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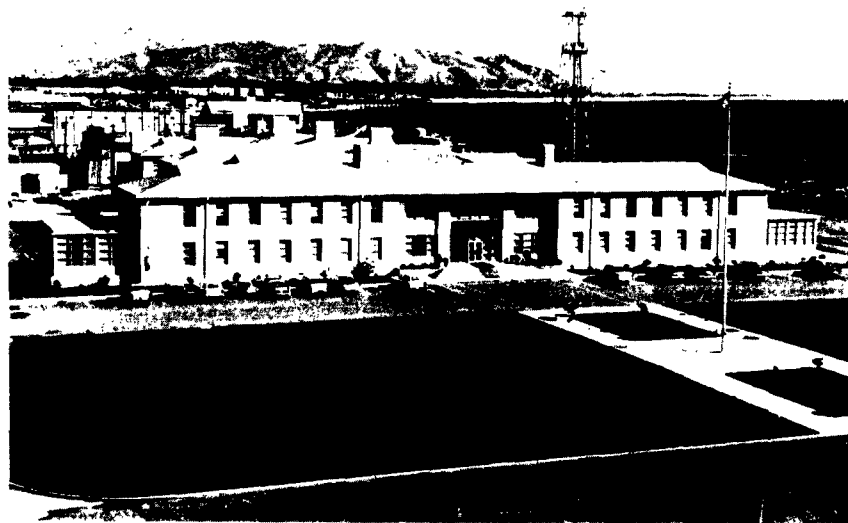


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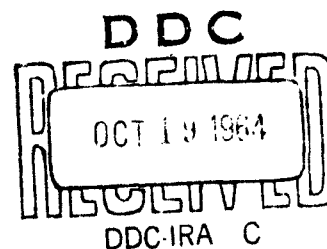
ANNUAL REPORT **FY 64** NAVY LABORATORIES RESEARCH Y-R011-01



U. S. NAVAL CIVIL ENGINEERING LABORATORY

Port Hueneme, California

September 1964



## U. S. NAVAL CIVIL ENGINEERING LABORATORY

W. J. Christensen, CAPT, CEC, USN  
Commanding Officer and Director

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Technical Director

### Foreword

This annual progress report on Navy Laboratories Research, Fiscal Year 1964, is submitted in compliance with SECNAV Instruction 3900.13A of 1 November 1963.

NCEL was provided with funds for independent research to augment and to exploit technical competence through the investigation of new ideas which were generated in-house.

WILLIAM B. PLUM, Ph. D.  
Coordinator

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ANNUAL PROGRESS REPORT  
on  
NAVY LABORATORIES RESEARCH PROGRAM

Y-R011-01-01-003, Young's Modulus of Elasticity and Poisson's Ratio of Plain Concrete

The objective is to establish a relationship between the elastic constants for concrete as measured separately by static and dynamic methods.

Dynamic values of Young's modulus (E) are affected slightly by prior static loading, the concrete cylinders exhibiting a small reduction in E. The magnitude and recovery of this loss in E is dependent upon the age and/or the moisture content of the concrete at the time of test.

There is no constant relationship between the value of (E) and Poisson's ratio for concrete as determined by static and dynamic methods. The relationship changes with the age and curing environment of the concrete.

Principal investigator - W. L. Cowell

TR-285, W. L. Cowell, "Young's Modulus of Elasticity and Poisson's Ratio of Plain Concrete", 3 April 1964

Y-R011-01-01-021, Accelerated Testing of Protective Coatings

The objective is to develop rapid methods of evaluating protective coatings by investigating fundamental properties of coatings, such as permeability, electrical properties, production of degradation products, etc., and relating these properties and chemical composition to the service life of coatings.

