • rig is on as long as the battery is installed
Oxygen Addition Valve	• acoustically quiet • pizoelectric design • no significant drain on battery power
Secondary Display	• back lighted liquid crystal display • automatically cycles readings on PO_2 from each sensor and power remaining in primary electronics battery • operates on four off-the-shelf nonmagnetic batteries with life of more than 1000 hours
Carrying Case	• injection molded • closely conforms to rig profile • provides superior rig protection and durability
Depth Limitations	• maximum depth: 150 feet on N_2O_2 300 feet on HeO_2 • HeO_2 limited to 190 feet without approved diver safe haven (bell, lock-out system, etc.)*
Depot Level Maintenance Facility	• established at EOD Technology Center • all MK 16 spare parts will be controlled, stocked and shipped from the Center
PO_2 Control Set Point	• increased to 0.75 on MK 16 for increased margin of decompression safety

**The diver safe haven is in the conceptual design phase and has no projected delivery date to the fleet. The MK 16 was exhaustively tested to 300 feet in March 1980 during a three week saturation dive at NEDU.*

setups, dive supervisor checks, post dive setups and recalibration of the electronics. An experienced operator can predive the rig and have it ready to dive in 35 minutes. He may prepack his CO_2 cannister up to 24 hours before the dive, thereby reducing predive time to less than 20 minutes, including the dip test. (This is a closed circuit rig and must be dip tested to check for leaks in the tubing.)

If the rig will not set up correctly, a detailed trouble shooting guide is provided in the O&M Manual. Once the defective component is identified, that entire module can be replaced with a new one from the spare parts kit. Average replacement time is less than 15 minutes. The defective module is then returned to the depot for repair and a new one is put on order. For example, the oxygen regulator, along with its mounting bracket, is considered one spare part. The spare parts kit does not contain any internal regulator parts, just the regulator assembly. Internal parts are used only by the depot, thereby reducing the stocking and maintenance burden on the user.

It is also important to note that the decompression tables for these rigs the result from most exhaustive table development series ever conducted by NEDU.

When work on the MK 16 was begun in 1974, making the MK 15 nonmagnetic and acoustically quiet seemed an easy goal. In practice, nonmagnetic and acoustic design requirements fathered a host of engineering challenges, such as meeting military standards for low measure magnetic signature and changing the oxygen add valve from a solenoid (which makes a clicking sound) to the acoustically quiet pizoelectric model. These challenges were only resolved after years of hard work by personnel from the EOD Technology Center, NEDU, NAVSEA, the contractor and a dedicated crew of test divers.

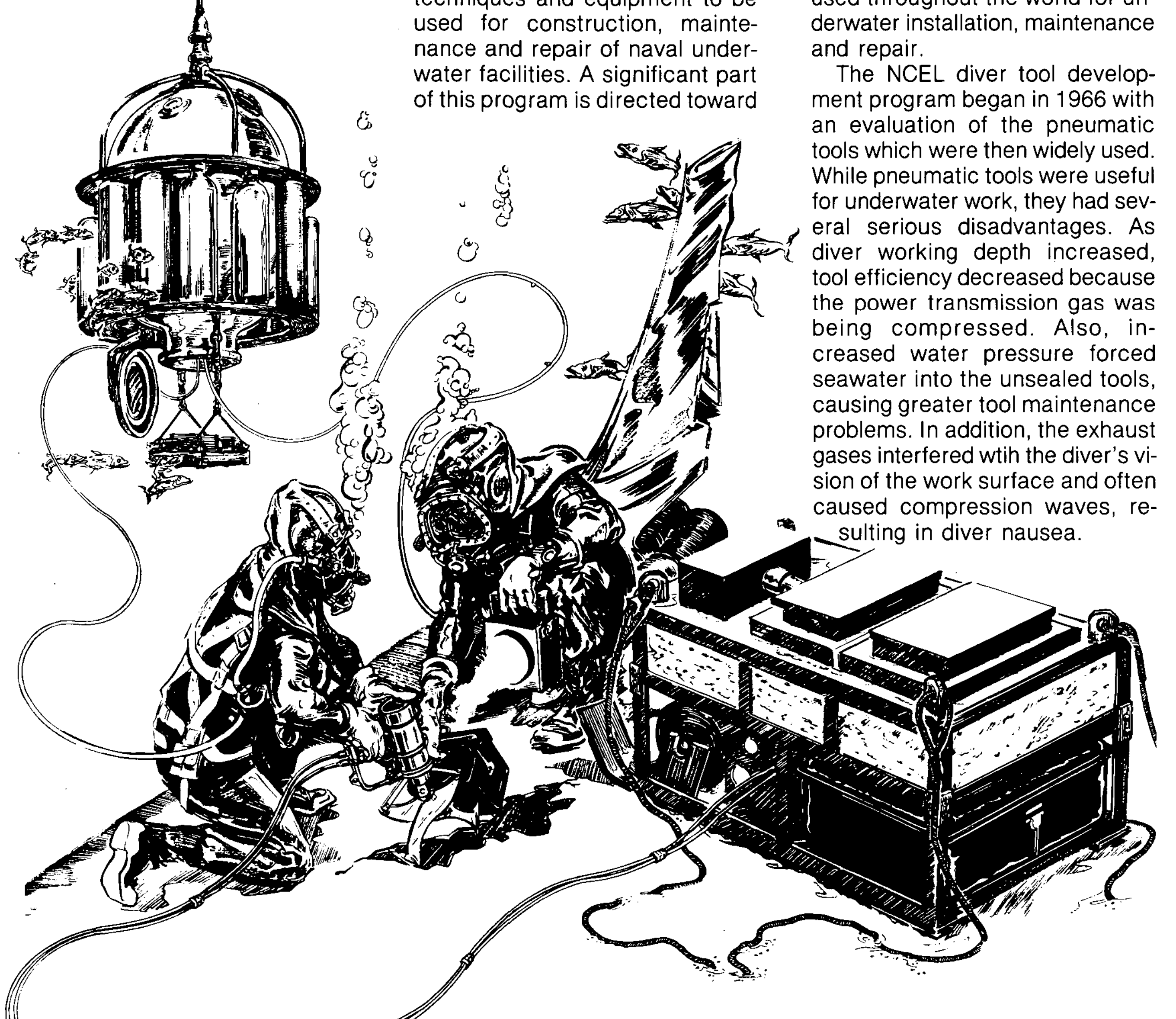
For further information contact LCDR Cocowitch (SEA OOC-34) at Autovon 227-7606.

DEVELOPING

By Stanley A. Black
and Wayne R. Tausig
Naval Civil Engineering Laboratory

To support the Naval Facilities Engineering Command (NAVFAC), the Naval Civil Engineering Laboratory (NCEL) is developing tools, techniques and equipment to be used for construction, maintenance and repair of naval underwater facilities. A significant part of this program is directed toward improving the naval construction diver's ability to work effectively underwater. This program has produced diver tool packages that are used throughout the world for underwater installation, maintenance and repair.

The NCEL diver tool development program began in 1966 with an evaluation of the pneumatic tools which were then widely used. While pneumatic tools were useful for underwater work, they had several serious disadvantages. As diver working depth increased, tool efficiency decreased because the power transmission gas was being compressed. Also, increased water pressure forced seawater into the unsealed tools, causing greater tool maintenance problems. In addition, the exhaust gases interfered wtih the diver's vision of the work surface and often caused compression waves, resulting in diver nausea.



Artist rendering of saturation diver tool package.

DIVER TOOL PACKAGES

Oil-hydraulic tools, introduced in 1967 as a substitute for pneumatic equipment, are better suited for underwater use than pneumatic tools. Because oil-hydraulic systems are sealed to prevent the oil from leaking, the surrounding seawater cannot enter into the internal working parts; the result is reduced maintenance. The power transmission oil is incompressible, allowing the tools to be used at any diver depth without reducing efficiency. Also, oil-hydraulic tools have more output power per unit of tool weight and volume than their pneumatic counterparts, making them more compact and easier for a diver to handle.

The early development of oil-hydraulic tools primarily included the modification of equipment used on land. Modifications involved improved trigger configurations and general human factor engineering to increase the diver's ability to handle the tools. As the demand grew, new equipment was developed and packaged specifically to meet the needs of the underwater construction diver. These tool packages now include two sizes of drills, a manual nut splitter, a portable band saw, impact wrenches and a diver-operated hydraulic pile cutter. Each package contains the basic tool, spare parts, repair components and operating manuals.

Rock Drills

Navy construction divers must often drill holes in sea-floor rock and coral to install anchor bolts to stabilize seafloor cables and pipe, to place explosives or to obtain seafloor core samples. To meet these needs, light- and heavy-duty rock drills were developed; both use carbide-tipped precision bits similar to land rock drills.

The light-duty rock drill tool package is an oil-hydraulic powered rotary hammer drill which can produce holes ¼ inch to 1-½ inches in diameter. The package includes a special adapter which allows the diver to attach a diamond tip core bit for taking seafloor samples up to 2-½ inches in diameter by 2 feet long.

The fiberglass housing and shaft seal arrangement allow the drill to be operated to depths of 120 feet. The sealed housing is necessary to prevent flooding and damping the mechanical hammering mechanism. Four pockets molded into the housing hold up to 32 pounds of lead weights which supply the drill bit bearing load necessary to produce the best drill rate. Operational tests of the light-duty rock drill show that the tool can drill ¾-inch diameter holes in granite at a rate of 3 to 4 inches per minute.

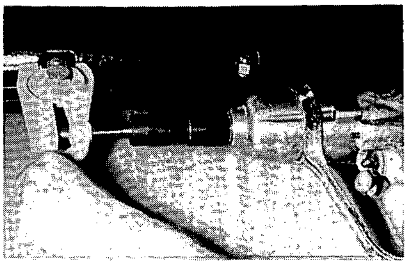
The heavy-duty rock drill was developed so that the diver could drill larger diameter holes (up to 3-½ inches) for grouted fasteners and placement of explosives for excavation. The 84-pound drill provides the proper bearing load for the drill bit. Tests showed that it can drill 2-½ inch diameter holes in granite at rates of up to 3 inches per minute. The drill may be used confidently at most depths because none of the drill components are ambient pressure sensitive.

Nut Splitter

The manual nut splitter was designed primarily for removing corroded and damaged nuts from underwater cable protection hardware. It can be operated either manually, with a socket to turn the main drive screw, or powered,

Divers using light-duty hydraulic rock drill.

using the hydraulic impact wrench. The tool splits the nuts by pinching cutters into opposite flats of the nut; approximately 20 stainless steel nuts from ¾-inch bolts can be removed with each set of cutters. This compact tool was designed for use in very tight places. Because of the extreme forces required for splitting, high-strength steels were used for the removable cutters and other nut splitter parts. Each tool package contains sufficient spare parts to remove 1000 nuts.



The nut splitter is hydraulic or manual.

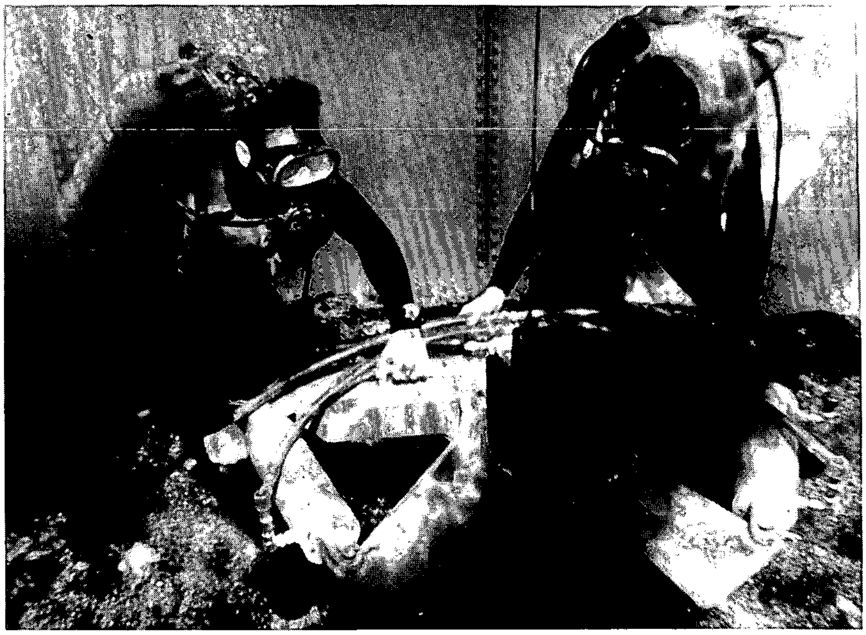
Portable Band Saw

This instrument was developed by NCEL to cut double-armored 3-½ inch diameter cable to remove damaged sections for inspection and repair. The tool cuts material up to 3-½ inches deep and 4-1/8 inches wide; it can be used on such materials as steel, aluminum and plastic. The width of the cut is defined by the saw throat. The depth is set by blade guides that twist the saw blade 30 degrees away from the vertical.

