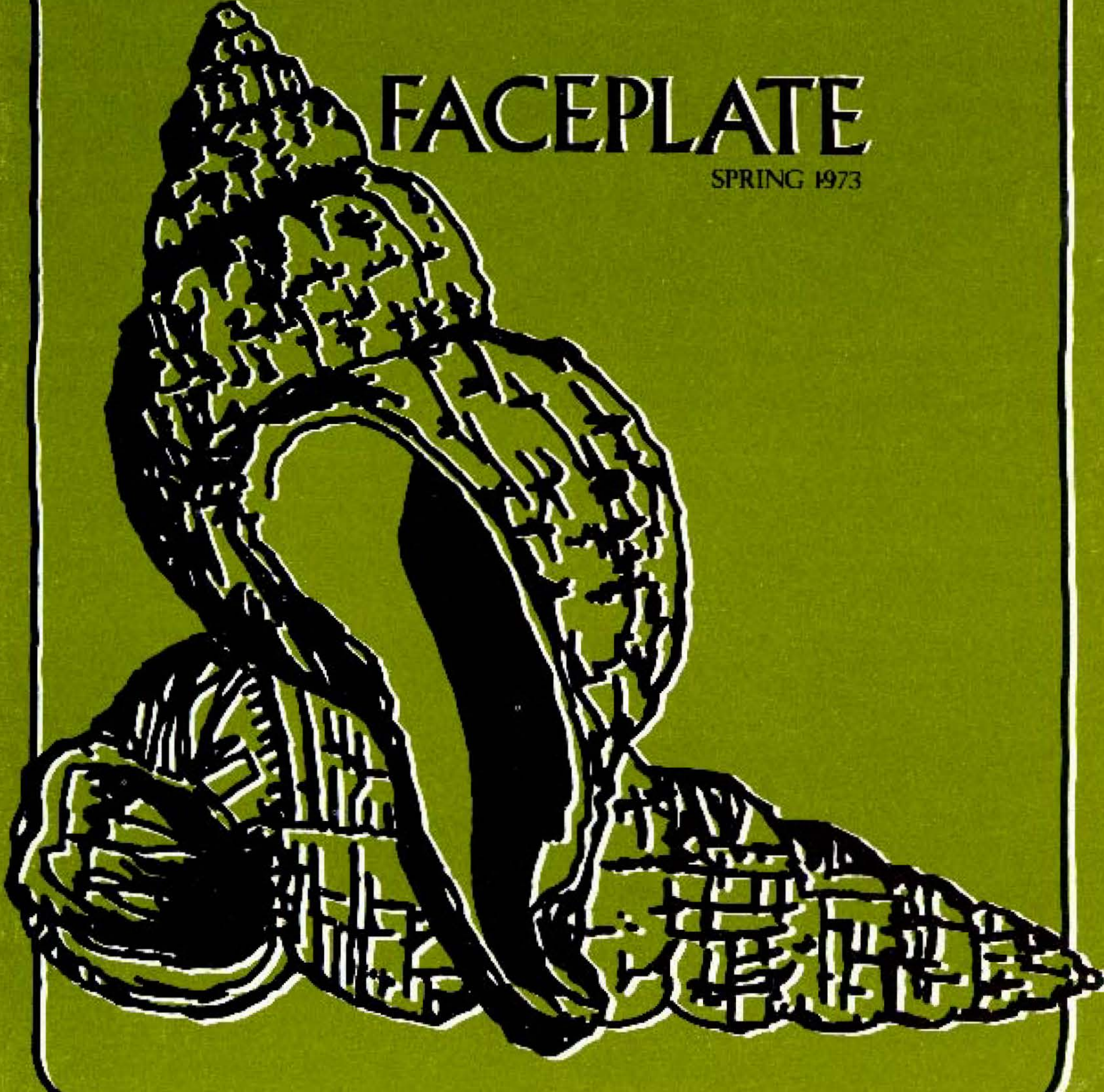
FACEPLATE

SPRING 1973



Salvor burning during recovery operations.

VOL. 4 NO. 1

FACEPLATE

. . . the official magazine for the divers of the United States Navy.

FACEPLATE is published quarterly by the Supervisor of Diving to bring the latest and most informative news available to the Navy diving 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

Trouble with CO_2 Cylinders

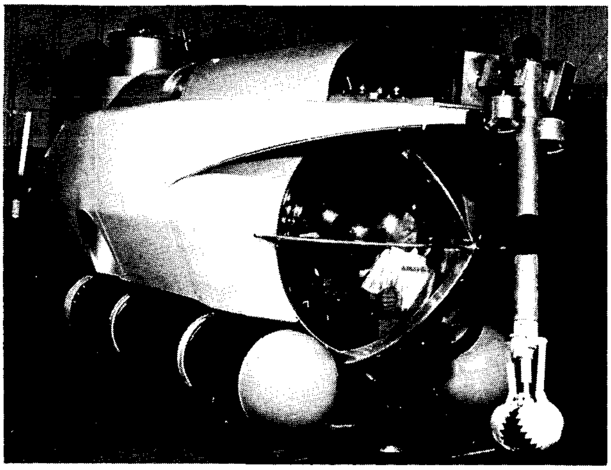
Recently the Supervisor of Diving received reports from two Fleet diving activities that a high percentage of life jacket CO_2 cylinders, when weighed, had an insufficient CO_2 charge. The difficulty centered on the 18 gram non-magnetic CO_2 cylinder (FSN 4220-287-3741) used in the UDT inflatable life jacket and the 31 gram non-magnetic CO_2 cylinders (FSN 4220-965-0595) used in the Mark III life jacket. In one case, 51 percent of the CO_2 cylinders had an inadequate CO_2 charge. NAVOP 090004Z JAN 73 was issued to alert Fleet users to this condition. The NAVOP particularly requested that all users and stock points inspect their CO_2 cylinders for evidence of cracks and/or weight loss, with defective cylinders to be disposed of locally.

The Diving Manual and the NAVSHIPS Tech Manual both require that life jacket CO_2 cylinders be rejected when they weigh 3 grams or more below gross weight marked on the cylinder. The NAVSHIPS Tech Manual further requires that the CO_2 cylinders, for in-service life jackets, be weighed every 6 months. But a careful review of the inspection procedures for CO_2 inflatable life jackets, now established in the Diving Manual and NAVSHIPS Tech Manual, shows that it is possible to follow these procedures exactly and still issue a life jacket to a diver without the CO_2 cylinder having been examined or weighed. Furthermore, the Diving Manual, while requiring a life jacket for all SCUBA divers, does not specifically require a pre-dive inspection of the life jacket, its CO_2 cylinder, or its activation mechanism. However, a check of several Fleet units that routinely engage in SCUBA diving operations revealed that many of them already require the diving supervisor to conduct some form of visual pre-dive inspection of the life jacket CO_2 cylinder for punctures or cracks.

In recognition of this potential safety hazard, and in addition to the steps already recommended in the NAVOP, NAVSHIPS has initiated action to change the applicable section of the NAVSHIPS Tech Manual to require that life jacket CO_2 cylinders be inspected and weighed when they are initially received on-board a user activity. In addition, the new Diving Manual, now in the final stages of preparation, will require a pre-dive visual inspection of the CO_2 inflatable life jacket as well as the CO_2 cylinder and its activation mechanism.

These procedures should insure that when a diver draws a life jacket from stock, its CO_2 cylinder will have been inspected and weighed. As the diver uses his life jacket it will get an inspection before every dive, including a visual check of its CO_2 cylinder and activation mechanism. Any evidence of cracks or punctures in the CO_2 cylinder would cause it to be discarded and a new one used for the dive. These steps coupled with the already established requirement to weigh the CO_2 cylinder every 6 months should give the diver increased confidence in his life jacket.

Deep View Christened in California



Deep View, (shown here) the world's first submersible with a pressure hull built with a 44-1/2-inch diameter glass hemisphere at the front, was recently christened at the Naval Undersea Research and Development Center (NUC), San Diego, California. A 3-hour manned dive in 20 feet of water near the NUC pier checked out the propulsion, life support, communications, and weight and balance systems. The system is designed for oceanographic research to depths of 1,500 feet. Occupants normally ride in a prone position, but the hull is roomy enough to allow upright sitting for note-taking.

The transparent glass hull of the Deep View will permit observers a full view of their underwater surroundings at greater depths than is now possible in similar hulls made of acrylic plastic. Plastic-hulled submersibles are presently limited to depths of 600 feet.

Navy certification of the Material and Operations Capability of Deep View is pending. When this has been received, the following test and operations are scheduled: Intermittent untethered operations at Catalina Island, using a marine railroad for launch and recovery at depths of about 100 feet, and 20 days of sea trials at NUC, Hawaii, using the Launch and Recovery Platform.

Naval Heritage Display

A new 14 million dollar Civic Center was recently dedicated at Lake Charles, Louisiana. As part of the ceremonies, a Naval Heritage Display, was designed and fabricated through the combined efforts of the military and the Public Works Center personnel of the Inactive Ship Shore Facility, Orange, Texas. The work was supervised by CDR John H. Vosseller, Commanding Officer.

Diving Gas Sources

The Supervisor of Diving is compiling a list of commercial and military sources of diving gases, particularly helium and mixed gases, available throughout the world. The finished listing is intended to provide a reference for diving activities which may require resupply of diving gases when away from their normal sources. Any activity, organization, or company having information on availability of diving gases is requested to send it to:

Supervisor of Diving
Naval Ship Systems Command
Washington, D.C. 20360

Specific information desired includes:

—Name and address of supplier

—Types of gases available particularly premixed gases and specifications to which mixed

—Quantities available

—Delivery Time

—Delivery Points

—Approximate Prices

All contributors will receive a copy of the completed listing.

Anti-Fogging Compounds

An in-depth test program, performed both in the laboratory and during diving operations, has verified the following substances as very effective anti-fog compounds: Lemon Fresh Joy, and Sun Fogproof. It is recommended that either of these anti-fog compounds be an important item in every diving bag. For further inquiries concerning compounds tested and detailed results, contact W.W. McCrory, Jr. at Naval Coastal Systems Laboratory, Panama City, Florida 32401.

More on the "Sea Cutter"

A new Navy Underwater Cutting Torch was recently issued to selected activities. See Soundings of the Winter '72 issue of *FP* for a description of the torch.

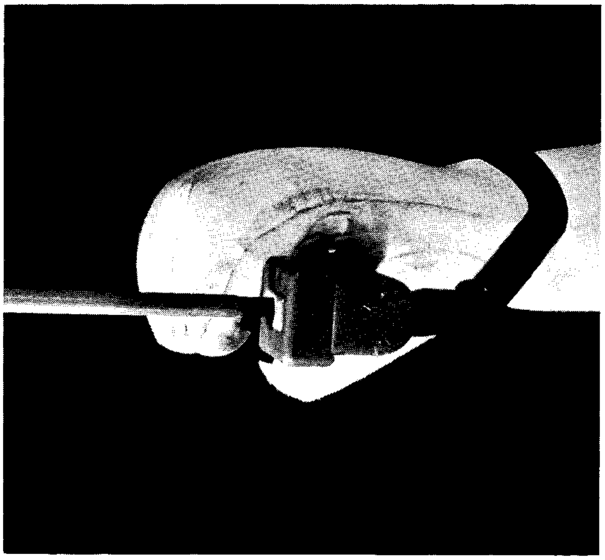
Comments to date have resulted in the following points to remember when using the torch:

- The electrical cable is designed as an adjustable wrist loop to be shaped around the diver's wrist as illustrated here. The wrist loop provides for ease of handling by freeing the diver's hand for other work when not cutting.

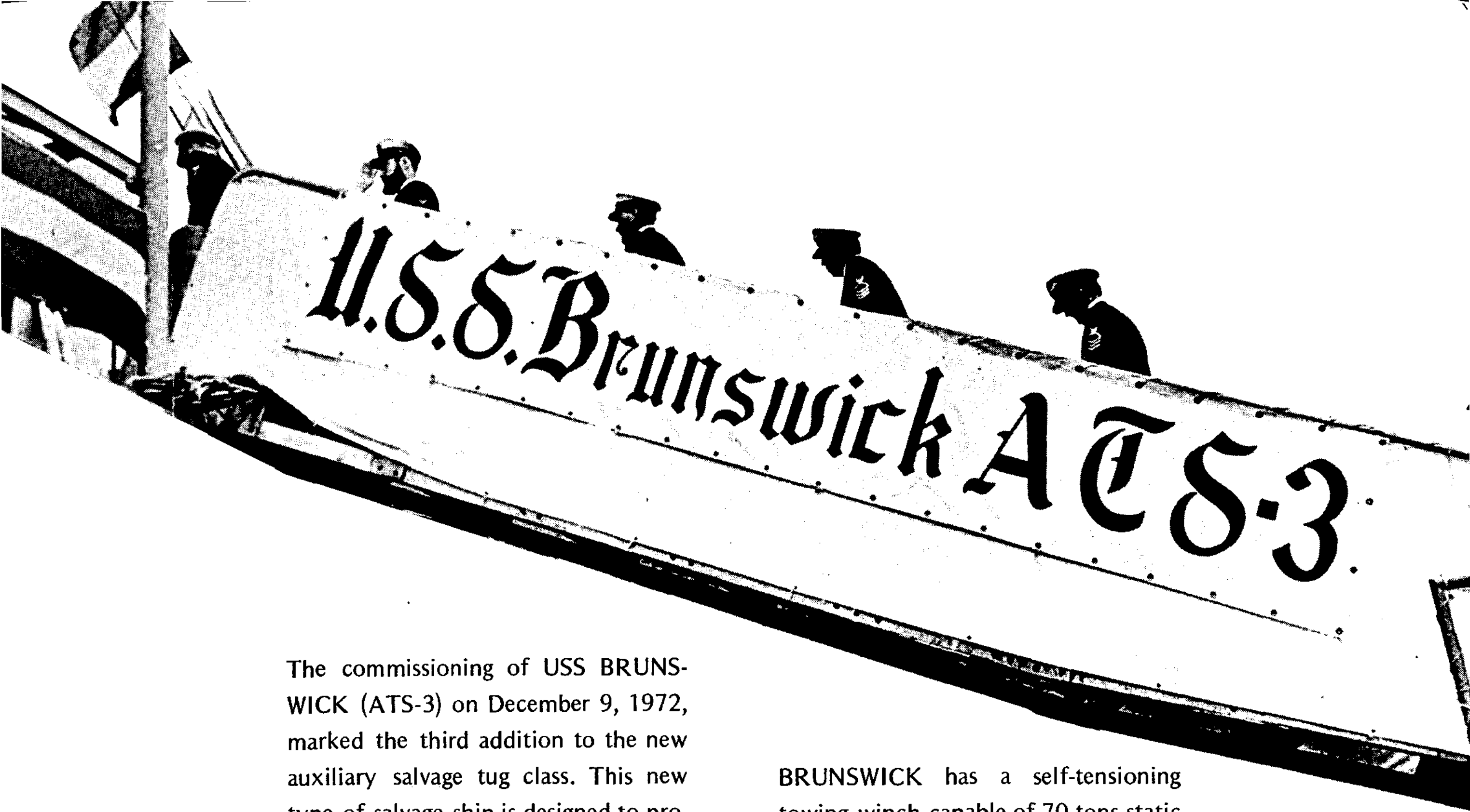
- The thumb screw requires approximately 1/2 turn by the THUMB to sufficiently loosen or tighten the torch jaws when changing the electrode. Excessive tightening of the thumb screw is not required.