In addition to the clear vehicle films reported previously, some vinyl acetate films were irradiated in air using a mercury arc. Also some of the other vehicles were re-run under better conditions. The peaks at 912 and 992  $\text{cm}^{-1}$  may be due to vinyl groups in depolymerized degradation products. Products obtained from the degradation of gray pigmented oil, alkyd and vinyl alkyd films by irradiation with a mercury source gave much weaker infrared spectra and no evidence of formic acid formation was found. Experiments were initiated to study changes in the vehicle films themselves as a result of ultraviolet irradiation. ATR spectra of both alkyd paint and vehicle films showed the loss of several originally strong absorption peaks after irradiation, and no very significant strong new peaks were formed.

It is planned to make further electrical resistance measurements, both A.C. and D.C., and dissipation factor measurements with additional systems exposed in sea water. Further degradation studies will be made with clear and pigmented systems with a xenon arc (rather than a mercury arc) which more nearly approximates natural sunlight. The feasibility of studying the degradation products with ATR or with gas chromatography will be investigated.

Principal investigator - P. J. Hearst

Y-R011-01-01-022, Investigation of Boiling Heat in Vapor Compression Stills

The objective is to study the basic mechanisms limiting heat transfer with a change in phase. Emphasis is placed on those aspects important in water conversion in vapor compression stills.

Further literature study led to a small laboratory bench investigation of evaporation from thin films, which will allow rapid heat transfer rates apparently not possible with boiling as such. Two small experiments demonstrated the capability of the process and indicated possible ways of establishing and maintaining a thin film with rapid evaporation.

One more bench experiment, involving a single small tube is planned for FY-65, during which methods of maintaining and replenishing a thin film will be investigated. Also, probable difficulties from scaling will be checked.

Principal investigator - Earl J. Beck

Y-R011-01-01-025, Investigation of Physical and Chemical Properties of Concrete

The objective is to measure water vapor transmission of concrete; to investigate salt whisker crystal growth on concrete; and to measure electrical resistivity of concrete.

Sixteen electrical resistivity specimens were cast and tested. The variables were, (a) strength of concrete and (b) salinity of mixing water. A voltage of 1.15 volts direct current was impressed on all specimens continuously for 1,000 hours.

The steel grids embedded in the wet cups of Phase III were removed, cleaned, and weighed to determine the percent corrosion. All specimens have been evaluated for the final report.

- (1) Water vapor transmission rates were found to decrease with a decrease in water-cement ratio, an increase in aggregate size, the presence of NaCl, and an increase in age of concrete.
- (2) Whiskers grow only on specimens containing NaCl, and the amounts of whiskers are larger on lower strengths of concrete.
- (3) Electrical resistivity of concrete was found to increase with age and to decrease with increased salinity of the mixing water.

This task is completed.

Principal investigator - R. L. Henry

TR-314, "Water Vapor Transmission and Electrical Resistivity of Concrete", 25 June 1964, R. L. Henry.

#### Y-R011-01-01-026, Near Infrared Attenuating Fluids

The objective of this task is to find fluid(s) (additives to water) which will most effectively attenuate the near infrared radiation.

The test equipment consisted of a droplet collimator, infrared source, droplet sampler, additive mixing tank, all of which have been designed, constructed, and satisfactorily tested. A radiometer has been ordered to replace the one on loan from the U. S. Naval Radiological Defense Laboratory. The droplet size distribution data of several sprays have been collected and evaluated. Several additives have been tested to find their attenuation characteristics in the near infrared. Near infrared transmission data were also collected for pure water for comparison. Some inconsistencies in the results were noted when the tests were repeated. A completely new set of test data will be collected, for checking, when the new radiometer arrives. The absorption of radiation by water droplets has been solved, by P. H. Thomas, using geometrical optics. Although this approach does not account for conduction and convection between the droplet surface and the radiation-heated air nor to possible droplet phase transformation, it is deemed adequate for this work. However, an attempt was made to arrive at a mathematical model for the absorption of radiation by the droplets from the heat transfer standpoint. Numerical results from this attempt failed to agree with experimental measurements. In view of the limited time to conclude the work, further work on the model was discontinued.

During the next quarter further testing will be made and a final report written on the task.