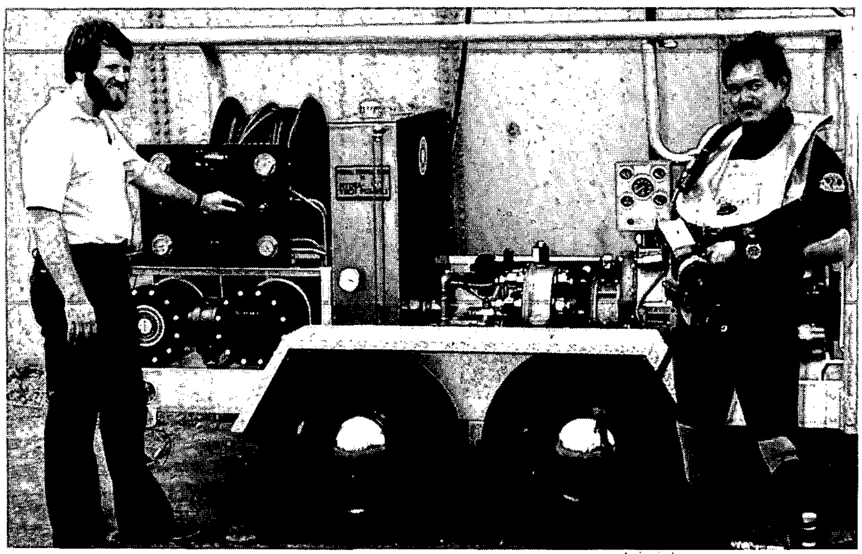
The saw blade is driven by a friction-drive mechanism that allows the blade to slip if it becomes jammed while in operation. The weight of the saw provides the cutting force and a built-in stop takes up the reaction force of cutting. A special blade guard protects the diver and allows flush cutting of materials. Tests showed that the saw can cut 3-½ inch diameter, double armored cable in less than one minute.

Impact Wrench

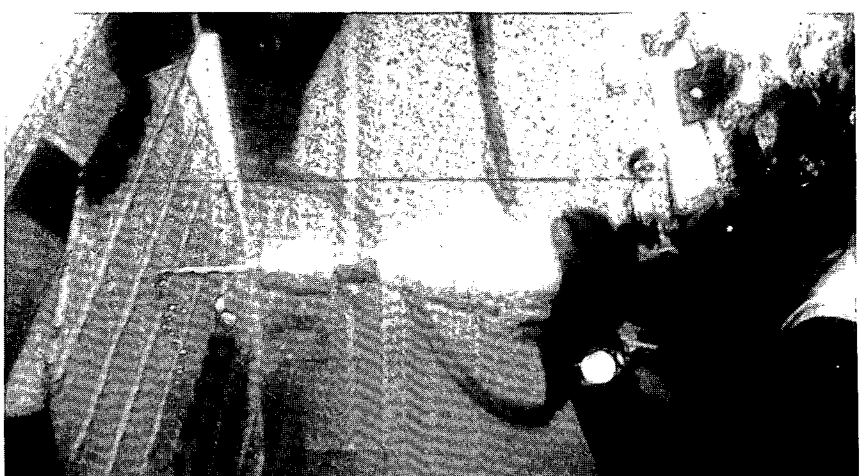
Divers must often remove or tighten threaded fasteners such as nuts and bolts. They can use a number of different sizes of impact wrenches to do this. The wrenches



The pile cutter severs 13-inch diameter piles in 10 seconds.



Experimental seawater hydraulic impact wrench.



The impact wrench drilling holes in metal.

Heavy-duty drill bores holes to 3.5-inch diameter.

are commercially available for underwater use. The first such wrench was very awkward; some modifications have since been made to the trigger mechanism and reversing valves. The manufacturer has incorporated other improvements into the tool. The wrench can also be used for drilling holes in metal by attaching a drill chuck.

Pile Cutter

The underwater pile cutter was developed by NCEL to allow divers to cut timber piles up to 13 inches in diameter at the mud line. This work is often done when preparing a site for a new pier or for cleaning debris from an abandoned pier or foundation.

The cutting force required for shearing timber piles is provided by two 5-inch bore hydraulic cylinders. Each cylinder closes its blade in a scissor-like motion against the pile. Spikes on the commercially available blades grip the pile during the initial cutting to prevent the blades from sliding off the pile.

The diver operates the cutter using a spring-loaded off control valve—a deadman switch. If the diver releases the switch, the shearing action immediately stops. The pile cutter, which weighs 300 pounds, is maneuvered by the diver using conventional lift bags. The total time necessary to shear a 13-inch diameter pile is less than one minute.

Future Developments

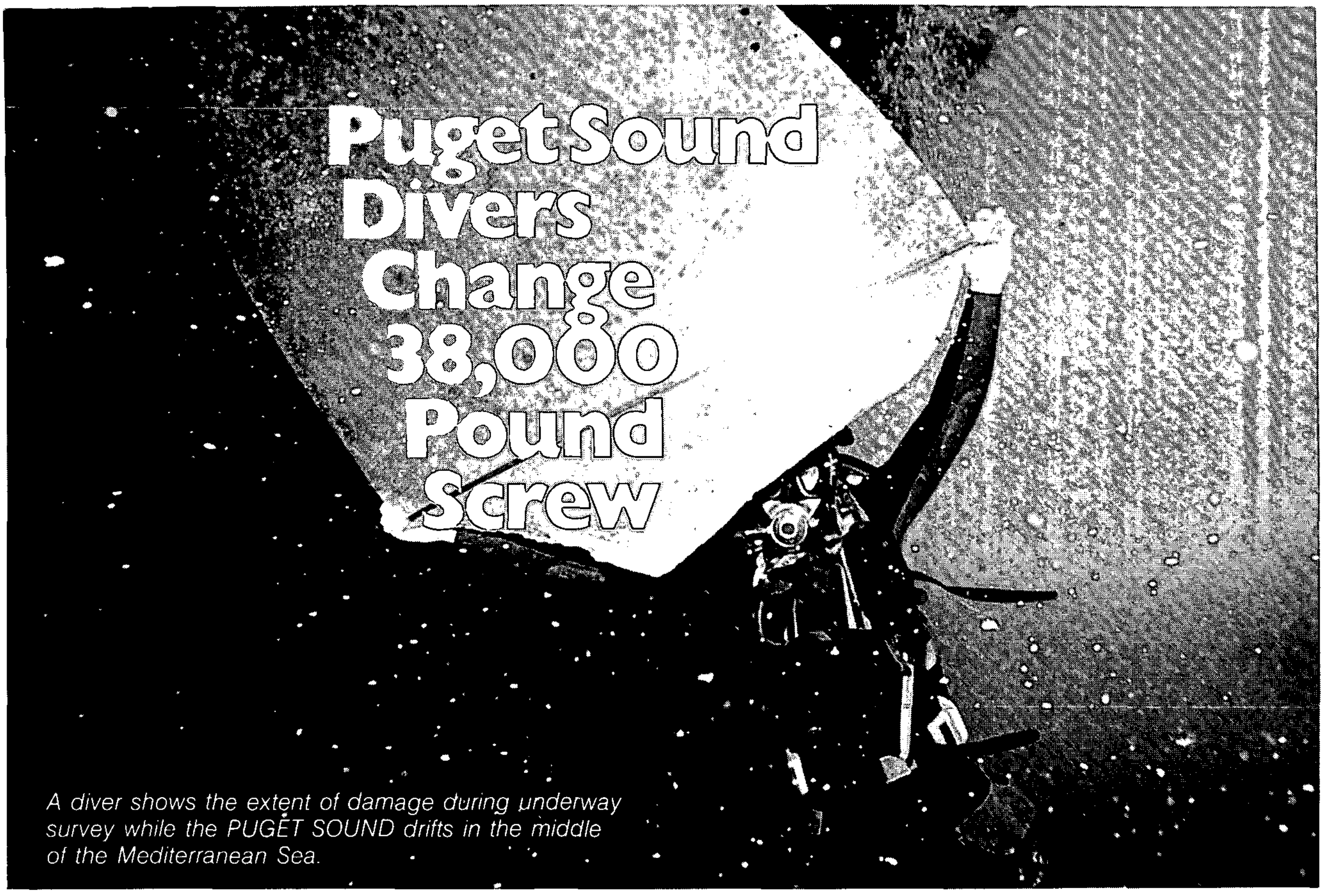
While the equipment described here has greatly increased a diver's ability to work underwater, NCEL is constantly improving the reliability of tools, reducing maintenance requirements and developing new tools which will expand construction, maintenance and repair capabilities. The next generation of tools will enable the diver to work faster, with more freedom and at greater depths.

Tool packages are being developed specifically for the Navy's deep-ocean saturation divers. These systems will use hydraulic fluids composed of 95 percent water with 5 percent additives to improve viscosity, lubricity and corrosion inhibition. These fluids eliminate the problems associated with toxicity and fire which are present when using hydraulic oil near the diver's high-pressure oxygen environment.

Saturation divers can descend to depths of 1000 feet. The saturation diver tool package will allow effective and efficient operations at these depths. The tool package will be independently powered, self-contained and offer the diver five interchangeable heads which can be connected to a universal power handle. The tool heads consist of a low-speed rotary/impact mechanism, a cable cutter, a spreader jack and a water-jet eductor for removing sediment.

Concurrent with the oil-hydraulic diver tools program and the saturation diver tools packages, NCEL is developing hydraulic equipment which uses seawater as the working fluid. These systems will be totally compatible with the environment and the working diver. The return hose has been eliminated because the working fluid is emptied into the ocean; this improves the diver's ability to manipulate the tools. NCEL's recent success in developing a 3-hp seawater vane motor and experimental seawater hydraulic tool system (consisting of an impact wrench and power source) has demonstrated that seawater hydraulic tools are feasible.

With the development of seawater hydraulics, future construction and saturation diver tool packages will eventually be powered by seawater. The unique materials used in these packages allow them to use the ocean as the fluid reservoir so that seawater-powered tools will be as convenient and natural to operate underwater as pneumatic or electric tools on land.



A diver shows the extent of damage during underway survey while the PUGET SOUND drifts in the middle of the Mediterranean Sea.

Puget Sound Divers Change 38,000 Pound Screw

By LT(JG) Richard Eley
USS PUGET SOUND (AD-38)

(Ed. note: The most sophisticated research and development efforts would be meaningless if the systems and procedures were not put to use in the fleet. A recent screw change performed by divers on board the USS PUGET SOUND is one example of how Navy divers use the results of R & D to fulfill all types of mission requirements.)

The 38,000 pound screw of the USS PUGET SOUND (AD-38) was recently changed by the ship's eight-man diving team, who accomplished the entire operation, with the exception of welding, in SCUBA gear. The job took 14 days and more than 1,352 diver man hours, with nearly 300 hours of in-water time. The work was completed while the ship was moored outside of Naples, Italy.

Potential damage to the screw was first identified on 6 December 1982 when the ship experienced an unusual shudder. One hour later the PUGET SOUND could only make an SOA of six knots while making turns for 18 knots.

