Portraits in Science

David Watson TAYLOR

established the U.S. Experimental Basin at the Washington Navy Yard in 1899. During the 15 years he supervised the facility, his work influenced the design of over one thousand vessels. "The Speed and Power of Ships" by David Watson Taylor became internationally known as a standard book on ship resistance prediction. In 1917 he was promoted to the rank of Rear Admiral.

When a new ship experimental facility was built in 1939 at Carderock, Maryland, it was named the David Taylor Model Basin, in his honor.

Multiplexing Techniques Applied to Military Electronics

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Early photographs of any major city show great forests of telephone poles festooned with hundreds of wires, occupying many cubic feet of space. Expansion of such a system was obviously limited. The development of multiplexing techniques enabled the telephone industry literally to miniaturize its system. Thus, a relatively few cables could be employed to carry the bulk of the signals and to furnish the desired expansion capabilities.

The modern military aircraft is faced with the same problem as the early telephone industry. Although electronic black boxes can be miniaturized in spectacular fashion, the weight and volume of the wires, cables, and connectors required to interconnect the complex avionic equipment units are equivalent to that of a large bomb, missile, or several thousand pounds of ammunition. In addition, the task of engineering and documenting the vast circuit complex is time-consuming and very costly.

The Multiple Interior Communications System (MINCOMS) takes advantage of multiplexing and integrated circuits to allow total information transfer—voice, video, data, synchro—between all system components using a minimum of coaxial cabling. This system is a miniaturizing technique developed by the Radio Corporation of America for the Naval Air Development Center, Johnsville. It is the application of systems engineering and multiplexing techniques to the information-transfer requirements of any ground, aircraft, or shipboard command, control, or monitoring systems complex.

Traditionally, information transfer between system components has been accomplished by multiconductor cable and multipin connectors. Line drivers, amplifiers, impedance matching circuitry, and level converter circuitry have been required to provide the proper interface. While this approach was effective for the less sophisticated systems of the past, its application to modern and future systems would be costly and impractical.

The new MINCOMS concept uses one coaxial cable having a large information bandwidth to transfer information between all system components (see figure 1). Components such as radar or computers inject or extract information through impedance-matching "tee" connectors. This single-cable concept provides the distinct advantage of increased flexibility and expansion. For example, by including spare jacks in the initial installation, a plug-in-anywhere capability is provided where system components can be changed or rearranged without expensive modifications to system cabling. Providing spare jacks during initial installation may be compared to installing spare AC outlets in a house during construction. Just as installing such outlets after the house is completed can be costly, modifying cabling in existing aircraft can be exorbitant.

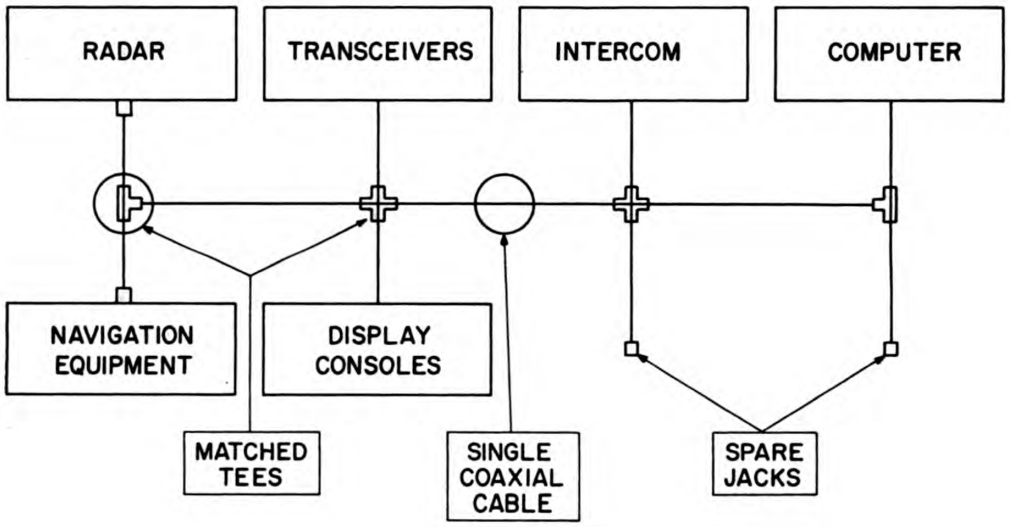


Figure 1

There are two methods of applying the MINCOMS concept. The adapter unit method is employed for existing systems (see figure 2). Although this method does reduce weight significantly, it is not the optimal approach. It does eliminate the conventional hard-wire between system components; however, the multipin connectors and driving circuitry must be retained. The second method, the built-in approach (see figure 3), is used in new systems when it can be specified in the initial equipment procurement. The built-in MINCOMS approach achieves greater weight savings by eliminating the cable connectors and provides increased system reliability by eliminating redundant driving circuitry.

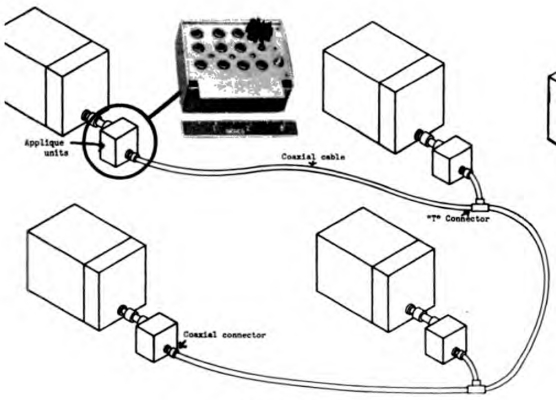


Figure 2

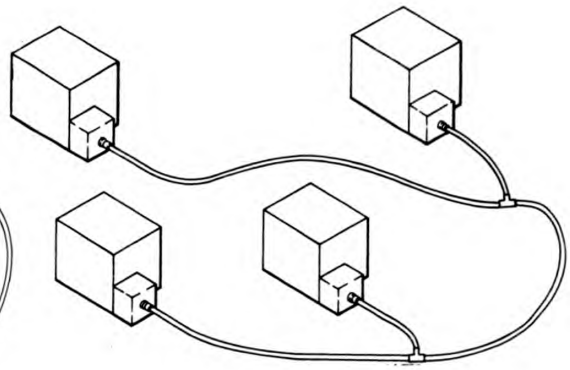


Figure 3

MINCOMS Applied to Aircraft Systems

The possibilities of using multiplexing techniques to reduce aircraft cabling was first envisioned by the Naval Air Development Center as far back as 1955. However, until the advent of integrated circuits, multiplexing equipment was too large and heavy for aircraft use. In 1963, NADC negotiated a contract with the Telephonics Corporation to study the feasibility of using radio frequency multiplexing to reduce the cables in the new computerized antisubmarine warfare aircraft system (A-NEW-ASW).

In 1964, NADC Johnsville awarded a contract to the Radio Corporation of America to apply the multiplexing concept in the A-NEW system. This system, which is aimed at increasing the effectiveness of ASW aircraft, was selected because it was one of the largest and most complex airborne systems being developed by the Navy. The basic concept centers on a digital computer which services multisensor cathode-ray tube displays for observing and controlling ASW information. In the RCA contract, the MINCOMS concept was to be applied to a feasibility model of the A-NEW system. This model, designed to operate in the laboratory, was equipped with a problem generator which furnished ASW sensor and navigation system outputs, thus simulating an operational ASW environment.

The study for the A-NEW system application was completed in January 1965. The following September, the MINCOMS concept was integrated and demonstrated in the A-NEW feasibility model at NADC. Since the A-NEW design was well advanced, the adapter unit approach (see figure 2 above, left) had to be used. This approach did not constitute the ideal method of applying the new technique. However, the study did indicate that over 4000 wires, which, when stretched end to end, would total more than 74 miles, could be eliminated and replaced by 34 coaxial cables. The resultant net weight reduction—in excess of 1000 pounds—provided a gross cost reduction of $500,000 per aircraft. Actually, the net cost savings could exceed this amount since other

factors such as decreased system downtimes, engineering change proposals, training requirements, and documentation had not been taken into consideration. The study also indicated that the MINCOMS concept would provide growth potential through flexibility and improved reliability through the use of integrated circuits.

In defining the operational elements of the A-NEW system, it was determined that the system could be divided into 20 equipment groups or stations, each with an adapter (see figure 4). All intrastation transfer of data was accomplished over conventional wiring. Interstation communication was handled by the MINCOMS concept.

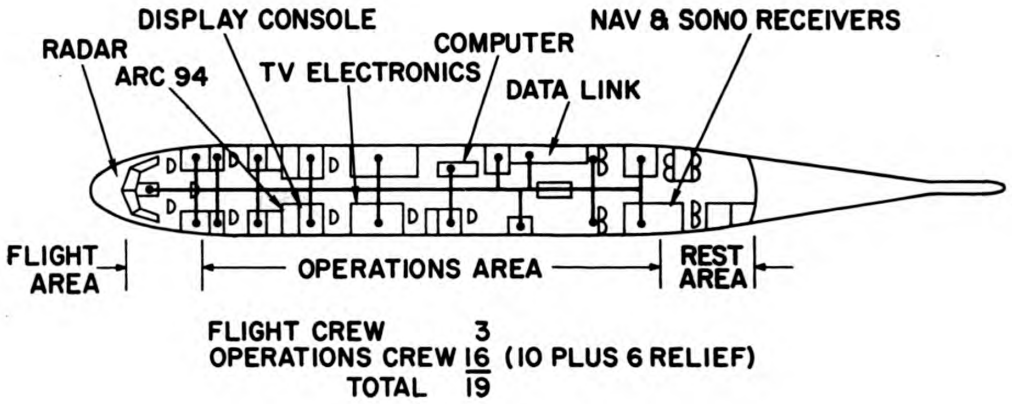


Figure 4

If the built-in method (see figure 3, page 3, right) had been used during the A-NEW system application, the Mean-Time-Between-Failures (MTBF) could have been increased by more than three-to-one. By multiplying the amount of circuitry required for the built-in approach by the expected failure rates for these circuits, a MTBF of 2500 hours was obtained. On the other hand, the MTBF of the circuitry replaced by the adapter method—which included 420 line drivers and 1840 pin connectors—was only about 720 hours. It was the elimination of the wire cables and pin connectors that was largely responsible for the 1000-pound weight reduction mentioned previously.

The A-NEW system application demonstrated the feasibility and distinct advantages of the MINCOMS concept. Accordingly, in order to speed its application within industry and to methodologically evaluate the optimal technique for information transfer, the Office of Naval Research, under the Joint Army-Navy Aircraft Instrumentation Research program (JANAIR), awarded a contract to RCA in April 1966. A further objective of the contract was to define for a wide variety of potential applications multiplexing selection and usage engineering procedures. The resultant report, entitled *Multiplexing Guidelines and Standards for Interior Avionics Systems,* has recently been issued. It is

available through the Defense Documentation Center, Cameron Station, Alexandria, Virginia to qualified organizations under accession number AD-809 854.

Other MINCOMS Applications

RCA is currently conducting NADC-supported studies on the feasibility of applying MINCOMS to a revised version of the A-NEW system and the VFAX (interceptor) aircraft system. Also, a Marine Corps-supported study is concerned with applying the MINCOMS concept to Tactical Air Operations Center (TAOC) huts.

In the latter program, the multiplex system design will reduce TAOC hut weight from 13,000 to 3,000 pounds, increase hut-to-hut distances by 100%, and reduce set-up and take-down time by 80%. This will be achieved by combining frequency division multiplex techniques and time division multiplex techniques. A single coaxial cable will be used as the transmission medium for radar, video, data, signalling, voice and other forms of information flow between TAOC huts. The realizable design goals for this system are a MTBF in excess of 5000 hours and an availability of 99.98 percent.

In addition, in-house studies are in progress to apply MINCOMS to several other complex systems, including the Airborne Early Warning/Control (AEW/C) aircraft and Carrier Based-Airborne Tactical Aircraft Control System (CBATACS). Its application to the AEW/C aircraft indicates that communication between the various system components can be accomplished in the same manner and with similar savings as indicated for the A-NEW system. The study shows that present AEW/C aircraft utilize an in-flight performance monitor which requires 177 wires and 32 coaxial cables to interface with the system components. The MINCOMS concept will reduce this array to three coaxial cables.

A similar system employing many of the MINCOMS concepts for control, routing and transfer of audio and digital signals is presently being designed and fabricated by RCA. This system, which has been designated the Integrated Communications Control System (ICCS), is an application of MINCOMS to Early Warning aircraft. The ICCS is used to interface five intercom stations, 12 radio sets, link data modems, security devices, a computer, a recorder, and emergency tone inputs, thus controlling all interior and exterior communications. It provides for the functions of net calls, party calls, radio access and control from any crew member in the aircraft, multiple access to individual radios, and the monitoring capability of all receivers. The system further provides for radio relay operations, transmission over multiple radios, initiation of radio self-tests, and maintenance communications.

ICCS is operated by multiplexing signals over a common coaxial cable. Time division multiplexing is used for signal and control functions and frequency division multiplexing is used for audio signals. Common timing and synchronization are used for inherent system stability. The panel layout is shown in figure 5. An ICCS using a combination of centralized and decentralized circuit functions designed for shipboard installation is shown in figure 6.