Principal Investigator - Edward Lumsdaine

#### Y-R011-01-01-028, Improved Static Measurement of Concrete

The objective is to develop a rapid and accurate electronic method for determining static properties of concrete.

A strain gage hoop transducer device has been developed and strain-measuring capabilities have been compared with conventional surface-mounted strain gages and with a mechanical compressometer. A report has been completed which summarizes all test results and presents specific recommendations.

Surface-mounted strain gages provide an accurate method for measuring longitudinal and lateral strains in concrete and compare favorably with measurements made with mechanical compressometers.

Principal Investigator - J. H. McCarthy

TR-295, J. H. McCarthy, "Electronic Methods for Determining Young's Modulus and Poisson's Ratio of Portland Cement Concrete", 16 April 1964.

#### Y-R011-01-01-035, Physical Chemistry

The objective is to study the fundamental factors involved in metal corrosion and the adhesion of films to metals as a means of developing improved corrosion resistant systems.

The study of fundamental factors involved in metal corrosion by modern electrochemical methods is continuing. Potentiostatic polarization measurements were made on iron in sulfuric acid solutions by the potentiodynamic method, in which the potential of the iron electrode is changed at a constant rate. Current and potential were simultaneously recorded on a two-pen recorder which has been incorporated into the polarization apparatus. A technical note describing the effects of variation in potentiostatic techniques on the anodic polarization of iron is in preparation.

The long range objective will continue to be the elucidation of the mechanisms of the electrochemical and physical transformations that occur at interfaces. Intimate knowledge of the details of these transformations is of vital importance in the prevention and control of corrosion.

Principal investigator - Howard A. Porte

TN-568, Howard A. Porte and Thomas E. Nappier, "The Electrochemical Behavior of Armco Iron in Sulfuric Acid", January 1964

#### Y-R011-01-01-037, Heat Storage with Salts

The objective of this task is to find an economical method of storing heat for long periods of time (in compact units) at relatively high temperatures.

The small prototype container, designed to store heat for several days, was tested at temperatures of 1350 Fahrenheit and vacuum pressures of 0.001 torr. The insulation consisted of alternate layers of highly reflective foil and layers of potassium titanate paper in vacuo. There was room for 13 layers of each in the present container which was twice the number of reflective layers contained in the previous test. Calculations involving the number of shields, emissivity, insulation thickness, thermal conductivity and other parameters were made by a computer in order to determine the rate of heat loss and also to approximate the actual test data.

It is planned to investigate and compare the heat storage capabilities of an insulation consisting of 45 layers of reflective shields and potassium titanate paper in vacuo. Results will be compared with those obtained by computer and the previous tests. A technical report will be issued upon completion of tests in February 1965.

Principal investigator - Charles A. Dittus

#### Y-R011-01-01-042, The Effects of Marine Organisms on Engineering Materials for Deep Ocean Use

The objective of this task is to investigate, analyze and evaluate the effects of deep ocean marine organisms upon all types of engineering materials exposed in the deep marine environment.

Numerous oceanographic and biological data collection trips to the Submersible Test Unit (STU) test site have been completed. Biological and bacteriological analysis were performed on deep sea water samples and sediment samples collected during these trips.

STU 1-3 was recovered in February 1964 after four months exposure at 5640 feet of water. The various metallic and nonmetallic test specimens were examined for signs of biological deterioration and for fouling and boring organisms. Teredo-like borers (Xylophaga washingtona) were found boring into pine test panels exposed near the ocean floor. These borers were also found boring into manila rope. It is believed that this is the first report of finding marine borers at such depth in the Pacific Ocean. Cotton rope fibers were destroyed by the action of deep sea microorganisms. Several microorganisms were isolated from cotton and manila rope fibers in the laboratory. Bacterial slime growth were found on some plastic materials and on nickel plated shackles.

A Technical Report R-329, Deep Ocean Biodeterioration of Materials - Part I., "Four Months at 5640 Feet" is in preparation.

