guide to technical documents

volume II

january 1982 through december 1982

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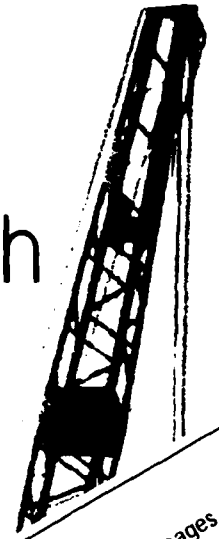

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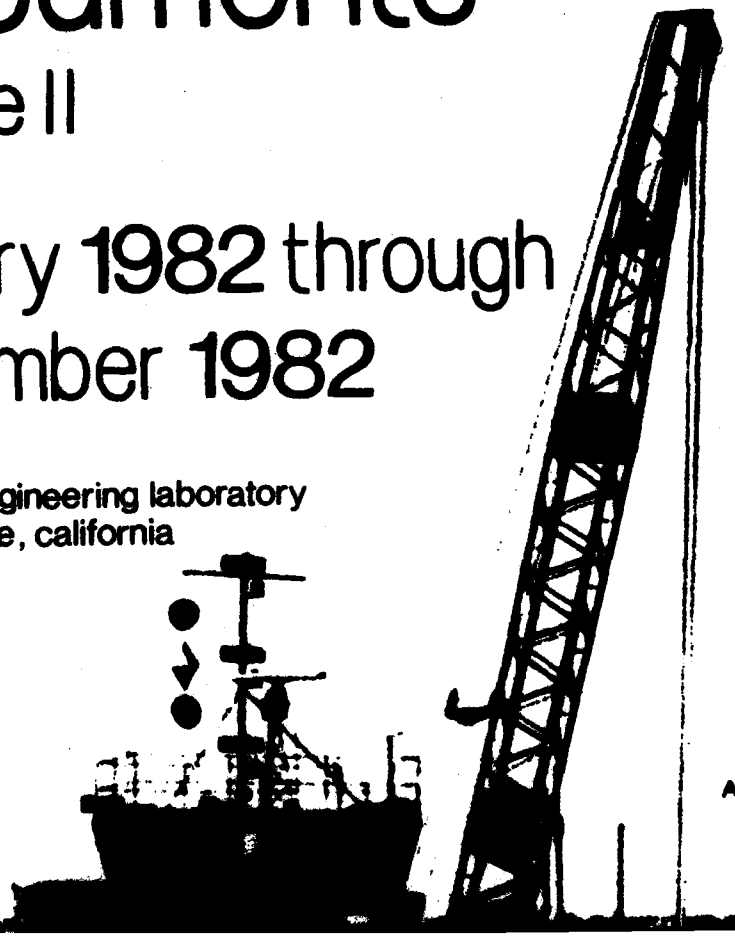

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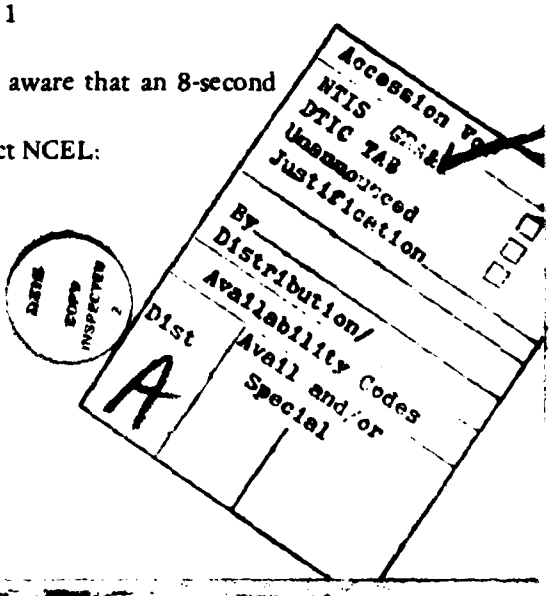

with spudwells mounted internally or externally to NL pontoon sections, (b) the adequacy of the elevating mechanisms to raise, secure, and interface with NL pontoon sections, (c) the practicability of transporting fenders to the site and installing them on the elevated pier, (d) the capabilities of the fenders to function as intended, (e) the capability of the elevated causeway to perform the container off-loading functions, including truck/trailer trafficability and turnaround, and (f) the practicability of expanding the cargo-unloading platform (pierhead). Also tested during Phase II was the Lo/Ro concept which delivers containers deck-loaded on a causeway ferry; the ferry is beached, and the containers are off-loaded with commercial container handlers. The Phase I laboratory tests were conducted at an open-ocean beach site at Point Mugu, Calif. The Phase II tests were conducted by military operators in conjunction with laboratory personnel at an open-ocean beach training site at Coronado, Calif. The results of the tests verified the practicability of all elevated causeway elements to perform their individual concept functions. Crane container-handling rates of up to 20 per hour were attained.

R-852-II
Container Off-Loading and Transfer System (COTS), Advanced Development Tests of Elevated Causeway System, Vol. II: Elevated Causeway Installation and Retrieval, Nov 1977, C. I. Skaalen, A. B. Rausch, ADA050262

A two-phase advanced development test program was conducted to evaluate the installation, operation, and demobilization of an elevated causeway system. This volume details the portion of the program dealing with the pier installation and retrieval. Pier installation and retrieval methods, lift system, pile positioning, driving and pulling techniques, site and elevated causeway surveys and survey methods, and utilization of associated lift system equipment are covered. A human engineering study was made of both the elevated causeway system hardware and the associated operational procedures. The results of the tests verified the practicality of the elevating mechanisms to perform their functions; however, some modifications concerned with improving construction methodology were deemed desirable. The recommended improvements are noted in the report.

R-852-III
Container Off-Loading and Transfer System (COTS), Advanced Development Tests of Elevated Causeway System, Vol. III: The Elevated Causeway Structure, Oct 1977, B. R. Karrh, ADA049248

This report documents the conversion of the U.S. Navy's floating causeway into an elevated structure. The construction of elevated causeway units for development tests is described. Design and testing of modular exterior and interior spudwells for the elevated causeway units is reported. The development and test of a device for connecting floating causeway sections side-to-side to make an expanded platform, floating or elevated, is related. The connection of the causeway structure to supporting piles is examined with respect to manpower and time constraints. These structural features and components were integrated to assist in the construction and testing of an elevated causeway structure.

Analyses and tests of the elevated structure to ascertain the operating capabilities and limitations are described. A structural analysis technique was formulated for the unique modular causeway structure. To compute stresses due to single and combination loads, graphical solutions are presented. A failure analysis of the structure was made to determine operational safety factors. Structural aspects of an elevated crane platform and the impact of the 40-ft (12.2-m) container on the elevated causeway system are discussed.

R-852-IV
Container Off-Loading and Transfer System (COTS), Advanced Development Tests of Elevated Causeway System, Vol. IV: Fender System and Lighterage Motions, Jul 1977, D. A. Davis, ADA043430

The design, fabrication, and testing of a boat fender, which is compatible with a transportable elevated causeway system for unloading container-bearing lighterage, are described. The pile-restrained, floating fender is comprised of a standard 1x15 string of Navy NL pontoons faced with commercially available foam-filled cushions. Each fender unit has an overall length of 90.0 ft (27.4 m), a breadth of 11.0 ft (3.4 m), and a depth of 5.0 ft (1.5 m). Tests of the fender, made in conjunction with tests of the elevated causeway system, indicate that the fender can absorb the berthing impact from a fully loaded 1610 Class Navy Landing Craft, Utility (LCU) having a normal impact velocity of 2 kt (1.0 m/sec). Wave-induced motions of container lighterage at the Phase II site were small and had an inconsequential effect on cargo unloading.