- The contact area of the electrode should be free of corrosion in order to obtain a proper fit between the rod and the torch jaws and to insure good electrical contact.

Users comments on the torch would be appreciated. Mail c/o *FP* address.



Proper position of wrist loop of "Sea Cutter"



The commissioning of USS BRUNSWICK (ATS-3) on December 9, 1972, marked the third addition to the new auxiliary salvage tug class. This new type of salvage ship is designed to provide the Navy with the most advanced and comprehensive capabilities for sophisticated ship salvage, extensive diving, and emergency repairs. Rescue and firefighting assistance and long distance towing services are also greatly enhanced by these new vessels.

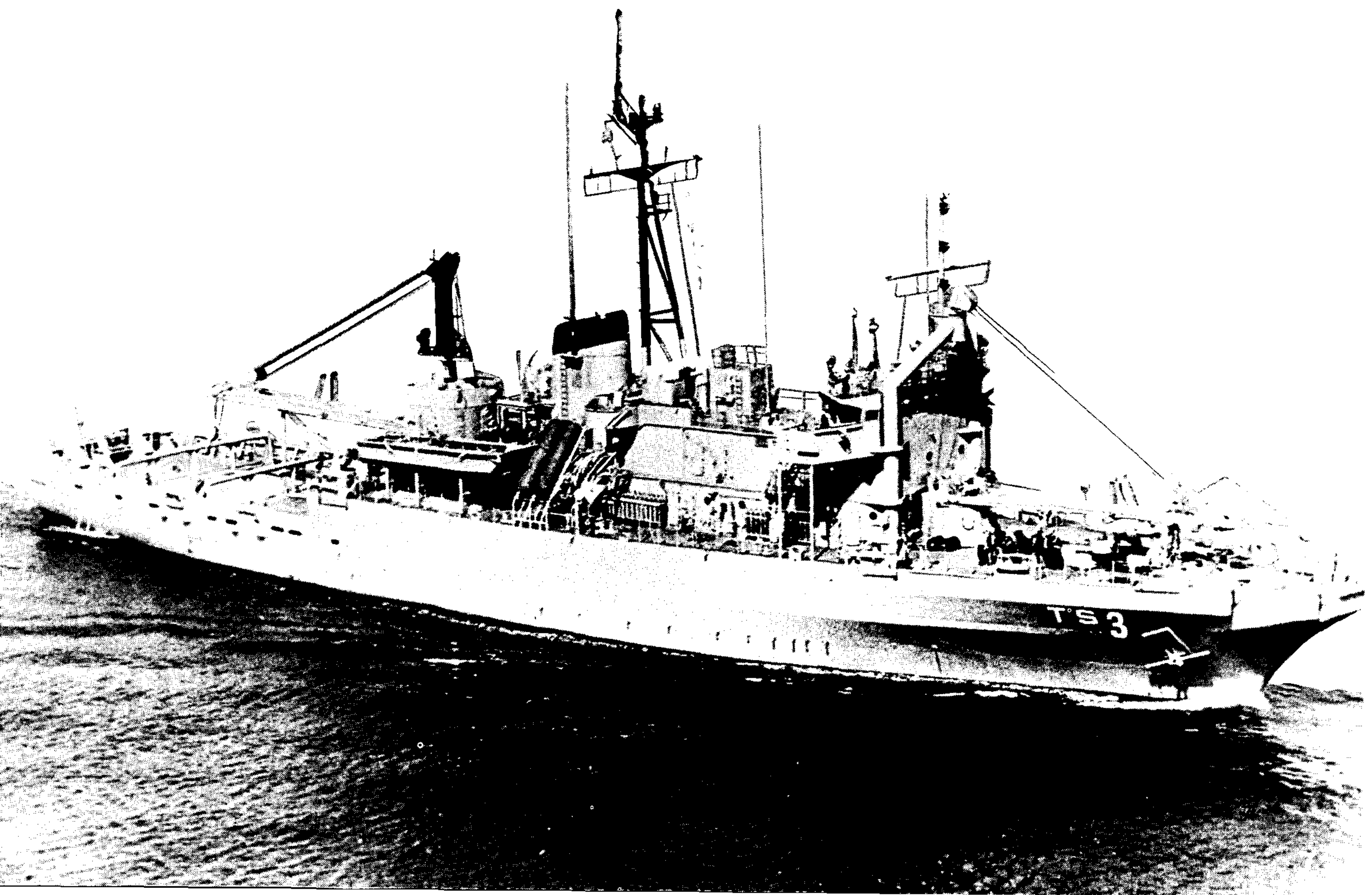
Most of BRUNSWICK's propulsion, auxiliary, and deck machinery are of British manufacture—larger, more powerful, and more sophisticated than any presently found on commissioned U.S. Navy salvage vessels. The keel was laid at Brooke Marine, Ltd, Lowestoft, England on June 5,1968; the hull was launched October 14, 1969. Twin propellers, twin rudders and a bow thruster unit enable USS BRUNSWICK to attain greater maneuverability at the low speeds required by most salvage operations. Also, her propellers are of controllable pitch design, allowing her to adjust speed or power as required by a particular situation.

BRUNSWICK has a self-tensioning towing winch capable of 70 tons static pull and two large hydraulic deck cranes with 10 and 20 tons lifting capacities, respectively, to handle salvage and beach gear stowed in the large storerooms. Her towing stern rollers are hydraulically raised and lowered, allowing them to be stowed out of the way when not in use. Bow rollers provide heavy lift capabilities required in many salvage operations, her auxiliary providing 60 tons of dynamic lift while her main bow rollers can lift 150 tons dynamically, or 300 tons by using the tide. BRUNSWICK has the latest and most advanced facilities for communication and navigation, and also has underwater search capabilities.

The ship itself is 282 feet long and has a beam of 50 feet. Its displacement, fully loaded, is 3,450 tons. The complement of BRUNSWICK includes nine officers and 93 enlisted men, with an average age of 23 years and with experience ranging from several months to 24 years. She is named after two American cities - Brunswick, Georgia, located on St. Simons Sound, southwest of Savannah; and Brunswick, Maine, located at the falls of the Androscoggin River, northeast of Portland.

The first commanding officer of USS BRUNSWICK is LCDR John B. Haskins, USN, who is reporting from duties as Head, Recall and Release and TAD Orders Section in the Bureau of Naval Personnel, Washington, D.C. His career includes serving as Operations and Engineer Officer, USS VIGOR (MSO-473); Main Propulsion Assistant, USS HAMMERBERG (DE-1015); Engineer and Operations Officer, USS S.N. MOORE (DD-747); CG-23 Advisor, Song Cau, Vietnam; Commanding Officer, USS PATAPSCO (AOG-1) and USS TOMBIGBEE (AOG-11). LCDR Haskins was graduated in June 1965 from the Naval Destroyer School, and in June 1969 from the Naval Postgraduate School, with an MS Degree in Management.

After an outfitting period at the Norfolk Naval Shipyard, BRUNSWICK will be attached to COMSERVRON-FIVE and homeport in Pearl Harbor, Hawaii. Her ability to provide the fleet with better support from a single ship in a shorter period of time will enhance fleet mobility by increasing its endurance in a combat zone and reducing the time of exposure to enemy attack during salvage, diving, and towing operations. Also, she will be particularly well suited to humanitarian rescue and assistance tasks. Whether towing disabled ships, salvaging grounded vessels loaded with valuable cargo, or performing a wide variety of other rescue and salvage tasks, BRUNSWICK will be a powerful and versatile addition to the U.S. Navy fleet.



NEW LIFE JACKETS TESTED

Thomas Cetta *Office of the Supervisor of Diving*

Four commercially available life jackets and three U.S. Navy life jackets were recently field tested to determine field condition buoyancy capability. Prior to this test each commercial vest had at least one endorsement from one or more Navy diving activities. The following commercial life jackets are recommended as interim replacements for the standard UDT life jacket: (1) Rubber Fabricator Inc – Supervest; (2) Rubber Fabricator Inc – 110669; (3) Buoee 70 or Fenzy M-3; (4) Nemrod Scuba Vest.

The method of testing was simple and straightforward. A padeye was fastened to the bottom of a 142-foot rock quarry now completely flooded. Using 1-inch nylon line and a Welch 100-pound spring scale, each jacket was inflated at 130 feet and then brought to the surface in steps, using the self-contained CO_2 or air of the jacket. A total of 11 buoyancy measurements were taken for the U.S.N. Mark III, Buoee 70, and Nemrod jackets. A total of seven buoyancy measurements were taken for the UDT, UDT MOD 1, Supervest and RFI 110669. The data collected is shown in tabular form below. All of the jackets tested, except the standard UDT, provided enough buoyancy at 130 feet to be considered acceptable as emergency buoyancy devices.

The recorded data was compared to a mathematical model for each vest under the test conditions, and was found to be within 10 percent of the mathematical model values. Except for the standard UDT jacket, each jacket has expansion valves with the relief pressure set by the manufacturer. There are four variables that effect the buoyancy that is provided. These variables are water temperature, salinity of water, CO_2 or air supply quantity, and exhaust valve setting. The aforementioned tests were performed in very cool, fresh water, with lower limit CO_2 and air supplies and factory exhaust valve settings. Environments that would produce lower buoyancy exist, but assuming that 32°F, fresh water is the most severe, approximately 2 per cent decrease of buoyancy would be realized with the CO_2 inflated jackets and less with the air inflated jackets.

For additional information concerning the test described, contact Mr. T. Cetta of the Office of the Supervisor of Diving.

	BUOYANCY IN POUNDS										
DEPTH / VEST	SURFACE	10	20	30	40	50	60	70	80	90	130
STD. UDT	25	19	16	10	na	na	6	na	na	5	4
UDT MOD 1	25	25	25	25	na	na	25	na	na	18	13
SUPERVEST	30	30	30	25	na	na	19	na	na	14	11
R.F.I. 110669	25	→	→	25	na	na	19	na	na	14	11
USN Mark III	33	→	→	→	→	→	→	→	→	35	36
BUOEE' 70	33	→	→	→	→	→	→	33	31	29	21
NEMROD	36	→	→	→	→	→	→	36	34	32	22

Editor's Note: Several issues ago *FP* presented a listing of billet locations and the types of duty available.An updated version appears here to assist you in filling out your NAVPERS 1306/34-E7/E8/E9 Duty History and Preference Card. This is not a list of vacant or open billets!

TYPE DUTY BY NEC

GEOGRAPHIC LOCATION	5346	5341	5342	5311	5343
Philadelphia, PA			1		1
Newport, RI		1	1,2,5		2,5
Portsmouth, VA			1		1
Norfolk, VA		1,2	1,2		1,2
Panama City, FL		1	1		1
Key West, FL		1,2	1,2		1,2
Orange, TX					1
San Diego, CA	1,5	1,2,5	1,2	1,5	1,2
Long Beach, CA		1	1,2		2
Port Hueneme, CA			1,2		1,2
Point Mugu, CA					1
San Francisco, CA			1		1
Vallejo, CA	2		1	2	1
Bremerton, WA		2	1,2		1,2
Keyport, WA		5	1,5		1,5
Annapolis, MD					1
Indian Head, MD		1	1		
Washington, DC	1	1	1	1	
Solomons, MD		1	1		1
Quantico, VA					1
Pensacola, FL			1		1
Davisville, RI			2		2
Vietnam			3		

	5346	5341	5342	5311	5343
Guantanamo Bay, Cuba			3		3
New London, CT		1,2	1,2		1,2
Quonset Point, RI			1		1
Mayport, FL		2	2		2
Little Creek, VA	2	1,2	2,5	2	2,5
Charleston, SC		2	2		2
Groton, CT		2	2		2
Gulfport, MS			2		2
Pearl Harbor, HI	2	2,6	2,6	2	2,6
Guam, MI		4	3,4		3,4
Subic Bay, PI		3	3		3
Adak, AK			3		3
Mare Island, CA	2	2	2	2	1,2
Coronado, CA			2		2
Naples, Italy			4		4
Holy Loch, Scotland		4	4		4
Rota, Spain		4	4		4
Roosevelt Roads, PR			6		6
Portsmouth, England				6	
Yokosuka, Japan			6		
Sasebo, Japan			6		
Turkey			3		
Australia			6		

EXPLANATION OF DUTY TYPES

Type 1 — Shore duty for rotation purposes. Includes CONUS shore duty, fleet shore duty and certain fleet activities considered as shore duty.

Type 2 — Sea duty for rotation purposes. Includes ships or units which spend considerable periods at sea away from their homeport during local operations and which, when deployed overseas, operate at sea extensively.