Several biological test specimen racks containing various kinds of materials for the purpose of attracting, collecting and evaluating biological effects were fabricated and placed aboard Submersible Test Unit (STU) 11-1 and on STU 1-4. These were placed on the deep ocean floor in June 1964.

Plans are being readied to recover STU 11-1 (exposed six months at 2340 foot depth) and STU 1-2 (exposed one year at 5640 foot depth) during the latter part of 1964. The materials will be examined for any biological effects and a report published on the findings.

A laboratory study on the effect of deep ocean microorganisms on electrical insulating materials such as neoprene rubber, silicone rubber, GR-S rubber, polyethylene, and polyvinyl chloride (PVC) is near completion. A report on the result of this study is in preparation.

Principal investigator - J. S. Muraoka

An article entitled "The Effects of Fouling by Deep-Ocean Marine Organisms" has been published in Undersea Technology, Volume 4, No. 5, May 1963, pp 24-28.

#### Y-R011-01-01-049, Solid State Electronic Devices

The objective is the development of solid state devices for the detection of electromagnetic and nuclear radiation.

Experimental apparatus has been assembled for studying the interaction of superconducting thin-film devices with submillimeter radiation. The apparatus includes: (1) far infrared monochromator, (2) liquid helium cryostat, (3) high speed cryostat pumping system, and (4) four inch electromagnet.

Work to be done during FY-65 will be the utilization of the apparatus designed and set up in FY-64. An attempt will be made to measure the quantum detectivity of superconducting tunnel devices in the region of the electromagnetic spectrum between 0.1 and 1.0 mm.

Principal investigator - R. D. Hitchcock

TN-496, R. D. Hitchcock, "The Superconductor Energy Gap and its Explicit Utilization in Radiation Detection", 5 August 1963.

#### Y-R011-01-01-054, Emergency Sea Water Demineralizer

The objective is to develop a practical and economical device that may be used in emergency situations to obtain potable water for the sustenance of human life.

Three unglazed cores were tested in the pressure device with surface failures in each case. The remaining cores were ordered glazed and appear to offer a solution to this problem. Tests on two of the glazed cores have resulted in failures due to an inadequate end seal between the membranes and core. Tests were conducted to provide a more positive seal.

Our method of applying the membrane to the core material has been a radical departure from the normal method of membrane production. Even though a successful flux test has not been consummated, the membranes appear to be clear and homogeneous. In addition, the glazed ceramic core seems to offer a satisfactory semi-porous backing for the membranes. Most backings under investigation outside the Laboratory have been of sintered metals.

To date the principal problem has been the development of a technique to apply a good film to the ceramic cylinder. In part, this has been caused by defects in the cylinder. Therefore, additional work will be done to attempt to rectify these difficulties.

Principal investigator - J. W. Chapin

#### Y-R011-01-01-055, Investigation of Yaite

The objective is to determine the chemical substance in Yaite (Gliricidia sepium) that has rodenticidal properties.

Toxicity studies had indicated that much of the toxicity of Yaite resided in its phenolic fraction. Steam distillation of this fraction followed by solvent extraction of the distillate and crystallization from low-boiling petroleum ether produced a colorless, crystalline solid melting at 67-68° centigrade. On the basis of ultraviolet and infrared spectra, the Rast molecular weight and mixed melting point, the solid was identified as coumarin. Although coumarin itself has no rodenticidal properties, it is converted under hot, humid conditions by bacteria to dicoumerol which is a potent rodenticide.

Dried Yaite leaves and its extracts were tested for rodenticidal activity at the Denver Laboratories of the Fish and Wildlife Service of the Department of the Interior. These preparations were non-toxic by both the single and multiple dose test.

Dried leaves that had been moistened and allowed to ferment for about two months showed, on chemical analysis, a marked increase in dicoumerol content. Sufficient dicoumerol is present to be toxic to rodents when used as a relatively minor part of their diet.