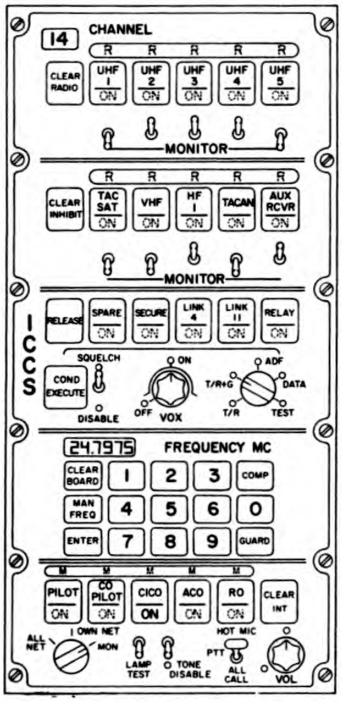


Figure 5

MINCOMS is also being applied to shipborne radar and fire control systems. This study has already shown that the concept is advantageous in reducing the wiring problem. The interface between the AN/SPS-48 Search Radar and the Naval Tactical Data System can be reduced from 41 cables and about 600 wires to six coaxial cables by using MINCOMS. Similarly, the interface between the AN/SPG-55B Radar and the Terrier Fire Control System can be reduced from 28 cables and about 690 wires to six coaxial cables. In both cases, additional

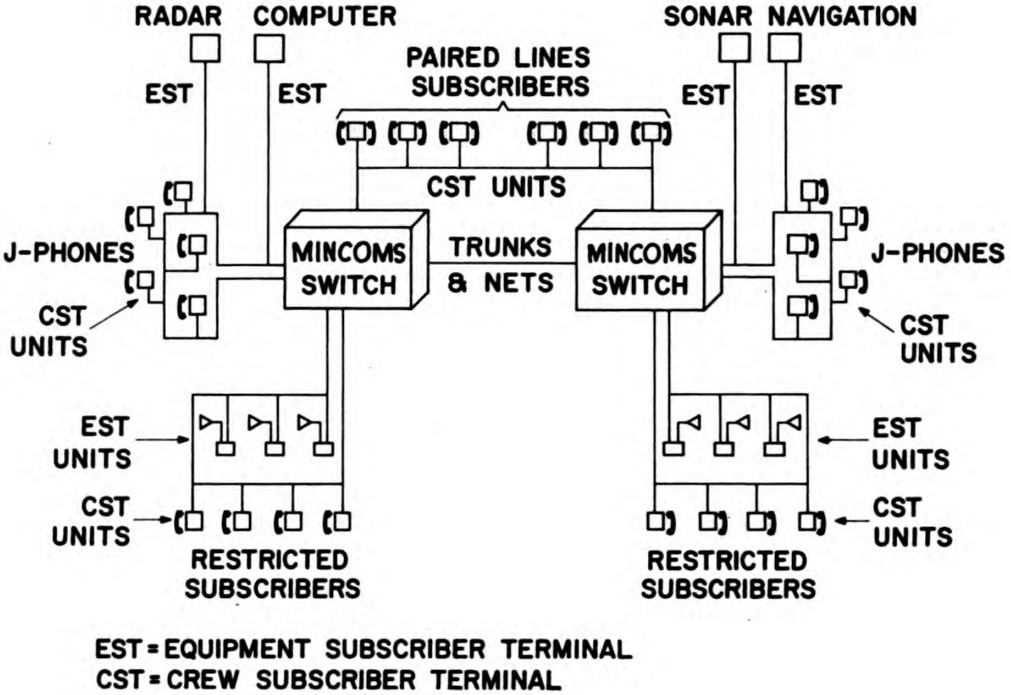


Figure 6

benefits accrued by making available redundant signal paths between the forward fire control system and the aft fire control launcher, thus greatly enhancing the ship's flexibility. Further, the MINCOMS concept made it possible to have a remote central location for monitoring, test, and checkout equipments.

RCA studies made in conjunction with prime contractors in a Naval Ships Systems program indicated that MINCOMS can serve the Navy's need for a flexible interior communications system by installing spare jacks throughout that system. It could even provide walkie-talkie communications with the interior communications system with a minimum of cabling. A method of providing sectional construction using MINCOMS is shown in figure 7.

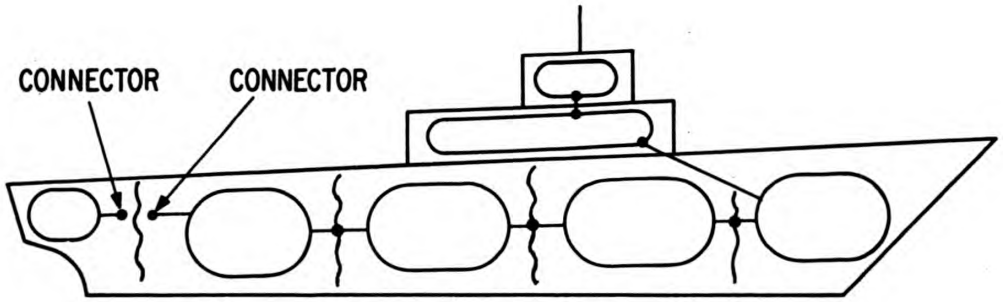


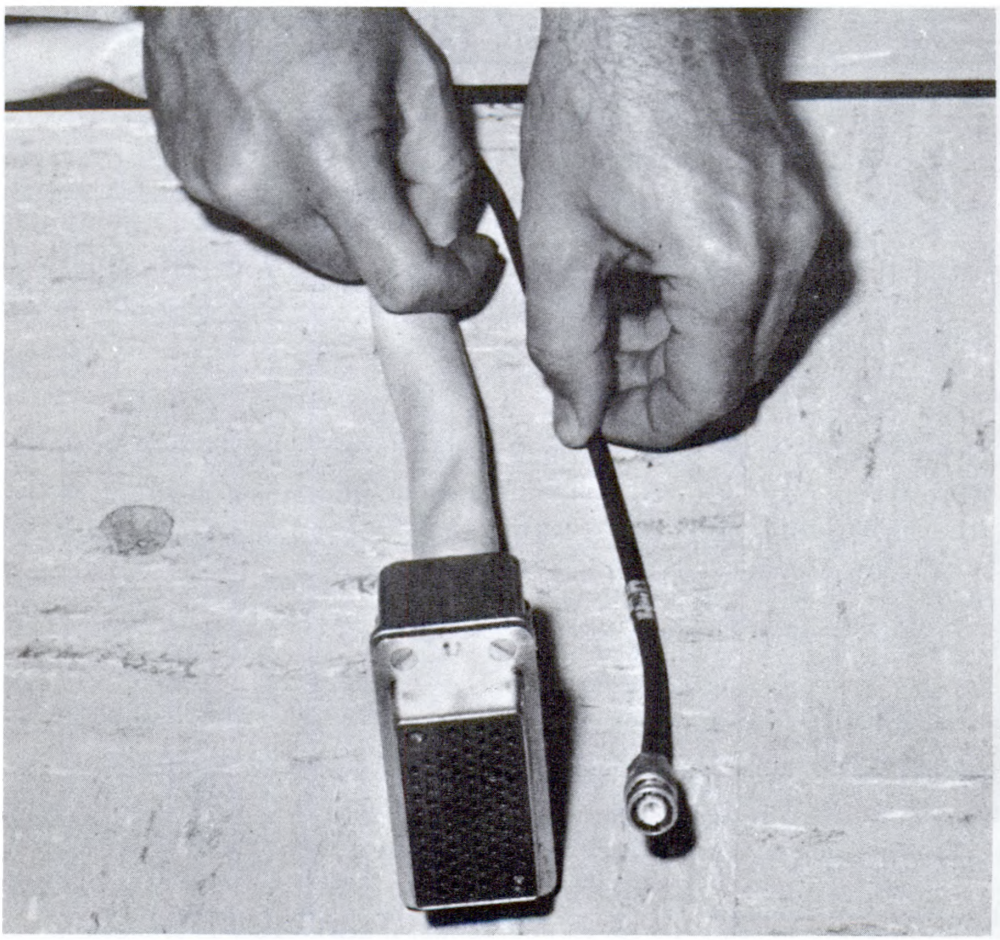
Figure 7

Other areas of study underway include the provision of equipment test points at a remote central monitoring point and the use of computer systems for shipboard performance analysis. The MINCOMS approach to ships systems shows promise of realizing entirely new concepts in vessel construction, utility, and employment.

All of the studies discussed above were made as a result of the initial A-NEW contract addressed to cable saving. The great impact cable savings would have on electronics systems was not fully realized until these further studies had been made. The effects—both physical and economical—of equipment factors and supporting requirements on system performance are shown below:

Equipment Factors	*Effect*
Electronic complexity increasing due to demands for more sophistication	Added cables and connectors; deterioration in reliability and maintainability
Size and weight shrinkage of equipment	Connectors limited in shrinkage
Line drivers and signal conditioning equipment required for hard-wire interface	Equipment complexity and reliability worsens
New components required for old hard-wire interface	Added weight and volume problems

Supporting Requirements	*Economic Effects*
Engineering change proposals for installation changes	Costs increase due to high initial installation and modification costs
Installation downtime for changes in wiring excessive	Larger inventory of subsystem may have to be provided to maintain operations. Personnel costs increase during downtime
Black box contractors are presently not controlled as part of interface management	A change in one system component affects others. Effects are not always known
Documentation data requirements excessive	Increase in program costs. Present data effects still inadequate
Maintenance support to check wire connection/equipment problems are increased	Costs for maintenance, manpower and support equipment increase
Inflexible, frozen design	Obsolescence on vehicle due to equipment interface changes. Equipment has to be designed two years before the hull



MINCOMS coaxial cable (right) compared to 91-pin hard-wire connector now used

Summary

In summary, the Multiple Interior Communication System will:

- Permit the transmission of all types of information over a single transmission path,
- Provide low installation and documentation cost because considerably fewer cables are required,
- Permit flexibility for redesign or layout change,
- Increase system reliability, and
- Reduce weight and volume in critical applications.

Although much remains to be done before MINCOMS can be applied to future complex and sophisticated electronic systems, the groundwork has been laid. Its advantages have been demonstrated and have made a very significant contribution to the use of total integrated circuit systems. Multipin connectors, with all their inherent weaknesses, may soon become as outdated as vacuum tubes are today for general use in electronics.

Vigness Memorial Award Established

The Institute of Environmental Sciences has announced the establishment of an award in honor of Dr. Irwin Vigness, a Naval Research Laboratory expert in shock and vibration. Dr. Vigness, who was a Fellow of the Institute, died last year.

The Vigness Memorial Award will be presented annually to the author of the best paper pertaining to Dynamic Shock presented during the calendar year preceding the Institute's annual meeting. The Institute is composed of engineers, scientists, and management people involved in the simulation of natural environments and environments induced by the operation of such equipment as missiles and rockets, as well as testing of men and materials in these simulated environments.

At the time of his death, Dr. Vigness was Head of NRL's Shock and Vibration Branch. He had made extensive contributions to naval engineering through pioneering research in this field. He initiated, directed and conducted far-reaching studies in the analysis, measurement, and simulation of mechanical shock and vibration.

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Frontiers in Corrosion Science

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Metallurgy Branch
Office of Naval Research

The United States Navy maintains a vigorous program of basic corrosion research, both in-house and contract-supported. This program is currently undergoing a surge of increased activity due, in large measure, to the hypercritical corrosion associated with the high strength alloys which may be used in future deep submergence vehicles.

The Office of Naval Research has supported corrosion research for the past 20 years, and has had a formal program on surface phenomena since 1950. During the early 1950's, ONR's Metallurgy Branch was a leading supporter of stress corrosion research. However, in the late 1950's, this field seemed to be losing its sense of direction and accomplishment. There seemed to be a lack of ability to get fresh insight into the complex of parameters that determine corrosion reactions. Accordingly, ONR's interest shifted to more basic science, including nucleation and epitaxy on carefully controlled single crystal surfaces. This excursion into surface science dominated the Metallurgy Branch program in the early 1960's.

In the last few years, there has been an increasing awareness that the field of corrosion has not really benefited from many of these specialized studies. Also, there has been an increasing engineering awareness of the limitations on design and material utilization imposed by the sensitivity of certain materials to stress corrosion cracking and hydrogen embrittlement. In these forms of attack, failure is not caused by a mere wasting away of material or by the material's exposure to stresses near its design load. Rather, failure occurs rapidly and without warning under an appropriate combination of stress and corrosive atmosphere. This attack has been aptly named "hypercritical corrosion." It is thus timely for ONR to redirect its attention to the basic phenomena relevant to hypercritical corrosion.

ONR is concerned with a basic scientific input that will provide relevant answers to the engineering problems. A major goal is to couple the results gained from its long-term basic surface program and the new scientific approaches to the large engineering program now underway. The coupling problem is not unique to corrosion—it exists in almost any technological enterprise where there are basic scientific principles. However, the engineering practice involves such a complex of parameters that it is often difficult to employ these scientific principles.

The Advanced Research Projects Agency has long been concerned with the problem of speeding up coupling processes in areas of interest

to the Department of Defense. Accordingly, to meet the critical need of coupling in corrosion, ARPA named the Naval Research Laboratory last year as a prime contractor to direct a three-year or longer program* on stress corrosion cracking of high strength alloys. Other contractors are Boeing of Seattle, Lehigh University, Carnegie Institute of Technology, and Georgia Institute of Technology. The program, which spans disciplines from basic surface studies to philosophies of mechanical testing, will acquaint academic participants, especially students, with the challenges of applied research in fulfilling an important military goal. The participants and their areas of interest are:

Naval Research Laboratory	Electrochemistry, surface chemistry, oxide films, hydrogen diffusion, cracking mechanisms, electron fractography, low-cycle fatigue, fracture mechanics concepts, and strain hardening
Boeing	Generation and computerization of mechanical test data, test translation, selection and characterization of high-strength alloys, advanced testing concepts, phase transformations, and electrochemistry
Lehigh University	Fracture mechanics and surface chemistry
Carnegie Institute of Technology	Surface physics, cracking of austenitic steels, plastic deformation, crack propagation kinetics, and ceramic materials
Georgia Institute of Technology	Stress-corrosion cracking model and low-energy electron diffraction

The Washington Corrosion Dialogue

ONR, in conjunction with NRL and the National Bureau of Standards, sponsored a Symposium on the Coupling of Basic and Applied Corrosion Research at Washington in March 1966. This two-day symposium, sometimes referred to as the "Washington Corrosion Dialogue," attracted 350 people, about evenly divided between basic and applied researchers. The meeting was motivated in part by the realization that both researchers and supporters seemed to be ignoring

*This ARPA program is described in more detail in NRL Memorandum Report 1739, Dec. 1966

corrosion research; rather, they were turning to more glamorous fields, *e.g.,* lasers and microelectronics. Also, overall progress in the field appeared to be limited by a lack of communication between the applied and fundamental workers.