R-852-V
Container Off-Loading and Transfer System (COTS), Advanced Development Tests of Elevated Causeway System, Vol. V: Container-Handling Operations, Jun 1977, J. J. Traffalis, J. J. Hromadik, M. J. Wolfe, R. A. Bliss, ADA042164

A two-phase advanced development test program was conducted to evaluate the elevated causeway system installation, operations, and demobilization. This volume covers the container-handling operations of the Phase II tests (no containers were handled during Phase I) and provides container transfer rates and operational data pertinent to container-handling cranes, containers, spreader bars, lighters, truck/ trailers, pontoon deck reinforcement, turntable, beach transition ramp, beach matting, and air bearing transporter. Also tested during Phase II, and reported in this volume, was the Lo/Ro concept which delivers containers deck-loaded on a causeway ferry; the ferry is beached and containers are off-loaded with commercial container handlers.

Under the ideal sea conditions at the Coronado test site, crane-container handling rates of 20 containers per hour were attained, but the overall productivity was degraded to 15.4 containers per hour with a causeway ferry because of truck/trailer movement on the causeway which could not keep up with the crane operation. A rate of 14 containers per hour was attained with the LCU. Time to unload containers during the Lo/Ro tests varied from an average of 1.6 min per container on the first section (nearest shore) to 2.4 min per container on the third section.

R-853
Preliminary Selection of Anchor Systems for OTEC, Mar 1977, J. M. Atturio, P. J. Valent, R. J. Taylor, ADB018106L

Anchor systems capable of mooring the proposed Ocean Thermal Energy Conversion (OTEC) power plant are described and compared. The comparison is made for two environments: the first, typical of the deep ocean between ±20° latitude; the second, typical of the Gulf Stream. Deadweight anchors with cutting edges were selected as the best choice for anchoring OTEC in the deep ocean. The deadweight required could reach 40 m on a side by 4 m high with 4-m-deep cutting edges and could weigh 18 MN (4 x 10^6 lb) submerged. For the Gulf Stream environment a deadweight anchor offers only slight advantage over a pile anchor group using large-diameter steel-pile shells grouted into the seafloor. On rock seafloors the advantage is with pile anchor groups, but considerable technical development is required before such an anchorage is attainable. Deadweights to moor OTEC in the Gulf Stream could reach 76 m on a side by 7.6 m high and could weigh 600 MN (133 x 10^6 lb) submerged.

R-854-I
A Finite Element Head Injury Model, Vol. I: Theory, Development, and Results, Jul 1977, T. A. Shugar, ADA043605

The results of a head injury model development program are presented, including a description of the resulting model's features and its capabilities for simulating direct and indirect impact forces. The model's validity is discussed in terms of level of confidence and verification. Skull bone response and brain response are presented for a variety of dynamic simulations. Over 75 dynamic and static computer runs have been executed in its development. The basic features of the model are described, including recognizable skull geometry, linear elastic and linear visco-elastic behavior, and a capability for specifying arbitrary impact loads and boundary conditions. A special modification of the isoparametric element is shown to be particularly suited to simulation of the dynamic response of nearly incompressible brain matter.

A preprocessor enables automatic mesh generation of a skull model consistent with a prescribed set of geometrical data supplied by the user. Either complete three-dimensional skulls or skulls symmetrical with respect to the midsagittal plane can be specified in the mesh generation process. Additionally, scale factors can be prescribed which modify existing skull meshes and achieve parametric control on size and shape. A postprocessor facilitates the reduction of the large amount of data that is typical of a head impact simulation. The scope and limitations imposed by the assumption of linearity are discussed. The results demonstrate that while some minor changes appear indicated, the model predictions yield useful insight into the mechanical causes of skull and brain injury.

Volume I of this report also contains Appendix A, a clinical description of head injury. Volume II contains Appendixes B through G covering the computer programs for skull modeling.

R-854-II
A Finite Element Head Injury Model, Vol. II: Computer Program Documentation, Jul 1977, T. A. Shugar, ADA043582

Volume II contains necessary information and documentation for executing the HIM computer program. Documentation includes a user's manual, a flow chart, CDC 6600 control cards, sample input data, and a FORTRAN IV source code listing of the HIM program. In addition, listings are provided for a preprocessor (skull mesh generator), a bandwidth minimizer, and a subroutine for an improved finite element for simulating the load-deformation response of the skull.

R-855
Expendable Doppler Penetrometer: A Performance Evaluation, Jul 1977, R. M. Beard, ADA043912

An expendable penetrometer using the Doppler principle has been developed to expediently test seafloor soils to a depth of 9 m (30 ft) at water depths to 6,000 m (20,000 ft). The velocity of the penetrometer is measured as it penetrates seafloor soils. From the velocity record, soil penetrability and an estimate of the undrained shear strength profile can be calculated. The penetrometer has a mass of 173 kg (12 slugs), is 2.9 m (9.5 ft) long, is 90 mm (3.5 in.) in diameter, and is easily deployed from a ship. This report presents data from 11 tests at four locations off the southern California coast. Undrained shear strength profiles determined from penetrometer data are compared to other types of in-situ data and core data. It is concluded that the expendable Doppler penetrometer is reliable and simple to use and that reasonable estimates (+30% of actual values) of undrained shear strength profiles can be obtained even though the analyzed phenomenon is complex. This tool will be of particular value in surveying potential embedment anchor or foundation locations and can, for some cases, provide information sufficient for design purposes.

R-856
Efficiency Study of Implicit and Explicit Time Integration Operators for Finite Element Applications, Jul 1977, M. G. Katona, R. Thompson, J. Smith, ADA043968

Direct integration techniques (step-by-step) are widely used for the time integration of discretized equations of motion that result from applying numerical techniques such as the finite element method to structural dynamic problems. The integration methods are commonly classified in two groups: (1) explicit methods, which are computationally fast per step but are limited to relatively small time steps due to numerical instability, and (2) implicit methods, which are computationally slower per step but are often capable of utilizing significantly larger time steps with comparable accuracy. In many, if not most, problems it is not obvious which integration method is more efficient. In this study the Newmark Beta-Method is examined for stability, accuracy, and efficiency, where Beta = 0 provides an explicit algorithm, while Beta $\neq$ 0 provides an implicit algorithm. Both algorithms are used in the same finite element program to solve a soil-structure boundary value problem composed of a cylindrical steel shell encased in a relatively soft rock-like material and subjected to a surface blast loading. For this problem with linear system properties, the implicit method was significantly more efficient as measured by computer time. For nonlinear systems, the two methods are approximately equivalent in efficiency. A combined explicit-implicit integration technique is proposed for these types of interaction problems with two or more materials. The combined explicit-implicit algorithm employs explicit integration in the soft material and implicit integration in the stiff material with a potential increase in efficiency by an order of magnitude over either method applied individually.