Yaite leaves are mixed with corn meal by Central American natives when used as a rat bait. The fermentation experiment will be repeated using a Yaite leaf-corn meal mixture for incubation and the maximum amount of dicoumerol produced with 48 hours determined. Rat feeding experiments will be based on the results of amounts of dicoumerol produced. Dead rats will then be autopsied to determine the cause of death. Should it be by hemorrhage, the task will be completed and the rodenticidal agent in Yaite proven.

Principal investigator - H. Hochman

#### Y-R011-01-01-056, Water Level Pickup of Infrared Type

The objective is to develop infrared type water level pickup for use in the ocean.

A new index wheel was fabricated by the Trades Department. Electronic circuits to measure time were designed and built. The full scale development pickup was bench tested and field tested on land.

If further development is undertaken, the following work is anticipated: (1) The index wheel will be modified. (2) A mechanical device to periodically interrupt (chop) the infrared energy will be built. (3) An optical system will be used to increase sensitivity at the pickup.

Principal investigator - F. E. Nelson

TN-623, F. E. Nelson, "Preliminary Development and Test of an Infrared Water Level Pickup", August 1964.

#### Y-R011-01-01-057, Eccentrically Loaded Long Piles

The objective is to study the behavior of pre-cast concrete long piles eccentrically loaded, including theoretical development for predicting critical loads and verification tests on model specimens. Efforts are directed toward solution of cross sections difficult to analyze, as circular and octagonal, with and without hollow cores. Results are to be presented in the form of usable charts for predicting ultimate loads.

Computer programs have been written and verified. Theoretical solutions on selected parameters are completed. Thirty-nine (39) specimens have been

cast and tested. Theoretical analysis of eccentrically loaded members appears to be compatible with former studies on concentrically loaded long piles.

Effort during FY-65 will be to analyze and verify test results and prepare final report. Estimated completion is third quarter, FY-65.

Principal investigator - J. J. Hromadik

#### Y-R011-01-01-058, Undersea Air Supply

The objective is to ascertain the feasibility of utilizing the air dissolved in sea water as a source of oxygen for manned undersea chambers and subsequently utilizing the deoxygenated sea water as a vehicle to remove carbon dioxide.

A laboratory model of a counter current gas exchanger was constructed and operated with tap water. With the model it was demonstrated that the gases dissolved in water can be employed to replenish the oxygen of a chamber previously depleted of oxygen. A larger model of the counter current gas exchanger has also been constructed and it was recently installed in a small shed on the corrosion dock. Oxygen was depleted from the air in the exchanger by purging the system with nitrogen. Sea water was then pumped through the exchanger. The gases in the air chamber of the system were thereby continually washed with sea water and the oxygen concentration within the air chamber slowly rose.

Before performance data can be obtained for the new gas exchanger it will be necessary to redesign the discharge and overflow lines. These lines are now inadequate and permit the escape of air. When this modification has been made, an attempt will be made to maintain a mouse in a small chamber ventilated via the counter current exchanger. An attempt will also be made to identify potentially toxic or objectionable compounds in the gases dissolved in sea water. It is anticipated that a Technical Note describing the counter current gas exchanger will be submitted to the Bureau in FY-65.

An air separator and a pressure-reducing pump are perceived as auxiliary components of a counter current gas exchanger employed to ventilate undersea structures. These and other refinements will be considered in future investigations.

Principal investigator - Harold P. Vind

TN-543, Harold P. Vind and Mary Jane Noonan, "A Proposed System for Supplying Air to a Hypothetical Underocean Seabee Base", 8 November 1963.

#### Y-R011-01-01-059, Electromagnetic Cross Sections of Material

The objective is the investigation of the absorption and scattering of plane electromagnetic waves from spherical surfaces based on the various properties of the surface.

Theoretical examination of the absorption and scattering produced by approximately 120 different types of material was accomplished during the past year.

The properties of the materials investigated were varied over a broad range of values for the 120 types examined.