After a number of sessions on various aspects of corrosion, a panel was convened to examine several factors which have limited progress in the field. The following areas were discussed:

- Decline of corrosion education and research in universities. Government agencies have claimed for years that adequate funds have been available to support corrosion research. However, imaginative proposals have not been forthcoming, indicating a lack of interest in this field and a decline in both corrosion education and research in universities. The question was raised as to whether this was a true picture, or whether, in fact, allocation of funds in other areas by government agencies has inhibited expansion of fundamental corrosion research activities in universities. The consensus indicated that although interest in corrosion research had been on the decline, there is increasing interest by universities in this field.
- Diversification of corrosion research. There is great difficulty in classifying corrosion research. Current disciplinary pressures of chemistry and physics of surfaces, electrochemistry and electrode kinetics, metallurgy, and solid state physics have so diversified and fragmented the field that it can no longer be neatly packaged and labelled.
- The uncertainty concerning corrosion research. The field of corrosion research appears to have reached a point at which no major new leads or paths are being uncovered and where most or all readily identified basic approaches have been sufficiently explored. All that remains appears to be the complex problems of studying heterogeneous systems or characterizing the atomic nature and topography of a surface, the delineation of active sites, *etc.* If this is the case, an onslaught of new critical ideas either directly in or tangential to corrosion science may be required. Also, new sophisticated instrumentation and high resolution techniques may be required to permit a fresh attack on some areas of corrosion research.
- Results of corrosion research. A survey made some years ago indicated that cathodic protection was one of the few protection developments that had resulted directly from corrosion research. Further, it appears that corrosion research has not significantly contributed to the mitigation of corrosion damage in recent years. A consensus indicated that corrosion science has had too little impact for the amount of funds invested. As a result, many industries are reducing the size of their programs in this field or redirecting their efforts.

Comments from the floor after the panel discussion indicated that the field must improve its image in order to attract people with fresh ideas

and new approaches. Because of the complexity of engineering alloys and corrosive environments, it is difficult to conduct phenomenological research of direct relevance to the corrosion process. Also, corrosion research is a "defensive" enterprise aimed at solving known problems. Thus, studies of basic phenomena are not likely to lead to new technologies as is the case in solid state physics and electronics.

Corrosion research is also largely a derivative technology. Advancement in the fundamentals is generally dependent on advances in other sciences (optics, vacuum physics, high-purity materials, *etc.*). Corrosion technology often advances in direct response to a practical need, *e.g.,* the advent of nuclear power reactors and high-strength alloys for aircraft and submersibles led to a large increase in the number of publications in stress corrosion.

ONR's Program in Corrosion Research

The ONR contract research program in corrosion research, which has generally increased in the last few years, is attempting to look for unconventional approaches to the problem. In programs begun this fiscal year, emphasis has been placed on research on the characterizations of films that form on free metallic surfaces. It is felt that much of the corrosion research performed in the past has been overconcerned with either alloy structure or electrochemical considerations. The influence of environment on corrosion and stress corrosion has been relatively neglected.

The study of films has not attracted researchers in the past because of the difficulty in handling films and the inability to correlate bulk and film properties. However, such studies are necessary in order to really understand corrosion. For instance, it appears that the formation and rupture of thin oxide films play an important role in the propagation of stress-corrosion cracks. This hypothesis, originally advanced a decade ago, may well explain cracking mechanisms in several systems. Also, recent work done at the Research Institute for Advanced Studies on the cracking of brass in ammonia solutions indicates the importance of a tarnish film. Further work on morphology, defect structure, electron and mass transfer, and mechanical and optical properties of these films is needed.

In a program being conducted at Yale University, with partial ARPA support, low energy electron diffraction (LEED) is being used to examine several alloys, *e.g.,* Au-Cu, Ni-Cu, of metallurgical interest. Considerable metallurgical information is already available on these alloys, partly as a result of previous work supported by ONR at Yale. The task is to correlate electron diffraction behavior with metallurgical structure. The alloys have to be selected for compatability with LEED

experiments: they must be homogeneous, have smooth equilibrium surfaces, have component elements with markedly different chemical reactivity, and, finally, they must not vaporize in ultra-high vacuum. This last requirement eliminates zinc alloys such as brasses from consideration.

Studies on the characterization of passivity by ellipsometry (optical) and electrical (impedance) studies are being conducted jointly at the Universities of Alabama and Waterloo. The program at Alabama, by studying electrical transport through passive films, is expected to provide a means of characterizing the optical properties of these films. Work done at the University of Waterloo in this area has shown the existence of two passive film layers on iron.

Plastic deformation in corrosion products is being studied at the Virginia Institute for Scientific Research at Richmond, Va., and the Stanford Research Institute. The lack of any plastic deformation in the corrosion product should lead to scaling and cracking, thus opening a path for the corroding medium to reach the metal surface. Little is known at present about the intrinsic ductility of metal oxides, particularly in thin films; the requirements for matching ductility in oxide and substrate; and means of increasing ductility. Oxide films are also being examined at the Pennsylvania State University.

Certain high strength aluminum alloys show considerable promise as naval structural materials. However, they also show a propensity toward stress corrosion at the higher strength levels. To learn the causes for this phenomenon, ONR is supporting programs at the Research Institute for Advanced Studies at Baltimore and at the Cornell Aeronautical Laboratory. The program at RIAS will examine the role of the so-called precipitate-free zone in the delayed fracture of these alloys. The program at Cornell will attempt to characterize the mechanical behavior of single crystals of these alloys grown by the strain-anneal method. Although the mechanical and environmental properties of these alloys appear to be determined by the grain boundaries, data on single crystals will provide a proper frame of reference.

The ONR-sponsored program at Midwest Research Institute at Kansas City, Mo., is an attempt to extend some empirical observations that the reflection of acoustical waves from a metallic surface is dependent on the surface conditions. By making these acoustical measurements on metals and alloys whose surfaces have been well characterized metallurgically, it may be possible to obtain more control over surface degradation.

Some aspects of stress corrosion cracking from an applied mechanics point of view are being examined at the Southwest Research Institute in San Antonio, Texas. In particular, cracking of deep-diving structures is being examined.

These are a few of the programs in corrosion research currently being sponsored by ONR. Pursuit of this blend of traditional and somewhat speculative studies should help keep the Navy in the forefront of corrosion science and technology.

Other fundamental corrosion studies are being supported by the Navy Material Command. Also, significant in-house studies in this area are being conducted by the Naval Research Laboratory; the Naval Civil Engineering Laboratory; the Naval Ship Research and Development Center, Annapolis Division; and the Aeronautical Materials Laboratory.

With this across-the-board resurgence of interest in basic corrosion problems, it is hoped that new talent will be drawn into the field and stimulate even greater advances. The first Washington Corrosion Dialogue served to point out the many factors which have limited the importance and influence of corrosion research. It is hoped that in a few years a second Dialogue will be held to examine the great strides that have been made in the basic understanding of the deterioration of metals.

Underwater Seismic Experiments to be Conducted

The Navy has scheduled an underwater seismic test off the Aleutian Islands in Alaska for mid-August. This test is a continuation of those being conducted by the Navy as part of the Advanced Research Projects Agency's VELA UNIFORM seismic research program.

The Office of Naval Research will detonate 1000 tons of obsolete conventional explosive material at a depth of 4000 feet at a site just south of Amchitka Island. The deteriorated explosives are contained in old mines, torpedo warheads, and other obsolete ordnance. The cargo will be sunk in the hull of the World War II Liberty Ship SS ROBERT L. STEVENSON. The ship will be towed to the site from the Naval Ammunition Depot at Bangor, Washington and then scuttled.

The underwater test will provide data for the VELA UNIFORM research program designed to study the techniques of and improve the methods for detecting and locating underground and underwater explosions. Results of the test will complement the information obtained from earlier tests. A similar test was conducted a year ago about 78 miles off Cape Mendocino, California.

These VELA UNIFORM experiments utilize the Navy's obsolete ammunition disposal program, "CHASE." This program was developed by the Naval Ordnance Systems Command for deep water disposal of obsolete ordnance in ship hulls authorized for destruction. Previously the ordnance material was carefully packaged and jettisoned at sea. The disposal program was coordinated with ARPA's VELA UNIFORM research program in order to obtain seismic research data at low cost.

Test plans have been coordinated with the Alaska Department of Fish and Game and the U.S. Bureau of Commercial Fisheries in order to minimize interference with shipping, fishing and other marine interests. Effects of the underwater detonation will not be noticeable on adjacent coastal areas, except on special recording instruments.

Safety patrols and notices to mariners of the northern Pacific test area will be made by the U.S. Coast Guard. Observers from the Bureau of Commercial Fisheries and the Alaska Department of Fish and Game have been invited to monitor the test. A Coast Guard cutter will be on patrol station at the test site.

Sleep and Sleep Loss-
Their Effect on Performance

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How much sleep does a man need? Is one kind of sleep "better" than another? What work-rest sleep schedule is best in situations of extreme mental fatigue?—in situations of extreme physical fatigue? What tasks are most resistant to the damaging effects of chronic sleep loss and fatigue? These questions and others concerned with the effects and alterations in waking-sleep cycles are part of a research task currently underway in the Psychophysiology Division, Navy Medical Neuropsychiatric Research Unit, San Diego.

In preparation for this research effort, a conference on sleep loss and the recuperative effects of the various stages of sleep was held May 20-21, 1966, in San Diego. Funds for this conference, which was jointly sponsored by the San Diego State College Foundation and the Navy Medical Neuropsychiatric Research Unit, were provided by the Physiological Psychology Branch, Office of Naval Research. Participants in this small working conference were selected for their demonstrated competence in the areas of sleep research and the effect of sleep loss.

This article presents a summary of some of the areas discussed at the conference. The following paragraphs are included as a brief introduction for those not familiar with the field of sleep research.

Stages of Sleep

It has been generally believed—by laymen and scientists alike—that sleep is a continuous steady state. However, a study made in 1937 indicated that brain wave patterns of sleeping subjects could be classified into five stages.* The electroencephalograph (EEG) patterns associated with these stages varied from the low voltage brain wave pattern seen with sleep onset to the high voltage one cycle-per-second waves seen during what is called "slow-wave" sleep. The continual shifting in the sleep stages during the night was attributed to external or presumed internal stimuli. The cyclic nature of the sleep stages was not emphasized.

*Loomis, A. L., Harvey, N., and Hobart, G. A., "Cerebral States During Sleep as Studied by Human Brain Potentials," *J. Exp. Psychol.*, 1937, 21, 127-144.

In 1953 another sleep phenomenon—rapid eye movements (REMs)—was the subject of a report.* It was found that REMs were associated with a low voltage EEG pattern very much like that seen during sleep onset. Also, during this REM stage of sleep, the subject was most likely to report dreaming. This REM plus low voltage EEG pattern usually first appeared 60 to 90 minutes after sleep onset and then reappeared approximately every 90 minutes. In 1957, a report of the currently accepted classification of sleep stages, including stage 1-REM, was published.† These stages are shown in figure 1.

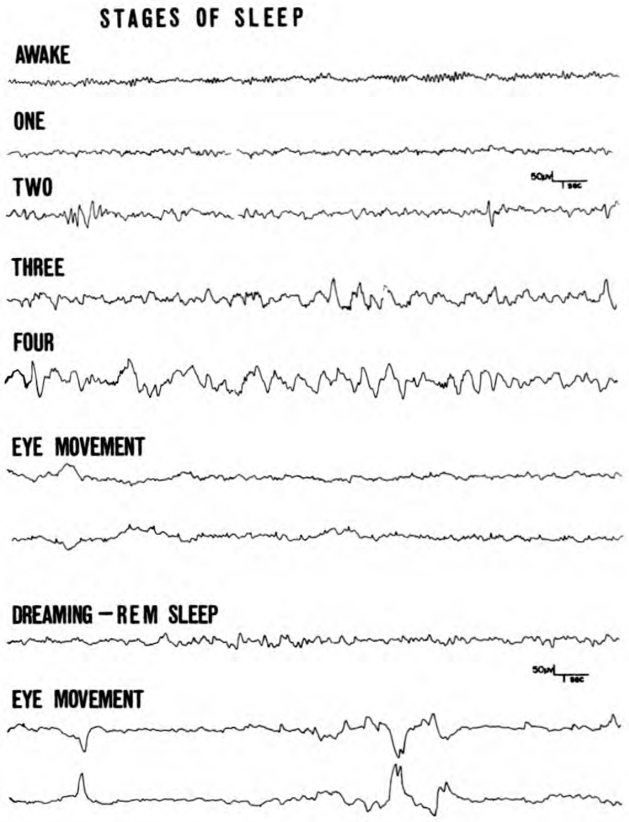

Figure 1 — Dement-Kleitman classification of stages of sleep utilizing EEG and eye movements. The eye movements at the bottom of the figure are the rapid eye movements seen only during stage 1-REM sleep.

The last ten years have witnessed an information explosion on the cyclic nature of sleep stages and the mental, biochemical, and physiological activity that occurs during sleep. During a night's sleep, it has been found that a person goes through a very regular pattern. This pattern is shown in figure 2. As indicated, the subject begins with stage 1, goes on to stages 2, 3, and 4, and then back to stage 2 again. About 60 to 90 minutes after sleep onset, he usually goes from stage 2 to stage 1-REM, his first dream period. He will then return to stage 2,

*Aserinsky, E., and Kleitman, N., "Regularly Occurring Periods of Eye Motility and Concomitant Phenomena During Sleep," *Science*, 1953, 118, 273-274.

†Dement, W. C., and Kleitman, N., "Cyclic Variations in EEG During Sleep and Their Relations to Eye Movements, Body Motility and Dreaming," *EEG Clin. Neurophysiol.*, 1957, 9, 673-690.