R-857
Corrosion Protection of Existing Utility Lines Under Piers and Wharves: Results of 3 Years of Marine Atmospheric Exposure, Dec 1977, E. S. Matsui, ADA050883

Most utility lines under piers and wharves are made of iron or galvanized steel which become badly corroded when exposed to severe marine environment. The problem is compounded because of the difficulty of preparing good surfaces of these lines before coating because of their location and shape. CEL is investigating new and improved coating systems that can tolerate minimum surface preparation, extend the service life, and reduce the maintenance cost. Various coating systems were subjected to 3 yr of in-service and atmospheric exposure tests. Of these systems, the grease-impregnated tape, Denso tape, was found to provide the best protection against corrosion attack under piers.

R-858
Project TRASH: Total Refuse Advanced Systems Handling, Dec 1977, C. J. Ward, W. V. Miller, ADA050882

Preliminary and conceptual designs of alternative approaches to a small-scale solid waste transfer/resource recovery station were developed. Equipment components and processes were examined, and their life-cycle costs were compared. Selected modules were combined to process two types of solid waste: (1) completely mixed waste and (2) waste from which most glass and metals had been source-segregated. All system designs were ranked according to life-cycle cost. A solid waste two-component source-segregation experiment was then conducted to resolve questions of workability and to quantify the associated effectiveness and cost factors. In addition, a computer program was developed to aid in the economic analysis of proposed changes in waste practices, such as implementation of source segregation, resource recovery, and transfer station operations.

R-859
OTEC Anchors: Selection and Plan for Development, Dec 1977, P. J. Valent, J. M. Atturio, ADA049552

Anchor systems capable of maintaining the Ocean Thermal Energy Conversion (OTEC) power plants on station were identified and compared. Deadweight anchors with base shear keys were selected as the best choice for the more common ocean environments. Concepts for transporting and lowering the required deadweight anchor systems to the seafloor site are described and their limitations noted. The attractiveness - and technical feasibility - of using a free-fall-emplaced deadweight anchor installation is highlighted. Pile anchors attached to a common frame (template) were selected as the better choice on the hard (rock) seafloors often found in the high-energy, shallow-water areas of the Gulf Stream. Further development of the pile anchor system for OTEC, however, is probably not necessary because it is expected that such hard seafloor anchor sites are best avoided by OTEC plants. A plan for development of the free-fall-emplaced deadweight anchor is presented and a plan for implementation recommended. The development plan includes evaluation of the hydrodynamic stability of the free-falling anchor, development of the soil-penetration/anchor-deceleration inter-relationship, assembly of a structural analysis and design technique for the anchor, and finally a demonstration of a near prototype size OTEC freefall deadweight anchor in early 1980.

R-860
Ice Engineering: Study of Related Properties of Floating Sea-Ice Sheets and Summary of Elastic and Viscoelastic Analyses, Dec 1977, K. D. Vaudrey, ADA051184

This report summarizes approximately 12 yr of research effort by the Civil Engineering Laboratory for developing engineering data and analytical capability for calculating operational bearing capacity of sea-ice sheets. The objectives of the report are: (1) to summarize the CEL elastic and viscoelastic experimental programs; (2) to review the two CEL-developed finite-element techniques for analyzing the structural behavior of the material; and (3) to present bearing capacity limits for both short- and long-term ice-sheet operations.

At the outset of this research program little engineering data and only limited analytical techniques were available to assist the practitioner in evaluating ice-sheet bearing strength. Though much still remains to be learned, it is now possible to make qualitative engineering predictions on bearing strength as a result of the comprehensive laboratory and field research program directed at defining the tensile strength, compressive strength, flexural strength, elastic modulus, creep behavior, and their relationship to temperature and salinity. Bearing strength analysis, using the CEL-developed finite-element computer codes, can now be based on the material properties corresponding to the actual temperature and salinity gradient existing across the vertical profile of the ice plate.

R-861
Exploratory Development of Structures for Tactical Container-Shelter System (TACOSS) Units XI and XII, Dec 1977, R. H. Seabold, ADA053505

Structures for two types of container-shelters were developed for use as part of the Tactical Container-Shelter System (TACOSS). Both types are to serve as 8 x 8 x 20-ft (2.438 x 2.438 x 6.096-m) intermodal shipping containers and as portable shelters. TACOSS XI has removable side panels and telescoping corner posts. Cargo handling can take place through the personnel door and through both sides with any number of side panels removed. In the extended configuration, the roof can be extended upward by means of the telescoping corner posts to obtain a 10-ft (3.048-m) clear ceiling height, and closure panels can be inserted to increase the wall height. In the complexed configuration, side panels are removed and units can be coupled together to form shelters of any length, depending on the number of units used. The units also can be extended and complexed simultaneously to form shelters about 20 ft (6.096 m) wide, with a 10-ft (3.048-m) clear ceiling height, and of any length in increments of 8 ft (2.438 m). TACOSS XII has a detachable pallet base. In the pallet configuration, the entire upper structure is lifted away in one piece and stored elsewhere. The floor of the structure in this configuration serves as an 8 x 20-ft (2.438 x 6.096-m) pallet for ordinary cargo, for a large equipment base, or for a floor of a prefabricated building module. Cargo handling can take place from both sides and both ends. Both types were designed, analyzed, fabricated, and tested. Two experimental models of type XI and one of type XII were fabricated and tested. Neither type fully qualified as a container due to lack of weatherproofness and qualification as shelters was not fully validated due to the cancellation of drop and rain tests, but both concepts were found to be feasible. The operating principles work and need not be changed. The payload, tare weight, dimensional, and residual deflection requirements can be met for all configurations of use and all modes of transportation.

R-862
Development and Testing of an Experimental Heavy Duty Hydraulic Rock Drill for Use by Divers, Dec 1977, R. L. Brackett, W. Tausig, ADB026721L

Underwater construction operations often require drilling holes in seafloor rock and coral for the placement of explosive charges or the installation of seafloor fasteners. To meet this need an experimental hydraulically powered rock drill was developed by combining a commercially available concrete breaker and a hydraulic motor coupled to the tool chuck to provide rotational indexing. Three types of concrete breakers were tested for possible rock drill candidates. The selected breaker was used to build the prototype underwater rock drill, capable of operating to ocean depths of 120 ft. Tests with the rock drill show it is capable of drilling up to 2-in.-diameter holes at a rate of 3 in./min in 17,000 psi granite. In addition, a stabilizing chassis with an articulated positioning arm was designed and fabricated to provide accurate drill positioning. The stabilizing chassis enables underwater construction divers to drill holes up to 4 in. in diameter by 15 ft deep with improved penetration rates.

R-863
Effectiveness of Over-Rust Primers for Naval Shore Facilities, Jan 1978, E. S. Matsui, ADA053557

Various over-rust primers topcoated with government specification paint TT-E-489D were applied over brush-off sandblasted and wire-brushed rusted steel specimens and were exposed 5 yr at three Civil Engineering Laboratory (CEL) marine atmospheric test sites. The performance of the coating system at the CEL test sites was compared with that of the government specification test standard coated over sandblasted, brush-off sandblasted, and wire-brushed steel specimens. The results indicate that a coating system using a superior over-rust primer can provide protection comparable to that of the test standard applied over the sandblasted steel specimens. However, most of the over-rust primers tested provided less protection than the test standard. A test standard coated with a wash primer (Formula 117) provided poorer protection than the same coating system without the wash primer when applied over the rusted steel specimens. Estimating anticipated durability of coating system at one site from data obtained from another site by a regression analysis is also illustrated.