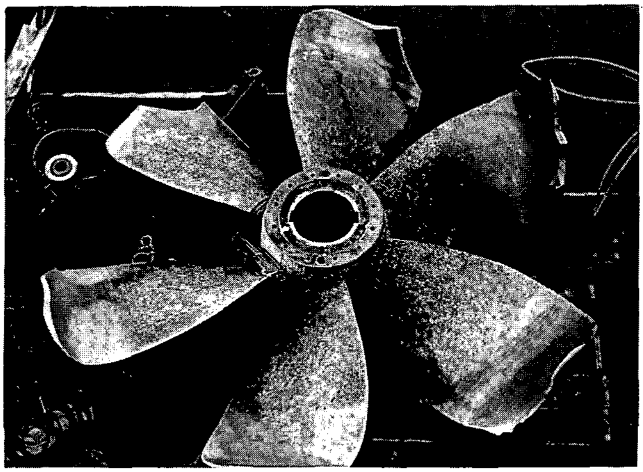
In-water investigation in the middle of the Mediterranean showed that the screw was severely damaged. As PUGET SOUND had an operational commitment to be in Beirut to tend ships for the entire month of January, the damage had to be repaired quickly.

It was decided to attempt an in-water screw change-out. Naples, Italy was chosen as the mooring location largely for its support craft and logistics. However, some major problems arose during the screw change which related directly to diver safety. For example, large ferries often passed directly in front of the PUGET SOUND, producing hazardous wakes.

The size and weight of this screw required a four point suspension rig, using two 20-ton chainfalls and two 16-ton chainfalls. Another small 6-ton chainfall was used for steadying while pulling the new screw on to the shaft. A belly band was used to rig out the dunce cap, bring the wrench in place and rig the nut.

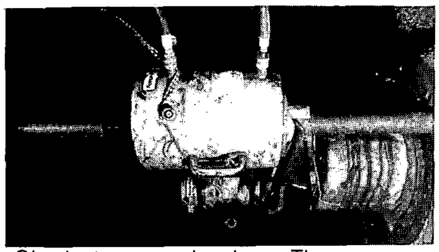
PUGET SOUND was moored to the pier with the barge and crane on the port side. The weather was an ever-changing menace. While the ship was behind the sea wall, she sat only a few hundred yards from the mouth of the harbor. The

Making preparations to install the new screw.



The old screw on the deck of the PUGET SOUND.

Diver working in the dark waters of Naples harbor. Note how a wire was laced around two blades. This technique was used because the lifting eye plug could not be removed.



Charleston gear in place. The threads of the shaft are covered with sheet lead to protect them as the old screw slides off and the new screw slides on the shaft.

photos by LT Richard Eley

combination of sea swells and wakes from the ferries made diving conditions tricky at best, especially topside, as the dive boat took extreme rolls. Freezing rain, hail, winds up to 40 knots and waves breaking over the sea wall all hindered the divers' work. The average temperature, without considering the wind chill factor, was 40° Fahrenheit. Visibility underwater ranged from 1 to 20 feet. Fortunately, visibility was good on some critical days of the operation.

By 15 December, only five days after PUGET SOUND arrived in Naples, the rigging was completed and the ropeguards, fairwaters, dunce cap, retaining ring and nut had been removed. All gear requested from Charleston had arrived except the hydraulic pump.

A hydraulic pump was located onboard and some special high pressure T-fittings were made. The strongback sent with the Charleston gear turned out to be 8 inches too short. PUGET SOUND had a strongback, but it was not certain that it could take the required 200,000 pound pull without bending.

In preparation for the first pull, the strongback found onboard PUGET SOUND was installed. Meanwhile, a heavier strongback weighing nearly 1600 pounds, was located.

The next day the new pump arrived and was quickly put in place of the one from PUGET SOUND. The first pull was then attempted—the strongback bent under the pressure. The weaker strongback was replaced with the heavy-duty one by 1000 hours the morning of 18 December and the divers were ready for the second pull attempt.

This attempt broke the screw off the taper. It was now noon, but because of the weather it was impossible to remove the screw completely. The winds exceeded 30 knots with waves crashing over the sea wall, causing the crane to bounce like a cork. Diving was cancelled for the rest of the day.

Contending with sleet and hail, the divers successfully removed the damaged screw on 19 December and loaded it aboard the barge for transport.

The new screw, which had arrived a few days earlier, presented an unusual problem. The streets of Naples are narrow and congested and the screw—18 feet in diameter—would be difficult to transport through the town. A plan was devised to move the screw at midnight when traffic was at a minimum and to block off the intended route.

The new screw went on with only minor complications. On the first attempt to slide the screw up the shaft, it cocked on the bottom. The nut was placed to 40,000 pounds of torque and by 23 December the PUGET SOUND's screw was replaced and the ship was underway to Gaeta, the ship's home port.

PROGRESS CONTINUES ON

Closed Circuit Saturation Diving System

By LCDR Ray Swanson
Supervisor of Diving

L. Tracy Harris
Staff Writer

The MK 14 Mod 0 Closed Circuit Saturation Diving System (CCSDS), now nearing the final stages of evaluation, will advance the Navy's capability to perform extended deepwater salvage and submarine rescue operations while allowing fleet commands to conserve substantial amounts of helium. The MK 14 CCSDS, designed for use with the MK 2 Deep Diving System (DDS), provides breathing gas, thermal protection and communications to a maximum of two saturated divers at depths to 850 feet.

The mission of the MK 2 DDS is rescue and salvage, primarily directed toward distressed naval platforms. Adding the closed-circuit breathing apparatus to the Deep Dive System will greatly reduce breathing gas consumption and costs, thereby simplifying logistical problems associated with supplying diving gas at various locations on short notice.

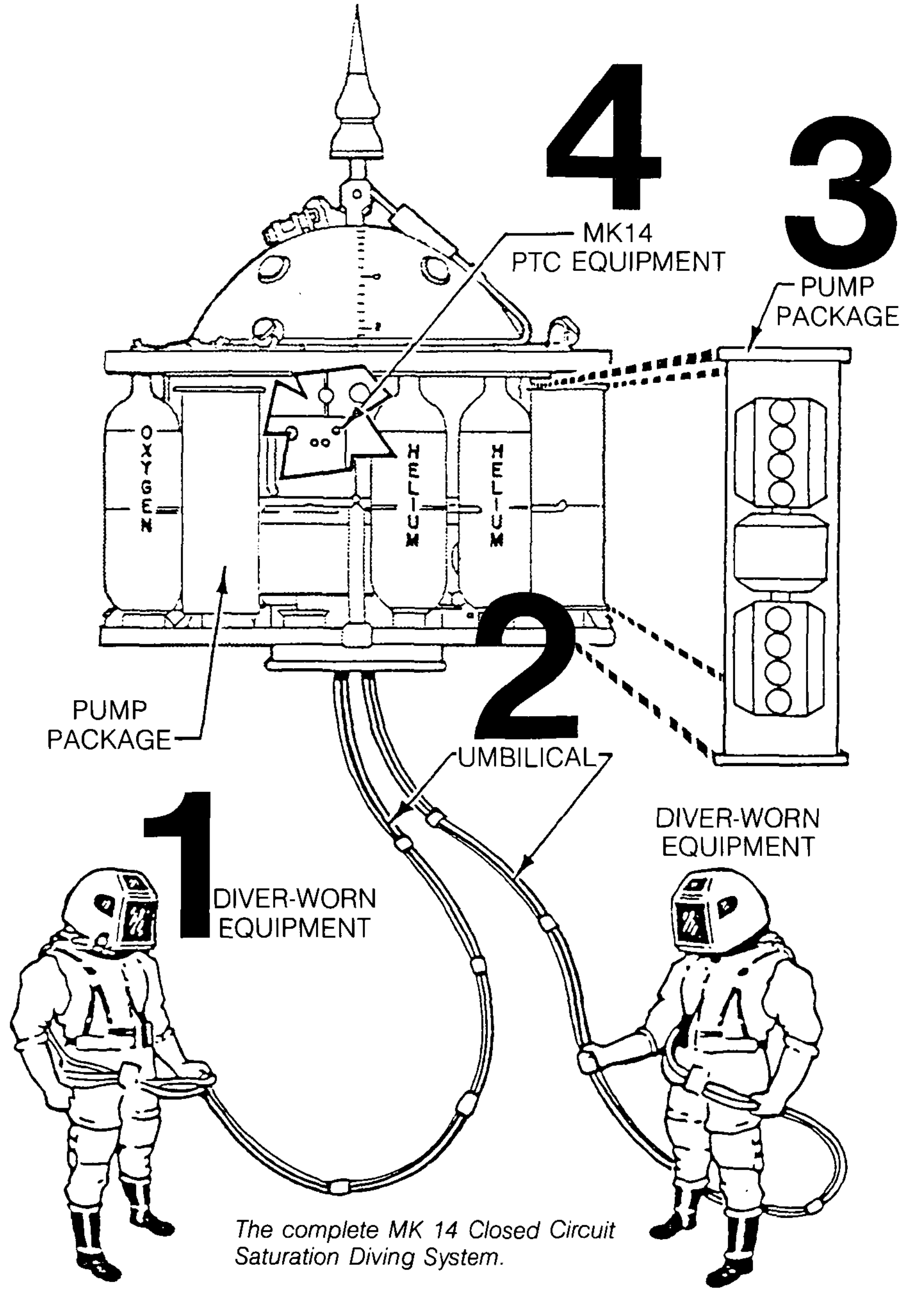
The complete MK 14 CCSDS is organized into four subgroups. The diver worn equipment group includes the helmet and several associated parts: muffler, supply valve, safety exhaust valve, manual exhaust valve, exhaust regulator, helmet check valve, helmet and lower breech ring, neck dam, viewports and communications. It also includes the hot water suit (part of the diver thermal protection), manifold, breathing gas heater and hose whip.

The umbilical group is the life critical connecting link between the Personnel Transfer Capsule (PTC) and the diver. It provides separate hoses for supply and return breathing gas, a hot water hose, a pneumofathometer and an electrical cable which supplies the link for communications.

The third group—and key to the MK 14 CCSDS—is the pump package, which includes the supply and return pump motor unit as well as the containment vessel with its associated couplings, valves, piping and penetrators. There is one supply and one return pump motor unit for each diver. The purpose of the pump is to supply sufficient breathing gas for a diver operating between the limits of 200 and 850 feet sea water (FSW) and, as mentioned above, to provide for conservation of helium.

The PTC equipment makes up the fourth subgroup of the system. This group includes the PTC interface piping, penetrators, connectors, return pressure gauges, sup-

Diver-worn equipment of the MK 14 CCSDS.



The complete MK 14 Closed Circuit Saturation Diving System.

ply pressure gauges, pump condition indicator lights, switches, control valves, scrubber, filter, flow meter, water separator, electrical controls, motor starter and cables. It also includes HEO_2 emergency gas supply for the divers.