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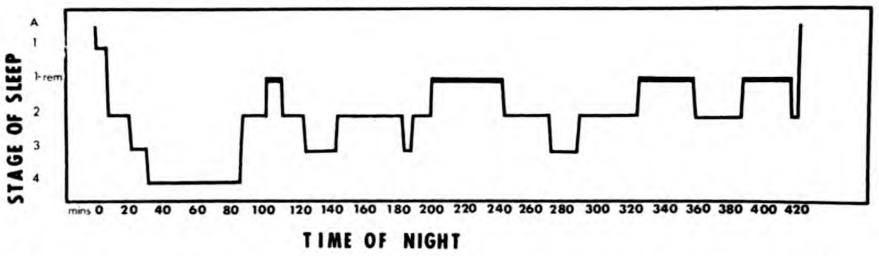


Figure 2 — Pattern of sleep illustrating the cyclic nature of the various sleep stages.

possibly go on to stage 3, back to 2, and then to 1-REM again. After this second dream period, the subject will go back to stage 2.

As shown in figure 2, the periods of slow wave sleep (stages 3 and 4) disappear as sleep continues. Instead, there is an alternation of stage 2 and stage 1-REM sleep. It is very unlikely that a subject will enter stage 1-REM or the dream period from any stage but 2. Thus, those researchers interested in slow wave sleep are primarily concerned with the first third of the night, and those concerned with 1-REM sleep concentrate on the last third. The average sleeper spends 6 percent of his sleep time in stage 1, 50 percent in stage 2, 7 percent in stage 3, 16 percent in stage 4, 20 percent in stage 1-REM, and about 1 percent in body movements.

The Conference

One of the conference participants, Dr. Wilse Webb of the University of Florida, Gainesville, reported that he and his staff have found that the sleep pattern illustrated in figure 2 is difficult to manipulate. A subject will follow the pattern whether he first goes to sleep at 6:00 p.m. or 6:00 a.m. Further, if he is awakened at 6:00 a.m. and allowed to go back to sleep after an hour or so, he will continue with his normal early morning sleep pattern, *i.e.*, an alternation of stage 2 and stage 1-REM. If, however, he is awakened at 6:00 a.m. and allowed to stay awake until the afternoon hours, it is highly probable that stage 2 sleep will be followed by slow wave sleep—stages 3 and 4—instead of stage 1-REM. Thus, the sleep pattern appears to continue over the 24-hour period, with the complete cycle repeating itself after a period of time. The waking time interval necessary before slow wave sleep reappears in the cycle has not yet been determined.

Dr. Webb also reported that attempts to push slow wave sleep into the second half of the night and to accelerate the appearance of stage 1-REM were not successful. Also, when subjects who normally sleep 7-1/2 hours per night were put on a fixed 3-hour sleep schedule for 7 nights, these 3 hours of sleep followed the same pattern as the first 3 hours of the normal 7-1/2 hours of sleep. Regardless of the duration of sleep, the pattern remains the same. In a 3-night study of 40 subjects,

Dr. Webb reported that 85 percent showed less than 6 percent variation in their 1-REM stage sleep time.

Other conference members supported the findings reported by Dr. Webb. They agreed that sleep patterns appear to be locked in biologically and are difficult to shift.

Sleep is no longer viewed as a quiet period where mental and physiological activity diminishes to a low ebb. The process of going to sleep itself is now viewed by many as an active process brought about by increased neuronal activity of certain subcortical centers. It is well established that, as one passes through the various stages of sleep, there is a fluctuating pattern of increasing and decreasing mental and physiological activity.* Figure 3 illustrates the fluctuations that occur in four autonomic variables during a night's sleep.

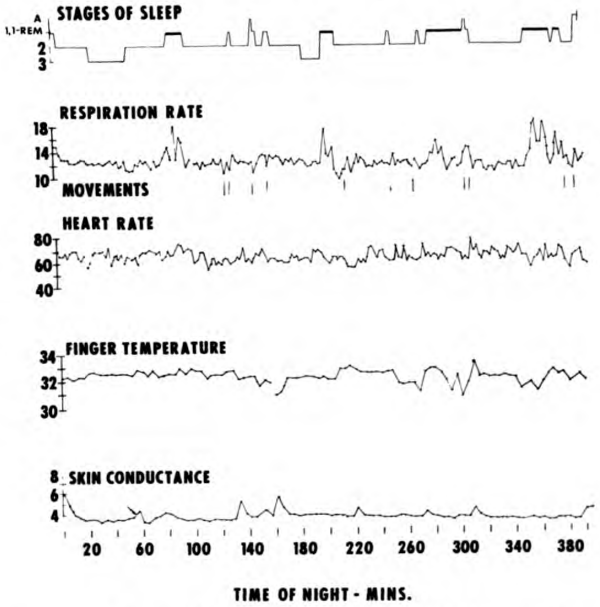


Figure 3 — Typical fluctuations in autonomic activity from one subject during a night of sleep. Note the marked increase in respiratory rate during stage 1-REM sleep and that the rate or level of activity during sleep of each variable often equals or exceeds the presleep rate of levels.

It has been found that most mental activity associated with dreaming occurs during stage 1-REM sleep. Many sleep researchers believe that the eye movements during this period of sleep reflect visual scanning associated with dream content. However, recent research has cast doubt upon this hypothesis, and there is an increasing number who feel that REMs are triggered by neurophysiological mechanisms independent of dream content. All agree that during 1-REM sleep there is increased variability in heart rate, respiration rate, finger temperature (see figure 3), and blood pressure. Although this increase in physiological activity formerly was associated with the emotional content of the dreams, recent research casts doubt upon such a simple explanation.

Stage 1-REM sleep has been the most studied period of sleep, primarily because of its association with dreaming. However, it has now

*Johnson, L. C., "Spontaneous and Orienting Responses During Sleep," Navy Medical Neuropsychiatric Research Unit Report No. 66-9, Jan. 1966.

been found that slow wave sleep—stages 3 and 4—and stage 2 sleep also have unique physiological correlates. During slow wave sleep there is an outpouring of spontaneous electrodermal discharges which exceeds that seen in the waking state. Stage 2 sleep is characterized by EEG bursts of sleep spindles, 12-14 cycle-per-second EEG waves, and K-complexes (a sharp wave followed by a slow wave). The K-complex is often followed by an increase in heart rate, vasoconstriction, and changes in electrodermal activity. Although this autonomic pattern is similar to that following bursts of rapid eye movements during stage 1-REM sleep, no one has associated K-complexes with dream content. Sleep is clearly a very active period with a very ordered pattern of physiological activity that follows a definite cycle from sleep onset to awakening.

Sleep Deprivation and Sleep Loss

Many hours of discussion were devoted to the significance of each stage of sleep with respect to waking behavior. However, few data are available. Selective deprivation of stage 1-REM sleep or stage 4 sleep has been the usual research approach. However, this approach poses many problems, with perhaps the biggest problem being the increasing insistance of the subject's attempts to enter the deprived stage of sleep. The usual procedure for sleep-stage deprivation is to sound a bell, call the subject's name, and apply a brief electrical stimulus when the EEG indicates he is entering the sleep stage of which he is to be deprived. On the first night, mild stimuli with few presentations are sufficient to move him out of that stage. However, by the end of the fifth night, almost continuous stimulation is necessary. Also, there is the problem of depriving the subject of one stage of sleep without interfering with the other stages.

Earlier reports that deprivation of 1-REM sleep would produce marked psychological changes have not been supported. Dr. William Dement and his staff at Stanford University conducted experiments with animals to study the neurophysiological and behavioral changes produced by both brief and prolonged stage 1-REM deprivation. Results of this work indicated that deprivation of 1-REM produces an excitatory effect while deprivation of slow wave sleep produces a depressive effect.

In this area, Dr. Webb noted that his human subjects who had been deprived of stage 4 sleep for 5 days were lethargic and wished the experiments were over. He said they acted as though they had been deprived of one night of total sleep.

Although there are few data regarding the effects of selective sleep stage deprivation, there are some well known effects of total sleep loss. One result of the increased study of this area has been to correct the

previously held belief that extensive sleep deprivation would inevitably result in marked behavioral changes, often including hallucinations and paranoid delusions. Although one subject was kept awake for 264 hours, no marked psychological changes occurred. Other studies reported only minor changes after 200 and 125 hours of sleep loss. Whether sleep loss will result in psychological changes appears to depend upon the age of the subject (the younger subject has more resistance), his psychological and physical health before the ordeal, and the expectations and support given by his environment.

Sleep loss, however, does produce changes in performance, with the nature and extent of such changes depending upon several factors. After prolonged sleep deprivation, the primary impairment takes the form of lapses. The subject is unable to maintain efficient behavior and increasingly experiences short periods when performance falters or stops. In general, when he can control the display of stimuli and the rate at which he will respond, his performance suffers less. Speed may be impaired but accuracy will be maintained. However, in work-paced tasks where the subject cannot control the time of appearance or duration of the stimulus display and must respond quickly, lapses will cause an increase in errors of omission.

Under acute sleep loss, sending orders (a subject-paced task) results in fewer errors than receiving and sending out orders (work-paced task). Tasks with strong incentive qualities and of brief duration suffer less than tasks which are long and repetitive in nature. Immediate knowledge of results helps to overcome the effects of sleep loss. It is also well established that performance during the sleep loss period follows a diurnal cycle: the best performance usually occurs in the evening and the poorest around dawn.

Another question discussed at the conference was the amount of sleep a subject needs to maintain his usual level of performance. Dr. Robert T. Wilkinson of the Applied Psychology Unit, Cambridge, England presented data on this question. He conducted tests on British sailors, allowing them either 1 hour, 2 hours, 3 hours, 5 hours, 7-1/2 hours of sleep—or no sleep at all. After these various sleep periods, he evaluated their performances on an hour-long vigilance test (detecting changes in tone intensities) and on an addition test. The performance decrement on the vigilance test was the same whether the subject received no sleep, 1 hour, or 2 hours of sleep. After 3 hours of sleep, however, a difference *was* seen, and the performance level continued to increase up to 5 hours of sleep. There was no further improvement if the subject received 6 or 7-1/2 hours of sleep.

In the addition task, 1 hour of sleep did give an improvement over the no-sleep condition, and there was a gradual improvement with increasing amount of sleep up to 3 hours. However, the performance after 5 or more hours of sleep was not significantly greater than that

after 3 hours. The length of time a person could continue to perform at the expected level with 1, 2, 3, or 5 hours of sleep has not been determined.

The closing session was devoted to future research efforts. Dr. Harold Williams, of the University of Oklahoma, said that more attention must be put on tasks that are similar to actual work or duty assignments. He feels that laboratory studies suffer from the artificiality of built-in motivational variables and often have limited applicability to field situations. Dr. Williams, in emphasizing the importance of examining the carryover effect of repeated periods of sleep loss over a long time, raised the following questions:

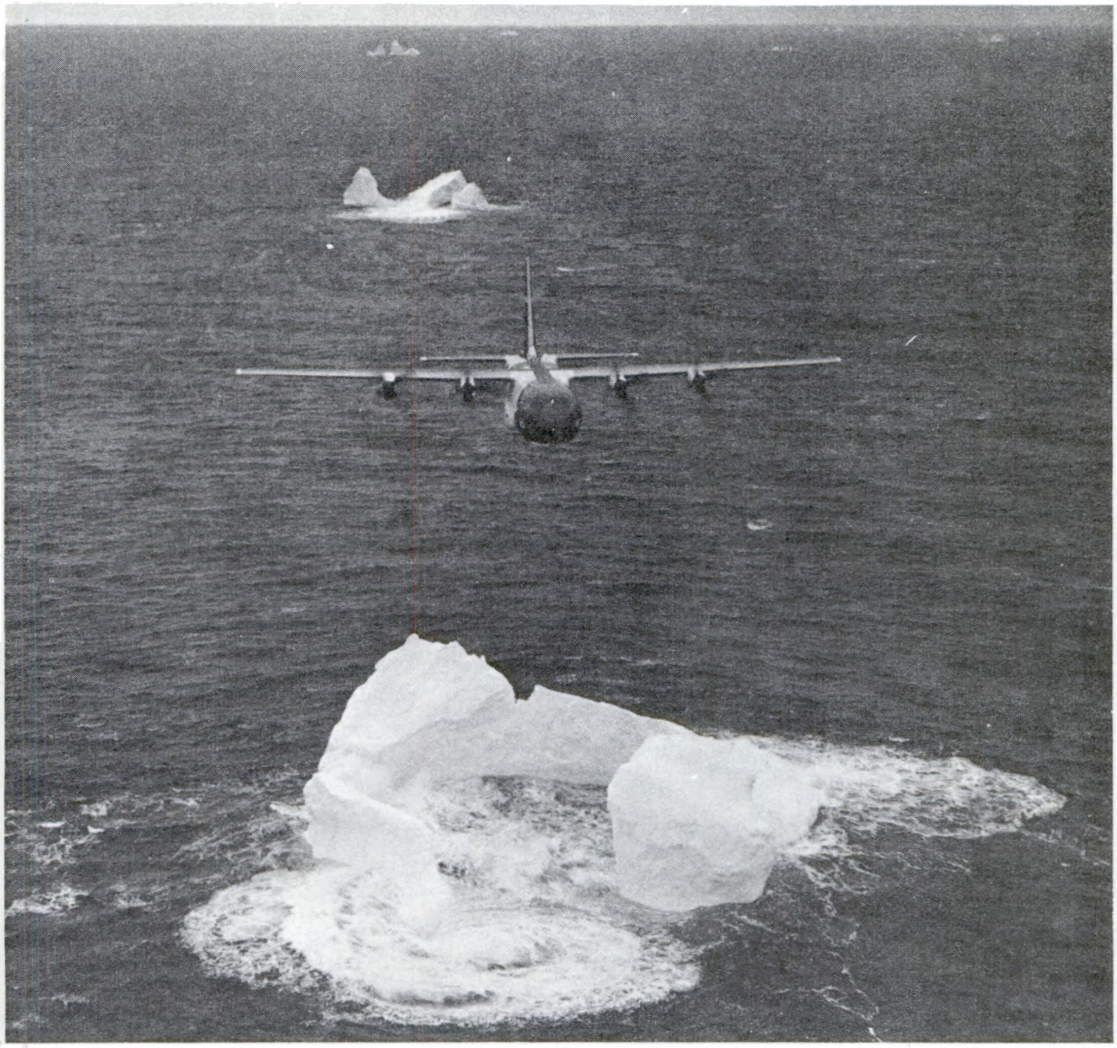
- Do repeated periods of 48 hours of sleep loss separated by 2 or 3 weeks have a cumulative effect?
- What is the optimal recovery period from sleep loss?
- Is the recovery period a linear function of the length of deprivation?
- Would a subject deprived of total sleep or certain stages of sleep show more decrement if he is under severe combat strain or has the responsibility of making crucial decisions?
- Could selective sleep-stage deprivation be used to motivate or control behavior?
- If a subject were promised a certain type of sleep only after performing certain acts, would this be more effective than total sleep loss which eventually results in total collapse? In this context, stages of sleep are viewed as motivational states. It is conceivable that they could prove to be a very forceful tool for shaping behavior.