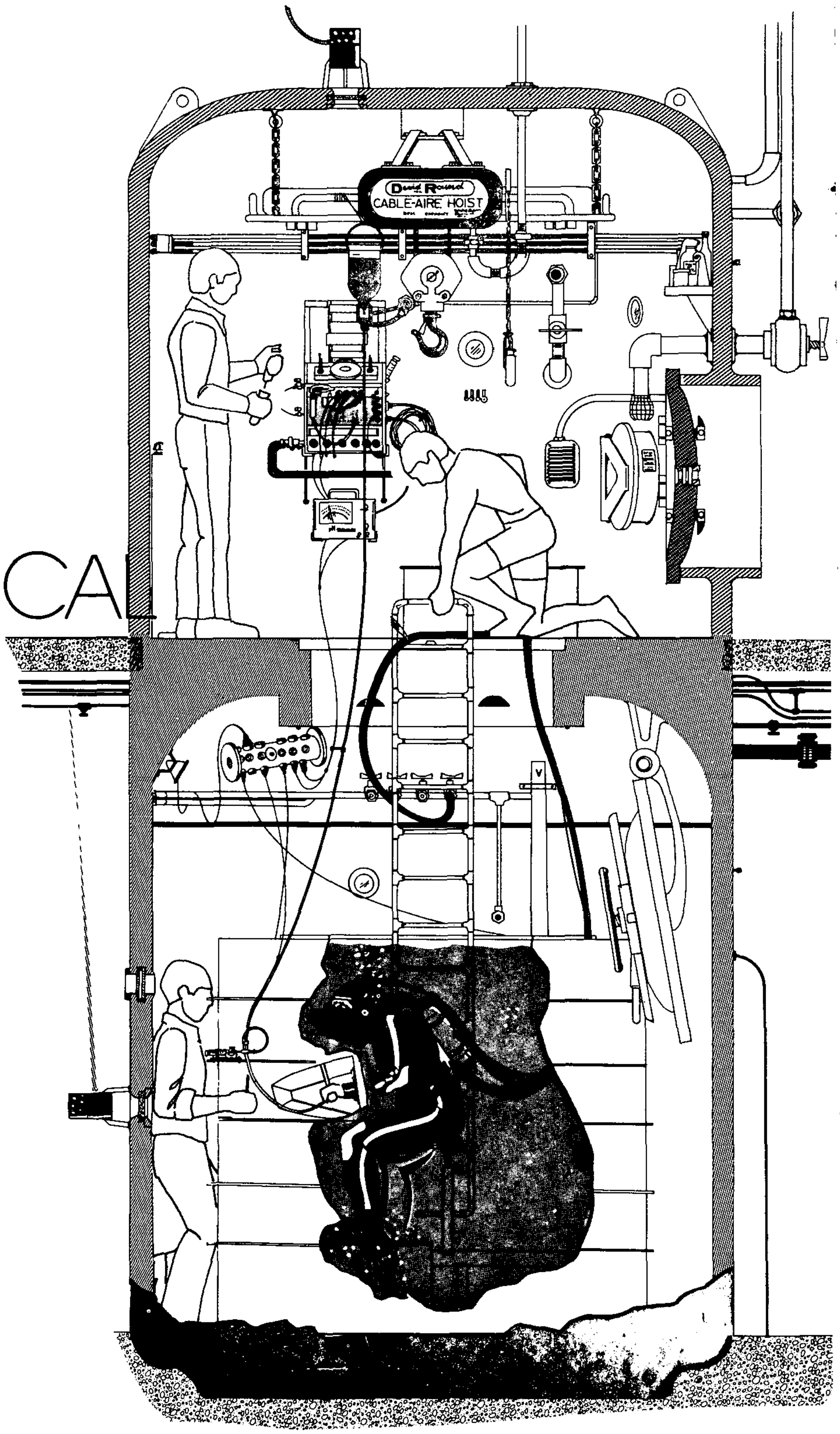
Type 3 — Overseas shore duty (sea duty for rotation purposes) is defined as duty performed ashore at activities outside CONUS where the prescribed DOD accompanied tours are less than 36 months.

Type 4 — Nonrotated sea duty (sea duty for rotation purposes) is defined as sea duty performed in nonrotated ships, staffs, or units home-ported outside CONUS (except Alaska and Hawaii), or in 12 month unaccompanied tour ships or staffs listed in OPNAVINST 4600.16.

Type 5 — Neutral duty (neutral time for rotation purposes) is defined as duty in ships, squadrons and staffs which normally remain in the assigned home port, or operate locally therefrom only for brief periods.

Type 6 — Preferred Overseas Shore Duty (shore duty for rotation purposes) is defined as duty at shore-based overseas activities where there are available suitable family accommodations and the prescribed Department of Defense accompanied tours are 36 to 48 months in recognition of the desirability of this duty.

Artist's conception of testing underway in "wet-pot" of biomedical hyberbaric chamber complex. The diver is sitting on an underwater pedal ergometer with one arm extended through a watertight sleeve in the tank wall.



PHYSIOLOGICAL TESTING PROGRAM AT NEDU

Successful diving at great depths requires that a diver be able to do useful work and still maintain sufficient physiological reserve to deal with emergencies. In order to plan and carry out satisfactory open-sea deep diving operations, it is necessary to know the limits to human function posed by the environmental stress encountered and the stress imposed by the underwater breathing apparatus. If an operational program unknowingly pushes divers into situations where the physiological stresses approach the limits, death or severe injury to the divers can be expected.

Historically, the method of establishing that a given environment was safe was to expose a few experimental subjects to that environment and see if they could survive. The ability of a diver to function was assessed by some gross tests such as swimming ability or ability to solve simple construction problems. These methods have generally been useful. In past experiments divers were easily rescued from the hostile environment when the limits of function (or physiology) were exceeded and permanent injury was unusual. Now, however, the decompression requirements of saturation divers at great depths make it impossible to quickly remove a diver from the hostile environment should he begin to fail physiologically. Therefore, a better method of establishing the biomedical safety of a given hyperbaric exposure is needed.

The medical staff at the Experimental Diving Unit, Washington, D.C., headed by CDR William H. Spaur, has undertaken the development of a systematic program of biomedical research and underwater breathing apparatus evaluation designed to establish the limits of safety for each system. The program is composed of a series of studies of well defined and progressively more stressful undersea environments. The basic assumption behind the program is that data from measurements of a physiological function at a series of increasing depths can be used to predict what that function would be at even greater depths. This method should make it possible to safely determine the maximum diving stresses that can be tolerated by working divers using state-of-the-art diving equipment.

An original approach to the problem, this program differs from basic biomedical research in that it is designed to produce information applicable to the realistic requirements of working dives. For this reason the hyperbaric stresses studied consist of actual work under water with currently available breathing apparatus. These studies can be considered physiological equipment testing rather than simply studies of basic physiology. Physiological equipment testing should provide the most useful information of any method of evaluation of diving apparatus for use by man. It will also provide valuable insight into those parameters which must be improved in the design of future underwater breathing apparatus.

In a normal experiment of this program, the diver, dressed in full diving gear, is completely immersed in water in a specially constructed fiberglass tank. He sits upright on an underwater pedal ergometer and has one arm protruding through a watertight sleeve in the wall of the tank, exposing his wrist to the dry chamber. As the diver pedals against various resistive loads, arterial blood gases and direct blood pressures are sampled in the dry from a radial artery cannula in the exposed wrist. Also, breathing apparatus pressures, and O_2, CO_2, and Ph levels are measured. This underwater exercise system has been installed in the "wet-pot" of the biomedical hyperbaric chamber complex at EDU where these studies under pressure are being conducted.

Evaluation studies of the Navy's new prototype hard-hat diving system (MK XII) (see *FP* Fall, 1972) were the first to be conducted, from October, 1972 to January, 1973. Preliminary analysis of the data indicates that the MK XII system functions adequately to support the divers' ventilatory requirements at sea level on air and HeO_2. The system is generally adequate for air at 100 feet— deeper depths on HeO_2. However, in some circumstances as, for example, in the case of a diver with a short neck whose mouth falls below the normal ventilatory gas stream of the helmet into the neck of the suit, definite CO_2 retention occurs at moderate and heavy work loads.

Future experimentation will include the MK X Mod 4 UBA to be tested to a depth of 1000 feet at EDU, and subsequently tested to a depth of 1600 feet at Taylor Diving and Salvage Company, New Orleans. It is also intended that *all* currently used underwater breathing apparatus will eventually be evaluated. Concurrent studies on-going at EDU related to the same area include tremor studies, pulmonary mechanics, hearing, performance, and the study of vestibular and cerebellar functions.

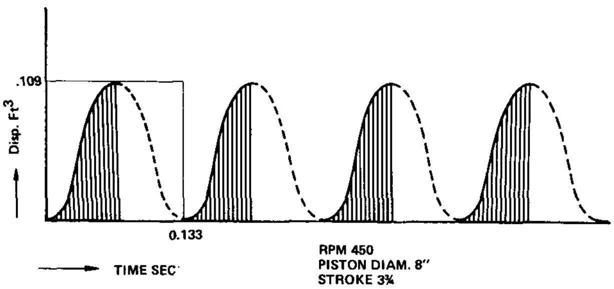
The primary limiting system in diving is the underwater breathing apparatus, and it is the only system that has the potential for significant functional improvement. Most physiological investigations, while valuable in their own right, ultimately become useful when they provide information needed for proper design of underwater diving systems. The medical staff at the Experimental Diving Unit is going one step further and using the tools of physiology to evaluate the functional state of the diver-underwater breathing apparatus during controlled and graduated underwater stresses. They can thereby determine the adequacy and safety of diving systems before any diver is endangered. By using this system of physiological testing during the initial evaluations of a newly designed apparatus, information on the adequacy of this system is provided as is valuable feedback into the design process itself.

Richard Hansen
Office of the Supervisor of Salvage

Articles appearing in the summer and fall 1972 issues of *FP* presented some recently published criteria relating the pressure and flow rate (SCFM) required to support ventilated diving systems. Included was a discussion of some of the characteristics of positive displacement reciprocating type compressors as applied to diving systems. This concluding article on air compressors will be directed toward the installation, operation and maintenance of compressors used in diving systems. The topics addressed here include pertinent results from field inspection and evaluation of existing diving systems, or from on-going experimental or analytical programs performed to improve current diving systems.

Attention should be given to the compressor intake, since it has been observed in system performance contributing to the reduction of approximately 30 percent in capacity of an installed system. The loss in capacity was the result of inadequate design of the ducting and the limited intake filter area. Since the flow into the intake of a compressor is both cyclic and intermittent, reasonable pressure loss can be obtained which should be at or below 3–1/2 inches of H_2O. The change in the intake volume of a typical 50 CFM compressor is shown in figure below. The 50 CFM enters during the first 30 seconds, and the air is compressed in the second 30 seconds.

Also important is the change in volume or flow rate, which occurs during the stroke and which is related to the ratio of the length of stroke (L) and the radius of the crankshaft throw (r). Assuming (r) is infinite, a sinisoidal rate of change in the volume can be computed, and will provide a maximum instantaneous flow rate equivalent to 3.14 X CFM or π X CFM. Using this flow to design the inlet filter-ducting to the air compressor should eliminate the potential loss in capacity.



If the rated pressure and capacity of the selected compressor is adequate to support the projected diving missions, the next item that should be investigated is the size of the receiver. This can be done by determining the optimum on-off time desired and the peak demand anticipated in the system. Relating quantity of air in and the quantity out, relative to that existing between the upper and lower pressure switch limits, will provide the "on" time. "Off" time can be obtained by dividing the quantity existing between the upper and lower limit by the flow requirement. In the following example, it is assumed that the upper limit is 200 psig, the lower limit is 150 psig, and the use rate is 25 SCFM from an air receiver supplied by a 50 SCFM compressor. It is essential that the electric motor not be started more than 6 times per hour. *SCF available in the receiver between 150–200 psig is:* $\frac{214.7}{14.7} - \frac{164.7}{14.7} = 3.4\ \text{SCF/Ft}^3$.

Difference between supply and use is 50–25 = 25 SCFM *and the minimum off-on cycle is* 60/min./6 cycles = 10 *minutes, so the volume must be recharged in 5 minutes. The compressor will charge the receiver in 5 minutes and the following 5 minutes the pressure will decay 200 psig to 150 psig. Total flow in or out is* 25 SCFM x 5 min = 125 SCF; *therefore, the receiver volume must be* 125/3.4 = 36.76 ft^3. Other conditions can be similarly analyzed to provide appropriate receiver capacity.

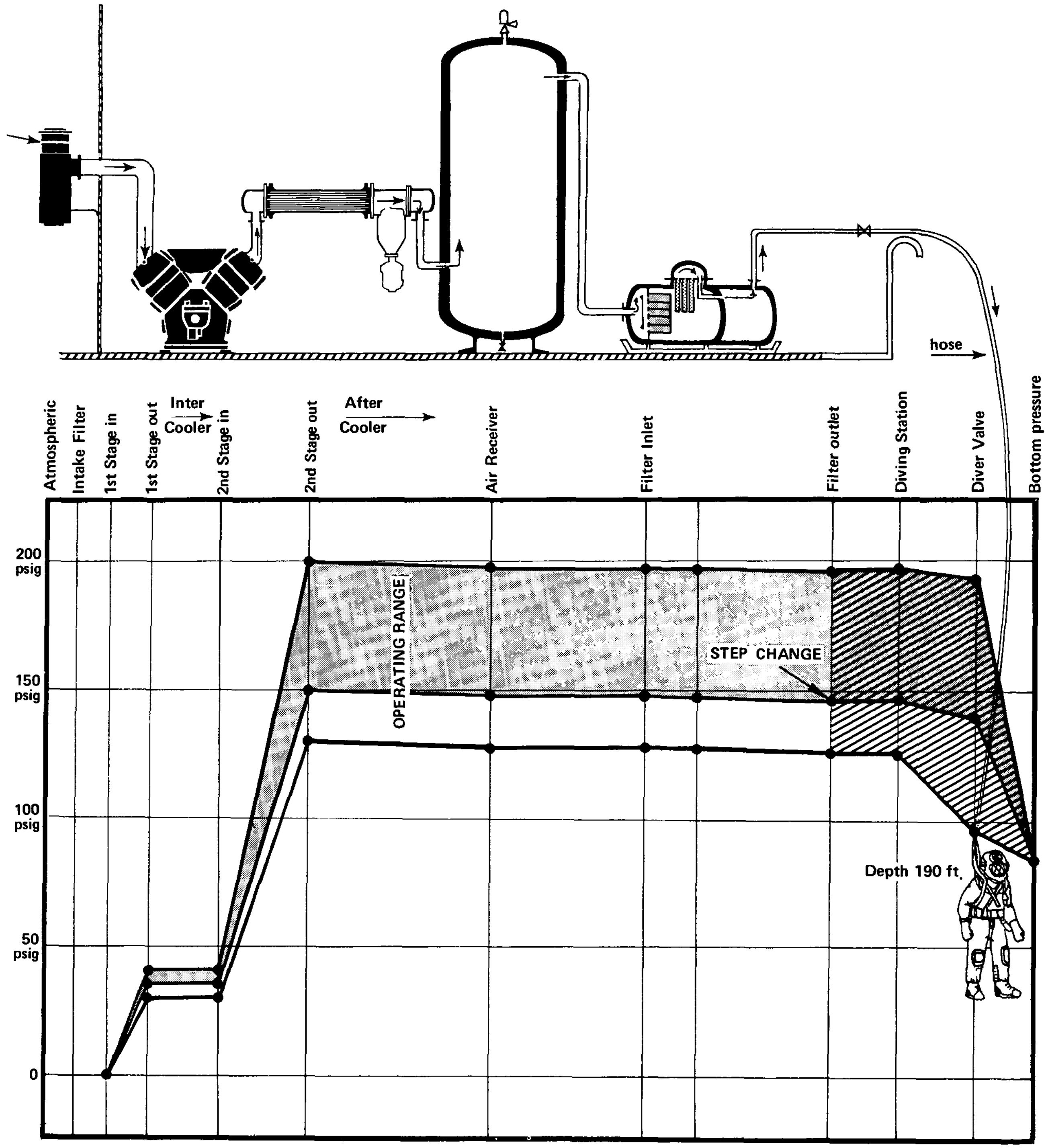
The installation of an adequate filtration unit is essential. It must be capable of eliminating the oil mists that exist in air compressed by lubricated compressors. The aerosol particle sizes range from 0.1 micron to 10 microns in diameter, necessitating staged filtration which includes settling, impaction, absorption and surface collection. The filtration system must also have a capacity capable of collecting up to 120 mg/M^3 (inlet concentration) for an operating period of 200 hours.