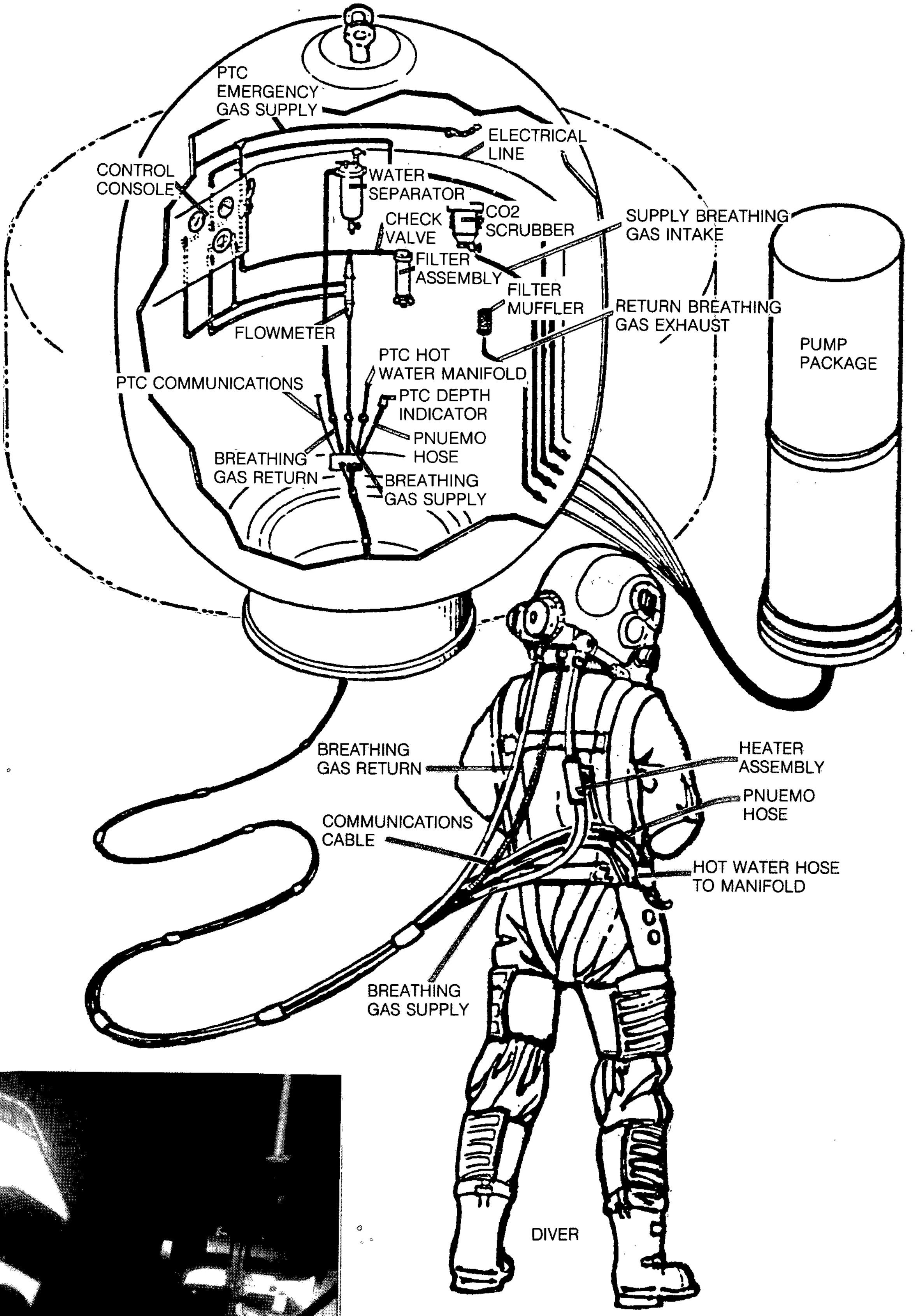
The flow path of gas through the MK 14 system is as follows: the PTC environmental helium oxygen atmosphere is drawn into an externally mounted pump. The gas is pumped from there through a network of piping, through a filter, check valve and flow meter in the PTC to the diver through the gas supply hose, achieving a flow rate of up to 6 ACFM. Once it reaches the diver the gas is heated in a hot water heat exchanger attached to the diver's suit. This provides the other part of the thermal protection necessary to keep the diver alive.

From the hot water heater, the breathing media flows into the helmet through a check valve and a supply valve. The return gas exits the helmet through a safety exhaust valve and an exhaust regulator, then it is drawn through the return gas hose of the umbilical back through the water separator and carbon dioxide scrubber located in the PTC and into an externally mounted suction pump. From the return pump, the return gas is pumped back into the PTC atmosphere.

Because this is a closed circuit system, helium is continuously recycled. The MK 14 CCSDS' ability to conserve helium is an important advantage over demand or open-circuit systems. At 850 FSW, a diver uses helium at the rate of 1.4 actual cubic feet per minute. Since helium costs 5-9¢ per cubic foot, if not recirculated, it would cost approximately $250 an hour to supply one diver with helium alone. As most salvage operations take several weeks of long work days and involve many divers, the cost of replenishing helium can be considerable.

Conserving helium not only means cost savings, but more importantly, extends time on station for the ship hosting the diving operation. Helium is available mainly in the United States; divers working at remote locations must depend on the amount of helium their host ship can carry. The ASR-21 class ship (which is scheduled to receive the MK 14 CCSDS) carries approximately 500,000 standard cubic feet of breathing gases, sufficient for approximately 30 days of deep diving. If the ship runs low on gas, she must be resupplied on station, a difficult task at best, or trip out of the moor and proceed to port to load out. In either case, valuable time is lost and the salvage or recovery mission is delayed. With the MK 14 CCSDS, the helium supply lasts almost indefinitely and diving operations are no longer limited by the amount of helium a ship can carry.

The MK 14 CCSDS is a significant advancement for the U.S. Navy. Work on the system was born

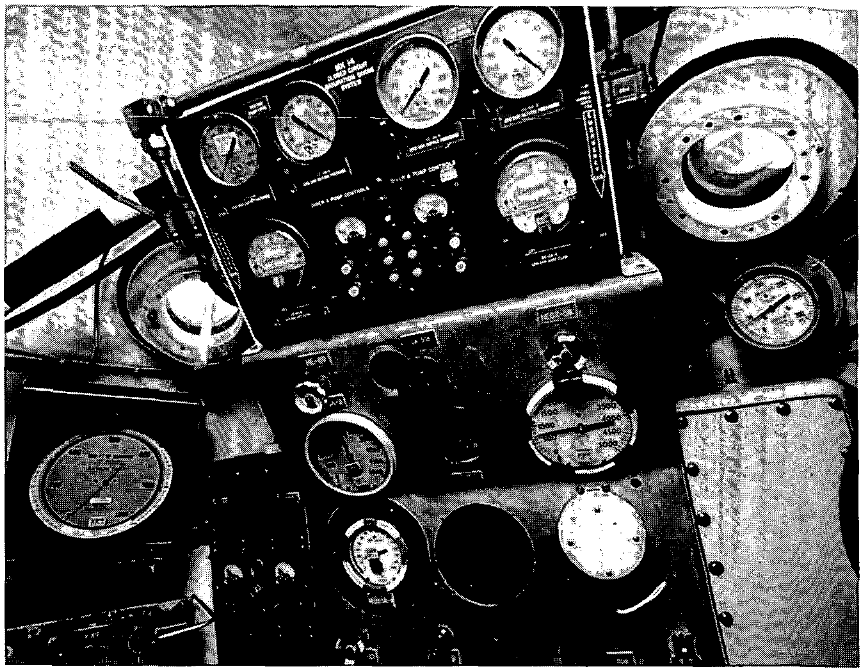

PTC
EMERGENCY
GAS SUPPLY
ELECTRICAL
LINE
CONTROL
CONSOLE
WATER
SEPARATOR
CO2
SCRUBBER
CHECK
VALVE
SUPPLY BREATHING
GAS INTAKE
FILTER
ASSEMBLY
FILTER
MUFFLER
RETURN BREATHING
GAS EXHAUST
FLOWMETER
PUMP
PACKAGE
PTC HOT
WATER MANIFOLD
PTC COMMUNICATIONS
PTC DEPTH
INDICATOR
PNUEMO
HOSE
BREATHING
GAS RETURN
BREATHING
GAS SUPPLY
BREATHING
GAS RETURN
HEATER
ASSEMBLY
PNUEMO
HOSE
COMMUNICATIONS
CABLE
HOT WATER HOSE
TO MANIFOLD
BREATHING
GAS SUPPLY
DIVER

out of the Man in the Sea program in 1973. Closed-circuit systems being developed by commercial companies were surveyed for potential use, but after technical testing of several candidate systems, the Navy decided that to meet military standards and specifications, they would develop their own system (see FACEPLATE Fall 1974 and Fall 1977). Since that time, there has been extensive testing of the system at the Navy Experimental Diving Unit (NEDU) and the Naval Coastal Systems Center in Panama City, Florida. To date the MK 14 or components of the system have completed more than 1300 hours of manned and unmanned laboratory testing.

A series of unmanned tests were successfully completed in the spring of 1977 at NEDU verifying the design and integration of system components. Manned testing of the system to its design limits was successfully completed in November 1977 in NEDU's Ocean Simulation Facility. A total of 56 saturation dives, simulating actual diver excursions from a PTC, were made during this test series. These manned saturation dives were to a depth of 1100 FSW. The MK 14 CCSDS is only authorized for diving depths of 850 FSW because of the MK 2 DDS depth limit.

In the spring of 1979, additional unmanned system tests were successfully performed at the Naval Coastal System's Center, Hydrospace Laboratory. These tests were conducted over a period of 465 hours to demonstrate system life support reliability.

One of the major concerns in developing the CCSDS was that divers must receive gas at a constant pressure. Feeding over- or under-pressurized gas to divers could cause serious injury. The tenders in the PTC breathe the same gas as the divers outside, but with different pressure requirements. As gas flows through the system, its pressure must change to meet the requirements of divers both inside and outside the PTC. This potential problem with the CCSDS has been resolved through several mechanisms. The exhaust



The control station inside the PTC.

regulator attached to the helmet helps maintain pressure and the control panel inside the PTC allows the tenders to set and monitor pressure continuously.

The control station also has a come-home system to protect the divers outside the PTC should any part of the system malfunction. An emergency gas supply is attached to the exterior of the PTC. The control panel will indicate to the tenders when the diver is not receiving enough gas. The diver will then be switched to the emergency supply and brought back up to the PTC.

In early 1982 a package was developed to install the MK 14 CCSDS in the MK 2 DDS. DTV ELK RIVER (IX-501) was selected for the platform since she had the only certified diving system at the time.

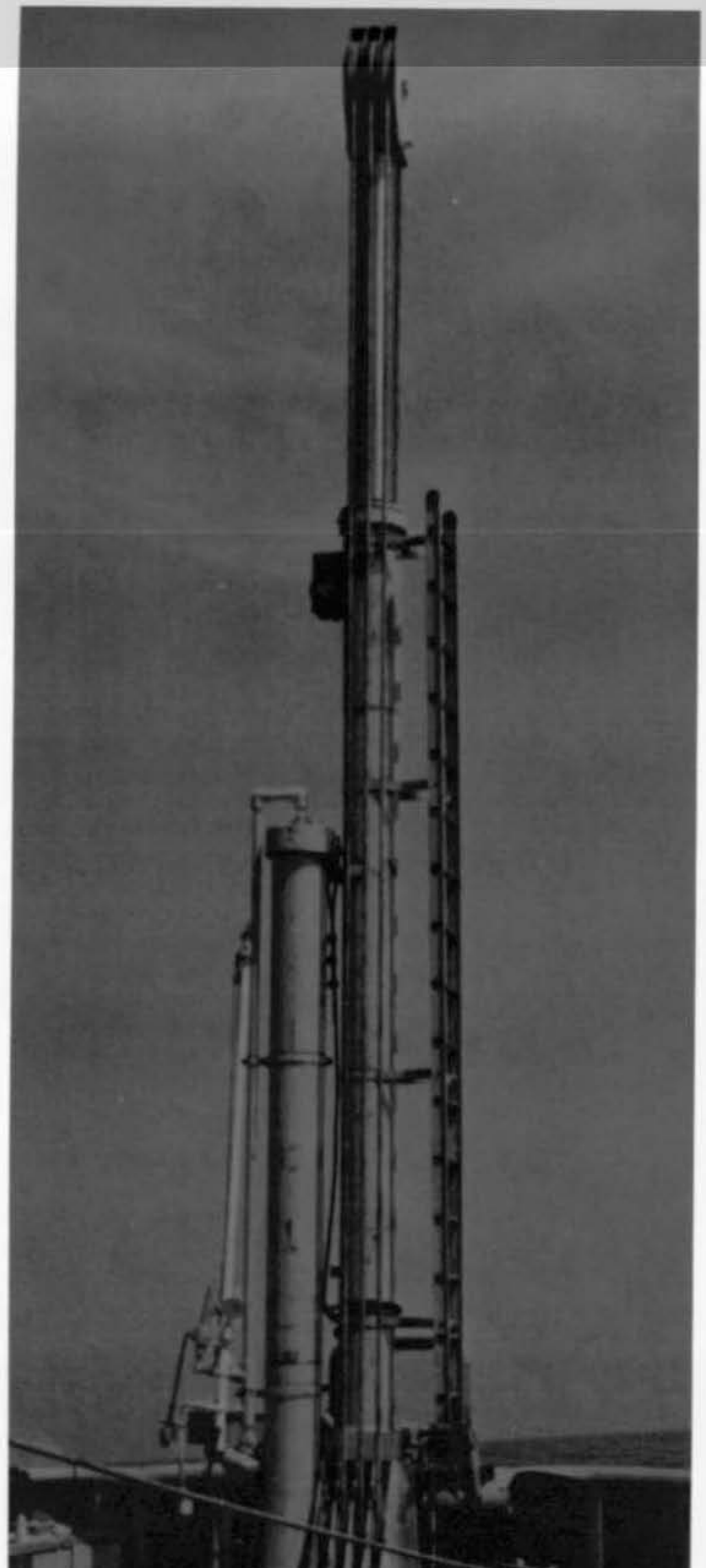
Installation of the MK 14 on the number two PTC of the ELK RIVER was completed by summer 1982. Until that time, all MK 14 testing had been done under laboratory conditions. It was now necessary to begin at sea testing and to work minor bugs out of the system. Divers from the ELK RIVER were trained both at NEDU and at the Submarine Development Group in San Diego, California.