In the final session, brief mention was also made of the biochemical factors involved in sleep and sleep loss, and the obvious importance of monitoring these factors in any studies of sleep and sleep loss.

In the past decade, the mysteries of sleep have been examined and found to fit into an organized pattern well suited for scientific study. The May conference highlighted not only the growing body of data on sleep but also the paucity of data on the relation of the various sleep stages to the waking economy. The leading sleep laboratories were able to pool their collective research experience and open up avenues for collaboration in order to help man use his sleep more efficiently to make him more effective when awake.

A Conference on High Frequency Generation and Amplification will be held at the School of Electrical Engineering, Cornell University, Ithaca, N. Y., August 29-31. Additional information on this conference, which is sponsored by ONR, may be obtained from Dr. H. J. Carlin, Cornell University.

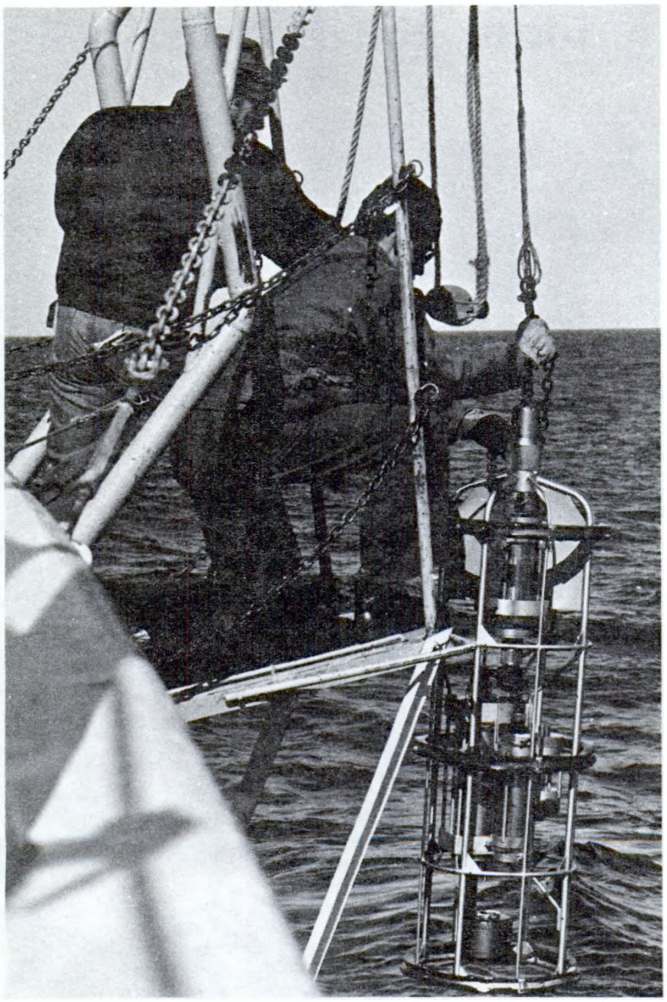
The International Ice Patrol



Since World War II, the major part of the Ice Patrol's work of hunting and tracking icebergs has been performed by aircraft rather than by ships. In this view, a Coast Guard HG-130-B "Hercules" Ice Patrol plane is hedge-hopping a row of icebergs spotted off the Coast of Labrador.

The U. S. Coast Guard's International Ice Patrol—now in its 53rd year—is the world's most successful international collaboration in the cause of safety at sea. Shortly after the loss of the TITANIC in 1912, the First International Safety Conference was held in London. The Conference recommended the formation of an International Ice Observation and Ice Patrol Service to be administered by the United States. In 1914 responsibility was delegated to the U. S. Coast Guard.

Every year since then, except for intervals during the first and second World Wars ships and aircraft of the U. S. Coast Guard have waged their annual war against the North Atlantic iceberg menace. In the



Constant probing for knowledge of the ocean currents—which greatly influence iceberg movements—is important to the Ice Patrol's predictions and tracking plots for iceberg seasons.

A Salinity Temperature Depth Sensor system was used for the first time by the Coast Guard oceanographic vessel EVERGREEN on a 1966 post-season Ice Patrol mission to determine if the source of the Labrador Current is formed in the Hudson Strait. Here, crewmen secure the Sensor on the EVERGREEN's platform as it is hoisted by cable and winch from the depths of the Hudson Strait.

The Sensor system instantaneously records readings of salinity, temperature, and depths down to 1,500 meters. Data from the special analog computer located in the upper cage of the Sensor passes through the conductor cable attached to the winch, and on to a recorder in the ship's laboratory.

modern Patrol, ice reconnaissance is carried out by Coast Guard aircraft deployed from their permanent base at Elizabeth City, N. C. to Argentia, Newfoundland. The Patrol's administrative quarters is in New York City. Ice surveillance starts early in March and continues throughout the ice season, usually through June or July.

Over the years, the Patrol has taken on an increasingly scientific character. Today it uses all of the techniques of modern science in accomplishing its task. Besides keeping a lookout for floating icebergs, the Patrol serves as a major source of information on the phenomena of northern waters.

In 1967, Coast Guard oceanographers are attempting to link present iceberg detection techniques with the existing weather satellite photo reconnaissance. Through a transceiver which has been installed in New York, the Coast Guard receives weather satellite photos of ocean areas covered by the Patrol. This information will be combined with data supplied by Coast Guard planes equipped with radiometric iceberg detectors to provide sharper definition and location of the areas under

surveillance. Eventually, the Coast Guard plans to participate in a satellite system which will provide higher resolution for earth phenomena.

The radiometric iceberg detector, developed by Coast Guard and Sperry engineers, is based on the principle that all matter emits electromagnetic impulses of varying intensity. By measuring each "signature," it is possible to determine whether the object under study is ice or some other floating material. Thus, through a combination of two highly advanced techniques, the science of ice detection has been brought into the vanguard of modern technology.

Coast Guard oceanographers will also continue to study the Gulf Stream and Labrador Currents in an effort to increase their understanding of the forces which influence the drift of the huge ice islands. They will also continue their studies of North Atlantic waters through sampling, salinity measurements, analysis of marine organisms, and other aspects of oceanic investigation. Other means of keeping icebergs under surveillance include using large oceanographic buoys to monitor the ocean currents, and marking icebergs with brightly colored calcium-chloride "bombs." The objective of the iceberg-staining experiment is to develop a type of marking which will last for an extended period, thus facilitating iceberg tracking.

The Coast Guard's weather ships in the North Atlantic back up the work of the Ice Patrol. During their patrols in the North Atlantic, the cutters not only transmit weather and other meteorological data to transoceanic ships and planes, but also conduct marine studies. Information obtained by these ships is of great value in studying the drift patterns and rate of deterioration of icebergs.

Observations made by the Ice Patrol and the weather ships are being processed through a computer. The resulting data will be employed in the construction of a dynamic model of the North Atlantic, which should prove helpful in solving iceberg detection and surveillance problems.

Mr. Buchanan Receives Superior Civilian Service Award

The scientist who headed the Naval Research Laboratory's effort in recovering the H-bomb lost off the coast of Spain was honored on May 11 for his part in last year's operation.

Mr. Chester L. Buchanan, Head of the Laboratory's Deep Sea Research Branch, was presented the Navy's Superior Civilian Service Award during the 4th U. S. Navy Symposium on Military Oceanography held in Washington, D. C.

Mr. Buchanan was particularly honored for his role as NRL's Chief Scientist aboard the USNS MIZAR, a research vessel which was instrumental in the final recovery of the weapon.

Visit to a Russian Arctic Station

Ned A. Ostenso
ONR Branch Office
Chicago, Illinois

The Office of Naval Research's Arctic Research Laboratory, operated under contract with the University of Alaska, has supported a research program on Ice Island T-3 (Fletcher's Ice Island) since early 1962 (see *Naval Research Reviews* issue of October 1966, "Arctic Basin Research"). In addition, since 1960, ONR has funded an airlifted gravity survey of the Arctic Ocean Basin conducted by the University of Wisconsin.

The Russians, through their Arctic and Antarctic Research Institute, have supported similar programs. They have maintained continuous occupancy of at least two drifting stations since 1954. Their airlifted survey, or "flying laboratory method," as they call it, was initiated in 1941. Although this program was interrupted by the war, it was renewed in 1954 and has subsequently steadily increased in size and scope.

The Soviet and U.S. airlifted surveys differ in several important respects, the foremost of which is the relative magnitude of effort. The Russians utilize scores of planes and helicopters of various capability, whereas the U.S. survey uses a limited number of Cessna 180 single-engine aircraft, usually flown in pairs. This contrast in committed effort reflects another major difference in the two programs—the Russian study is a national program and the U.S. survey is largely university-contracted research financed by ONR. Also, because of the small aircraft used, the U.S. has been constrained to operate primarily from shore bases of northern Alaska and Canada, with limited operations from drift stations. In contrast, the Soviets establish a major support station on the pack ice every spring which serves as a focus of aircraft operations during the flying season of March through May. This temporary Soviet station is moved from year to year to provide eventual coverage of the entire Arctic Basin. Studies conducted by the Soviets reportedly comprise a host of programs including geophysical, meteorological and oceanographic.

This year the U.S. gravity study has an added capability. Through cooperative support from the Gravity Division, Army Map Service, three helicopters were obtained from the U.S. Army Transportation Center at Fort Eustis, Virginia. By using these helicopters, plus the satellite navigation facilities established on T-3, it was possible to move operations onto the ice island and take full advantage of its central position in the Arctic Basin (79°N, 175°W). The helicopters were also able to provide valuable support to a number of other scientific programs on the island. They were ferried to T-3 by Air Force C-124s

An aerial view of T-3 (Fletcher's Ice Island)

on April 10-11, and the fuel was delivered by an Alaska Airlines C-130. Other logistic support was provided, as usual, by R4D aircraft from the Arctic Research Laboratory at Barrow, Alaska.

Russian aircraft activity in the vicinity of T-3 was first noted on March 26. On April 4, one of their survey aircraft landed on the pack ice near T-3 for about an hour to make geophysical observations. A few men walked out to the aircraft from camp, and, despite the language barrier, there was a very cordial exchange of smiles, cigarettes, and gesticulation.

Returning from a supply run to T-3 on April 13, the pilots of the Arctic Research Laboratory's R4D spotted a large Soviet temporary station on old floe ice at 76°40′N, 164°40′W. This position, nearly directly in line between T-3 and Barrow, was approximately 200 miles southeast of T-3 and 400 miles northwest of Barrow. The station was comprised of approximately 80 huts of various sizes lined along a 4000 ft by 100 ft runway. A shorter landing strip—1000 ft long—crossed the main runway at right angles. At the time two large helicopters and two AN-2 biplanes were on station; a third AN-2 was landing.

The station was equipped with two homer beacons which had elaborate antennae. These beacons, which broadcast at a frequency of 363 kc, used an identifier of BTU—indicating that our colleagues in Arctic research are not without humor. A fracture had already formed through the camp, separating the radio and beacon huts from the rest of the station.

On April 14, the Russian station was again overflown on the supply run to T-3. This time we had prepared a goodwill gift—a box containing cigarettes, candy, a list with the names of those aboard the aircraft, and an invitation to drop in at T-3 for "coffee" any time—and dropped it on the runway.

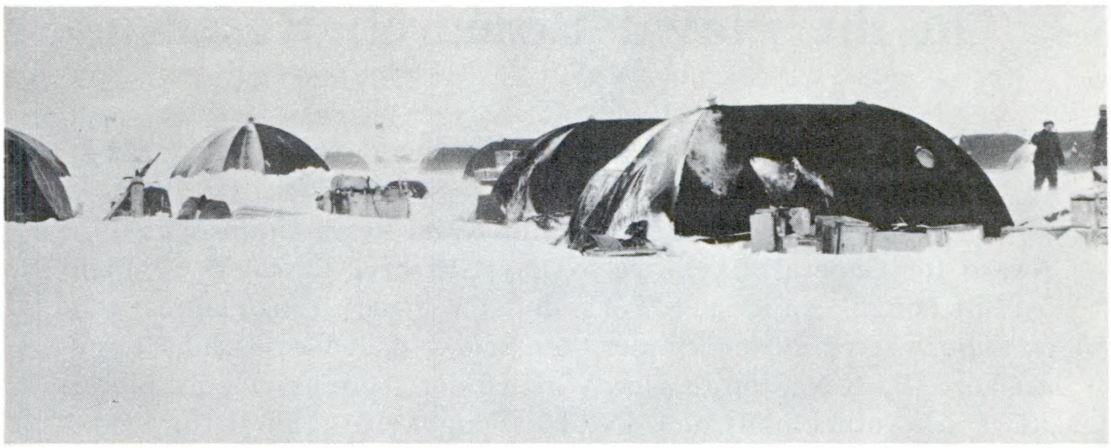
The next day, the R4D pilots Cliff Alderfer and Richard Dickerson landed at the station and delivered five cases of beer. Their arrival was met with great cordiality which included, according to the pilots, a delicious meal and appropriate toasts. Communication was through a single interpreter. Since Dickerson, prior to joining the staff at ARL, had been a Navy pilot in Antarctica with Task Force 43 and many of the Russian pilots had also flown in Antarctica, they had much in common to "talk" about. The interpreter was Dr. A. M. Karasik, a well-known scientist with the Arctic and Antarctic Research Institute. Knowing of my presence on T-3, Dr. Karasik extended an invitation to me to stop in for a visit on my next return to Barrow.