The results of the theoretical investigation were reported in Technical Note TN-553, "The Application of Absorption and Scattering Coefficients for Concentric Spheres to the Problem of EMI-Free Enclosures". The work accomplished on this task was reported orally at a national conference on radio frequency interference. The material has been reviewed for publication in a national scientific journal.

Based on the theoretical study, the material which exhibits the most uniform absorption of electromagnetic energy has conductivity on the order of one mho per meter. Dielectric materials are definitely not suitable for uniform absorption.

Experimental work has begun to verify findings obtained from the theoretical studies. A sphere made of a coke-concrete combination has been made and will be used as a model in the study. The coke-concrete will have a conductivity near one mho/meter and will be 57 inches in diameter. The spherical wall is to be three inches thick. Report on experimental and theoretical work should be completed by 1 January 1965.

Principal investigator - H. A. Lasitter

TN-553, R. A. Eldred, H. A. Lasitter and J. Roberts, "The Application of Absorption and Scattering Coefficients for Concentric Spheres to the Problem of EMI-Free Enclosures", November 1963.

#### Y-R011-01-01-061, Applied Mathematics

The objective is selected research in applied mathematics when particular laboratory problems can be generalized to a wider range of scientific and engineering problems.

Work accomplished during the past year includes generalization of the non-linear curve fitting techniques published in Technical Report TR-262, development of a criterion for the selection of a mathematical model from a set of asymptotic growth curves by automatic data processing equipment, and analysis, programming and application of a set of asymptotic growth curves.

Important findings during the past year include the model  $Y = Y_{\max} X / (R + X)$  can be fit by ordinary "least squares" techniques. In fact, any rational fraction can be fit by this method.

The model  $Y = A(10)^{\frac{bx}{c+x}}$  fit by Scarborough using non-linear methods can be fit by ordinary "least squares" methods.

Solution for the parameters in the model  $Y = Y_{\max} e^{-R/X}$  was not attained by the non-linear methods. Extension of the use of constraints as given in TR-262 will be tried.

Completion of a system for the solution of a basic set of asymptotic growth curves is planned which will serve as a framework for an over-all Statistical and Numerical Analysis Program. Many commonly used computer programs exist which can be incorporated into the system.

Principal investigator - W. Wilcoxson

#### Y-R011-01-01-066, Unified Consolidation Theory

The objective is to investigate the theory of soil consolidation combining primary and secondary consolidation.

The necessary equipment has been received, modified and calibrated to bring it up to an acceptable standard of performance. A total of 21 clays will be tested and analyzed in an attempt to develop the theory. The consolidation data have been combined with data from the x-ray tests in an attempt to define the constants appearing in the unified consolidation theory. A report on 13 clays is in draft form.

As initially planned 21 clays were tested. It is planned to halt testing and begin the analysis of the data. To do this, a computer program will be written and certain numerical analyses performed.

Principal investigator - John P. Nielsen

#### Y-R011-01-01-068, Static and Dynamic Failure Modes of Piles in Sand

The objective is to experimentally determine the failure modes of statically and dynamically loaded piles in sand. Knowledge of these modes would permit the formulation of a rational method for predicting the response of a pile-soil system to transient loadings.

The experimental procedure involves placing colored sand in layers about a small pile located inside a test bin, loading the pile to failure, and examining sections cut through the failure zone.

A test bin has been designed and fabricated so that it can be rotated from the filling orientation to the pile testing position. Clean fine beach sand has been stocked and an adequate portion of it has been dyed to fill the test bin about six times.

The bin has been filled with beach sand and saturated. The apparent cohesion of the sand is sufficient to allow vertical sections to be cut through this material. The removable wall of the inspection side of the bin is satisfactory. The pile has been completed.

A static loading frame is being devised. The first layered sand filling is under way. About three static and three dynamic loadings will be accomplished.

Principal investigator - L. W. Heller

Y-R011-01-01-069, Water Jet Propulsion and Steerage

The objective is to determine the feasibility of using water jet propulsion to replace the present propulsion units on 3x15 pontoon barges.