R-864
Operating Cost Evaluation of Sulfur Dioxide Removal Systems for Boiler Applications, Apr 1978, J. M. Slaminski, ADA054767

Seven commercial processes for extracting sulfur dioxide from steam or steam-electric generating plants are analytically compared. The operation and economics of lime and limestone slurry scrubbing, dilute and concentrated double alkali, and dilute sulfuric acid processes with

gypsum disposal products are contrasted with sodium sulfite/bisulfite and activated char sulfur recovery systems. Each process is critically analyzed to yield system flows and operating expenses (including equipment power consumption, product disposal costs or credits, reagent requirements and operating and maintenance costs). The laws for scaling these results to any given plant capacity and coal sulfur content are developed and parametrically graphed. This information is a valuable guide for the Navy or utility engineer to perform accurate system evaluations.

R-865
Nansen Drift Station Project - Remote Sea-Ice Runway Construction, Apr 1978, J. L. Barthelemy, ADA054720

In the past, surface-flooding activities have been confined to areas near major military logistic centers. As a result, techniques developed for sea-ice runway construction relied extensively upon the use of heavy equipment to clear snow and position large stationary pumping equipment. At remote sites, such as that planned for the proposed Nansen Drift Station, requirements are different. Construction crews will be severely restricted as to their size and number of support equipment available, and they may be required to work concurrently at a number of scattered locations. A field-test program conducted by the Civil Engineering Laboratory at Barrow, Alaska, during March 1977 added a new dimension to surface-flooding technology. The exercises demonstrated the feasibility and capability of using small, lightweight pumps to prepare sections of a sea-ice runway. The water-handling equipment included two modified, highly portable, centrifugally driven trash pumps that had undergone preliminary low-temperature testing in the cold-chamber facilities at CEL.

R-866
A Viscoelastic-Plastic Constitutive Model With a Finite Element Solution Methodology, Jun 1978, M. Katona, ADA057684

A textbook style development of viscoplasticity is presented. For completeness, the report also includes a detailed review of plasticity and viscoelasticity. The combination of plasticity and viscoelasticity is the basis for the so-called "viscoelastic-plastic" model developed herein. Other combo-viscoplastic models are also introduced. Each constitutive model is introduced with conceptual one-dimensional stress-strain models and then generalized for multidimensional stress space. Furthermore, each model is cast in an incremental form appropriate for numerical solution techniques. Finite element algorithms are outlined for incorporating these nonlinear constitutive models into boundary value problems. In particular, tangent stiffness and initial strain methods are discussed. The viscoelastic-plastic model is compared to experimental data for plexiglas and sea-ice to illustrate the versatility of the model in replicating nonlinear creep and flow of these materials. Moreover, the identification of the model parameters are shown to be no more difficult than the identification of parameters for the classical theories of plasticity and viscoelasticity.

R-867
A Probabilistic Procedure for Estimating Seismic Loading Based on Historic and Geologic Data, Aug 1978, J. M. Ferritto, ADA060204

This report describes a procedure for estimating site ground motion based on the historic data base of earthquakes adjusted to incorporate fault slip data. Procedures are given for determining site acceleration magnitude and duration for various confidence levels. Seismic risk analysis techniques are discussed. The report contains background material required for an understanding of the procedure.

R-868
Corrosion and Biofouling of OTEC System Surfaces - Design Factors, Nov 1978, J. F. Jenkins, ADA066115

Biofouling and corrosion of Ocean Thermal Energy Conversion (OTEC) plants are critical factors in the economic feasibility of the OTEC concept. As the mission and operating requirements of an OTEC plant are significantly different than those for any existing facility, many unique materials and design problems must be addressed. This report identifies factors that influence biofouling and corrosion, recommends specific design features where appropriate, and identifies items requiring further investigation.

R-869
Long-Term, Deep-Ocean Test of Concrete Spherical Structures - Results After 6 Years, Jan 1979, H. H. Haynes, R. S. Highberg, ADA070864

In 1971, a long-term, deep-ocean test was started on eighteen concrete spheres, 66 inches (1,676 mm) in outside diameter by 4.12 inches (105 mm) in wall thickness. The spheres were placed in the ocean at depths from 1,840 to 5,075 feet (560 to 1,547 m). Over a 6.4-year period, yearly inspections of the spheres by submersibles have provided data on time-dependent failure and permeability. After 5.3 years, three of the spheres were retrieved from the ocean for laboratory testing. Data on concrete compressive strength gain, short-term implosion strength of the three retrieved spheres, and permeability and durability of the concrete were obtained. This report summarizes the findings from the laboratory and ocean tests.

R-870
CEL Building and Experimental Subgrade Cooling System, Barrow, Alaska - Construction History and Performance Characteristics, Apr 1979, J. L. Barthelemy, ADA070865

Gravel requirements for structures placed on unstable permafrost can be reduced by incorporating various insulation materials into the floor and foundation systems. However, to reduce the need for gravel even more, some means of extracting heat from the ground beneath the structure must be provided. During the summer of 1976, personnel from the Civil Engineering Laboratory erected a building on the ice-rich permafrost near Barrow, Alaska. The structure, placed on just 1 foot of gravel, has been used as a test bed to evaluate an experimental subgrade cooling system. The cooling system consists of 15 loop-configured heat exchangers called convection cells. During the winter months, heat losses from the building into the permafrost are redirected via these convection cells to the cold environment outside, thus preventing progressive degradation from thaw. To date, data collected from some 150 thermocouples located in the subgrade and heat-exchange systems have shown that the rate of winter heat removal is even greater than originally anticipated. Although a small cyclical displacement of the floor and foundation resulting from seasonal summer thaw and winter freezeback has been apparent, this movement is minimal compared to settlement which would have occurred had the massive ice present in the subgrade been allowed to thaw unchecked.

R-871
Recycling of Asphalt Concrete Airfield Pavements - A Laboratory Study, May 1979, R. B. Brownie, M. C. Hironaka, ADA078655

Laboratory experiments have been conducted on aged asphalt concrete (AC) pavement samples obtained from three Naval airfields and two civil airports to develop and establish criteria and design guidelines for recycling such pavements. In these experiments, tests were conducted on nine agents for softening residual asphalt cements and designed hot- and cold-mix samples. It was found that aged AC pavement materials can be recycled to meet FAA and Navy specifications for new pavement surfaces and base courses

by hot-mix recycling procedures and new base courses by cold-mix recycling procedures. Based on the results of this investigation, criteria and design guidelines for recycling aged AC pavements by hot-mix and cold-mix procedures have been established.

R-872
Conductive Flooring for Munitions Facilities, Jun 1979, P. J. Hearst, ADA070953

Information is presented for use as guidelines in the selection of conductive flooring for munitions facilities. Available conductive floorings are described in the categories of concretes, organic composition toppings, coatings, coverings, and metal sheetings. Problems with conductive floorings and performance experiences at munitions facilities are discussed. Reconditioning, grounding, electrical resistance limits, and resistance measurement of conductive flooring also are discussed.