After installation, the system should be verified at the lower and upper pressure limits to ensure that the required flow rate and pressure can be maintained at the diver station. Any inadequacies, such as the intake filter and ducting, can only be observed during flow-pressure testing after installation. Operation of the system can be enhanced if pressure is maintained within the system at or above the lower pressure switch setting. This will prevent migration of unwanted condensate or oil water emulsions into the diving system hose or apparatus.

A pressure profile of a system is shown in figure below, indicating an operating range between 150 and 200 psig and the minimum permissible pressure profile for supplying ventilation to a diver at 190 feet.

A control of the pressure in the system through the introduction of a back pressure control valve to effect a step change will reduce the potential condensation in the diver's hose or will, at least, significantly reduce it.

It must be recognized that water vapor enters the compressor with the intake air and as the air is compressed and cooled the vapor condenses. Approximately 13–1/2 gallons of water enter a 50 SCFM



CAUSES ↓ / PROBLEMS →	Insufficient diver ventilation	Inadequate Over-bottom pressure	Cannot maintain treatment chamber pressure rate	1st stage compressor outlet pressure too low	1st stage compressor outlet pressure too high	2nd stage outlet pressure too low	2nd stage outlet pressure too high	Air discharge temperature above normal	Crankcase water accumulation	Piston, Piston ring, cylinder wear excessive	Valve wear or breakage abnormal	Compressor noisy or knocks	Compressor overheats	Starts too often	Operating cycle abnormally long	Receiver safety valve pops	Moisture condenses in diving apparatus	Excessive lube oil in diving apparatus	Motor overheats
Compressor capacity inadequate	●	●	●	●		●				●				●	●		●	●	
System demand exceeds capacity	●	●	●	●										●	●		●	●	●
Discharge pressure above rating					●		●	●				●	●			●			●
System leakage excessive	●	●	●			●			●			●	●		●		●		●
Intake filter clogged or too small	●	●	●					●				●							●
Intake ducting too small, too long		●	●					●				●							●
Rated pressure inadequate	●	●		●		●								●					
Valve worn or broken	●	●	●	● L	● H	● L		●					●						●
Valve improperly seated or located	●	●	●	● L	● H	● L		●					●						●
Gaskets leak	●	●	●	● L	● H	● L		●					●						●
Unload or control defective	●	●	●	● L	● H	● L	●	●			●		●			●			●
Control System ΔP too great	●	●		●									●						
Control System ΔP too small		●												●					●
Cylinder (piston) worn or scored	●		●	●	●	●		●	●	●			●						●
Valves dirty				●	●	●		●			●		●						
Worn valve on good seat											●								
New Valve on worn seat											●								
Discharge check valve defective					●	●	●	●											
Intercooler air passages clogged																			
Cylinder, head, intercooler vanes dirty								●											
Air flow to cooling fan blocked	●							●											
Oil level too high								●											
Oil level too low								●		●									
Lubrication inadequate										●	●		●						●
Oil viscosity incorrect										●	●		●						●
Oil feed excessive																			
Infrequent drainage of condensate traps									●									●	
"Off" time insufficient								●											
Demand too steady		●																	
Safety valve defective	●															●			
Safety valve set too low	●	●														●			
Belts too tight					●								●						
Air filter defective										●	●								
Speed too high								●											●
Speed lower than rating	●		●																
Excessive number of starts																			
Piston ring gaps not staggered				●		●												●	
Receiver too small																			
Infrequent drainage of receiver																		●	
Runs too little									●										
Ambient temperature too high								●											●
Resonant pulsation (inlet or discharge)											●								
Liquid carry-over									●	●	●							●	

H (in high pressure cylinder)
L (in low pressure cylinder)

compressor during 24 hours of operation when the dew point is 80°F. It is condensed within a two stage system operating at 200 psig and 150 psig as follows:

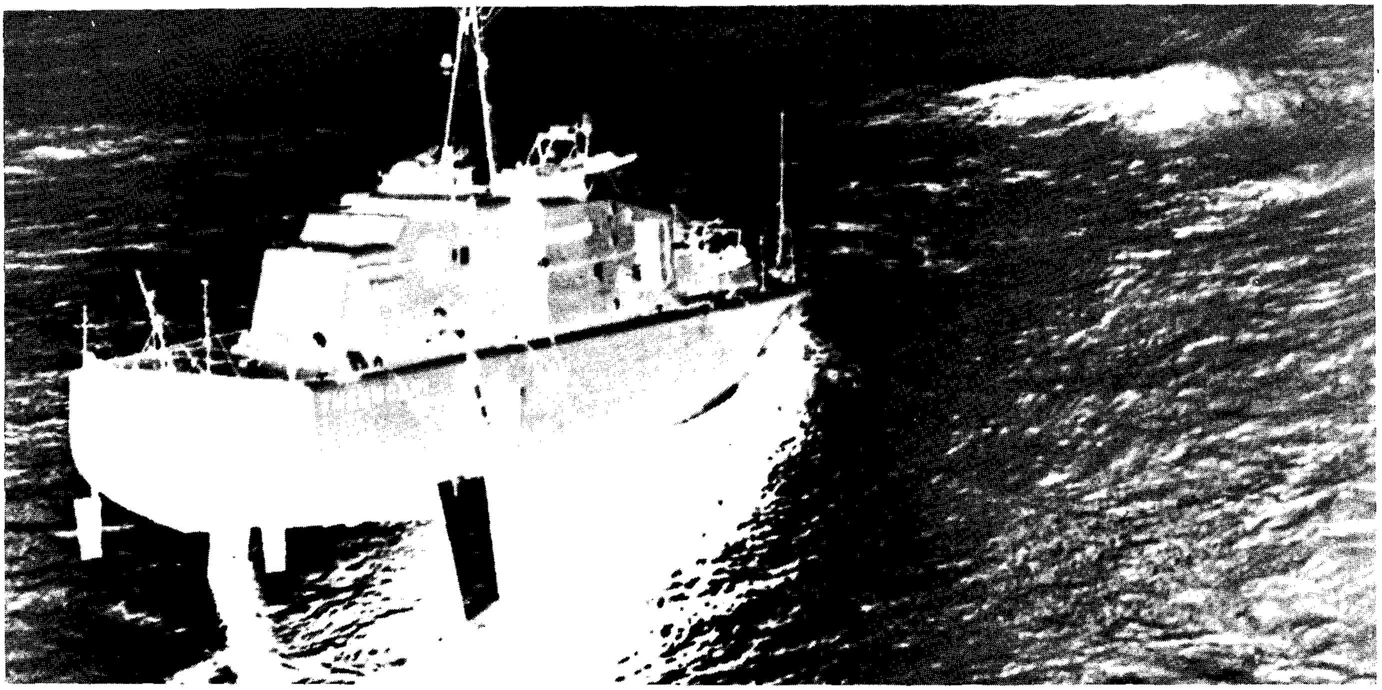
	200 psig	150 psig
Entering compressor	13.66 gallons	13.66 gallons
Intercooler condensation	10.19 gallons	9.59 gallons
Aftercooler condensation	2.44 gallons	2.85 gallons
Remaining in compressor air	1.03 gallons	1.22 gallons

This is based on a compressor with a balanced compression ratio and one with the intercooler and after cooler returning the compressed air to 80°F. It is apparent that the lower operating pressure permits migration of more vapor into the succeeding stages or system components.

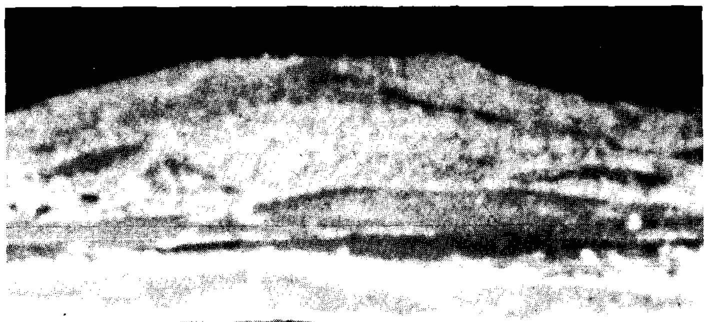
It should also be noted that the interstage pressures vary, relative to the operating pressure. Determining this pressure relative to the outlet pressure will provide an operational base that is essential in verifying the performance of the compressor. It can also be used to pin-point potential problems if operational logs are maintained. Deviation from the operational norm in pressure in a compressor stage is indicative of such things as valve wear, breakage or piston ring wear.

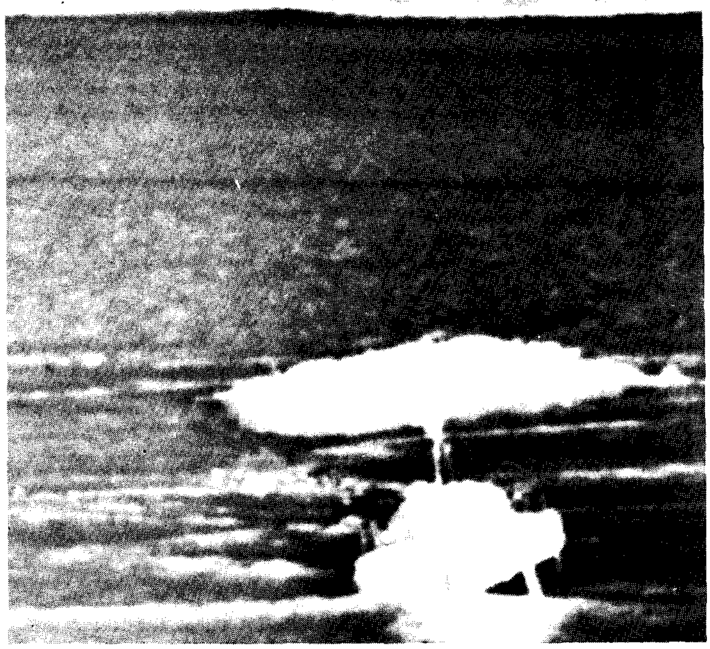
Routine maintenance during compressor operation should include careful elimination of the condensate, carried out every 2 to 4 hours of operation through slightly opened needle valves. A quarter turn or less will allow the liquid to drain. This is extremely important for compressors used in breathing air systems, because many of the lubricating materials carried in the air emulsify with the condensate providing a vehicle to carry them out of the system. The interstage pressure outlet pressure together with the air and cooling water temperatures should be recorded periodically, so that variances from the norm are observed. If changes in these temperatures or pressure are evident, then the problem may be associated with the cause using the Problem--Cause Matrix provided in figure at left.

This series of articles has addressed at least some of the considerations accompanying the selection, operation, and maintenance of air compressors. By discussing observed problems, it is hoped that they may be avoided in the future.



TUCUMCARI

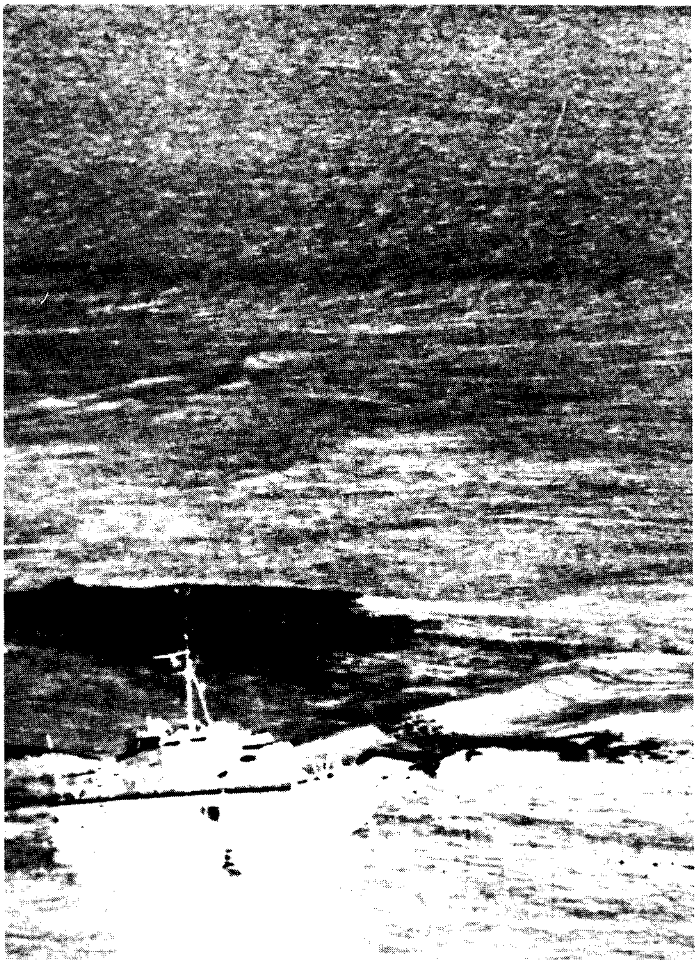




While performing night operations on November 16, 1972, TUCUMCARI (PGH-2) collided with and was stranded on Caballo Blanco Reef about 2 miles north of Vieques Island, off the coast of Puerto Rico and near the Naval Air Station, Roosevelt Roads. At 0100 hours, the ship struck the coral reef while foilborne at a speed of 45 knots and eventually came to rest in approximately 3 feet of water. SUPSALV and SERVRON 8 salvage officers immediately proceeded to the scene with a salvage team from HCU-2 to survey damage and get the salvage operations underway.