The study was completed in FY-64, except for publication of the report.

No further work is planned under this research. A task proposal for development work on water jet propulsion will be submitted to the Bureau of Yards and Docks. Further work depends on the reaction of the Bureau.

Principal investigator - B. H. Bryner

TN-618, B. H. Bryner, "Feasibility Study of Pontoon Barge Water Jet Propulsion and Steerage", June 1964.

Y-R011-01-01-070, Sanitary Research

The objective is to investigate the feasibility of biocatalytic drain cleaners.

Work accomplished during FY-64 includes a literature search, Laboratory experiments, field tests, and a final report.

Important findings during the past year include that biocatalysts (enzymes) are effective against organic materials in drains and use on a limited scale by Public Works staffs is recommended.

Principal investigator - W. R. Nehlsen

TR-307, W. R. Nehlsen and J. E. Halton, "Investigation of Biocatalysts for Drain Cleaning", May 1964.

Y-R011-01-01-071, Trafficability on the Ocean Floor

The objective is to investigate appropriate means of locomotion for equipment to be used in the conquest and exploitation of the ocean floor.

A literature search has been completed and evaluation of data obtained has been accomplished. A rough draft of the final report has been prepared and is being reviewed at the division level.

Because of the extreme differences in the physical characteristics of the ocean floor, there can be no universal vehicle used in all instances. There should be both swimming-type and bottom-oriented vehicles. A means, similar

to the rolligon bag, which would "flow" over the bottom would be most universally acceptable with relation to bottom sediment physical characteristics.

No further work is proposed for this task.

Principal investigator - J. J. Bayles

#### Y-R011-01-01-072, Detection of Alkylating Agents

The objective is to develop more simple and sensitive procedures for the detection of alkylating agents.

The task was based on the fact that a number of chemical warfare agents are also alkylating agents and that the known methods used to detect these agents were cumbersome and of low sensitivity. A literature survey was conducted and discussions were held with personnel from the Office of Naval Research and the Army Chemical Center. These discussions revealed, together with access to classified documents, that sufficiently simple and sensitive tests are now available for the detection of these agents. The task was closed by memorandum and letter to the Bureau of Yards and Docks dated 7 February 1964.

Principal investigator - H. Hochman

#### Y-R011-01-01-073, Biological Corrosion of Metals

The objective of this task is to learn more about the role played by living organisms in the corrosion of metals.

In FY-64 the investigation was limited primarily to a review of the literature. The NACE Abstracts, PDL Abstracts, and Chem Abstracts were reviewed. Nearly 400 abstracts pertaining to biological corrosion were collected in a large notebook. A bibliography and index to these abstracts were prepared.

From the literature it was learned that bacteria and other living organisms influence the corrosion of metals under a greater variety of conditions than is usually recognized. Bacteria and other living organisms influence the corrosion of metals in sea water in moist soil, or in fuel lines by altering the composition of the water in contact with the metal. Some studies have been made of the influence of carbon dioxide and hydrogen sulfide on corrosion rates, but very few studies have been made of the influence of other metabolites and biocatalysts on corrosion. In consequence, a serious gap exists in our understanding of the influence of living organisms on corrosion rates.

Laboratory experiments are being performed to ascertain the influence of metabolites and biocatalysts on corrosion rates. In preliminary experiments it was found that acetazolamide inhibits the corrosion of iron, whereas carbon dioxide and acetylacetone accelerate corrosion. Acetazolamide is a carbonic anhydrase inhibitor; carbon dioxide, a normal product of

metabolism; and acetylacetone, an organic compound related to several metabolites.

The experiments in which the influence of biocatalysts and the by-products of living organisms on corrosion will be continued. The results obtained in the initial experiments and the indexed bibliography on biological corrosion will be submitted to the Bureau of Yards and Docks as a Technical Note at the end of FY-65.