R-873
Seafloor Soil Sampling and Geotechnical Parameter Determination - Handbook, Aug 1979, H. J. Lee, J. E. Clausner, ADA078726

Geotechnical parameters are those seafloor sediment characteristics, such as shear strength or compressibility, that determine how a foundation will perform. Such characteristics are needed for design and analysis of all fixed seafloor facilities and also for assessment of seafloor penetration and breakout of other objects. This handbook shows the user, who is assumed to be an ocean engineer with little background in soil mechanics, how to obtain measurements of these properties to several different levels of accuracy. A flow diagram identifies the major decision blocks for selecting an appropriate properties determination program. The programs recommended vary from estimation and approximate measurement to coring, detailed laboratory testing, and disturbance correction, depending on the tolerable level of error. The greatest accuracy achievable is a possible error range of ±20% in shear strength. All aspects of the process of obtaining parameters are described: corers, coring procedures, coring accessories, oceanographic support vessels, core handling, laboratory testing, and test result analysis. Procedures are also given for correcting for coring disturbance in measurement of laboratory shear strengths to estimate the correct in-place strengths.

R-874
Design for Implosion of Concrete Cylinder Structures Under Hydrostatic Loading, Aug 1979, H. Haynes, ADA078641

This report presents updated design guides for both thick- and thin-walled concrete cylinder structures under hydrostatic loading. The design approach for thick-walled cylinders has been changed from that described in previous work to a semi-empirical basis; improvements in implosion strength on the order of 10% are found. A test on a thick-walled 10-ft-diam (3.05-m) structure loaded to failure in the ocean is reported. A major change in the guides is for thin-walled cylinders, where new data on 15 relatively large-scale specimens are reported. Design guides for thin-walled cylinders show an increase in implosion strength ranging from 0% to 35%, depending on the structures' t/D_o and L/D_o ratios, from that reported previously.

R-875
Coaxial Underwater Mateable Connectors - A New Technology for Seafloor Structure Applications, Sep 1979, J. V. Wilson, ADA085291

As part of the Deep Ocean Technology Program, an underwater-mateable coaxial connector for SD list I cable has been developed at the Civil Engineering Laboratory (CEL). The CEL-3 series connector includes the following features: oil-filled, pressure compensated, coaxial throughout, full cable breaking strength, both manipulator and diver compatibility, unlimited depth operability, and estimated 10- to 20-year life. Four complete units and several subsystem mockups have been built and thoroughly laboratory-tested. Limited field tests and at-sea demonstrations have also been conducted, culminating in a 2-year 6,000-foot demonstration of the CEL-3B prototype. After minor modifications and debugging, the prototype CEL-3B met all performance requirements, including impedance matching to within 2%, 6,000-volt DC operation, pressure testing and wet mating to 5,500 psig, mating by submersible, unmating under 10,000 pounds of tension, and sustained submergence without degradation. The variety of designs tested provides a basis for extending the CEL-3 series concept to a wide range of applications - from deep ocean cable repair to modular assembly of advanced ocean cable structures.

R-876
Electromagnetic Susceptibility Testing of Neurophysiological Equipment, Feb 1980, J. L. Brooks, ADA085521

A series of electromagnetic susceptibility tests were conducted on electromyographs, electroencephalographs, and an echoencephalograph. The tests were to determine the amount of electromagnetic shielding required to provide the proper operational environment needed in hospital neurophysiological departments. The results showed that careful arrangement of the electrode conductors can significantly decrease the susceptibility of the equipment. In addition, it was found that electromagnetic shielding provides minimum protection for the electroencephalograph because of its limited frequency response. Therefore, it is not recommended unless electromyographs (wide frequency range) are present or their use is anticipated.

R-877
Solar Heating of Buildings and Domestic Hot Water, May 1980, E. R. Durlak, ADA085815

The purpose of this document is to provide guidance in the design and cost analysis of solar heating systems for buildings and domestic hot water. Among the topics included are the types of solar systems, components, and solar collectors; discussions on storage systems, heat pumps, cooling systems, passive systems, controls, and pumps. Calculation methods are included for determining collector size, storage size, simplified building and DHW loads, value of fuel saved, and saving-investment ratios. The calculation procedure is based on parametric curves for "fraction of heating load supplied by solar energy" and several "rules of thumb" for design. A series of 11 worksheets is used to enable the engineer with no prior experience with solar systems to accomplish a complete design and cost analysis. With this information he can prepare bidding and specification documents for the job. Tables of solar insolation at various Navy stations, typical building heat loads, collector prices by type, and storage tank prices are included. An example problem is worked. A directory of manufacturers and bibliography is also included.

R-878
Design Criteria for Soil Cover Over Box-Shaped Ammunition Magazines, May 1980, W. A. Keenan, L. C. Nichols, ADA089300

Theory is formulated for effects of an internal explosion on the dynamic response and behavior of the earth-bermed roof of box-shaped ammunition storage magazines. The theory considers the ratio of charge weight to magazine volume, scaled vent area of the magazine, depth and density of soil cover, characteristics of the roof slab, and the net explosive weight of storage. Predictions from theory are correlated with experimental data derived from field tests in which HE charges were detonated inside small-scale, box-shaped ammunition magazines. Test variables were depth of soil cover, soil density, and net explosive weight. Excellent agreement was found between the measured and predicted response of the roof over the entire

history of response. Theory is translated into design criteria for the minimum depth of soil cover required over the roof of a box magazine in order to mitigate the debris hazard and/or contain explosion effects from an inadvertent explosion. Problem solutions are presented to illustrate applications of the theory and design criteria. Results have positive implications in the future design and siting of ready service and special weapons magazines and missile test cells which typically have a small ratio of net explosive weight to magazine volume. Further, results offer a rational basis for designing physical security and survivability attributes into construction standards which deviate from established standards without degrading the level of explosives safety.

R-879
Cogeneration Systems, Jun 1980, E. E. Cooper, ADA089269

Discussions are included of the four broad interrelated categories of factors to consider when evaluating candidate approaches to cogeneration at a site. The categories are technical, economic/financial, legislative/regulatory, and institutional. The inability to resolve difficulties in any area may obviate implementation of cogeneration. Generalized performance curves are presented for cogeneration systems utilizing commercially available steam turbines, diesels, or combustion turbines with heat recovery. A summary is given of federal energy and environmental legislation and regulations currently in effect which impact cogeneration systems. The nature of institutional constraints on implementing cogeneration is also discussed. The potential for cooperative ownership/operation options with utility companies or third party investors is described. The economics of cogeneration is detailed. Finally, steps are listed for proceeding through the categories of factors toward implementation of cogeneration.

R-880
Task-Ambient Office Lighting, Sep 1980, W. Pierpoint, ADA097119

A method is discussed for converting uniform office lighting systems to task-ambient lighting systems. The method requires only the use of a light meter and a mirror. A correlation between the method and equivalent sphere illumination is shown. Several examples of offices converted from uniform lighting to task-ambient lighting are discussed.

R-881
Solid Waste Management in Marine Amphibious Force (MAF) Operations: Analysis and Alternatives, Sep 1980, E. P. Skillman, ADA097118

The management of Marine Amphibious Force (MAF) generated solid waste is extremely manpower intensive. The components of a MAF wastestream are unique (60% metal). To render immediate relief to these problems, state-of-the-art volume reduction equipment has been recommended provided modification requirements (weight, mobility, ruggedness, etc.) can be met. The scope of the modifications has been investigated, applications/limitations established, and conceptual drawings developed for the fabrication of experimental solid waste management equipment for use in MAF operations.