The collision with the reef had rotated the forward foil and strut into the hull, causing the bow to drop and impact with the coral. Both the starboard and the port main struts remained intact and thus prevented the after portion of the hull from coming in contact with the reef. The starboard main foil remained attached to its strut while the port foil was dislodged.

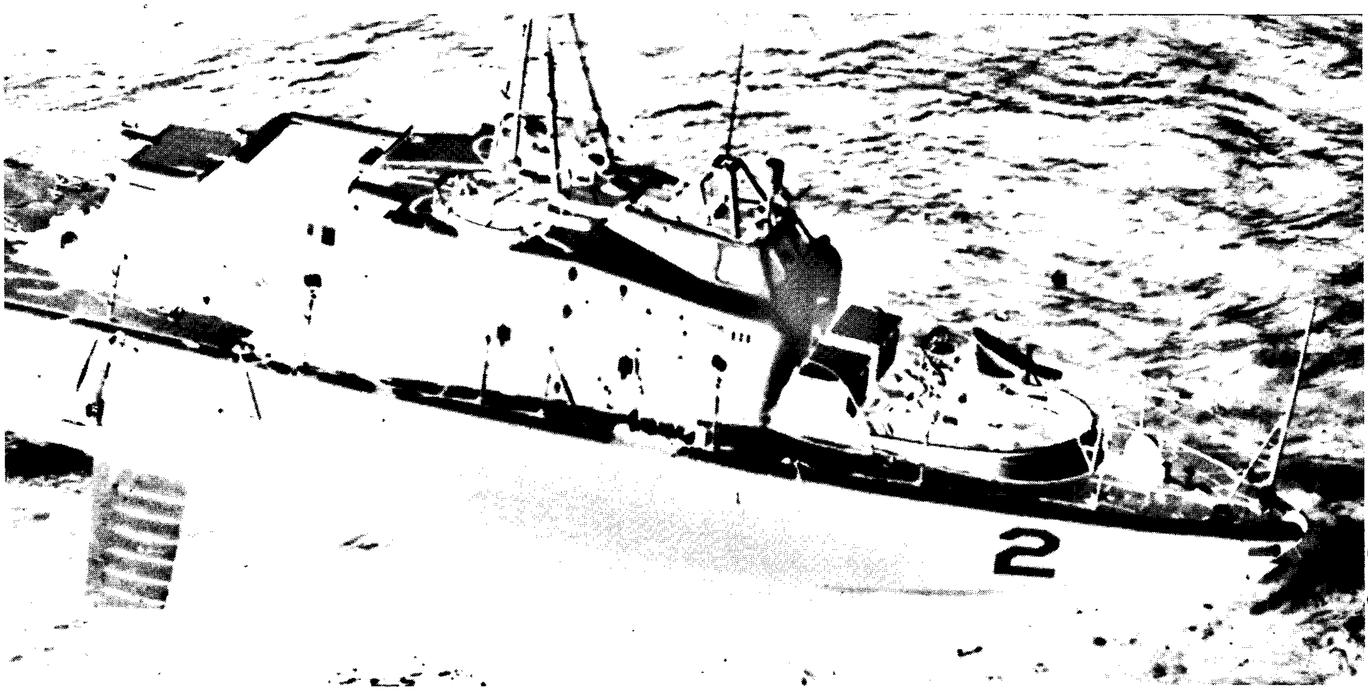
Further damage included a severely torn and punctured lower forward portion of the ship, back to Frame 7 1/2 and up to the 4-foot water-



line. Also, the bow thruster, strut downlock foundation, pin, and actuator were demolished and were pushed up through the platform deck. Additional damages were extensive and were later assessed as having been created by several possible causes—by initial stranding, during recovery operations, service induced prior to stranding, or a combination of these.

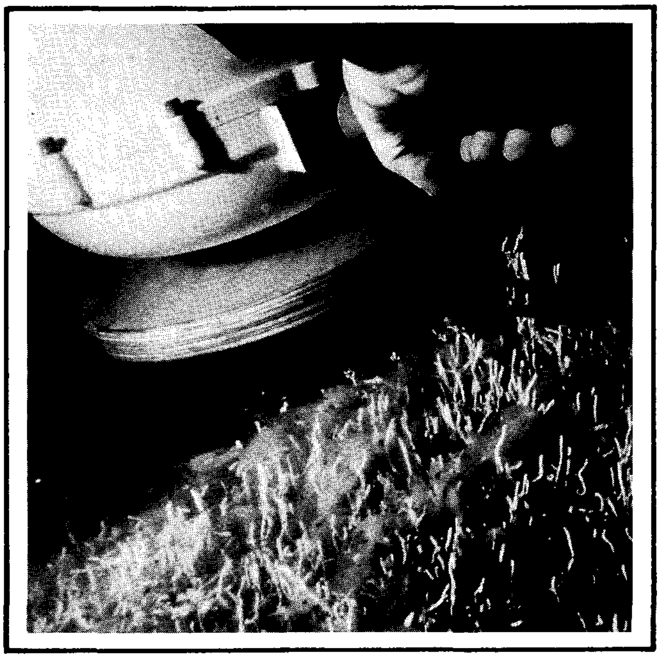
During subsequent recovery operations, the starboard foil became detached when the craft was pulled backward off the reef by means of lines attached to the aft struts. An attempt was made to ease the port strut over the coral with a CH-53 helicopter; however, this plan failed when the after port lifting lug sheared and caused the ship to roll momentarily onto its starboard side.

The contractor salvage ship RESCUE proceeded to the scene and laid two legs of beach gear and rigged them to TUCUMCARI's after struts. This procedure proved effective and the vessel was successfully dragged and floated off the reef on November 21, 1972, and towed to the Naval Station Roosevelt Roads. At that point the ship was loaded aboard USS FORT SNELLING (LSD 30) in order for it to be transported to the Naval Amphibious Base at Little Creek, Virginia, for repairs.



UNDERWATER SONAR DOME CLEANING

Maintenance of SQS-26 Sonar Domes is a new and important task for repair ship and tender divers. Because NAVSEC has found that a thorough and periodic cleaning of these HY-80 domes helps to keep sonar operations at peak efficiency, more than a dozen pneumatic and hydraulic brushing systems are already spotted on destroyer tenders on both coasts.



The Naval Civil Engineering Laboratory, Port Hueneme, California, is supporting the Supervisor of Diving by evaluating existing dome cleaning systems and modifying them to give better performance.

The evaluations include examining the hardware components for safety and reliability, as well as conducting field trials involving light and heavy sea growth. Modifications have included replacement of various components to obtain smoother operation and higher reliability, and new brush designs of better handling and cutting performance.

The basic dome cleaning package consists of a power source (diesel, gasoline, or electricity); an air compressor or hydraulic pump; flexible air or hydraulic hoses; an air or hydraulic motor in a watertight housing; and the brush head. Both pneumatic and hydraulic units have been evaluated at NCEL. Both types were found to be satisfactory for dome cleaning, but each with disadvantages.

For pneumatic units, the ready availability of 100-125 psi compressed air aboard ships makes pneumatic tools attractive. The brushes evaluated at NCEL drew approximately 55 cfm at 125 psi with a diesel engine running the compressor. Maintenance of the brush motor was reduced to a simple fresh water rinse by taking certain precautions. The underwater motor housing was sealed against salt water intrusion by means of an "O" ring. The exhaust air was led topside to prevent salt water from entering the exhaust port and to make the tool more comfortable for the diver. A moisture separator and an air line lubricator were inserted in the high pressure hose to keep the motor as water free as possible. Before shutting down when brushing was completed, the lubricator setting was increased from 50 to 60 drops per minute to a constant stream. Thus, when oil became visible in the exhaust air, adequate oil was in the motor for storage.

Since van-type motors normally run at a very high speed, a gear reduction is used between the motor and the output shaft. The watertight housing encloses the van motor, the gear box, and the on-off valve.

Hydraulic power is extremely attractive if 125 psi air is not readily available. It offers additional advantages in situations where mobility is a major consideration.

The power unit evaluated at NCEL weighs 205 pounds and is mounted on wheels. It consists of an 8 HP gasoline engine coupled directly to a hydraulic pump which is immersed in the hydraulic oil reservoir. The hydraulic oil is sent through the flexible hose to an underwater brush. The brush unit consists of a watertight housing enclosing an on-off valve and a hydraulic motor. No gear box is necessary since the pump and motor are chosen for direct control of brush speed. Since the gear motor in the underwater housing circulates oil, lubrication and salt

John Mittleman
Naval Civil Engineering Laboratory

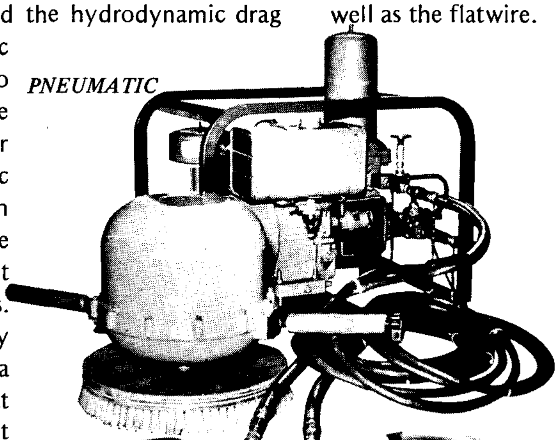
water intrusion are not major problems. Maintenance is minimal. Hydraulic brushes generally run at about 1000 psi and 4-8 gpm.

Several varieties of brushes have been evaluated by NCEL. The best measure of a brush's value is how well it removes growth from a hull or dome. Additional factors which were considered include the degree of suction between brush and hull, the smoothness of the ride for the diver, the lifetime of the brushes, and the hydrodynamic drag created by the brush. Synthetic bristles are applicable only to very light growth, such as the algal scum that precedes heavier growth. Brushes with synthetic fibers tend to "buck" more than wire brushes. Round wire bristles are used for light seaweed and small barnacles. Even better results can usually be obtained with flatwire or a combination of round and flat wires. The ride is somewhat smoother than with synthetic fibers, but this type of brush still bucks in heavy growth. Flatwire (or so-called butcher wire) bristles are most efficient in removing growth and give the smoothest ride. These bristles also produce the most even edge-feathering of corrosion pits on HY-80 domes. One excellent type of flatwire brush utilizes a spiral wire in the plywood backing. This wire holds flatwire "bobby pins" in the brush. No bristles have ever come out with this arrangement. Another flatwire brush uses epoxy to hold the bristles in holes in the plywood backing. Bristles usually crack off at the epoxy after about 1 hour of use.

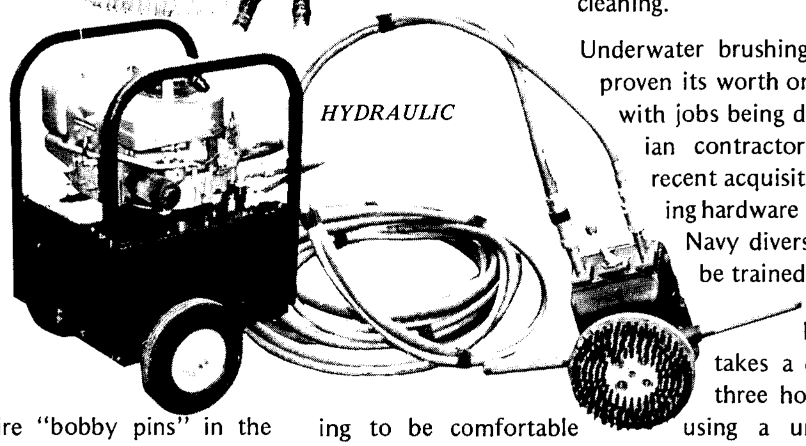
On painted surfaces, considerable experience is necessary to avoid marring the anti-fouling coating. The anticorrosion layer below the anti-fouling paint is generally impervious to damage by the brush except on weld beads and similar surface protrusions. Protection of these areas which are susceptible to damage can be restored with an anticorrosive epoxy paint developed by NCEL for underwater application.

Miscellaneous brush types evaluated include a "brush" composed of spur gears mounted on radial axles and used primarily on propeller blades. Another design consists of radial blades instead of bristles affixed to the outer edge of the circular backing plate. This brush is particularly useful on heavy growth but does not polish the surface as well as the flatwire.

PNEUMATIC



HYDRAULIC



All of the brushes mentioned are available in various sizes. Generally, brushes 10 inches to 14 inches in diameter are a good compromise between small brushes which do not ride smoothly and large brushes having excessive drag. Bristles on all brushes are 3/4 inch to 2 inches long. Current work at NCEL includes the design of improved brushes for lower drag and better cleaning.

Underwater brushing has already proven its worth on both coasts with jobs being done by civilian contractors. With the recent acquisition of brushing hardware by the Navy, Navy divers will have to be trained.

It normally takes a diver two to three hours of brushing to be comfortable using a unit in good visibility. An additional 20 to 40 hours of practice should be expected before the diver can operate well in zero visibility. As Navy divers are trained in the brushing operation, NCEL research will continue to identify, modify, and recommend the best tools for the job.

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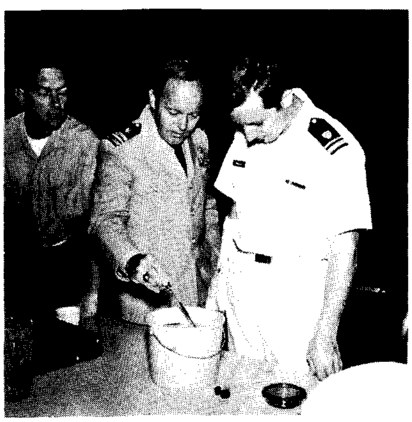
OIL POLLUTION SCHOOL UNDERWAY

LCDR J. Ringelberg and an officer of the Calif. Dept. Fish and Game discuss the effectiveness of oil dispersants with D. E. Irons, SUPSALV oil specialist.

Mr. Joe Crilly (NCEL) demonstrates the use of dispersants to LCDR W. Klorig and members of the U. S. Coast Guard National Strike Force.



LCDR Ringelberg tests the Navy's piston film oil containment chemical.