Principal investigator - Harold P. Vind

Y-R011-01-01-074, Investigation of Film Evaporation on the Outside of Horizontal Tubes

The objective is to study the effect of sea water on the performance of a horizontal tube evaporator wherein a boiling film is induced by spraying the water on the top layer of tubes.

It has been established by others that thin film evaporation is desirable from a heat transfer standpoint. In order to determine whether a spray film of sea water is satisfactory, an experimental evaporator was constructed and set up with the necessary auxiliary equipment. A suitable spray pattern was obtained after some experimentation. Satisfactory wetting of the tubes was obtained by a spray system above the tube bank. Rough heat transfer calculations were encouraging, but indicate that still more refinement in equipment is necessary. Heat losses through the large wall area resulted in a reflux condition and prevented accurate measurement of the total product. However, the production rate with the spray system was double that obtained with the tubes submerged.

Following these experiments, the tube bundle was operated in a vertical position with internal sea water flow. A comparison of heat transfer rates was made between the horizontal tube spray configuration and natural and forced circulation in the vertical position. The results were inconclusive, but did point up the need for modification of the equipment for horizontal operation.

It is planned to modify the evaporator to minimize the wall area. Some of the initial tests will be redone to see if the performance is improved.

Principal investigator - J. S. Williams

Y-R011-01-01-075, A Graphical PERT Analog

The objective is to develop a simplified method of project analysis, based on PERT concepts which will integrate time and cost factors.

PERT/time concepts were reduced to a graphical method of analysis which results in a time-phased flow-diagram schedule of the project without requiring arithmetic computations. A plastic PERT analog device was

designed and constructed. A patent disclosure has been made. Using PERT/cost data, a new method of synthesizing job element direct cost and time factors by means of the time-phased schedule was developed. This straightforward method results in least-cost schedules for accelerated projects. A method for deriving a project direct cost curve as a function of time with respect to the various job elements was also developed. The Graphical PERT Analog was introduced to the Laboratory and the Public Works Shops, NAS Point Mugu on a pilot study basis. During the past year it has been found that graphical PERT analog methods reduce project planning and scheduling time required for present manual PERT methods by 50 - 65 percent. Thus, GPA has made the programming of modest sized projects economically feasible. The GPA flow diagram schedule is easily understood by persons who are unfamiliar with the analytical methodology. Pilot studies have shown GPA to be a beneficial management tool which enhances understanding of the project and the coordination of productive effort. A technical report will be written in FY-65.

Principal investigator - LTJG D. F. Sampsell

#### Y-R011-01-01-076, Eye Protective Devices

The objective is to investigate the feasibility of using special optical filters to reduce the heat load on the retina of the eye from among those wavelengths of radiation responsible for producing damage to the retina. Elimination of any radiation which does not perform a useful function for visual activity will be sought.

Filter blanks and sunglasses were purchased and their transmission spectra were prepared. A vacuum metalizing system was assembled. The filter blanks were sputtered with chromium to give transmission approximately one percent and ten percent of the original value. It was found that it is practical to prepare eye protective devices with glass such that visible light is transmitted sufficiently for adequate vision while infrared radiation is nearly completely stopped.

A technical note will be published in September 1964.

Principal investigator - J. B. Crilly

#### Y-F011-01-01-077, Feasibility of Hydrodynamic Winch

The objective is to determine the feasibility of the hydrodynamic winch to raise and lower heavy loads from the bottom of the deep ocean. The study is entirely analytical; the concept originated at NOL.

Stability curves and dominant still water motions such as free periods of oscillations have been calculated; response of winch to sea state #4 calculated; all calculations and illustrations prepared for publication; draft of text of technical note started to include findings, conclusions and recommendations. It will be published in FY-65.

The findings include: concept is feasible generally for handling loads to 1,000 tons; tangling of lines when payed out to great depths constitutes an operational problem which can best be resolved by prototype study.

It is suggested that a small prototype, e.g., one to handle 100 tons, be designed, fabricated and proof tested in the ocean.

Principal investigator - J. T. O'Brien