After about two hours, the pilots left, loaded with gifts of delicacies for the table at T-3.

Due to the press of activities on T-3, it was not possible for me to accept Dr. Karasik's kind invitation until April 29. Our party included, in addition to myself, Dr. Max Brewer (Director of the Arctic Research Laboratory), John Beck (Station Manager at T-3), RADM David Tyree, USN (Ret.), and the two pilots, Richard Dickerson and Guy Shepard. RADM Tyree, who had been Commander, Task Force 43 in Antarctica from 1958 to 1962, is currently with the Arctic Institute of North America. He was returning from T-3 where he had been conducting a study of Arctic scientific operations for the National Science Foundation.

Because of the rapid convergence of time zones at high latitudes, it is most convenient to arbitrarily keep station time pegged to the local time of your principal communications and support center. Consequently, we were on Alaskan time and the Russian station was on Leningrad time. Thus, our arrival was inhospitably timed at 6:30 a.m. by our hosts' daily schedule. Despite this unwitting breach of etiquette, our hosts rose to the occasion and feted us in grand style. This included a hastily prepared, but nonetheless excellent, meal, numerous toasts to each other and everything remotely related to Polar research, and a spontaneous babble of conversation. The latter was particularly interesting since the party consisted of six who spoke no Russian, about 30 who spoke no English, and three who spoke both Russian and English. However, the minor problem of not being able to understand each other did not cause any noticeable damping of the gaiety of the occasion.

Dr. Karasik was assisted this time in translating by one of the Russian pilots and a geophysics student from Moscow State University who had a summer job with the Institute. The student, Sergey S. Ivanov, is the son of Dr. Risa Mikailova Demenitskaia, a leading authority on Arctic geology and geophysics. Both Dr. Karasik and the student showed a remarkable familiarity with research reported in western



The huts on the Soviet station were made of insulated canvas stretched over frames to form hemispherical structures

literature. Our discussions showed that they had read articles appearing in *Science* and *Nature* only weeks previously.

I estimated that the station would support a population of at least 300. Since we were informed that about 100 pilots were associated with the program, this guess seemed reasonable.

Every aspect of the Russian operation showed a high degree of professionalism and competence. The equipment, although obviously well used, was of excellent quality and in good repair. The huts were made of insulated canvas stretched over frames to form hemispherical or "bread-loaf"-shaped structures somewhat similar to our Jamesways. Electrical power apparently was used only for the radios and beacons; the huts were heated and lighted by bottled gas stoves and lanterns. Individual clothing appeared to be of much higher quality than that normally found on American polar stations. Liberal use had been made of leather and furs.

The ages of the residents ranged from students to men in their early fifties. There were many more men in the post-thirty age group than usually found at a U.S. station. I got the impression that most of the residents were long-term employees of the Arctic and Antarctic Research Institute. Unfortunately, Dr. Aleksei Fedorovich Treshnikov, Director of the Institute, had left the station only three days before.

The spirit of our visit was reflected not only by the Soviet hospitality but also by a letter from the Chief of Naval Research which we delivered. This letter complimented the Soviets on their work in the Arctic and invited an exchange of visits between the Soviet and U.S. Arctic drift stations. Unfortunately, a very heavy work schedule, already delayed by the worst Arctic flying weather on record, prevented the Soviets from returning our visit.

On the Naval Research Reserve

General Excellence Award Presented to NRRC 3-14

RADM J. K. Leydon, USN, Chief of Naval Research, presented the Award for General Excellence to Naval Reserve Research Company 3-14 of Poughkeepsie, New York, on 21 February 1967. To mark the occasion, a reception and dinner were held at the Officers Club, Stewart Air Force Base, Newburgh, New York. Honored guests included officers attached to other units of USNRTC, Poughkeepsie; the Group Commander and Commanding Officer of USNRTC, Poughkeepsie; and representatives of the Office of Naval Research; Commandant, Third Naval District; and Steward AFB. Congratulatory telegrams were received from Governor Nelson D. Rockefeller, Senator Robert F. Kennedy, and Congressman Joseph Y. Resnick.

The highlight of the evening was an informal speech by RADM Leydon. After congratulating NRRC 3-14 on its performance, he noted that the Research Reserve Program is of great value, both to the individual reserve officer and to the Navy. He praised the three seminars sponsored in the past by NRRC 3-14 and expressed the hope that they would be followed by others with outstanding technical content.

RADM Leydon discussed aspects of recent DOD policy and their influence on ONR. In particular, he mentioned the program to place civilians in billets formerly occupied by naval officers. This policy is affecting not only ONR but the entire Naval Shore Establishment. Its net effect is the reduction of the number of trained naval officers that could be available in the event of mobilization for work in R&D areas. The critical issue is the shortage of military officers with high technical capabilities in an era that is witnessing an unprecedented number of technological breakthroughs, many of which will influence military operations. RADM Leydon stated that a continued emphasis on the Research Reserve will help to provide the number of technical specialist naval reserve officers who would be required in the event of mobilization.

RADM Leydon emphasized the unique direct relationship that exists between the Chief of Naval Research and the Secretary of the Navy. He also pointed out that ONR functions as a link between R&D work on the one hand and the ultimate consumer (the Navy) on the other. This direct path of communciation between the R&D projects and the consumer permits a more effective response to military requirements.

The Admiral noted that more R&D work is being done by private industry than ever before. This means in the future even more effective communications between industry and the military will be required.

He believes that the Research Reserve can participate in forging more effective communications links.

Finally, the Admiral noted that there is one piece of "unfinished business" he will turn over to his relief—his desire to see more "in depth" projects and studies undertaken by Research Reserve units in direct support of ONR.

Fourth Naval District Reports
The Princeton Project—Recruiting

Two years ago, after seven involuntary terminations, the membership of Naval Research Reserve Company 4-1, Princeton, New Jersey dropped to 26. An ONR Washington letter of March/April 1965 had already warned that "over one half of the Research Reserve membership are senior citizens." NRRC 4-1 was no exception. The question was: Could NRRC 4-1, much less the Research Reserve, survive as World War II members phased out? This survival became the project of NRRC 4-1. Every member contributed, realizing that failure at the unit level would mean that the entire reserve concept for ONR, the Navy, DOD and even the nation would cease to be a reality.

The book methods of recruiting, as modified to meet our own requirements, were followed. However, the procedures are not important: it is the underlying philosophies which may prove helpful to other units. The World War II officer was allowed several years' absence from the Navy to adjust to civilian life. However, officers today must participate in the Research Reserve soon after release from active duty or damage their records by inactivity.

Three recruitment phases will be considered: personal approaches, university effort, and, most important, work with the semiannual BUPERS Report of Unaffiliated Officers, #1080-103.

Personal approaches are extensive and the most interesting phase of our effort. However, they are actually only a small part of our input. All members, plus others having an interest in NRRC 4-1, *e.g.*, USN and USNR officers in the area on active duty or in a retired status, keep on the alert for officers with a reserve status. For example, a member was recruited within three weeks after his release from active duty as an instructor at the Naval Postgraduate School, Monterey, California when he was employed by a firm in the area. Also, Army and Air Force Reserve members come to us through this means. They do not add to our on-board count. However, official cross-service training orders from their respective headquarters assign them to NRRC 4-1, enabling them to qualify for their own records. These officers contribute to our training program, thus insuring that the points of view of their services are not ignored.

The campus effort of placing announcements and scouring the graduate school rolls has been continued. This source provides one or two officers a year. NRRC 4-1 now has a total of five officers on board who are connected with the university, *e.g.*, graduate student, faculty, or administrator. By this means, two officers whose official addresses are in North Carolina and Colorado were recruited.

The major source of our input has been the BUPERS Report of Unaffiliated Officers, #1080-103, available semiannually through the training centers. The report from our center typically consists of a single page, listing less than 50 officers. Since four Selected Reserve units and an NROS unit use this list as an input source, it is obvious that NRRC 4-1 had to find other sources in order to survive. Thus, contacts were developed with training centers some distance from Princeton. Interestingly enough, on each of the BUPERS reports furnished by these centers, names of officers having an address within reasonable driving distance of Princeton were found. These officers became the major basis of our recruiting effort.

A general letter presenting a simple outline of the NRRC 4-1 program was sent to each of these officers. Immediately after an indication of interest was received, a phone contact was established. As a result, a number of "tourists" visited our drills. However, since less than one half came back to associate with the company, it was apparent that we were rushing our candidates. Thus, the immediate phone contact was eliminated. Instead, another brief outline of the company's activities, uniform requirements, and a diagram showing location is sent. In this way, the officer may search us out if he desires. Thereafter, the officer is kept advised of the specifics of our training program. After the second and third drill notices have been sent, a unit member related by rank, designator, NOBC and/or address is assigned to establish contact by telephone. If this fails, he is continued on our list for several more drills. Finally, a two-way postcard is used that provides him the option of being continued on or dropped from our mailing list.

Officers wishing to be continued on the list are asked by means of a two-way postcard when they expect to visit our drill. At times, explanations of school or work conflicts that may be resolved shortly, along with specific statements of interest, are received. For instance, a Merchant Marine Academy graduate responded that he was on an afloat assignment, but that he was expecting transfer to a shore situation nearby within a matter of months. In another case, an ensign with deferred active duty, pending completion of graduate studies, asked us to check his status. It was determined that, although he was currently in a suspended status, he could become associated with the NRRC program. In so doing, he could qualify for promotion and other benefits just like

post-active duty officers, and possibly qualify for that first half stripe even before going on active duty.

Officers not qualified for research are also recruited when interested, since the District Commandant may permit association when there is no other appropriate program available. Also, the Bureau of Naval Personnel unintentionally assists us in our recruiting when an officer receives his 12-point failee or "get active or out" letter in the same mail as our drill notice. For this reason, we assign first priority to junior unaffiliated officers in a ready status, hoping to save them a break in their service. In many instances, the 12-point failee letter is already on its way before they have had a chance to satisfy employment and home, much less reserve, requirements. If an unaffiliated officer does decide to join our company, after having had the opportunity to first check with his training center, commandant, friends and even draft board, he is ready to work with us and contribute to our unit performance. This contrasts with the officer who has to be coaxed to come and who is likely to create problems for all concerned. A kit of actual letters and cards currently being used by NRRC 4-1 is available to commanding officers of Research Reserve units from the Research Reserve Assistant, First, Third and Fourth Naval Districts, Office of Naval Research, Boston Branch Office, 495 Summer Street, Boston, Massachusetts 02210.

The Research Reserve Program, in contrast to the Selected Reserve Program, offers no direct remuneration to the officers involved. Rather, its training program, under the broad guidance of ONR, is directed towards increasing the technical competence of its officers. Often the civilian and military technical interests of participating officers closely parallel each other. Also, the major university campus facilities used by most research companies is a definite drawing item.

There are currently 49 naval officers on board and others currently in process of joining, proof of NRRC 4-1's ability to recruit post-WW II officers. This number includes four ensigns and 15 junior grade lieutenants—members considered vital to the continuation of NRRC 4-1. Two years ago, seven members participated in active duty for training (ACDUTRA) tours. This year 27 participated—13 for the first time. This increase was accomplished by pointing out that ACDUTRA is both a privilege and an opportunity—an independent type of tour where the individual officer can pick the activity of maximum interest to both himself and the Navy. In so doing, our unit took vigorous exception to the point of view expressed in an article entitled "ACDUTRA—A Reserve's Judgment" published in the March issue of the U.S. Naval Institute Proceedings.

RADM John K. Leydon, USN, Chief of Naval Research, has emphasized that a reservoir of research-oriented officers is becoming more

valuable, especially in view of the civilianization of the regular establishment. It is the mission of the Research Reserve to maintain this reservoir. By intensively combing the BUPERS Report #1080-103 on an extended surrounding basis, unaffiliated officers have been found who were orphans from other programs. If other units can do likewise, the Research Reserve can be strenthened.

Promotion Selections

Two thousand four hundred and five Naval Reserve line officers were selected for promotion to Lieutenant by the Fiscal Year 1967 Reserve Selection Boards. Of this number, 19 Research Reservists were selected.

	NRRC		*NRRC*
Block, Martin I.	12-9	McGovern, Thomas E.	4-1
Coleman, Leslie S.	3-14	Owsley, Thomas L.	6-6
Enderlin, Peter J.	4-1	Reed, Robert M.	13-3
Friedman, Henry S.	4-1	Sartori, Howard J.	8-12
Guberman, Herbert D.	6-3	Sims, "J" Robert	4-1
Henderson, Gary L.	12-6	Sprague, Vance G., Jr.	5-9
Hunter, Roger B.	9-4	Trudell, James R.	12-3
Knorr, Robert J.	4-1	Vince, Michael A.	3-4
Lieberman, Stuart I.	5-10	Womack, Edgar A., Jr.	1-1
McDonnell, Joseph F., III	5-4		

Twelve of the officers selected were from the new field, and seven were from the old field. Other statistics based on the records of the Research Reservists selected for promotion are as follows:

Date of Rank	*Year of Birth*	*Designator*	*Education*
12/5/54 Earliest	1930 Earliest	1105—14	Doctoral Degree—1
6/9/65 Latest	1942 Latest	1315— 1	Bachelors—18
1959 Median	1936 Median	1405— 4	

In addition, selections to Lieutenant Commander and Lieutenant were announced for officers in the Staff Corps. Officers in the Research Reserve were as follows:

Lieutenant Commander, Medical Service Corps

Curtis, Joseph C. NRRC 1-5

Lieutenant Commander, Dental Corps

Thompson, Charles C., II NRRC 13-5

Lieutenant Commander, Civil Engineer Corps

Hall, Joseph C., Jr.	NRRC 6-3
Nifong, Robert L.	NRRC 11-8
Rudich, Harvey (n)	NRRC 6-10
Shank, Roy (n)	NRRC 5-12

Lieutenant, Medical Service Corps

Nelson, Eldon C.	NRRC 8-13

CAPT James C. Matheson Becomes Director of Naval Research Laboratory

CAPT James C. Matheson became Director of the Naval Research Laboratory on May 29, assuming command from CAPT Thomas B. Owen who is scheduled to become Chief of Naval Research.