As the system was developed to operate in depths greater than 200 FSW some special problems arose. Divers had to begin at shallow depths to gain the proper feel of the equipment and the necessary experience before proceeding to deeper depths. However, there is a tendency for slight over-pressurization at the shallower depths. The divers had to adjust to this condition. A series of 18 shallow center well dives and 200 foot dives in a dry atmosphere were performed alongside the pier during late 1982 and early 1983. Results of these dives indicate that the MK 14 CCSDS will perform satisfactorily and is ready to proceed with technical and operational evaluation. Both phases of the evaluation must be successfully completed before full-scale production of the system is authorized.

Except for the pump package, the MK 14 CCSDS will be procured on a competitive basis. The pump package will be procured sole source from the developing corporation. Since the MK 14 CCSDS is a manned diving system, it must be certified before manned use by operational units.

NAVSEA is the developing agency for the MK 14 CCSDS and the Naval Coastal Systems Center is the lead laboratory for the system's development.

New Ram Tensioner Aids Underwater Lifting Operations



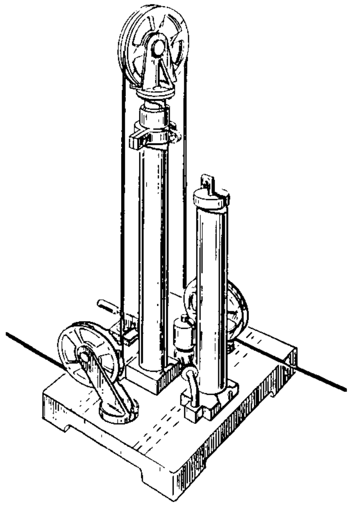
Welded on the stern of an ARS tug, the ram tensioner is rigged for the recovery of an SH-2F Army helicopter. The helicopter was lifted by its blade from a 450-foot depth off the coast of Italy in 1980.

By Nancy de Laval
Naval Civil Engineering Laboratory

A Fly-Away Deep Ocean Salvage System (FADOSS), capable of retrieving massive objects such as a downed aircraft from depths of 20,000 feet, is being developed at the Naval Civil Engineering Laboratory (NCEL) in Port Hueneme, California under the sponsorship of the Naval Sea Systems Command.

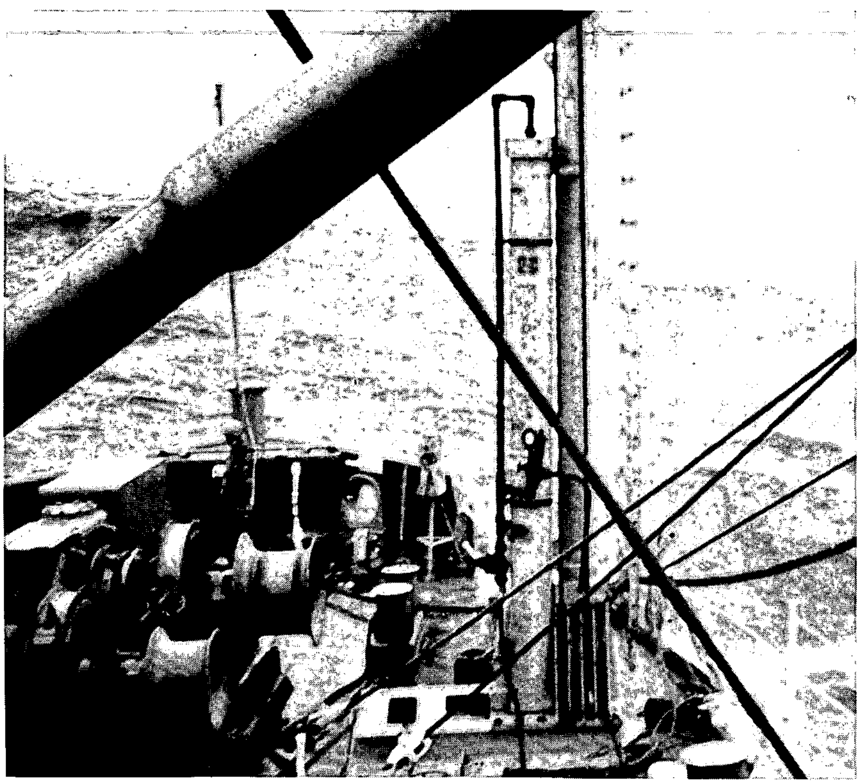
FADOSS is transportable via aircraft, can be rapidly installed and retrieved and will fit the deck configurations of most ocean going tugs. It is capable of lifting up to 55,000 pounds net-weight. One of the major components of FADOSS is the newly-modified ram tensioner, which allows the system to perform difficult lift operations without risking snap loads caused by changes in lift line tension.

The ram tensioner has been used since the early 1960s for underway replenishment operations and on oilers to maintain tension in overhead lines that support refueling hoses. Several modifications had to be made to it before the tensioner could be used for the deep ocean lifting mission of the FADOSS.



Design configuration for the new FADOSS ram tensioner.

"Underway replenishment requires a horizontal transfer from one ship to another," NCEL project engineer Francis Liu said. "The tension line runs between two ships as they travel parallel to each other."



The F-15 was towed under the bow of USS OPPORTUNE, using the ram tensioner to prevent snap loads.

In underwater lifting operations, the ram tensioner maintains static tension on a vertical line, attached from an on-surface ship to the load on the ocean floor.

"There is a similar need to compensate for the ship's movement, by payout and drawing in the line," Liu said. "In underway replenishment operations, the ram tensioner may use up to 120 feet of line travel, because the ships may drift quite far from each other. Underwater lift operations generally require only 5-7 feet of line travel, but even those small functions between a ship and its cargo can cause severe snap loads."

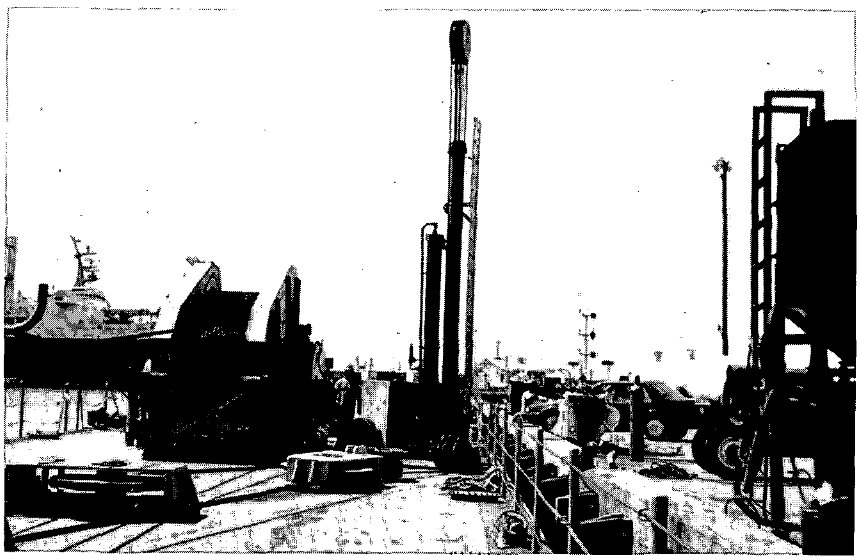
Snap loads are a major cause of lift line failure and can result in loss of the object being salvaged. They occur when the lift line (which runs from the ship above-water to the submerged cargo) suddenly slackens and retensions. The sudden pull on the line can cause the entire load to be lost. Some snap loads can pull with a force as high as ten times the payload's submerged weight.

Snap loads are a common problem for salvors, particularly when working in rough seas. The regular bobbing motion of the ship can cause continual changes in line tension. Snap loads are even more likely to occur when the support vessel slides into a wave trough faster than the payload can sink; when the suspended length of the line supporting the payload is close to the resonant line length, as determined by the load mass and sea state; or when the ship's motion is out of phase with the payload motion.

The ram tensioner eliminates the problem of snap loads. In the FADOSS, it is installed on the deck of the support vessel and attached to the lift line between the payload and the system's hydraulic traction winch.

The first step in adapting the ram tensioner for underwater lifting was to make it portable.

"You never know when you'll have a salvage job or which ship you'll be working from, so we had to convert the existing ram ten-



The ram tensioner on OTEC/CWP (cold water pipe) deployment barge YC 1525 ready for the deployment of a 400-foot long, 8-foot diameter cold water pipe off Waikiki in April 1983.

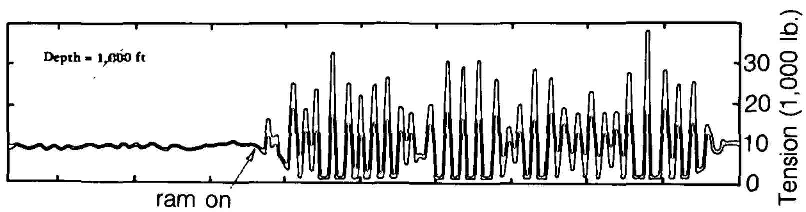


Figure 1. *Actual tension records showing the existence of high snap loads and their effective removal by the ram tensioner.*

sioner to a portable system readily transported to all corners of the world and readily mounted on small ships," Liu said.

The base of the conventional ram tensioner was modified to facilitate rapid welding and provide the required resisting force. The new base allows for removal of the ram tensioner within 3 to 5 hours. High pressure flexible hoses replace rigid piping and connectors to give added portability and a flexible configuration, so that the new ram tensioner can be used on most decks.

Once the ram tensioner was made portable, the second phase of system modification began. Three tensioners were selected to be converted for underwater lifting. (Final conversion of the three ram tensioners is still in progress.)

In the final design configuration the number of sheaves at the top of the ram tensioner's piston will be reduced from three to one and at the base of the pressure cylinder from four to two. The original configuration gave the ram tensioner mechanical advantage with six spots to provide compensation for the motion of water. In a lifting application, however, only vertical motion compensation is necessary. By reducing the number of sheaves, unused motion compensation is reduced and the motion compensation ability remaining is concentrated vertically. The net effect is to increase the lifting power of the system from the standard 20,000 pounds to 55,000.

Another modification in the final design configuration of the ram tensioner is an increase in the size of the sheaves to accommodate the 3-1/2 inch in diameter (11-inch circumference) polyester line, which will replace the conventional 1-inch diameter wire rope used for replenishment operations. The polyester line is more flexible than wire and is therefore much easier for divers or a submersible to attach to objects on the sea floor.

Another modification will be installing a valve system between the cylinder and accumulator. This modification will not only reduce operational wear to the system but will also allow rapid on/off control of the tensioner.

"This is an important adaptation for underwater lifting," Liu said. "The tensioner must be on when lifting the package from the ocean floor to compensate for the motion of the ship, but once the package reaches the surface and you're lifting it onto the deck, the tensioner must be turned off. At that point, you want the package moving with the ship, not traveling up and down because of the ram tensioner."

Other components of FADOSS include the hydraulic traction winch, rollers and sheaves that change the direction and orientation of the lift line and the three-tank self-contained air supply system which can be connected to the ship's air supply if necessary.