R-882
Holding Capacity of Plate Anchors, Oct 1980, R. M. Beard, ADA097116

This handbook-style report has been prepared to assist the engineer with limited geotechnical experience in determining the holding capacity of a plate anchor for all loading conditions – short-term static holding capacity, long-term static holding capacity, impulse loading holding capacity, cyclic loading holding capacity, cyclic creep holding capacity, and the effects of earthquake loading. A flow diagram leads the user to appropriate sections of the report in the process of analyzing the various types of anchor holding capacity. The user begins with site survey, soil property requirements, and assesses whether unusual or hazardous soil conditions exist. The short-term static holding capacity is then determined. From this base the user proceeds to the other holding capacity topics as required by the expected loading conditions.

R-882S
Guide to the Use of Propellant-Embedded Anchors in Coral and Rock Seafloors, Suppl. to TR-882, Jun 1982, R. M. Beard, ADA120025

This handbook-style report has been prepared to assist the engineer with limited propellant-embedded anchoring experience in estimating holding capacity of this type of anchor in coral and rock seafloors. Site survey requirements are discussed with regard to coral and rock types and sediment cover and their effect on holding capacity. An equation is provided for estimating holding capacity in coral. Limited general guidance is provided for estimating holding capacity in rock.

R-883
Management Procedure for Assessment of Friable Asbestos Insulating Material, Feb 1981, E. E. Lory, D. S. Coin, et al., ADB059013L

The document provides protocol for evaluating friable asbestos material conditions and determining, by use of the asbestos hazard index, if a Navy Occupational and Health deficiency abatement project should be initiated. Also included are: guidance on proper interim control measures, as well as guidance for selecting appropriate long-term control measures; writing valid specifications for long-term control measures; standardized safety procedures; and personnel protection during maintenance and control of friable asbestos-containing insulating systems and during disposal of asbestos materials. The long-term control measures emphasize the need for choice of a cost-effective, energy-conserving alternative which will meet current fiber pollution restrictions.

R-884
Thermal Insulation for Pipe Systems: Inspection and Maintenance Guidance, Feb 1981, E. E. Lory, ADB058922L

This document is primarily concerned with asbestos-insulating materials that can be crumbled, pulverized, or reduced to powder in the hand, thus readily releasing fibers with minimal disturbance. The document provides general information on thermal pipe insulation, types of insulation, lagging and coating materials, maintenance inspection methods, and maintenance procedures. The maintenance procedure guidance provides techniques that comply with OSHA and EPA regulations.

R-885
Procedure for Conducting Site Seismicity Studies at Naval Shore Facilities and An Economic Analysis of Risk, Feb 1981, J. M. Ferritto, ADB058923L

An automated procedure has been developed to perform seismic analysis using available historic and geologic data. The objective of the seismicity study is to determine the probability of occurrence of ground motion at the site. Response spectra and time history techniques are presented. The study reviews construction cost increases for seismic strengthening and expected damage.

The specification of a 225-year return time acceleration does not produce optimal least cost designs over all ranges of acceleration. The least total cost design acceleration varies with site activity. Included in the report is a discussion of structural analysis techniques.

R-886
Cable Burial in the Deep Ocean Floor, Apr 1981, P. K. Rockwell, J. H. Engel, W. B. Piercy, ADB058924L

Bottom-fishing equipment frequently damages or breaks Navy bottom-laid telecommunication cables, causing substantial repair costs and interruption of critical communication systems. The Naval Civil Engineering Laboratory (NCEL) has developed and validated an engineering concept for a Deep Ocean Cable Burial (DOCB) system to provide the Navy with a means of burying cables 3 feet deep in ocean sediments, at speeds not less than 1 knot in water depths to 6,000 feet. The DOCB system concept includes a remotely controlled machine which buries previously laid cables; it is powered and controlled from a surface ship via an electromechanical umbilical cable. The machine is self-propelled by ducted thrusters and supported on water-lubricated skids. The excavation system comprises an orbital vibrating plowshare and a vertical water jet. Full-scale field testing at NCEL focused on: (a) quantifying orbital vibratory plow drawbar forces; (b) evaluating a vertically impinging water jet trenching subsystem; and (c) demonstrating the effect of water lubrication on the soil drag of a flat-bottomed skid. Field tests showed that drawbar force was reduced 70% by applying elliptical orbital vibration to a plow. The water jet tests demonstrated that a 2-1/2-inch nozzle can cut 36 inches deep in 1- to 2-psi clay at a nozzle pressure of 75 psi and flow rate of 1,200 gpm. The water-lubricated skid tests showed that forcing a layer of water between the skid and soil reduced the skid/soil drag by 50%. Finally, a full-scale experimental cable burial vehicle was tested in shallow water. This 360-hp vehicle buried cables in excess of 42 inches deep at 1.2 knots.

R-887
Laser-Based Noncontacting Displacement Measurement, May 1981, G. Warren, ADB058925L

A laser-based noncontact method of directly measuring time-displacement has been developed as an alternative to electrical transducers and hard-wire cables. A biaxial device employing a He-Ne laser and position sensor has been built to monitor structural motion at distances up to 350 meters with displacement accuracies better than 2 mm. The method proved valuable in measuring dynamic displacement of large structures where accessibility was limited or where fixed points of reference were nonexistent. Also, a means of measuring triaxial displacement has been outlined.

R-888
Design Procedures for Embedment Anchors Subjected to Dynamic Loading Conditions, Nov 1981, H. G. Herrmann, ADA110325

This report provides procedures for determining allowable design loads for embedment anchors under all types of dynamic loads, including impact (as from a ship driving into a mooring), cyclic (as from a buoy or ship riding in a mooring system during a storm), and earthquake loading. The design procedures are simplified in the form of guidelines applicable to most site conditions and are complete to the point of including the following: (1) site survey requirements; (2) detailed static design procedures; (3) description and definition of dynamic loads; (4) design procedures for impact, cyclic, and earthquake loading; (5) selection and use of appropriate factors of safety; and (6) description of available existing NCEL embedment anchor hardware. While the procedures are designed specifically for the NCEL-developed family of propellant (often termed explosive) embedded anchors, they are applicable to other types of embedment anchors and screw anchors. For hardware configurations or site conditions beyond the range of the guidelines presented here, references to appropriate other documents are provided.

R-889
ESKIMO VI Results, Nov 1981, P. E. Tafoya, ADB064461L

ESKIMO VI, sixth in the series of Explosive Safety Knowledge IMprovement Operation Tests, was conducted to test and evaluate the safety and performance under blast loading of flat-roofed, earth-covered, box-shapes, reinforced concrete (smokeless powder and projectile) storage magazines. The test magazines were located at the minimum intermagazine distances allowed for magazines of the box type. The two magazines tested, the Type IIB (old design) and Type A (new design), were halfscale models characterized by the box shape, similar geometric dimensions, interior three-bay design, and two entrance doors located in the headwall. The donor structure was a mock-up of a Type IIB magazine and simulated the geometry and mass of the roof, earth-cover, and headwall of the prototype. The donor charge consisted of 60 Mark 16 torpedo warheads containing the equivalent to 44,000 pounds of TNT, corresponding to 350,000 pounds of TNT at full scale.