As Director of the "Navy's Corporate Laboratory," CAPT Matheson will administer a 3300-man complex whose basic and applied investigations have earned it the reputation as one of the world's foremost physical science research laboratories.

CAPT Matheson, 45, former Director of Support Services at the Laboratory, is a graduate of the United States Naval Academy and holds degrees in Naval Architecture and Nuclear Engineering from the Massachusetts Institute of Technology. He has completed the Advanced Management Program at the Harvard School of Business Administration and also studied at the University of Chicago.

A native of Oconomowoc, Wisconsin, the new Director served aboard the submarine DACE during World War II. Prior to becoming Director of Support Services in 1965, he served four years as the Nuclear Power Superintendent at Mare Island Naval Shipyard. He also has been assigned to the Portsmouth Naval Shipyard, the former Bureau of Ships, and the Atomic Energy Commission.

CAPT Matheson is a member of Sigma Xi, the Research Society of America, the Society of Naval Engineers, and the Philosophical Society of Washington. He and his wife, Mary Preston, have a son and three daughters.

Selected Contract Research Reports

The contract research reports listed below have been extracted from the Technical Abstract Bulletins 67-9 and 10 of May 1 and 15, 1967. Government agencies and their contractors who are registered with the Defense Documentation Center of the Defense Supply Agency may obtain *free* copies from the Center at Cameron Station, Alexandria, Virginia 22314. Abstracts of the reports are found in TABs 67-9 and 10.

For non-DDC users, most reports may be purchased from the Clearinghouse for Federal Scientific and Technical Information, Department of Commerce, Springfield, Virginia 22151.

AERONAUTICS

A Study of the Effects of Regular Waves on the Landing and Take-off Distances of a Seaplane; General Dynamics, San Diego; Hopkins; AD-648 848

ASTRONOMY AND ASTROPHYSICS

Observations of Galactic and Extragalactic Emission at 408 Mc/s; The Determination of the Accurate Positions of Radio Sources by the Lunar Occulation Technique; Observations of Emission from Flare Stars; Nuffield Radio Astronomy Labs, Jodrell Bank (England); Haslam *et al;* AD-648 576

ATMOSPHERIC SCIENCES

Determination of D-Region Time Constants for Electron Cooling and Electron Density Profiles from Phase or Amplitude Wave Interaction Measurements; Pa. St. U., Univ. Park; Spielman; AD-648 455

Double Bolometer Measurements of the Effects of Atmospheric Radiators; Wisconsin Univ., Madison; Kuhn *et al;* AD-648 521

Hook Whistler—A New Equatorial Whistler Observed by Injun 3; Iowa U., Iowa City; Gurnett *et al;* AD-648 795

Skyhook 1966; Winzen Research Inc., Minneapolis; AD-649 008

Explorer 12 Observations of Charged Particles in the Inner Radiation Zone; Iowa U.; Ackerson and Frank; AD-649 400

BEHAVIORAL AND SOCIAL SCIENCES

Computer-Assisted Instruction, a Survey of the Literature. Second Edition; Entelek Inc., Newburyport, Mass.; Hickey and Newton; AD-649 335

Associative Rules Governing Recall and Misrecall; Tulane U., New Orleans; Bilodeau and Fox; AD-648 846

The Object Identification Test: A Stress-Sensitive Perceptual Test; Human Factors Research Inc., Goleta, Calif.; Harris; AD-648 999

Further Data on the Relationship of Task Success to Liking and Satisfaction; American Institutes for Research, Silver Spring, Md.; Locke; AD-649 293

Behavioral Assay Procedures for Transfer of Learned Behavior by Brain Extracts; Cornell U., Ithaca, N.Y.; Rosenblatt and Miller; AD-649 408

The Effect of Leadership and Cultural Heterogeneity on Group Performance: A Test of the Contingency Model; Ill. U., Urbana; Fiedler; AD-649 423

Modification of the Conditioned Emotional Response by Treatment with Small Negative Air Ions; Institute for Research, State College, Pa.; Frey; AD-649 433

Methodological Studies of Tracking Behavior: The Effect of Various Supplemental Information Feedbacks; Bolt Beranek and Newman Inc., Cambridge; Ward and Senders; AD-649 574

Information Processing and Programmed Decision Systems; Carnegie Inst. of Tech., Pittsburgh; Kriebel; AD-648 382

Educational Planning for Economic Growth; Calif. U., Berkeley; Koulourianos; AD-647 988

Toward the Design of a Group: A Preliminary Model; Carnegie, Pittsburgh; Shelly and Stedry; AD-648 084

Source Credibility and Involvement as Variables Influencing the Reactions of Taiwanese Students to Persuasion; Md. U., College Park; McGinnies; AD-648 443

Same-Different Judgments and the Psychological Refractory Period; McGill U., Montreal; Corballis *et al;* AD-648 447

Leadership Status as a Modulator of the Determination of Social Interaction by Prior Reinforcement; Beaver College, Glenside, Pa.; Mausner *et al;* AD-648 449

Leadership Performance of Nursing Supervisors at Two Organizational Levels; Ill. U., Urbana; Nealey and Blood; AD-648 607

BIOLOGICAL AND MEDICAL SCIENCES

Initial Conditions, Physical Laws, and the Origin of Life; Stanford U.; Pattee; AD-648 738

Circular DNA From Sand Dollar Sperm; Columbia U., N.Y.; Rosenkranz *et al;* AD-648 853

Sensitivity and Behavioral Reaction of Sharks to Electric Stimuli (and Recording of Brain Activity with Chronic Implanted Electrodes); General Dynamics/Electronics, Rochester, N.Y.; Agalides; AD-648 936

Egg Masses and Early Developmental Stages of the Scorpaenid Fish, Sebastolobus; Oregon St. U., Corvallis; Pearcy; AD-649 060

Cell Membrane and Cell Permeability; Pa. Hospital, Philadelphia; Ling; AD-649 165

On the Neutral Modeling of Speech Processes; Cornell U.; Tappert; AD-649 160

A Study of the Specific Location of Leptospires with Respect to Various Tissue Cells of Infected Animal Hosts; Nebraska U., Omaha; Miller; AD-648 735

Ultrasonic Irradiation of Enzyme; Ill. U., Urbana; MacLeod and Dunn; AD-647 935

Isolation and Characterization of the N-Methyl Derivatives of 2-Aminoethylphosphonic Acid from the Sea Anemone, Anthopleura Xanthogrammica; City of Hope Medical Center, Duarte, Calif.; Kittredge *et al;* AD-648 493

Effects and After-Effects on Planarians of Reversals of the Horizontal Magnetic Vector; Northwestern U., Evanston, Ill.; Brown, Jr.; AD-647 939

Diurnal Patterns of Metabolic Variations in Chick Embryos; Northwestern; Johnson; AD-647 940

Interactions of Diurnal and Tidal Rhythms in the Fiddler Crab, Uca Pugnax; Northwestern; Webb and Brown, Jr.; AD-647 941

Daily and Tidal Patterns of Activity in Individual Fiddler Crab (Genus Uca) from the Woods Hole Region; Northwestern; Barnwell; AD-647 942

Propensity for Lunar Periodicity in Hamsters and its Significance for Biological Clock Theories; Northwestern; Brown, Jr.; AD-647 943

Annual Progress Report for 1966; Marine Biological Lab., Woods Hole, Mass.; Steinbach; AD-648 452

Electron Microscopic Study of the Relationship of Leptospira Pomona to the Renal Tubules of the Hamster during Acute and Chronic Leptospirosis; Nebraska U., Omaha; Miller and Wilson; AD-648 491

Vegetation Types in the Las Bela Region of West Pakistan; La. St. Univ., Baton Rouge; Snead and Tasnif; AD-648 605

Colonial Growth and Morphology of Trypanosomes Leishmanias and Leptomonads. Studies on Endotrypanum Schaudinni; Texas U., Galveston; Packchanian and Kelley; AD-648 598

Passive Sensitization in Vitro: Effect of Antibody Concentration on the Lag Period and Velocity; Stanford U.; Feigen and Nielsen; AD-648 632

Diurnal Variation in Organismic Response to Very Weak Gamma Radiation; Northwestern U.; Brown, Jr. *et al;* AD-647 936

Studies on the Mode of Action of Sea Urchin Toxin. Conditions Affecting Release of Histamine and Other Agents from Isolated Tissues; Stanford U.; Feigen *et al;* AD-648 631

Role of Sialidase in the Initial Phase of Infection with Influenza Virus; Calif. St. Coll., Los Angeles; Seto *et al;* AD-649 588

Uptake of C14 into the Brain and Other Tissues of Normal and Dysthyroidal Male Rats After Injection of C14-L-Glutamine; St. U. of N.Y., Brooklyn; Ford and Rhines; AD-648 844

The Effect of Age on the Uptake and Degradation of Thyroid Hormone by the Brain and Skeletal Muscle; St. U. of N.Y.; Cohan *et al;* AD-648 845

Physiology and Instrumentation of Respiratory and Circulatory Responses; Johns Hopkins U., Baltimore, Md.; Riley; AD-648 929

The Extracellular Space on Voluntary Muscle Tissues; Pa. Hospital; Ling and Kromash; AD-649 013

CHEMISTRY

Studies of Silicon-Nitrogen Compounds. The Base-Catalyzed Elimination of Silane from Trisilylamine; Ind. U., Bloomington; Wells and Schaeffer; AD-649 189

The Ethylene-Oxygen Reaction in Shock Waves; Harvard U., Cambridge; Gay *et al;* AD-649 571

Diffusion and Kinetic Control in the Discharge of Hydrogen on Platinum and Platinum Alloys; Western Reserve U., Cleveland; Ludwig *et al;* AD-648 830

Temperature Dependence of J (FF) in 2-Fluoro-Alpha-Chloro-Alpha, Alpha-Difluoro-Toluene and 2-Fluoro-Alpha, Alpha-Dichloro-Alpha-Fluoro-Toluene; Ill. U.; Jonas *et al;* AD-648 988

An Infra-Red Study of the Interaction of Polyamides with Iodine in Iodine-Potassium Iodide Solution; Mellon Inst., Pittsburgh; Matsubara and Magill; AD-649 167

Theory of Chemical Exchange Effects in Magnetic Resonance; Ill. U.; Gutowsky *et al;* AD-649 195

Shock-tube Measurement of Vibrational Relaxation Times in Deuterium; Cornell U.; Moreno; AD-649 239

Experiment on the Number of Particles Formed by Homogeneous Nucleation in the Vapor Phase; Yale U., New Haven, Conn.; Stein and Wegener; AD-649 260

Elastic Scattering of High-Energy Beams: Repulsive Forces; MIT; Amdur and Jordan; AD-649 269

Thermochemistry of Charge-Unsymmetrical Binary Fused Halide Systems. Mixtures of Magnesium Chloride with the Alkali Chlorides and with Silver Chloride; Chicago U.; Kleppa and McCarty; AD-649 301

Measurement of Relaxation Times of Concentration Fluctuations by the Electric Field Effect on Critical Opalescence; Cornell U.; Gravatt; AD-649 343

Aromatic Carbonyl Spectra at High Pressure; Calif. U., Santa Barbara; Kadhim and Offen; AD-649 575

The Systems Xenon Hexafluoride–Germanium Tetrafluoride and Xenon Hexafluoride–Silicon Tetrafluoride; Wash. U., Seattle; Pullen and Cady; AD-647 959

Fluorine NMR Spectra and Conformational Isomerization of 1,1-Difluorocyclohexane; Ill. U., Urbana; Jonas *et al;* AD-648 473

A Nuclear Magnetic Resonance Study of the Protolysis Kinetics of Glycine; Ill. U., Urbana; Sheinblatt and Gutowsky; AD-648 476

NMR Spin-Echo Trains for a Coupled Two-Spin System; Ill. U., Urbana; Wells and Gutowsky; AD-648 477

Spin-Echo Studies of Chemical Exchange. Closed Formulas for Two Sites; Ill. U.; Allerhand and Gutowsky; AD-648 481

Spin-Echo NMR Studies of Chemical Exchange. Intramolecular Exchange of a Coupled AB System; Ill. U.; Allerhand and Gutowsky; AD-648 482

Spin-Echo Nuclear Magnetic Resonance Studies of Chemical Exchange. Perfluorocyclohexane; Ill. U., Urbana; Gutowsky and Chen; AD-648 483

The Electrical Conductivity of Aqueous 0.03 to 4.0M KCl Solutions Under Hydrostatic Pressure; Little (Arthur D) Inc., Cambridge, Mass.; Horne and Young; AD-648 529

Spin-Echo Nuclear Magnetic Resonance Studies of Chemical Exchange. Rearrangement of Bullvalene and of its Silver Nitrate Complex; Ill. U., Urbana; Allerhand and Gutowsky; AD-648 583

NO + O Chemiluminescent Reaction Using Adiabatically Expanded Nitric Oxide; Va. U., Charlottesville; Fontjin and Rosner; AD-647 978

Diffusion and Heterogeneous Reaction X. Kinetic Consideration of Surface Reactions; Va. U., Charlottesville; Ablow and Wise; AD-647 979

Ion-Molecule Reactions in Electric Discharges; Va. U.; Franklin *et al;* AD-647 986