A series of three at-sea tests of FADOSS have been conducted by NCEL off the coast of southern California and near the island of Oahu. Tests were conducted at various sea states with payloads ranging in dry weight from 2,400 to 15,500 pounds. Loads were lifted from depths of 100 to 3,400 feet.

Before the ram tensioner was activated snap loads as high as 37,000 pounds were recorded. When the ram tensioner was activated the snap loads disappeared and the tension variation was reduced to less than 10 percent of its static value (see Figure 1).

These results showed that the ram tensioner is effective at eliminating dynamic line tension and with it dangerous and costly snap loads—the results also show that the system is operable at various sea states and capable of lifting heavy and deeply submerged loads.

Though the ram tensioners have not yet been converted to their final configuration, partially modified

The ram tensioner on the center well deck of USS PIGEON (ASR-21) to provide motion copensation during the recovery and redeployment of the Deep Seat, a bottom mounted training platform, for Deep Submergence Rescue Vehicle mating exercises.

models have been operated successfully in recovery operations directed by the Supervisor of Salvage. The first was recovery of an SH-2F Army helicopter from a 450-foot depth off the coast of Italy in 1980. Because the payload was relatively lightweight, the ram tensioner could be rigged to the fantail and the helicopter could be lifted directly onto the deck.

A recovery conducted in February, 1983 was not as simple. The USS OPPORTUNE (ARS-41) used the ram tensioner to recover an F-15 aircraft submerged to 150 feet off the coast of Virginia. Because the aircraft was so heavy, it could not be supported on the ship's fantail. The ram tensioner therefore had to be rigged on the fore deck. Once the aircraft was lifted, it was attached to bow rollers and towed to a location where it could be lifted. Throughout this operation, which included approximately one day of towing, the OPPORTUNE encountered significant motion in the water, but the ram tensioner successfully maintained a steady lift line tension.

The ram tensioner will also be used to deploy four- to eight-foot diameter plastic pipe for the Ocean Thermal Energy Conversion (OTEC) experiments off the coast of Hawaii. (The Winter 1982 issue of FACEPLATE featured use of the ram tensioner in recovery of the OTEC cold water pipes.)

The ram tensioner will make recovery operations easier for divers. By reducing the occurrence of snap loads, the ram tensioner will reduce the frequency which divers must adjust or attach lift lines to payloads.

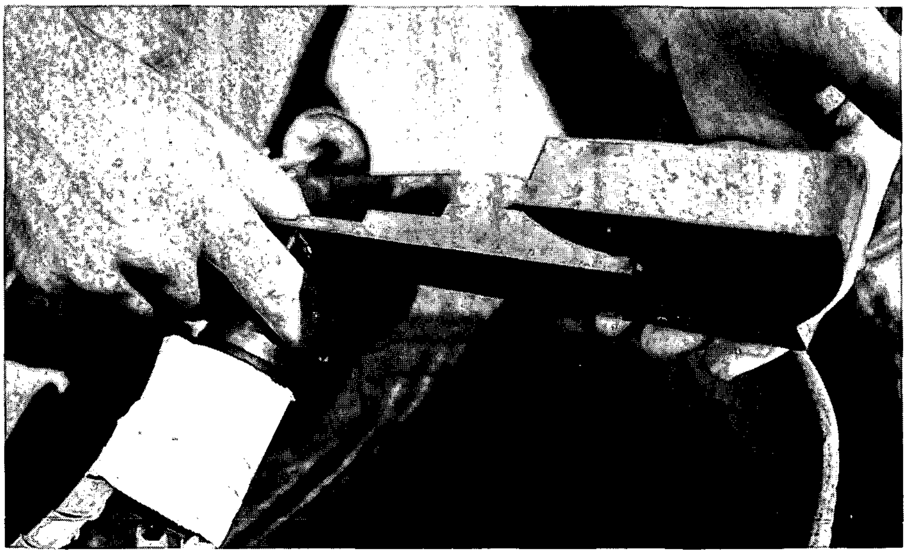
The Navy is in the process of developing three FADOSS, one to be deployed from the U.S. Atlantic coast, one from the Pacific and the third to be ready for deployment to any point in the world. One FADOSS is targeted for completion in fiscal year 1984 and it is expected that the three systems will greatly enhance the Navy's ability to recover valuable military equipment from the ocean depths.

For further information contact CDR H. M. Oien (SEA OOC-21) at Autovon 227-7387/88 or commercial (202) 697-7388.

HULL INSPECTION SYSTEM USES COMPUTER TECHNOLOGY

photos by LT John L. Hopkins

Divers discuss procedure before beginning the hull survey.



The transducer is calibrated before the underwater hull survey by wetting it in a bucket of water and holding it to a calibration plate. The readings at the computer are adjusted to coincide with the correct width.

By LT John Hopkins
Navy Public Affairs Center
San Diego

The Underwater Ultrasonic Thickness Inspection System, developed by the Naval Coastal Systems Center (NCSC) in Panama City, Florida, is bringing computer wizardry to the routine chore of hull inspection. Hull inspection is a routine part of ship maintenance and is necessary to determine if the hull is becoming corroded or pitted in certain spots due to rust, erosion or abrasion.

The new system, using sophisticated ultrasonics and computer technology, allows divers to inspect ships' hulls from the sea side while the ship is still in the water. This is a significant advantage over the previously-developed methods of hull inspection, which, although they make use of ultrasonic techniques, require either putting the ship in costly drydock or cleaning the inside of the ship and inspecting the hull from the ship's interior.

Work on an improved method of hull inspection began in 1977 as part of the underwater ship husbandry program at NCSC. According to NCSC engineer John Middleman, one of the major difficulties with the existing equipment is the awkwardness for the diver of handling both gear and data collection.

"Normally, the tester looks at the instrument, figures out the reading and records it," Middleman explained. "We decided to incorporate a computer into the system, thereby taking the chance out of misreading the equipment or miscopying the data."

The system developed at NCSC includes a desk-top computer, the ultrasonic instrument, an analog to digital converter, a plotter/printer, transducer, cables and various positioning lines. The system works by combining the features of ultrasonics with the rapid recording and calculating ability of a computer.

As the diver runs the ultrasonic instrument along the ship's hull, it sends an acoustic signal through the metal. The signal is reflected by the opposite face of the hull plate. By recording the travel time of the signal, the diver can determine differences in the hull's thickness and decide which positions may need repair work.

In non-computerized inspection systems, the continuous ultrasonic signals are shown on a screen. The diver monitoring the screen records what he sees, giving spot readings of the hull's thickness at an average rate of one reading every five seconds.

Computers—faster and infinitely more accurate than human beings—allow for 1,000 readings of the hull's thickness every five seconds. The diver, moving the ultrasonic instrument in the same 6-inch circle as when using the older systems, can now achieve a more complete analysis of the hull's thickness without risking human error.

The ultrasonic signal is transmitted through the acoustic transducer to the analog to digital (A/D) converter, which converts the signal from voltage (analog) to a digital reading. The computer eliminates the weak signals and takes averages of the readings. These averages are separated by mode, meaning the computer groups the signals according to the level of hull thickness they indicate (*i.e.* signals indicating the hull is 1/2 inch thick are averaged separately from those indicating 1/4 inch thickness). Through this technology, even the smallest pits and thin spots can be easily detected.

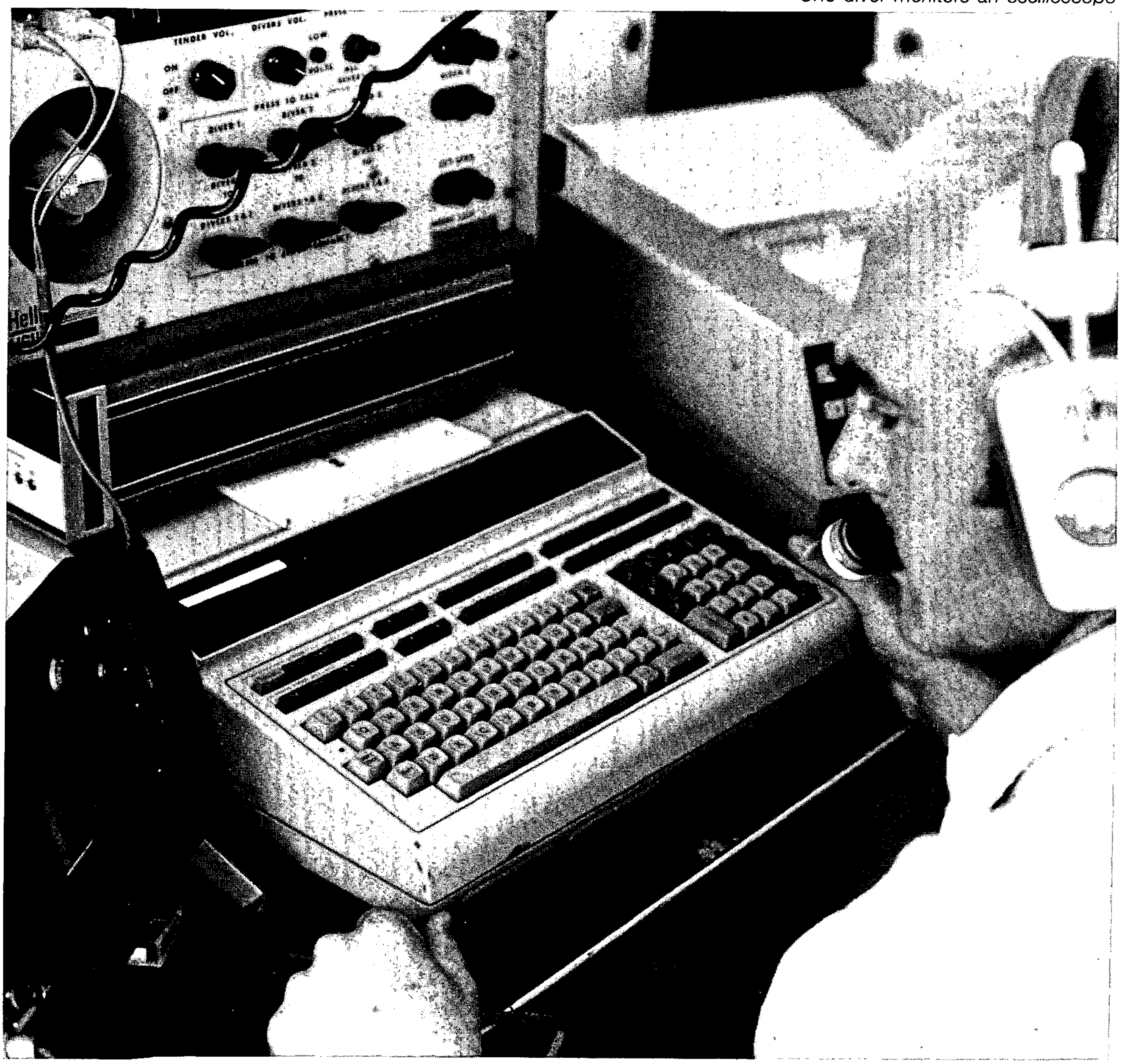
In addition to providing more accurate, complete readings of hull thickness, the system is waterproof and offers the major advantage of allowing underwater inspection. The transducer has a plastic housing to waterproof its connection with the rubber-coated cable. The plastic housing on the transducer also makes the 1/2-inch-diameter instrument easier to handle for divers, who often wear cumbersome gloves.

With waterproof equipment, hull inspections can be performed underwater from sea side, thereby eliminating the need to clean or rearrange a ship's interior before inspecting the hull. At the Ship's Intermediate Maintenance Activity (SIMA) in San Diego, where the system is being evaluated, Chief Hull Maintenance Technician Bruce Dewey explained the advantage of being able to inspect a ship from the outside under water.

"Cleaning an area for inspection is a time-consuming proposition. They've got to go bilge diving and maybe move a couple large pieces of gear, just to get to some areas that need testing.

"These prerequisites," he continued, "often caused cancellations because shipboard engineering departments were unable to comply. They often had to settle for

One diver monitors an oscilloscope



quick, minimal inspections of only areas suspected of having problems."

SIMA received the Underwater Ultrasonic Thickness Inspection System for fleet tests after initial testing was completed in Panama City. Mobile Diving and Salvage Unit (MDSU) ONE Detachment, also in San Diego, provided diver support.