Both structures survived the test with limited damage. The Type IIB doors failed during the bast and were blown into the structure; permanent roof deflections were limited (less than 1 inch); and minor cracking of the concrete roof and headwall was evident. The Type A magazine sustained priarily architectural damage to the roof parapet; roof deflections (less than 0.5 inch) were noted, with minor cracking of the concrete roof. Both magazines, if in the field, could be reusable after minor reworking.

R-890
Design Guidelines for the Development of a Trencher for Cutting Rock, Coral, and Frozen Sand in the Nearshore Environment, Dec 1981, W. R. Tausig, ADB063763L

Cables and pipelines that traverse the nearshore region often fail due to damage from hydronamic forces and dragging anchors unless they are protected. Trenching and burying cables below the seafloor has been shown to be a viable method for protecting cables and pipelines in nearshore and coral areas. This report summarizes nearshore trencher studies at the Naval Civil Engineering Laboratory, and surveys recent advances made in nearshore trenching technology. As a result of these studies, NCEL conducted a development program to demonstrate the feasibility of using cavitating waterjets for trenching in rock and coral. The results of this development program, along with a state-of-the-art review of mechanical trenchers combined with the data resulting from the cavitation waterjet development program, are presented at the conclusion of this report as guidelines for nearshore trencher design.

R-891
Underwater Splicing of Submarine Coaxial Cable, Feb 1982, A. T. Inouye, W. R. Tausig, ADB064462L

The Naval Civil Engineering Laboratory has developed a self-contained unit that can splice submarine coaxial cables in place in the seafloor. The unit restores electrical and mechanical characteristics of the cable by preparing the cable's end and inserting it into the splice. Experimental splice models were attached to cables in seawater at pressures up to 5,000 psig and were subjected to 6,000 VDC. Leakage currents were less than 1 μA. The splice was also subjected to steady state DC voltages to 35,000 volts and 10-nsec transient at voltages to 70,000 volts peak with no electrical degradation. Attenuation of the splice was measured at 0.01 db/m at 13 MHz. Strength restoration consists of a modified commercial sliding cone device with a holding capacity of about 4,600 pounds on a copper-cladded steel cable. The splice is filled with castor oil for pressure compensation and prevention of high-voltage breakdown or corona noise. The development of the splice shows that an underwater splicing technique on the seafloor is feasible.

R-892
Geotechnical Diver Tool Development, May 1982, J. A. Bailard, ADB065655L

Seven geotechnical site survey tools were developed for diver use; these include: an impact sediment corer, a vacuum-assisted sediment corer, a rock corer, a vane shear device, a miniature standard penetration test device, a water-jet probe, and a rock strength device. Laboratory tests and field tests and evaluation of the tools provided adequate geotechnical information to support the design of most nearshore Navy installations.

R-893
Design and Performance of Thermal Sensors for Measuring Ocean Currents, May 1982, A. P. Smith, T. R. Kretschmer, B. C. Streets, ADB065661L

The development of an ocean current sensor based on thermal anemometry principles is described. The sensor accurately measures current speed to ±5% of reading and current direction to ±8 degrees. Significant problems associated with the use of thermal sensors in water have been solved. For example, a unique antifouling technique, based on electrolytic hypochlorination, was developed that controls biofouling indefinitely on the sensor surface; the overall strength of the sensor was greatly increased by substituting ceramic substrates for quartz substrates; and a waterproof coating, based on Parylene D, increased sensor life expectancy from several days to several weeks. This report describes the design and manufacture of the sensor. An evaluation of the results obtained from laboratory and ocean testing of the sensor is presented along with a description of the antifouling technique. The theoretical background associated with sensor operation is covered briefly.

R-894
Air Infiltration and Stratification Investigation of Air Force and Navy Aircraft Hangars, Jun 1982, J. L. Ashley, ADB066649L

An investigation was conducted to measure the air infiltration and stratification characteristics associated with Air Force and Navy aircraft hangars. Four hangars were evaluated at different locations throughout the United States during the 1980-1981 winter. Air infiltration measurements were accomplished by measuring the decay rates of a tracer gas (sulfur hexafluoride) with hangar doors opened and closed. Floor-to-ceiling temperature gradients were measured and correlated to outside air temperature. Concepts to reduce stratification and air infiltration were evaluated and recommendations made. Lower limits for air infiltration were established, and a method to predict the severity of stratification was developed. (Also published as AFESC/RDVA ESL-TR-81-40.)

R-895
Seawater Hydraulics: Development of an Experimental Vane Motor for Powering Diver-Held Tools, Jul 1982, S. A. Black, ADB068205L

The Naval Civil Engineering Laboratory is developing a diver-operated hydraulic tool system that uses seawater as the working fluid. In the fall of 1978, work began on the development of an experimental vane motor capable of powering diver-held tools. Material requirements for the vane motor components were investigated in detail, and an engineering model of the motor was designed and fabricated using the most promising materials. The best results were obtained by using Torlon 4275, a high-strength thermoplastic, for the vanes, side plates, and bearings, and Inconel 625, a high-nickel-based alloy, for the housing and rotor. Based on the results of engineering development, an experimental vane motor was fabricated and tested in the laboratory. The motor, with a volume of about 25 $in.^3$, weighs only 5 pounds, and produces 3.3 hp at 1,600 rpm with 80% overall efficiency when supplied with 7 gpm of seawater at 1,000 psi. More than 60 hours of full-power operation have been achieved. The results to date of the development and testing are presented in this report.

R-896
Safe Underwater Electrical Power Transmission, Aug 1982, L. W. Tucker, ADB067752L

To enable divers to safely use electrical equipment underwater, the power transmission system design must include techniques for protecting the diver from electrical shock hazards. The Naval Civil Engineering Laboratory (NCEL) has developed an improved ground fault protecting system that can protect the diver when used in conjunction with other methods of protection. The NCEL ground fault system will shut down power to the underwater equipment in less than 10 msec if a breakdown in the insulation resistance of the transmission lines allows more than 2.5 mA to flow to ground. This report reviews the methods that can reduce the possibility of electric shock to the diver. The development of the NCEL ground fault detection is also presented along with the results from ocean tests of an electric-powered vehicle equipped with the protection system.

R-897
Improved Split-Pipe Cable Protection Techniques, Dec 1982, R. L. Brackett, W. R. Tausig, AD

The U.S. Navy currently maintains and operates numerous underwater power and signal cables. Most of these cables utilize split pipe systems to protect the cable from damage in the surfzone and when crossing exposed rocky seafloors. Past experience has shown that the hardware used to install the split pipe system lacks the reliability and maintenance-free operation required for the life of the cables. Based on previous experience with cable failures, the areas determined to be in greatest need of investigation are fasteners for holding the split pipe halves together, immobilization of the pipe, and cathodic protection for the entire system. As a result, NCEL tested prototype and commercially available hardware components which appeared to be suitable replacements for the existing split pipe hardware. The candidate hardware was then used in a 300-foot-long test section of split pipe installed March 1976 at Anacapa Island, to be inspected during a five-year period.

This report summarizes the candidate hardware investigation, the installation and periodic inspections of the Anacapa Island test installation, and finally the removal and analysis of that test installation.