Infrared Lattice Vibrations of Single Crystal Lithium Hydride and Some of its Isotopic Derivatives; Pa. St. U., Univ. Park; Brodsky and Burstein; AD-648 461

EARTH SCIENCES AND OCEANOGRAPHY

Zetes Expedition; Scripps; Reid; AD-647 931

Studies on Heterotrophic Activity in Seawater Based on Glucose Assimilation; Woods Hole; Vaccaro and Jannasch; AD-648 326

Estimates of Situ Rates of Nitrogen Uptake by Trichodesmium sp. in the Tropical Atlantic Ocean; Woods Hole; Goering *et al;* AD-648 327

Hydrographic and Current Data, Bering Strait, 5-7 August 1964; Wash. U., Seattle; Aagaard and Coachman; AD-648 474

Model Studies of Long Wave Amplification by Circular Islands and Submarine Seamounts; Hawaii Inst. of Geophysics, Honolulu; Williams and Kartha; AD-648 559

Benzene Synthesis by Low Temperature Catalysis for Radiocarbon Dating; Texas A and M, College Station; Noakes *et al;* AD-648 596

Estimation and Testing Procedures for Circular Normally Distributed Data; Northwestern U.; Jones; AD-648 082

Narrative of Chain Cruise No. 55; Phila. Naval Shipyard; Bowin; AD-648 141

A Geologic Interpretation of Seismic Profiles in Prince William Sound, Alaska; Scripps; Huene *et al;* AD-648 421

Some Consequences of the Decomposition of Organic Matter in Lake Nitinat, an Anoxic Fjord; Wash. U.; Richards *et al;* AD-648 388

Transport Velocities of Single Particles in Bed-Load Motion; La. St. U.; Meland and Norrman; AD-648 600

Physical and Chemical Data for Puget Sound and Approaches January 1962-December 1963; Wash. U.; Collias and Barnes; AD-647 917

Narrative of Chain Cruise No. 41; Woods Hole; Bowin; AD-648 142

Bottom Sediment and Rock Samples (1954-1965) Stored at the Department of Oceanography, University of Washington; Wash. U.; Woodruff and McManus; AD-648 475

Hydrostatic Actuation of Deep-Sea Instruments; Scripps; Rosfelfer; AD-648 494

Suggested Methods of Compiling and Indexing Scientific Observations for Cruise Navigation Reports, First Revision; Woods Hole; Dunkle; AD-648 660

Permafrost and Ice-wedge Effect on Riverbank Erosion; La. St. U.; Walker and Arnborg; AD-648 603

Contributions to the Knowledge of the Red Sea, Bulletin No. 42; Tel-Aviv U., Israel; Lemoine *et al;* AD-648 867

Israel South Red Sea Expedition Reports, Bulletin No. 41, 1962; Tel-Aviv U.; Clark *et al;* AD-648 868

Inorganic Nutrient Anions in Deep Ocean Waters; Scripps; Chow and Mantyla; AD-648 944

Quantitative Estimations of Temporal Variations of Zooplankton off the Coast of Washington and British Columbia; Wash. U., Seattle; Frolander; AD-649 170

Reconnaissance of the Somali Current During the Southwest Monsoon; MIT; Stommel and Wooster; AD-648 798

Observations of Internal Waves of Tidal Period Made with Neutrally Buoyant Floats; Scripps; Knauss; AD-648 799

Strontium-90 and Caesium-137 in Columbia River Plume, July 1964; Oregon St. U., Corvallis; Park *et al;* AD-648 839

Some Hydrodynamic Problems for a Nepheloid Zone; Lamont Geological Observatory, Palisades, N.Y.; Ichiye; AD-648 858

Ocean Current Observations from Offshore Drilling Platforms; Oregon St. U.; Burt and Borden; AD-648 996

Shaping of the Continental Rise by Deep Geostrophic Contour Currents; Lamont; Heezin *et al;* AD-649 237

Lead Isotopes and Uranium Contents in Experimental Mohole Cores (Guadalupe Site); Scripps; Chow *et al;* AD-648 998

Th230-U234 Dates of Late Pleistocene Marine Fossils from the Mediterranean and Moroccan Littorals; Lamont; Stearns and Thurber; AD-649 271

Classification and Organization of Quantitative Data in Geology; Northwestern U., Evanston, Ill.; Krumbein and La Monica; AD-648 834

Volcanic Ash Deposits in the Gulf of Alaska and Problems of Correlation of Deep-Sea Ash Deposit; Wash. U.; Nayudu; AD-648 851

Carbonate Deposits and Paleoclimatic Implications in the Northeast Pacific Ocean; Wash. U.; Nayudu; AD-648 852

New Seismic Data Concerning Sediments and Diapiric Structures in Sigsbee Deep and Upper Continental Slope, Gulf of Mexico; Texas A and M, College Station; Ewing and Antoine; AD-648 855

The Manihiki Plateau; Scripps; Heezen *et al;* AD-648 954

Marine Seismic Refraction Studies on the Continental Margin to the South of Australia; Lamont; Hawkins *et al;* AD-649 178

Deep-Sea Sediments and their Geological Record; Miami U., Fla.; Emiliani and Milliman; AD-649 219

Structure of the Bering Sea and the Aleutian Ridge; Scripps; Shor, Jr.; AD-649 427

Paleotemperature Analysis of Caribbean Cores P6304-8 and P6304-9 and a Generalized Temperature Curve for the Past 425,000 Years; Miami U.; Emiliani; AD-649 430

Some Computational Experiences with a Mathematical Programming Model for Optimum Design of Open Pit Ore Mines; Carnegie; Meyer; AD-649 539

In Situ Spectroscopy in Ocean and Lake Waters; Scripps; Tyler; AD-649 236

Electrolytic Conductance of Sea Water and the Salinometer; Oregon St. U.; Park and Burt; AD-648 837

Total Carbon Dioxide in Sea Water; Oregon St. U.; Park; AD-648 838

Gas Chromatographic Determination of Dissolved Oxygen; Nitrogen, and Total Carbon Dioxide in Sea Water; Oregon St. U.; Park; AD-648 840

Electrolytic Conductance of Sea Water and the Salinometer; Oregon St. U.; Park and Burt; AD-648 841

The Carbonate Content of Surface Sediments from the Northeast Pacific Ocean; Wash. U.; Gross; AD-648 842

Oceanic Structural History of the Bering Sea; Lamont; Ewing *et al;* AD-648 861

Determination of Nitrate in Sea Water; Scripps; Chow and Johnstone; AD-648 942

Flame Photometric Determination of Potassium in Sea Water and Marine Organisms; Scripps; Chow; AD-648 943

Chemical Properties as Indicators of Upwelling Along the Oregon Coast; Oregon St. U.; Park *et al;* AD-649 171

The Sediments of the Argentine Basin; Lamont; Ewing and Ewing; AD-649 191

A Feasibility Study for the Use of Monte Carlo Techniques in Computer-Aided Prediction of Seiche Activity in Harbors; Texas U., Austin; Ellis and Boston; AD-649 337

Tertiary Sediment from the Mid-Atlantic Ridge; Lamont; Saito *et al;* AD-649 404

Effect of Carbon Dioxide on the Electrical Conductance of Seawater; Oregon St. U.; Park *et al;* AD-649 419

Thickness of Coral at Midway Atoll; Scripps; Shor, Jr.; AD-649 425

Heat-Flow Measurements in the Northeast Pacific and in the Bering Sea; Scripps; Foster; AD-649 428

Water Characteristics of the Caribbean Sea; Johns Hopkins U.; Sturges; AD-649 431

A Multipurpose Large Volume Sea-Water Sampler; Woods Hole; Bodman *et al;* AD-649 583

Sediments and Structure of the Japan Trench; Lamont; Ludwig *et al;* AD-648 857

Red Sea Seismic Reflection Studies; Woods Hole; Knott *et al;* AD-649 296

Abyssally Generated T Phases; Hawaii Inst. of Geophysics, Honolulu; Johnson *et al;* AD-649 315

A Study of the Theory and Measurements of the Microwave Emission Properties of Natural Materials; Space-General Corp., El Monte, Calif.; Kennedy *et al;* AD-648 818

On the Extraterrestrial Ring Current During Geomagnetic Storms; Iowa U.; Frank; AD-648 909

ELECTRONICS AND ELECTRICAL ENGINEERING

Realization and Complexity of Commutative Events; Michigan U., Ann Arbor; Laing; AD-649 063

Bechmann's Number for Harmonic Overtones of Thickness-twist Vibrations of Rotated-Y-Cut Quartz Plates; Columbia U., N.Y.; Mindlin; AD-648 335

Project MAC Progress Report III, July 1965 to July 1966; MIT; AD-648 346

The Theory of Long Coupled Antennas; Harvard U., Cambridge; Padhi; AD-648 498

MATERIALS

Titanium Chalcogenide Infrared Transmitting Glasses; Texas Instruments Inc., Dallas; Hilton; AD-648 076

The Role of Surface Boron as Adsorption Center for the Sorption of Water by Porous Glass; Rutgers—The State Univ., New Brunswick, N.J.; Low and Ramasubramanian; AD-648 232

Composite Thermoplastic/Glass Filament Reinforcement for Bouyant Submarine Cable RG-372 (XN-1)/U and RG-373 (XN-1)/U Literature and Patent Survey; Union Carbide Corp., Bound Brook, N.J.; Arbit *et al;* AD-647 951

The Theory of the Critical Shear Stress and Work Hardening in Dispersion-Hardened Crystals; Harvard U., Cambridge; Ashby; AD-647 991

Optical Properties of Epitaxial Films of CdXHgL-XTe; Harvard U., Cambridge; Ludeke and Paul; AD-648 614

An Inherently Fibrous Organosilicon Polymer; Case-Western Reserve U., Cleveland; Frazier *et al;* AD-649 281

The Melting of Defect Polymer Crystals; Rensselaer Polytechnic Inst., Troy, N.Y.; Wunderlich; AD-648 796

MATHEMATICAL SCIENCES

On the Admissibility of Invariant Estimators of One or More Location Parameters; Cornell U., Ithaca, N.Y.; Brown; AD-648 234

Generalized Functions: Representation Theorems for Some Standard Function Spaces—An Introduction to Functional Analysis; Md. U., College Park; Benedetto; AD-648 383

On Infinitely Divisible Laws and a Renewal Theorem for Non-Negative Random Variables; N. Carolina U., Chapel Hill; Smith; AD-648 577

Fourier Transforms, Generalized Functions and Two Classes of Integral Equations; Brown U., Providence, R.I.; Pao; AD-648 672

The Symmetric Formulation of the Simplex Method for Quadratic Programming; Va. U., Charlottesville; van de Panne and Whinston; AD-647 949

A New Foundation for a Simplified Primal Integer Programming Algorithm; Calif. U., Berkeley; Glover; AD-648 053

Fluctuations of Renewal-Reward Process; Calif. U., Berkeley; Jewell; AD-648 222

The Cost Function; Calif. U., Berkeley; Shephard; AD-648 409

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Random Noise

Dr. Ralph Roberts, Head of ONR's Power Branch, was recently elected a fellow of the American Association for the Advancement of Science.

Dr. J. Warren Horton, Technical Director Emeritus of the Navy Underwater Sound Laboratory, New London, died on May 10. Dr. Horton, who was considered an international authority on underwater acoustics and sonar systems, retired as Technical Director of NUSL in 1963.

The NRL Branch of the Research Society of America has selected Dr. H. B. Rosenstock and Dr. I. L. Karle, both of the Optical Physics Division, to receive, respectively, the RESA Award for Pure Science and the RESA Award for Applied Science.

Personnel of the Navy Electronics Laboratory, San Diego have received special commendations from Commander First Fleet for their participation in support of Base Line II, a major fleet exercise conducted off the Southern Californian coast last fall. This exercise involved 39 ships and was conducted under simulated wartime operations to examine in depth the current performance of fleet communications. Commendations went to LCDR C. A. Byers, LT M. J. Harris, Mr. W. H. Hockstra, Mr. T. J. Word, Mr. R. E. Lawrence, and Mrs. P. Panabaker.

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Mr. Wilcox Receives Superior Civilian Service Award

Richard Wilcox (right) receives award from CAPT Melson

Mr. Richard Wilcox, Acting Director of the ONR Mathematical Sciences Division, recently received the Superior Civilian Service Award, the highest award that a bureau or office chief can bestow upon a member of his staff. The award was presented by CAPT L. B. Melson, Assistant Chief for Research for RADM J. K. Leydon, Chief of Naval Research on May 10, 1967.

Mr. Wilcox normally serves as Head of the Information Systems Branch, Mathematical Sciences Division. His award is based on his initiation and leadership of a research effort aimed at improving intelligence operations by applying high-speed computer and information science technology. The specific objectives of this research effort include the automation of the processes of collecting, organizing, and retrieving intelligence information; the development of means for achieving language compatibility among bodies of data from diverse sources; and the accomplishment of a mechanized capability for recognizing and classifying meaningful or significant relationships. As a result of this program, a Navy Intelligence Research Advisory Group (NIRAG) was formed in 1961. This Group, under Mr. Wilcox's chairmanship, serves the primary function of identifying, describing, and assigning priorities to intelligence problems.

The intelligence research effort has already begun to yield valuable results. A computer simulation model has been developed which evaluates effectiveness of sensor configurations for the acquisition of tactical intelligence under various conditions. Also, criteria for choosing analyst personnel has been developed and a curriculum for the training of selectees has been established.

Mr. Wilcox is chairman of the Naval Research and Development Information System Steering Board and a member of the Committee on Scientific and Technical Information which advises the Federal Council on these areas. In 1956, he was elected to the Scientific Research Society of America (RESA).

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Dr. Mortimer C. Bloom, a corrosion consultant at the Naval Research Laboratory, inspects a hydrogen effusion apparatus used to study the corrosion of steel inside high pressure, high temperature Navy boilers. Dr. Bloom designed the apparatus which is part of an extensive NRL program in corrosion study. *See article beginning on page 10.*