In answer to the growing need for experience and competence in the area of oil spills, a one-week pilot training course, held during the week of September 18, 1972, at Berkeley, California, was sponsored by the Supervisor of Salvage. Geared to provide maximum support to those activities responsible for handling spills of oil and hazardous material, the course dealt with the command and control aspects of ship-salvage-related and open sea oil spills.

Attended primarily by Salvage Officers, the course covered the curriculum illustrated below. Many valuable comments were provided during the critique period that will be of considerable benefit to future courses.

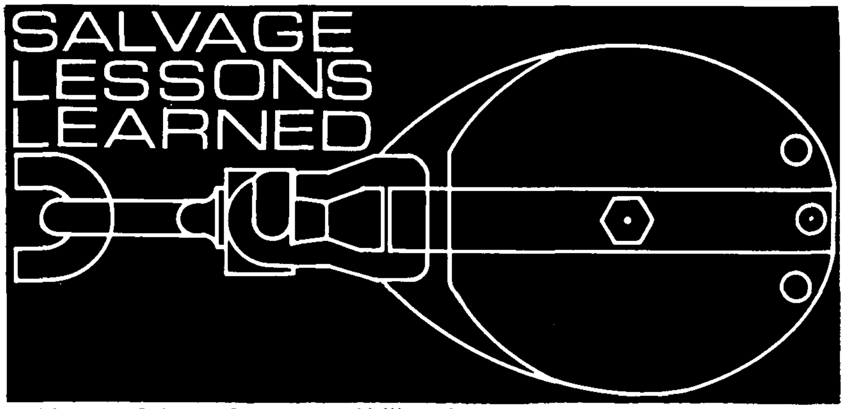
CONTROL OF MAJOR OIL SPILLS

	9–10	10–11	11–12	1–2	2–3	3–4
MON	Introduction Registration *Welcome*	Nat'l Contingency Plan	Regional Pollution Contingency *Plans*	Environmental Protection Agency	State and Local Authorities	Navy Responsibilities
TUE	Oil Containment and Recovery; Introduction	Containment	Collection (Skimmers)	Collection (Absorbents, Endless Belts and On-Scene Fabrication)	Commercial Tankers and LNG	Control of Hazardous Material
WED	The Command Post, Deployed Field Activities, Public Relations, Communication			Case Histories	Navy Programs other than Open Sea Oil Spills	Movement of Oil, Surveillance, and Monitoring
THUR	Laboratory Demonstration (Lecture on oil, its characteristics and types. Class participation in exercise using dispersants, absorbents, piston film, etc.)			Beach Clean-up Restoration & Disposal	Bird Cleaning Stations & Eco-system Protection	Logistics
FRI	Field Demonstration Exercise (Using bio-degradable oil)			Critique	Discussion	

Informative lectures were given by experienced members of the environmental community; i.e., U.S. Coast Guard, Environmental Protection Agency, California Fish and Game, National Wildlife Foundation and private industry. Mr. Joseph Crilly from the Naval Civil Engineering Laboratory, Port Hueneme, California conducted a morning laboratory session in which all the students had an opportunity to test the Navy's oil containment piston film and compare the effects of several oil emulsifiers.

Because of the success of this pilot course, an additional course has been scheduled for this fiscal year. It is planned to take place during the week of March 5, 1973, with the intention of preceding the Salvage Officers' Conference scheduled for the same week. Leading officers on the Area Coordinator's and Fleet Commander's Staff are expected to attend both.

With the success of this program, future Supervisor of Salvage training programs will be modified and expanded as more equipment becomes available and more experience is developed.



Cold-water Salvage Operations. Utilizing their rapid response, fly-away team concept (with preplanned/palletized equipment), a 6-man diving/salvage team from Harbor Clearance Unit ONE was recently dispatched to Alaska in answer to an urgent Coast Guard request for assistance for the USCGC JARVIS. Use of this fly-away technique has repeatedly proven that a team of experienced salvage divers can be fully ready for departure within 4 hours of official notification and can provide the early repairs that prevent the salvage operation from becoming critical.

Of immediate concern to the team upon their arrival was an L-shaped tear at the very bottom of the hull in the main engine room. This tear extended approximately 19 inches longitudinally and 11 inches transversely with the hull plating at the intersection of the tear pushed in approximately 2 inches. Although covered with a temporary concrete patch which had slowed the flooding so that it could be controlled by a large battery of pumps, the patch was not sufficient for the ship to get underway in the open seas of the wintery North Pacific and proceed to a port for permanent repairs.

Working with the senior Coast Guard Marine Engineering Officer on the scene, the team spent their first day laying in a properly drained concrete patch to reinforce the initial patching attempt and to further reduce the flooding rate. Once the hull was satisfactorily patched internally and flooding reduced to a rate that could be controlled with minimum effort, the team commenced diving operations to effect semi-permanent repairs that would allow the ship to get underway.

In order to stop the flooding completely and eliminate stress against the concrete patch once the ship was underway, it was decided to weld a box patch over the tear. In attempting to template the damaged area of the severely rippled hull, however, it was determined that the simplest and most expeditious method of fitting the patch would be to manufacture the patch in sections. As each section was manufactured, it was positioned, marked, and brought back on board for modification. This process was repeated until each section matched its own area. The sections were then welded together to form a custom-made box patch.

Once the patch was properly fitted it was positioned with hogging wires and the underwater welding began. This was a slow, laborious process because of the near freezing (40°F) water temperature which limited the diver in-water time and made it extremely difficult to obtain a satisfactory weld. The welding was finally accomplished by the divers working in relays, with each diver spending approximately 30 minutes in the water during his dive, and using a high welder amperage. Another problem area encountered during the welding process was the formation of gas bubbles inside the patch. As these bubbles formed they ignited, producing miniature explosions. Although not of sufficient strength to break the patch loose once it was firmly seated, these explosions did have a disconcerting effect on the divers.

When the patching phase was complete, the ship was made ready for sea. The salvage crew set the patch hogging lines taut to provide a back-up for the weld, and a transit/escort/tow unit was formed. When a forecast of good transit weather was received, the ship was towed out of the harbor and cast loose to proceed, escorted, under her own power. This transit, made on one shaft, was without incident and the salvage operation was terminated when the ship arrived safely at Pearl Harbor.

Lessons Learned:

1. Underwater welding in a cold climate is extremely critical, time-consuming and requires extensive heat.
2. A gas build-up with the resultant explosions from continued heat application can be eliminated by installing air blow/vent valves.

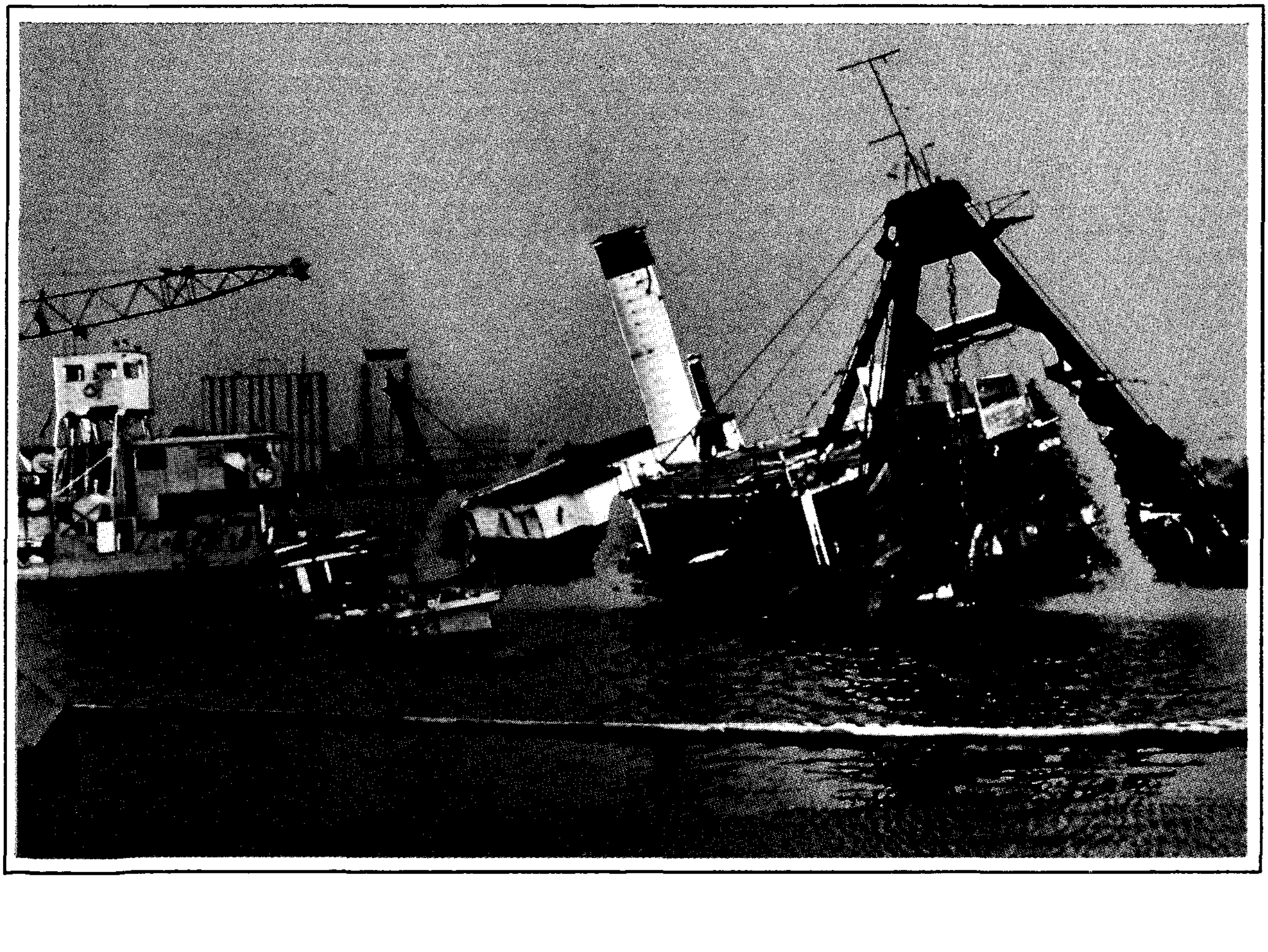
70,000 Gallon Fuel Ammi. A regular ammi pontoon, which was being used as a fuel barge, was mined and sunk. Two of six major compartments were holed, the major damage being a 10-foot by 14-foot hole. The wreck was quickly and successfully raised by shoring bulkheads, patching, and pumping operations. The wreck was then towed to port, secured to a river bank and left unattended while other operations were in progress.

Swift river currents loosened the patches, tore the ammi barge loose from its moorings, and it again sank requiring a renewed salvage operation.

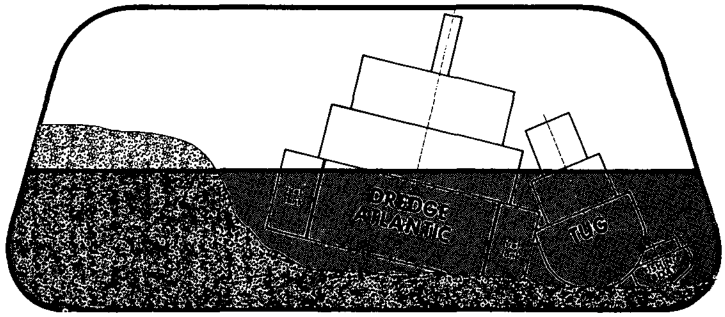
Lessons Relearned: The salvage operation is not complete until *ALL* work is completed and the vessel/craft is returned to its custodian in a safe, stable condition.

The salvage and pollution abatement plan for the Dredge ATLANTIC included installation of an oil containment boom, subsequent oil skimming and removal operations, internal and external hull surveys, stability and ground reaction calculations, and rigging of two legs of beach gear to facilitate raising the dredge. The operation also included the removal of a tug and fishing boat which had sunk alongside the ATLANTIC. Additional work was conducted in pumping and minor patching, using six 10-inch pumps and two 3-inch pumps, which eventually resulted in the successful completion of the operation.

dredge ATLANTIC salvaged from the Elizabeth River



LENGTH	**120 feet**
DRAFT	**9 feet**
BEAM	**40 feet**
DISPLACEMENT	**1200 tons**
CONSTRUCTION	**hull • wood**
	superstructure • steel, wood
	rigging • steel



The U.S. Coast Guard (5th District) requested the assistance of the Supervisor of Salvage on August 11, 1972, in undertaking the salvage of the sunken Dredge ATLANTIC and in eliminating the pollution hazard posed by the leaking vessel. In addition to the dredge, the tug MARQUETTE was sunk and resting on the submerged (starboard) side of the dredge and a small fishing boat was sunk and resting under the tug. Units of COMSERVRON 8, Harbor Clearance Unit 2, and the Supervisor of Salvage contractor proceeded to the salvage site, located at the junction of the southern and eastern branches of the Elizabeth River, Norfolk, Virginia.

The conditions as found were that Dredge ATLANTIC was heading 135° T, grounded on the starboard side, and listing 18.5° starboard. Approximately 18,000 gallons of Bunker "C" fuel oil were aboard at the time of the mishap and had since commenced leaking into the surrounding waters, making diving hazardous and unusually foul.

During the months prior to the start of salvage efforts, a considerable amount of Bunker "C" oil had passed into the Elizabeth River. However, by the end of the first day of the operation, floating booms rigged across the mouth of the cove and around the dredge had halted further pollution. An absorbent material was liberally spread on the water and throughout the dredge and subsequently picked up with nets, shovels and buckets, and deposited in 55-gallon drums for safe disposal. Also, double diaphragm air pumps, discharging into a tanker truck, were employed to skim the water and eliminate pockets of oil within the dredge.

The initial stages of the operation began with an underwater hull survey of the dredge, tug, and fishing boat. Hull damage and holes were measured and recorded; patches were manufactured and installed. The starboard side of the dredge deck house was patched to use as a cofferdam. The salvage contractor's equipment arrived on August 26 and two legs of beach gear were rigged as preventers from the dredge to deadmen on the beach. The tug was righted and the portholes were patched after the fishing boat was pulled clear of the other two vessels to the opposite side of the cove.

Three 10-inch pumps were initially spotted on the dredge, but three additional pumps were ordered after preliminary test pumping revealed large quantities of water being drawn between the rotten hull and deck planking of the dredge. Bunker "C" oil removal continued on a round-the-clock basis with pumps and by hand.