The SIMA and MDSU ONE team were qualified to operate the system during a training session aboard the guided-missile Frigate USS JOSEPH STRAUSS recently conducted at Pearl Harbor, Hawaii.

One of the ships tested was the San Diego-based aircraft carrier USS CONSTELLATION. For seven days, MDSU ONE divers obtained underwater readings from almost 800 locations on the carrier's hull. The computer statistically analyzed nearly 800,000 readings and provided a complete hull thickness picture, previously an impossibility in such a short time.

There are presently two systems being operated out of SIMA and two at NCSC. Naval Sea Systems Command will oversee the distribution of more systems.

Future applications of the Underwater Ultrasonic Thickness Inspection System include locating cracks in the hull, finding solid plate around cracks prior to welding or determining liquid levels in underwater tanks. In all applications, the new system will give shipboard engineers, shore-based maintenance specialists and Navy divers a greatly improved ability to maintain ships.

while another inspects the hull.

Divers Must Fill Out 9940s Accurately and Completely

By Fred Humphrey
Safety and Occupational Health Specialist

The Naval Safety Center has frequently been requested by CNO to submit a complete dive history on all Navy divers. Not too long ago, several hundred divers received letters from the Navy Finance Center indicating the possibility of losing their previously paid entitlement to diving pay. This was due to a Naval Audit Service Report highlighting errors between Naval Safety Center diving records and individual pay records. While follow-up verification of each command's local records, individual dive history logs and service record (page 13) entries did substantiate many divers' entitlements, other divers faced recoupment action unless their requalification dives were adequately documented. The Naval Safety Center was swamped with telephone calls and written requests for personal dive history printouts from the computer storage data bank.

The Diving Log/Accident Report instruction and reporting form underwent a complete revision in early 1982 with the promulgation of OPNAVINST 9940.2B. More recently, the Naval Safety Center conducted an analysis of the new Combined Diving Log-Accident/Injury Report (OPNAV Form 9940/1) (Rev. 7-81), examining more than 63,000 reports received from active duty and reserve divers assigned to the Navy, Marine Corps and Coast Guard Commands. Twenty-eight percent (17,562) of all dive reports analyzed had errors caused by either incorrect or omitted data.

The omission of individual social security numbers, depth of dives and bottom times caused 1,224 reports to be returned to parent diving commands for resubmission.

The following is a brief description of the most common errors found. These errors prevented the diving report information from being entered into the computer data bank until costly and time consuming manual corrections were made.

SECTION A—DIVER'S DATA

Block 1—Dive Data—The dive data must be a valid, two-digit month (01-12), and day (01-31).

Block 2—UIC—The Unit Identification Code (UIC) or Reporting Unit Code (RUC) is the sole entry point for crediting a dive to a command. The dive is filed with the command assigned that UIC or RUC. Additionally, UICs or RUCs which do not cross reference to known diving commands listed in the Navy Comptroller Manual, Volume 2, Chapter 5 or Marine Corps Order P1080.20H, will result in the OPNAV form 9940/1 being rejected. As a reminder for TAD personnel, regardless of the command sponsoring a dive always use your parent command's UIC or RUC.

Block 4—Social Security Number—The most common source of social security number omissions are from individuals at training commands and individual's undergoing selection, indoctrination, pressure test or 0_2 tolerance test. Foreign diving personnel should enter all zeros for a social security number.

Block 10—Service—The primary problem is not completing the block. For those commands with foreign military personnel assigned, regardless of their branch of service, they must enter Code "F" into the block, and foreign civilians must enter Code "H".

Block 11—NOBC/NEC—The following NOBC/NEC should be used by personnel who have not completed training or who would not be regularly assigned an NOBC/NEC:

1. Foreign divers (military/civilian)—0000.
2. UDT/SEAL candidates—5301.
3. EOD candidates—5302.
4. Second class diver candidates—5303.
5. Pre-training screening, *i.e.,* selection, pressure test, 0_2 tolerance, indoctrination dives, *etc.*—0000.
6. Diving officer dandidates—0000.
7. Department of Defense civilians—0000. (Do not use Navy NECs.).

SECTION B—ENVIRONMENT

Block 18—Bottom Type—Even if the depth of water exceeds the dive depth, the type of bottom can be extracted from a chart. For dives in recompression chambers, Code "Y" should be used and an explanation given on the back.

SECTION C—DIVE AND EQUIPMENT

Block 25—Source of Gas Supply—The following are the accepted codes based on the type of equipment:

Type of Equipment	Acceptable Codes for Block 25
1. None	None
2. MK 5	B, D, Y
3. HeO_2 Helmet	E, M, Y
4. MK 12	B, D, Y
5. Jack Browne	B, D, Y
6. MK 1	B, D, Y
7. MK 14	E, M, Y
8. MK 11	J
9. SCUBA open	J
10. SCUBA closed O_2	J
11. SCUBA closed mixed gas	J
12. SCUBA semiclosed	J
13. MK 15	J
14. MK 16	J
15. MK 6	J
16. EMERSON	J
17. MK 12 HEO_2	E, M, Y
18. MK 1 HEO_2	E, M, Y
19. Draeger	J

Block 26—Breathing Gas Percent—Several examples are provided below to indicate that type of information which will be accepted:

(1) Air Dive 26. Breathing gas percent or oxygen partial pressure in tenths of atm.

He_2 N_2 O_2

0/ 0/ 7/ 9/ 0/ 2/ 1/ 0/ 0

36/37/38/39/40/41/42/43/44

(2) Mixed Gas Dive

He_2 N_2 O_2

8/ 4/ 0/ 0/ 0/ 1/ 6/ 0/ 0

36/37/38/39/40/41/42/43/44

or

He_2 N_2 O_2

0/ 0/ 6/ 0/ 0/ 4/ 0/ 0/ 0

36/37/38/39/40/41/42/43/44

(3) Closed Circuit SCUBA (other than MK 16)

He_2 N_2 O_2

0/ 0/ 0/ 0/ 1/ 0/ 0/ 0/ 0

36/37/38/39/40/41/42/43/44

(4) MK 16

He_2 N_2 O_2

0/ 0/ 0/ 0/ 0/ 0/ 0/ 0/ 7/

36/37/38/39/40/41/42/43/44

SECTION D—DECOMPRESSION SCHEDULE

Repetitive dives—In order to document a repetitive dive properly, the following blocks must be completed:

Block 34—Decompression Schedule

1. Decompresion Schedule—Use Code "C".
2. Depth/Partial Pressure—Enter the depth used for computing decompression. For a 63-foot dive, 70 feet should be entered; leading zeroes must be used (0070).
3. Time (minutes)—The time used for computing decompression. For example: For a 23-minute dive, 30 minutes should be entered; leading zeros must be used (0030).

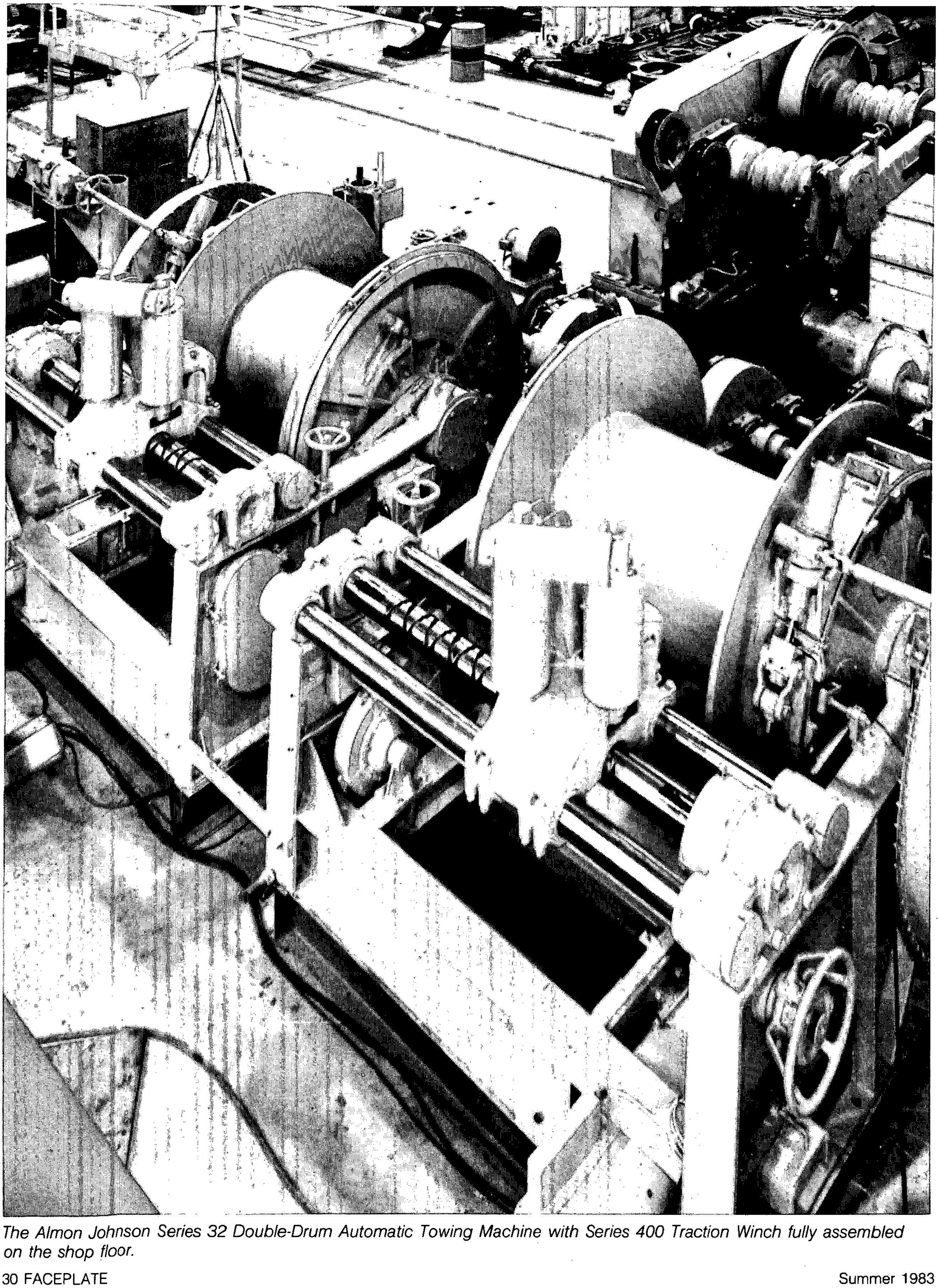
Block 35—Surface Interval for Repeat Dives. The time entered here should represent the difference between reaching surface from the last dive and the commencement of the dive being reported. The difference must be greater than 10 minutes and less than 12 hours.

If decompression occurs as a result of the dive, blocks 36, 37 and 38 must be completed.

Signatures of the diving supervisor and/or the diving officer were omitted on 2,944 diving reports. It was evident that when the diving supervisor and diving officer had reviewed and signed the diving reports there were far fewer reports rejected by the computer and returned to commands for resubmissions.

Personnel must be trained to document and submit their diving reports properly. Effective 1 June 1983, old OPNAV form 9940/1s (Rev. 4-70) received at the Naval Safety Center will be returned to the individual commands for resubmission on new OPNAV form 9940/1 (Rev. 7-81). The diving report, OPNAV form 9940/1 (Rev. 7-81), is available through the supply system under NSN I1I 0107-LF-791-9102, unit of issue is (PD) and cost is $2.30.

If there are questions concerning data entry on OPNAV form 9940/1, write or call the Naval Safety Center: Autovon 690-1292, FTS 954-1292 or commercial 804-444-1292. Ask for LT Steaadley, MMCM(DV) Williams, EMCS(MDV) Butterbaugh or BMC(DV) Farris.



The Almon Johnson Series 32 Double-Drum Automatic Towing Machine with Series 400 Traction Winch fully assembled on the shop floor.