The first major effort to dewater the dredge failed when a large patch covering the opening for a set of double doors carried away. A stronger patch was fabricated and installed over this opening, but a second pumping was again unsuccessful because of excessive leakage through two winch accesses. Several days were spent removing the two winches to allow the placement of two 6-foot by 4-foot patches, fabricated from 1/4-inch mild steel plate with stiffeners. In addition, the dredge was completely sheathed with heavy-gauge plastic sheeting to stop the hull leakage. A follow-up internal hull survey found no new hull penetrations.

The dredge was successfully raised on September 14, with the third major pumping effort. Oil removal was then directed at the previously inaccessible spaces, and divers began caulking cracks to achieve a certain degree of seaworthiness. On 25 September, the ATLANTIC was moved to Norfolk Shipbuilding and Drydock Company for dismantling and final disposition.

New One-Man Chamber Developed for SUPDIVE

by

P.S. Riegel
BATTELLE
Columbus Laboratories

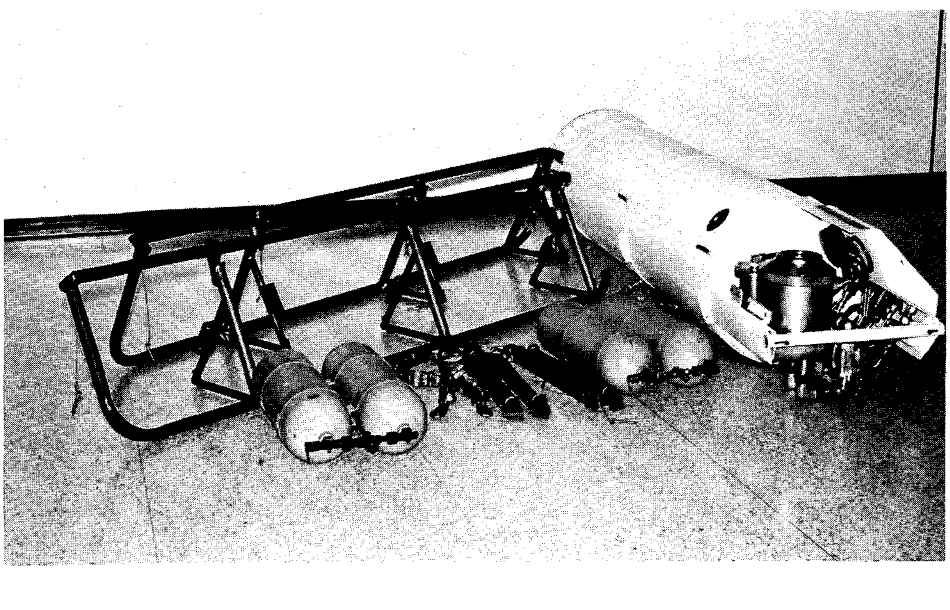
A new type of one-man recompression chamber has been developed for SUPDIVE. Operating on a semiclosed-circuit principle, it makes efficient, effective transportation of a stricken diver to a recompression facility possible for the first time.

Although treatment of decompression sickness by recompression is generally effective, it has its drawbacks. One of the most serious disadvantages of such treatment is that the accident often occurs in an area that may be a long way from a treatment chamber. Often a semiconscious, suffering diver must be transported by the fastest means to reach the nearest recompression facility, with the probability of permanent damage increasing with every minute he remains untreated.

To provide means of protecting divers in remote worksites, some small, portable recompression chambers have been developed and marketed. These chambers are of various forms – some are cylindrical, some tapered, some telescoping. Entry may be head first or feet first. All chambers of this type are sized for one man and are intended to give immediate treatment to the sufferer, wherever he may be. Once the patient is under pressure, the chamber may be transported to the nearest recompression facility for subsequent treatment of the occupant. During transportation, the atmosphere in the chamber is kept pure by continuous ventilation with air, which supplies oxygen and removes unwanted carbon dioxide. However, one aspect of the problem that has not received much attention is that the air to supply the chamber must also be transported, and a one-man chamber uses a lot of air.

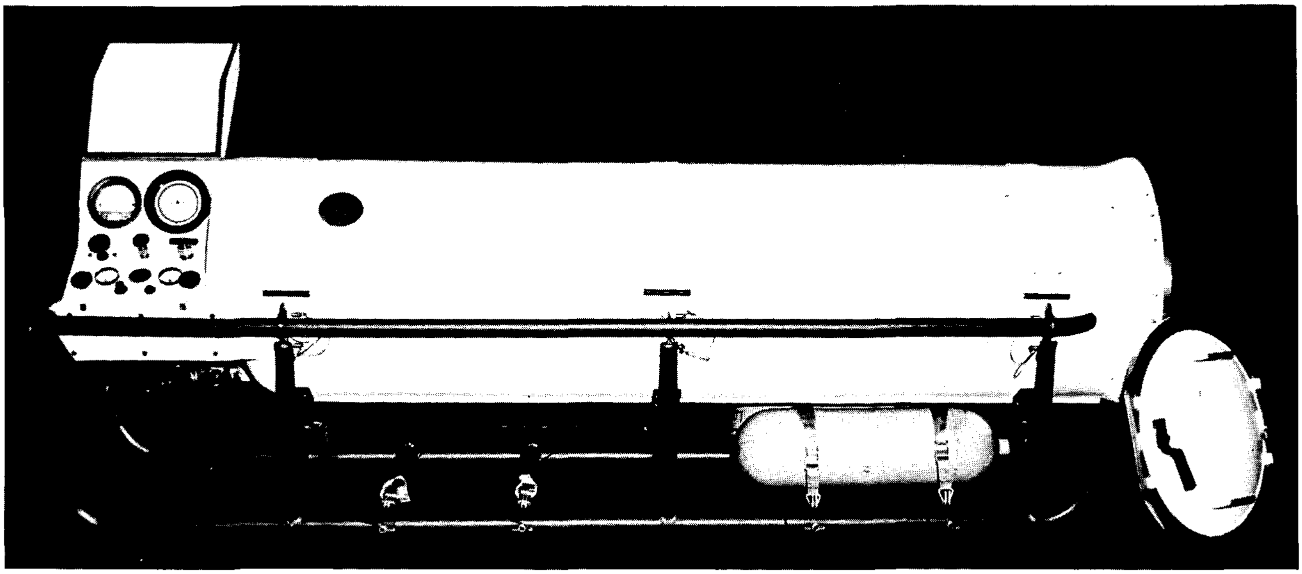
Partial pressure of carbon dioxide can be maintained at a safe level of less than 1/2 percent surface equivalent by ventilation at a rate of 2 ACFM. However, to produce a flow of 2 ACFM at treatment depth of 165 feet requires a flow of 12 SCFM of air. A typical commercial air flask contains about 240 cubic feet, or enough for less than 20 minutes of operation. Efficient treatment and transportation would require that enough of these heavy, cumbersome bottles accompany the chamber to provide air for the entire duration of the trip. In some cases, this is difficult or impossible either through weight or size limitations of the carrier or because not enough air is available.

SUPDIVE was one of the first to recognize this problem and to suspect that there might be a better way to do



Left: Chamber may be removed from its supporting structure to permit insertion into a submarine.

Upper right: Side view of assembled chamber.



the job. Rebreather SCUBA has been developed by the Navy to help reduce consumption of diving gases, and SUPDIVE felt that the same principles might well be applied to the one-man chamber problem.

An examination of the problem was conducted by Battelle, and it was found that a semiclosed-circuit approach, using air as the breathing gas, was indeed feasible. To determine the value of the concept, SUPDIVE contracted with Battelle to produce a prototype chamber to meet the Navy requirements. This was done, and testing at EDU has confirmed that the system performs well. The pressure shell is made of 5/32-inch rolled and welded aluminum with a semielliptical self-energizing hatch. The basic shape is a 22-inch-diameter cylinder with an inside length of 84 inches. Total system volume, including piping and scrubber, is about 18.3 cubic feet. Pressure capability permits treatment to depths of 165 feet of seawater. Two 4-inch viewports permit observation of the patient.

To enter the chamber, the patient is placed on a stretcher, strapped down, and slid in head first. The hatch is closed and dogged, and the system is ready for pressurization. Water and food containers are placed within the patient's reach to keep him supplied for the duration of his stay. No medical lock is provided.

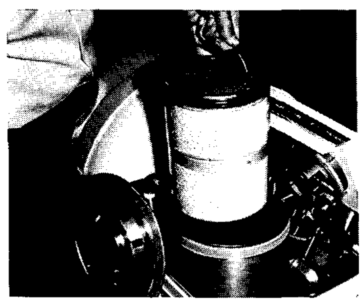
The chamber may be operated in two modes—open circuit or semiclosed circuit. In locations where a large compressed air supply is available, open-circuit operation can be employed. During transportation and in places where limited compressed air is available, semiclosed-circuit operation can be used. When operating in the semiclosed-circuit mode, an ejector, or venturi, is used to circulate the chamber air through a CO_2 scrubber containing Baralyme. The operating principle is very similar to that of a helium hard-hat deep sea diving rig.

A control console which contains all control valves, gages, and communications equipment is located at the head end of the chamber. The gas scrubber is located at the head end also, with isolation valves provided to permit changing Baralyme while the chamber is pressurized. The entire system is mounted on skids to facilitate handling. Total system weight is 320 pounds.

As built, the system permits pressurization to 165 feet, and subsequent operation for 2 hours, on a single set of twin 90 SCUBA bottles. A second set of bottles provides air for another 5 hours of operation. Both sets of twin 90's are mounted beneath the chamber and permit operation for about 7 hours. Scrubber life is normally 8 to 12 hours. At 165 feet, air consumption of the new chamber is only 26 cubic feet per hour, while a conventional chamber requires 720 cubic feet per hour, or 27 times as much air. This large reduction of air required for operation greatly increases the transportability of the one-man chamber, and makes possible its use in areas where it had previously been impossible.

Development of the new chamber is another step in the Navy's continuing progress toward diver safety.

Right: Scrubber being loaded with Baralyme cartridge. Cartridge holds 10 pounds.



Editor's Note: Faceplate recently had the pleasure of touring the Navy School of Diving and Salvage, and interviewing its new Commanding Officer. Much of the conversation is of interest to all who are in some way connected with Navy diving, and is recalled here for your information and enjoyment.

LCDR ESAU DISCUSSES NEW POST

As the new commanding officer of the Navy School, Diving and Salvage, LCDR Anthony C. Esau, USN, considers one of his major objectives to be that of continuing the progressive modifications which his predecessor, LCDR Walter E. O'Shell, initiated. LCDR Esau assumed his new post in October, 1972, from duty as Commanding Officer, USS SUNBIRD (ASR-15), where he had also previously served Executive Officer and during which time he qualified for command of submarines.

A 1961 graduate of the Naval Academy, LCDR Esau first served aboard USS LAKE CHAMPLAIN (CVS-39) as Assistant Navigator. He graduated from the Submarine School at New London, Connecticut, in July 1963. LCDR Esau has also served aboard USS BARRACUDA (SST-3) and USS CARP (SS-338). After attending the Polaris Weapons Officers' Course in Dam Neck, Virginia, he reported to the USS GEORGE WASHINGTON CARVER (SSBN-656) for duty as a member of the commissioning detail and later as a member of the Blue Crew.

LCDR Esau graduated from the Diving School as a Helium Oxygen Deep Sea Diving Officer in March, 1969. Returning to the school now, he recognizes the constructive changes which have taken place since his own enrollment and intends to expand this modernization policy.

In order to achieve his goal of "training the best operational diver possible," he is updating the training curriculum by "gearing up" programs; i.e., acquiring new tools and diving equipment from SUPSALV, and by reorganizing the teaching system, to allow instructors to specialize in one area of diving education. Establishing more open communication between the diving school and the fleet is another central facet of a plan to improve the Diving and Salvage School's capabilities. By traveling to diving sites, visiting ships which have received Diving and Salvage School graduates, and talking to the instructors and divers themselves, LCDR Esau feels he can better appreciate the Fleet's diving requirements, and subsequently gear the school to better meet these needs.

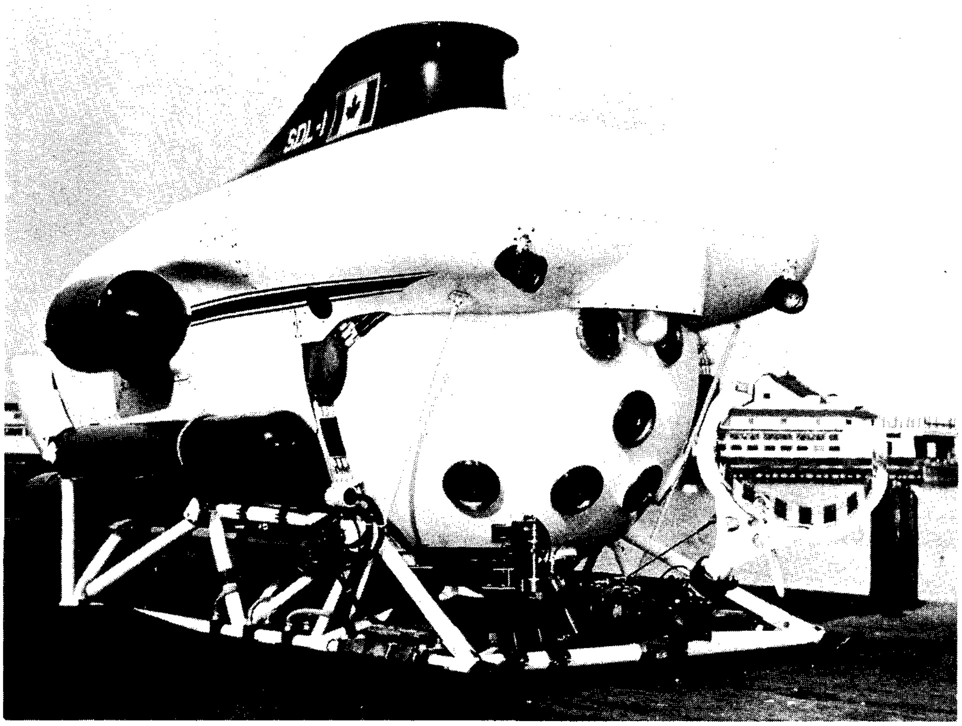
The largest and most advanced school of its type, the Naval School of Diving and Salvage of Washington, D.C., is the only training command authorized to qualify officer and enlisted personnel in all phases of diving, ship salvage, and submarine rescue for the entire United States Navy, U.S. Armed Forces, and selected allied nations. Classes are available for deep sea (HeO_2) diving officers, ship salvage diving officers, Diver-First Class, medical deep sea diving technicians, and Master Divers. In addition, the school provides such special short courses of instruction as refresher training for all classes of divers, training of Engineering Duty Officers and Commanding/ Executive Officers of diving ships, training for foreign officers and enlisted personnel under the Military Assistance Program; and training for Navy civilian industrial divers. These industrial divers are instructed with particular emphasis on the supervision of diving operations and major underwater mechanics.

The Naval School is also assigned several special functions, as directed by the Chief of Naval Technical Training. Providing emergency diving services to local, state, county and civil authorities as requested is one of these particular tasks. In addition, the school maintains liaison with the Navy Experimental Diving Unit in regard to improvements in diving techniques and equipment. It is also responsible for keeping a ready pool of qualified officers and enlisted personnel experienced in deep diving, submarine rescue, and salvage techniques in a ready reaction status in the event of a marine emergency.

Under LCDR Esau's direction, the students attending the school have the benefit of 25 instructors presided over by 5 Master Divers. They cover in their curriculum all phases of basic diving, salvage diving, and advanced diving. The school affords the benefits of two YDT's, one YSD, and a refitted YRST used for diving and classroom work. During the salvage training the divers and instructors travel by ship to nearby Oxon Cove where a sunken vessel is salvaged by a process of patching holes and pumping. Another area located near Dahlgren, Virginia is used in the simulation of open-sea dives to complete that phase of the curriculum. Overall, the students' time is divided approximately in half between classroom instruction and practical training.

In the Master Diver qualification course, the standards are high. Graduating an average of 4 qualified Master Divers each term, the course lasts 5 weeks and is given 5 times a year. When these candidates are tested, the CO and XO closely monitor the candidates during the practical portion of the qualification. A Master Diver qualification board consisting of the CO, XO, Staff Diving Officers and Staff Master Divers then meets to review the written exams, and discuss observations made while the candidates were on station. Each candidate is fully evaluated, and voted upon by the qualification board to ensure uncompromising standards.

The Navy School of Diving and Salvage occupies a unique spot in the educational structure of the United States Navy. Because the quality and skill of all Navy diving rests with this group, it is imperative, LCDR Esau feels, for the training programs, equipment, and efficiency of the school to be superior. By this thinking, LCDR Esau has formulated a policy he intends to make a reality, "To train a man so that he would be welcome on any diving ship."



(Left) The new Canadian submersible, SDL-1, ready for use in depths up to 2,000 feet.

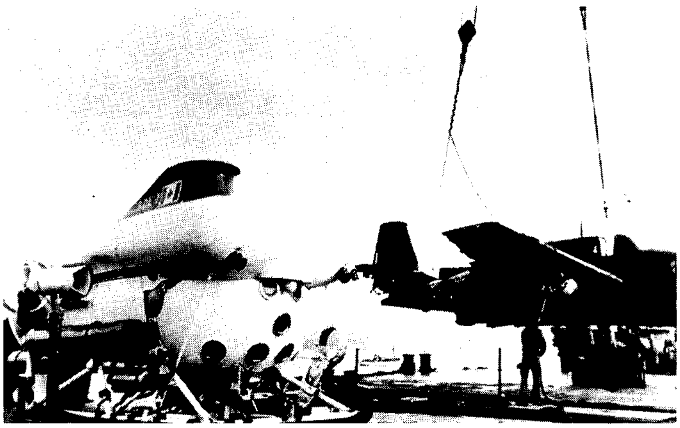
SDL-1 EXPANDS DEEP DIVE

Today's increasing concern over the possible loss or abuse of natural resources on the continental shelf has caused the Canadian Government to place greater emphasis on activities relating to offshore waters and the seabed. Recently, it has led to the acquisition of a diver lock-out submersible for seabed exploration and surveillance by the Canadian Forces. The submersible, SDL-1, was purchased from International Hydrodynamics of North Vancouver and delivered to the Maritime Command in December, 1970.

The SDL-1 is well suited for this undersea role since it can perform both as a submersible and a diver lock-out vehicle. The SDL-1 operates from a surface support vessel without a tether and descends independently to depths as great as 2,000 feet. At depth, the two pilots and an observer can investigate the ocean floor through ten large viewports or perform simple tasks by utilizing the submersible's two mechanical arms. When more complex tasks are encountered on the bottom, three lock-out divers are able to exit the vehicle to carry out the work. The divers are accommodated within the submersible's rear lock-out compartment, which is designed to support lock-out diving to a maximum depth of 1,000 feet. Because of a delayed procurement of support equipment for helium-oxygen diving and a mate-up recompression chamber, lock-out operations are temporarily limited to depths of 150 feet on compressed air.

The pressure hull of SDL-1 lends itself very easily to deep diving. The hull is fabricated from HY-100 steel and is composed of two spheres interconnected by a cylindrical tube. The forward sphere is 7 feet in diameter and serves as the command station. The after sphere is the lock-out compartment and measures 5-1/2 feet in diameter.The interconnecting tube, 6 feet in length and 25 inches in diameter, joins both of these spheres and allows personnel to transfer between spheres at depth. This design enables the command sphere to remain at normal atmospheric pressure, while divers compress or decompress in the after sphere.

Overall, the SDL-1 measures 20 feet in length, 10 feet in width, 12 feet in height, and weighs 30,000 pounds when manned. With these compact dimensions, the submersible is transported easily by road, sea and air. This feature enhances the versatility of SDL-1 because the



(Above) SDL-1 beside 7-ton Avenger aircraft recovered from the bottom of Bedford Basin, near Halifax, N.S.

(Right) CDR J.J. Coleman, NAVSHIPS Supervisor of Diving, receives his SDL-1 Deep Dive Card from LT Bruce Martin, Assist. O-in-C of SDL-1, after a 3-hour demonstration at 250 feet.

CANADIAN CAPABILITY

vehicle can be readily deployed to search and work in most of Canada's waters.

The submersible is powered throughout by lead acid batteries. Eighty 2.2–volt cells are arranged in three banks of 120 volts, 28 volts, and 12 volts respectively, to meet the various power requirements of equipment within SDL-1. These cells are carried externally to the pressure hull and provide the vehicle with sufficient power to operate submerged for periods up to 8 hours. Much of this power is used to operate two independent thrusters mounted on either side of SDL-1, which propel the vehicle at varying speeds of 2 knots or less. To assist the crew in navigating the SDL-1 safely at depth, the submersible also is equipped with underwater lights, sonar, echo sounders, acoustic interrogators and an underwater telephone.

Two major advantages of SDL-1 are its transportability and its capability of employing either mechanical arms or divers at deep depths. These features enhance the submersible's effectiveness in a variety of tasks in remote areas, both inland and offshore. It could, for example, be used to retrieve experimental weapons for the military or gather geological samples for scientific research. Recently, the SDL-1 has been employed in recovering intact a 7-ton Avenger aircraft from the bottom of the 240-foot-deep Bedford Basin, near Halifax, N.S. Other completed tasks include the salvage of an S2F Tracker aircraft and an investigation of marine life on the continental shelf for the Department of Fisheries.

To support the SDL-1, the Canadian government intends to acquire a surface vessel specifically for that purpose. It is planned that the submersible tender will be capable of supporting SDL-1 and lock-out diving to the designed limits. The tender will utilize an 'A' frame to launch/recover the submersible and will include a deck decompression complex with mate-up capability to support saturation diving. The vessel will be of sufficient size to conduct independent operations in remote regions for prolonged periods. The Canadian Forces deep diving capability is proudly coming of age with the acquisition of SDL-1 and associated equipment.

HONORS AND AWARDS

CITED FOR DIVING TECHNOLOGY---Admiral Isaac Kidd, Chief of Naval Material, pins the coveted Navy's Superior Civilian Service Award Medal on Tom Odum, Head of the Development Division of the Ocean Technology Department of the Naval Coastal Systems Laboratory. Admiral Kidd made the presentation to Odum during his visit to NCSL earlier this week. Odum received the award for his outstanding contributions over the years to the advancement of diving technology. (Official U. S. Navy Photograph)

In a ceremony held during his visit to the Naval Coastal Systems Laboratory, Chief of Naval Material Admiral Kidd made a special award presentation of the Navy's Superior Civilian Service Award to Mr. William T. Odum, Head of the Development Division of the Laboratory. Odum was presented the award, one of the highest available to an employee of the U.S. Navy, in recognition of his exceptional contributions to the advancement of Navy diving technology, equipment, and techniques for the past 17 years.

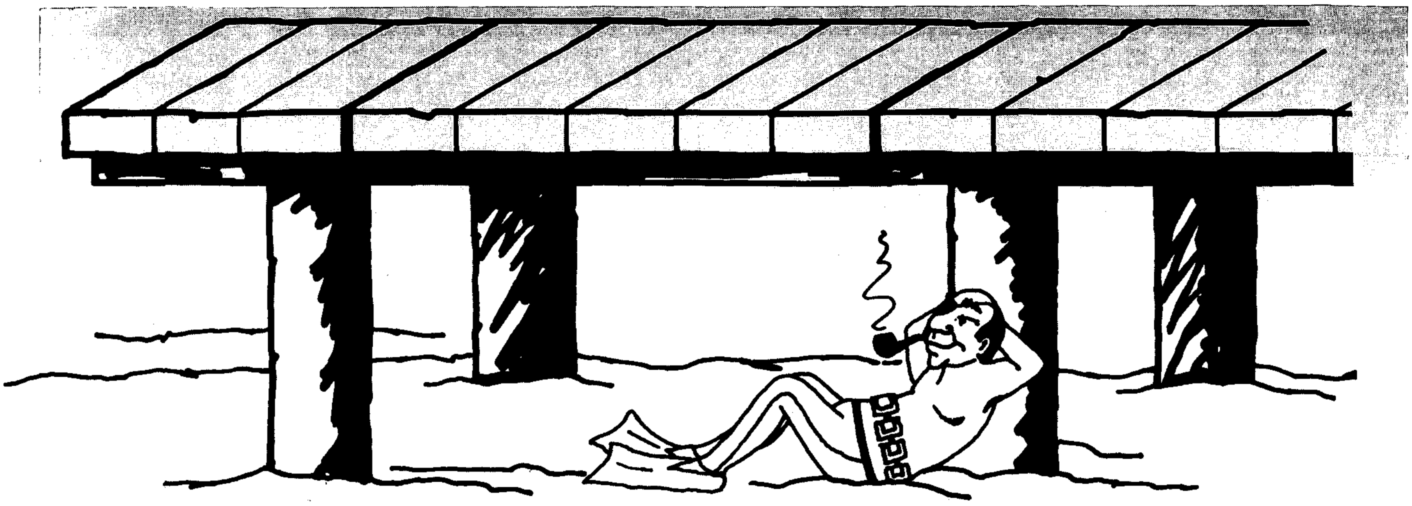
In developing a first-hand appreciation and knowledge of the problems of diving, Odum was one of the first civilians to become a qualified Navy diver. He gradually created an awareness of the great need for improved equipment and diving development programs and was instrumental in gaining support for the continuance of progress in these areas.

Odum was assigned the task of drafting the initial structure of the organization of hardware and equipment of the Underwater Demolition Teams (UDT) and Sea-Air-Land (SEAL) teams into an integrated system. His initial concept laid the groundwork for the ensuing development of various swimmer-delivery vehicles (SDV's), hand-held navigation and sonar equipment, underwater diver communications equipment, and various explosive ordnance disposal (EOD) equipment.

Shortly after the concept of saturation diving was proven feasible, Odum played a key role working with the Office of Naval Research in the design, construction, and test of the first U.S. Navy undersea habitat. The success of this operation, known as SEALAB I, was responsible for launching the Navy's saturation diving program and is regarded as one of the "most significant and successful undersea experiments of the past decade."

During the escalation of the conflict in Southeast Asia, he became the first laboratory representative in the diving area under the Vietnam Laboratory Assistance Program. Mr. Odum spent four months in Vietnam and on his return, succeeded in applying his first-hand information to the requirements used for developing new and more applicable equipment for the operating forces.

More recently, Odum's division has expanded its interests to include the area of ship salvage and recovery. He was instrumental in the development and testing of the Large Object Salvage System (LOSS) (see *FP* Fall '72), a new approach to the salvage of large objects from the bottom of the sea. In the words of Mr. Odum's letter from the Chief of Naval Material, "The professionalism with which you consistently carry out your responsibilities is very much appreciated, and you are deserving of the Navy Superior Civilian Service Award. Well Done!"



the Old Master says...

The BUD/S diving locker at the Naval Amphibious School, Coronado, was recently the scene of a fire and explosion causing several thousands of dollars worth of damage. The trouble occured while cascading oxygen into 200-cubic-foot bottles to achieve a 60 percent oxygen, 40 percent nitrogen mixture. Investigation into the fire did not reveal a specific cause, but did determine that the design of the mixed gas system contained some features that should be avoided in oxygen and high pressure mixed gas systems. Specific items to be avoided are:

1. *Ferrous Metals.* Ferrous metals are susceptible to rusting and flaking which creates particulate matter. This particulate matter may be accelerated in the gas flow and impinge on other components of the system causing local hot spots. Monel (70/30 nickel-copper) is the most desirable material for piping valves and fittings. Pure copper or 70/30 copper-nickel may be used. If it is not possible to use any of these materials, 316 stainless steel may be used.

2. *Quick Acting Valves.* Opening of a quick acting valve can cause a shock wave to be set up in the gas flow with adiabatic heating of the gas. Quick acting valves should be used for emergency shutoff only. Needle or globe type valves should be used for normal flow control.

3. *Buna-N Elastomeric Hose.* Buna-N should not be used in oxygen systems, since Buna-N is not compatible with oxygen because of its high flammability. Viton should be used for all O-rings. Teflon-lined hose is most desirable; nylon-lined hose is acceptable.

4. *Uncovered Couplings and Disconnect Fittings.* Uncovered couplings and fittings allow oil and particulate matter to enter the system. Plastic caps or attached quick disconnect caps should be used on all disconnect fittings and couplings.

All electrical items should be located in positions where their probable exposure to high oxygen concentrations will be minimized, and 200-cubic-foot gas bottles should be so mounted as to prevent unwanted movement during charging.

Activities having questions concerning design of oxygen or mixed gas fittings may contact Mr. R. Hansen, Office of the Supervisor of Salvage, 202-692-3615 or AUTOVON 222-692-3615.

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