TOW MACHINE TRAINING

COMING ON LINE IN 1985

By LCDR Ken Smith
PMS-383C

Providing realistic, hands-on practical training for the men who operate and maintain automatic towing machines on-board salvage and towing ships has been a long-term objective within the Navy's diving and salvage community. Recognizing this important requirement, the Naval Sea Systems Command's Auxiliary and Special Mission Ship Project Office (PMS-383) is sponsoring development of a comprehensive training system which parallels the characteristics of the towing machines currently used.

The Almon Johnson-type automatic towing machine has been the workhorse of towing and salvage vessels for many years. The Navy has 17 of these machines in service and will soon introduce the first of four new generation dual-drum towing machines on the new class of salvage ships, the ARS-50.

To receive full benefit from these versatile and dependable workhorses, fleet salvage personnel must be able to operate them in all the modes for which they are designed, *e.g.* manual, automatic, free spooling, dual drive, overhauling, high torque-low speed, low torque-high speed, *etc.*

The towing machine training system developed by PMS-383 (illustrated in Figure 1) consists of an automatic towing machine, a haulage winch and a tensioning structure or wave-maker, which simulates wave action. The automatic machine trainer will be equipped with all the features which characterize one of the new 322 engines on the ARS-50 tow machine. The trainer will also have a hawser tensionmeter and remote clutch-brake operator as well as the same remote controls, indicating lights and alarms as installed in an ARS-50 Remote Control Room (COOP) and on the haulage winch.

The training system's towing machine is powered by a 50 horsepower motor whereas the 322 engine on the ARS-50's towing machine is a 125 horsepower motor. The training machine will, however, be calibrated to simulate the load conditions of the 322 so that the dials, meters, spring travel and other features will essentially duplicate the conditions of an actual towing operation. For example, the training machine may only be strong enough to pull 10,000 pounds, but the meter would be set at 100,000—in this way the trainees will see everything (except the size of the wire and the machine) exactly as it will appear on the job aboard an ARS-50.

The haulage winch is similar to the towing machine except that it will be equipped with a larger motor. This gives it the capability to overhaul (overpower) the trainer towing machine in the same way that a tow or vessel can overhaul a towing machine. The haulage winch will be operated by an instructor.

The wave-maker, also operated by the instructor, is equipped with a programmable hydraulic ram, which can be set to simulate the sea state from zero (calm sea) to eight (fresh gale). The simulation is accomplished by stroking the hydraulic ram at a given period and amplitude. This places an impulse-type load on the trainer towing machine, causing it to react to its fullest capability and beyond; thereby requiring an operator (trainee) to take corrective action.

Both the training and the ARS-50 towing machines are driven from a 230 volt DC motor-generator set driven by a 125 horsepower AC motor. The towing machine trainer will incorporate the same variable voltage system as is used on the ARS-50. Control logic, as well as the hardware, is identical to the ARS-50 configuration so that electrical troubleshooting can be a part of the training course. The trainer is a single-drum machine—the machine on the ARS-50 is oval-drum with a traction winch for synthetic rope towing.

The training program for the Almon Johnson-type automatic towing machine is being established at the Naval Diving and Salvage Training Center (NDSTC) in Panama City, Florida and will be phased to insure that training is completed as the first ARS-50 completes final construction. After the ARS-50 class lead crews have been trained, the program will become part of the First Class Diver course. Training will also be available to other operators.

The training system is supervised and operated by an experienced instructor who is out of view of the towing machine. The instructor operates the haulage winch and tensioning structure, simulating the towed vessel and producing various conditions on the towline. These conditions can be handled automatically by the automatic tension controller or manually by the trainee working the towing machine upon commands given by the instructor.

Direct sound powered telephone

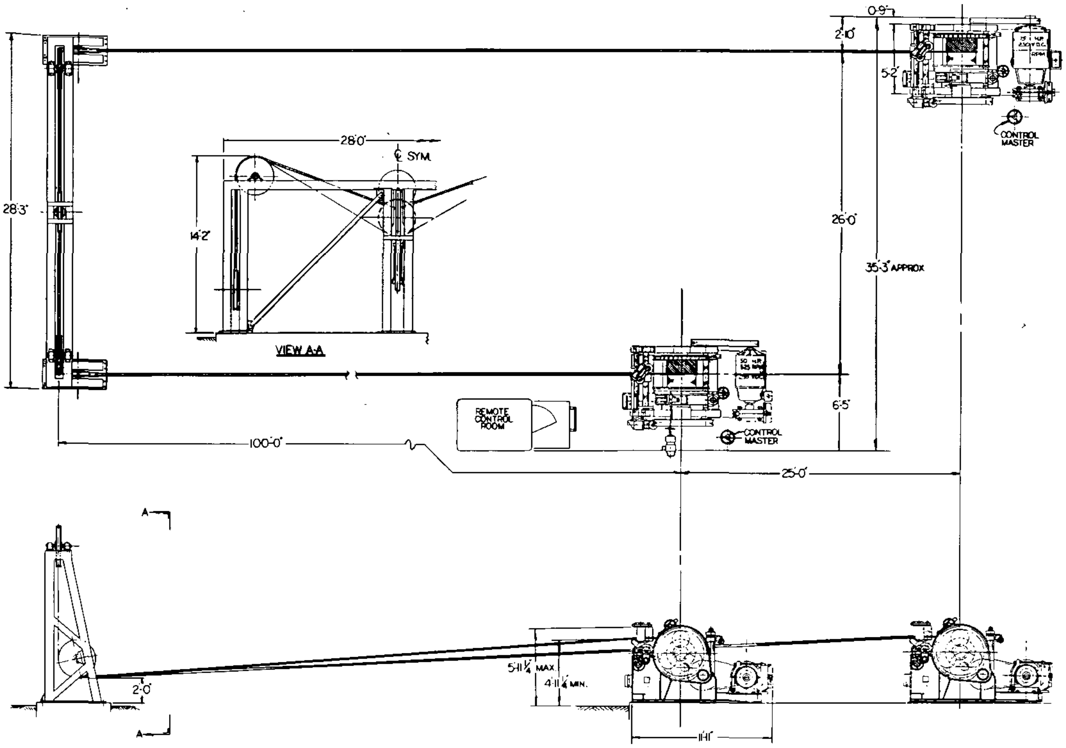


Figure 1. *Engineer's drawing of the towing machine training system.*

communication is provided between the instructor at the haulage winch station, simulating the pilot house, and the towing machine trainee. This simulates ARS-50 vessels, where the towing machine operator will be stationed in the COOP. Also located in the COOP are the Master Controllers and the lights and instruments which indicate the operation of the towing machine, including hawser tension, scope and rate of payout (motor RPM's), which are simulated in the training system.

The following training scenarios illustrate how the towing machine training system will function in a variety of simulated conditions.

At any time during this operation the instructor can adjust the speed of the haulage winch to simulate different conditions during the tow operation, such as the tow hitting a bar and stopping or the wind shifting and driving the tow toward the tug. For each of these conditions the trainee would learn to adjust the towing machine according to the commands of the instructor.

For example, when entering port, it is desirable to shorten the scope of the tow. This can be accomplished under automatic controls by having the instructor place the haulage winch in slow pay-out, thereby creating a condition under which the operator must heave-in line to shorten the scope.

The automatic towing machine's ability to heave-in or pay-out the hawser automatically is one of its most important features. It prevents the tow from taking charge under towing conditions of short stay, such as when the ship enters or departs a harbor and is subject to following seas or tidal currents.

Another common towing problem that the training system simulates occurs in the process of making up a tow or getting the towed vessel and the tug under way, when extremely high line pulls (tensions) are sometimes exerted. These can be corrected by the trainee by either paying out hawser or notifying the Bridge (where the instructor is stationed) of the simulated condition. The Bridge can then slow down until the proper amount of hawser has been payed out to reduce the strain and shock on the hawser and its connections.

The training operator will set the haulage winch and the time cycle on the tensioning structure. The trainee will set up the towing machine at a given line tension and hawser scope. When the trainee has the towed vessel and tug in step with the simulated wave action the towing machine will stop cycling.

The instructor will be able to adjust the tension control on the haulage winch to permit cycling of the towing machine reclaimer for maintaining the scope of tow.

Introduction of the ARS-50 of salvage ships and their accompanying towing equipment will be a major milestone in the Navy's progress toward having state-of-the-art capabilities to perform salvage missions. The first ARS-50, the USS SAFEGUARD, is currently under construction in Sturgeon Bay,, Wisconsin (see FACEPLATE Winter 1982). The towing machine training system developed by PMS-383 will insure that fleet salvage personnel will be prepared to operate and maintain the new equipment to its fullest capacities.

For further information LCDR Ken Smith (NAVSEA PMS-383C) at Autovon 222-3510 or commercial (202) 692-3510; or LCDR J. T. Harrison (CNTT N354) at Autovon 966-5975 or commercial (901) 872-5975.

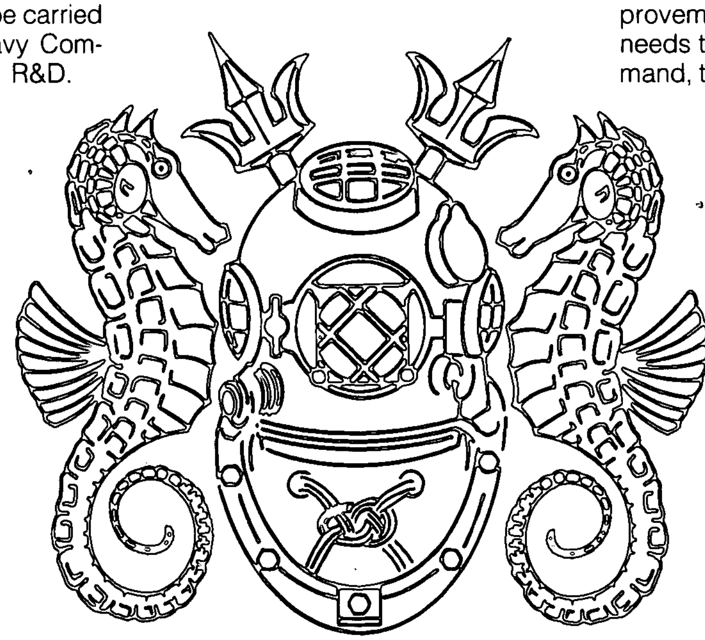
The OLD MASTER

Many divers reading FACEPLATE wonder how the Navy Research and Development organizations can help them get their jobs done better. Navy R&D exists for just that purpose—to conduct research and develop systems that will help divers (and all Navy personnel) meet current and future mission needs. Each R&D effort is directed in response to a specific mission requirement. Your R&D requirement must be identified and supported through your operational chain of command to the CNO level which sponsors the mission. If the CNO sponsor approves and funds an R&D effort in response to your stated operational requirement, it will be assigned to the Chief of Naval Material (CHNAVMAT). CHNAVMAT will designate a Program Manager or send the requirement to NAVSEA to manage the research and. development effort. Portions of the effort can be carried out by the numerous Navy Commands involved in diving R&D.

As equipment and procedures are developed, they will be tested for technical adequacy by NEDU. Their capability to meet your operational requirement will be evaluated by OPTEVFOR. Once the system has proven its ability to meet your needs, it will be procured and delivered. Full training, technical and material support normally follow such a development.

The evolution of diving equipments such as the MK 12 SSDS, MK 14 CCSDS, MK 15 UBA and MK 16 UBA followed this pattern. Systems other than diving equipment follow similar program paths—we now have the T-AFTs as working platforms, the ASR-21 class ship which combines the capabilities of saturation diving and manned submersibles for submarine rescue and the Swimmer Delivery Vehicle for combat missions. In addition, the ARS-50 class ship is forthcoming. Hydraulic tools have been developed to support many fields of diving and diving tables and treatment procedures are being developed to allow use of advancing technology. These tables and procedures will be refined as we gain operational experience.

The only way to receive R&D support is to identify your operational requirements through the chain of command. In some R&D programs it takes years to produce usable equipments or procedures. Others can be acomplished in relatively short times, provided the needs justify the expense and the appropriate technology exists. Though time and effort are always required, R&D results in systems and procedures which are fully funded and supported by training, PMS, configuration management, logistics support and planned improvements. If you forward your needs through your chain of command, the system will work for you.



R&D

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