N-1514
Earthwork Construction in Support of a Marine Amphibious Force - A Case Study, Jan 1978, P. S. Springston, ADA050797

A Marine Amphibious Force (MAF) level Marine Air/Ground Task Force (MAGTF) will generate multiple, large-scale horizontal construction projects totaling thousands of cubic yards of earthwork. Even with Naval Construction Force (NCF) support, a landing force commander may be confronted with simultaneous critical earthwork requirements that would exceed the engineering capability of the MAF. A hypothetical earthwork construction case is defined by a set of limiting assumptions. Within the boundaries set by these assumptions, facility construction activity estimates are calculated and arrow networks are drafted. The Critical Path Method (CPM) is utilized to predict project earliest finish dates and resource allocation. The presented data (networks, resource requirements, project durations, etc.) will be of use to researchers and planners in the area of amphibious logistic support. Specific Initial Operating Capability dates for facilities will vary with operational requirements; thus, a general discussion of the projections was substituted in lieu of specific conclusions of whether facility construction was in pace with tactical and operational requirements.

N-1515
Long-Term Stress-Strain Behavior of a Seafloor Soil, Feb 1978, P. J. Valent, ADA053506

A calcareous deep-sea soil from the central Caribbean was subjected to a series of consolidation, triaxial shear, and triaxial shear creep tests to determine its response to loadings of engineering interest. The soil, classified as an inorganic silt, tended to densify during transport. Compression index C_c is 0.80; empirical terrestrial engineering correlations between C_c and other easily and rapidly measured index parameters may be in error by 30%. No significant crushing of the hollow foraminifera tests (shells) comprising the coarse-size fraction of the sediment was noted in the consolidation tests up to stresses of 1,530 kPa (32,000 psf). This coarse-sized fraction does, however, undergo significant crushing if material finer than 0.43 mm is removed, suggesting that the fine-sized fraction distributes loads on the coarse-sized test (shell) surfaces. Grain crushing may be partly responsible for the curved failure envelope developed from the triaxial shear tests. For specimens consolidated up to 30 kPa (4 psi) the angle of internal friction of the calcareous ooze is 0.60 rad (34 deg); specimens consolidated to greater pressures describe a flattening of the failure envelope to 0.49 rad (28 deg). Triaxial shear creep tests indicate that creep failure in this soil is not a significant engineering problem. The data suggest that material consolidated to higher stress levels than those used here (< 100 kPa) and then shear loaded undrained will develop failure strains at stress levels less than 80% of short-term failure stress levels.

N-1516
Repair System for Damaged Coatings on Navy Antenna Towers, Pt. 1, Mar 1978, L. K. Schwab, R. W. Drisko, ADA053507

A series of epoxy coating systems (some solvent-based and some water-emulsion) and an alkyd coating system were exposed on steel panels to a tropical environment for use in repair of damaged coatings on antenna towers. Laboratory bonding tests were conducted before and after exposure. Three candidate coating repair systems were applied on a tank exterior at San Nicolas Island, and a larger experiment using two surface preparations and 16 coating systems on an antenna positioner was initiated at the Pacific Missile Range, Point Mugu, California. Coating systems are also being - or have been - exposed in a laboratory salt spray cabinet. Results of all these studies are described in this report.

N-1517
Analysis of Chamberlin Flat Plate Solar Collector Using National Bureau of Standards Test Criteria, May 1978, E. R. Durlak, ADA054215

Test results are presented for a flat plate, single glazed solar collector tested in accordance with the National Bureau of Standards test criteria. A description of the test apparatus and instrumentation is given. A graph of solar collector efficiency is presented. There was good agreement between test results and data taken from the manufacturer's brochure.

N-1518
Optimum Dynamic Design of Nonlinear Plates Under Blast Loading, Mar 1978, J. M. Ferritto, ADA055601

A computer program was developed to determine the approximate nonlinear dynamic response of plates subjected to blast pressure loading. Given the explosive parameters and geometry of the plate, the program computes the blast environment and the structural resistance, mass, and stiffness of the plate and solves for the dynamic response. The program contains optimization subroutines that provide for automatic optimum design of least-cost plates. The program will assist engineers in the design and analysis of blast doors that are intended to contain the effects of accidental explosions. The report gives a user's guide and sample problems with data input and program output.

N-1519
Power System Simulator, Apr 1978, K. T. Huang, ADA054476

A power system simulator (PSS) that can be parametrically programmed to simulate the electrical transient performance of a medium-sized power system and its elemental components is described. It employs analog circuit modules to achieve simulation. Once programmed, the analog computer can be used to test the system for transients, load response, etc., by varying the parameters of the modules. The input and output terminals of these modules are interconnected according to a signal flow diagram of the selected power system to form a simulated power system. If a simulated transient is injected into an input terminal of the simulated power system, different transient responses will appear on the terminals of each module simultaneously. These responses can be recorded for use in transient analysis. The output of each module can also be read through an output meter on the front panel. Besides the transient simulation, the PSS can be used for studying electrical steady-state problems at various AC frequencies. A definite advantage of the analog simulation is that voltages and currents can be recorded with meters or oscilloscopes at any point in the system.

N-1520
Modular Mooring System for Ocean Construction; User's Guide, Apr 1978, J. M. Atturio, ADA055926

The modular mooring system is a reusable, multileg mooring system for vessels of opportunity. This document describes modular mooring components, outlines maintenance requirements, and describes system performance. Mooring components were purchased to establish a spread mooring for small ocean construction vessels of the LCM 6 to LCU size. The system components, packaged in four multipurpose equipment shelters to facilitate shipping and storage, include two hydraulic winches, an anchor windlass, 3,200 ft of 1/2-in. alloy steel chain, four urethane foam mooring buoys, 4,800 ft of braided nylon, and four 200-lb Danforth anchors. Analysis of the system showed that vessel excursion and system stresses in shallow water are especially sensitive to wave excitation. Mooring line forces approaching 10,000 lb are predicted for all vessels in sea state 4 conditions. A suggested mooring design procedure is included.

N-1521
Nearshore Trenching Technology Development, Jun 1978, W. R. Tausig, ADA057941

Cables and pipelines that traverse the nearshore and surfzone regions often fail because of damage from hydrodynamic forces and anchor snags. This report discusses the technology base necessary to design and operate ocean-bottom trenching equipment for operation in sand, rock, and coral. It also reviews the state-of-the-art in all operational trenching concepts. This investigation addresses only the trenching mechanism and does not consider the platform for its support or transportation under water. Two basic trenching concepts have been identified as applicable to the Navy's needs:

(1) The ladder-type mechanical trenching system using carbide cutters can (with limitations) improve the performance of the Navy's trenching capability using state-of-the-art technology.

(2) The high-pressure waterjet trenching system utilizing the cavitation phenomenon is the development area that shows the most promise for providing significant performance improvements.

N-1522
Results of Some Uplift Capacity Tests on Direct Embedment Anchors, Jun 1978, P. J. Valent, ADA057942

This report presents results of uplift capacity tests on direct embedment fluke-type anchors in some cohesive ocean sediments. Most of the tests were short-term tests with a duration of one to four minutes between the first load application and the completion of pull-out. Data on the optimum fluke design, on the travel distance required to effect fluke keying, and on the relationship of developed uplift capacities to those predicted are presented and discussed. A modification to the standing relationship for predicting uplift capacity is offered. Recommendations are made regarding optimum fluke design and uplift capacity prediction techniques.

N-1523
Acoustic Siting and Verification of the Holding Capacity of Embedment Anchors, Jul 1978, R. J. Malloy, P. J. Valent, ADA058713

In order to determine the holding capacity of a direct embedment anchor, a 3.5 kHz battery-powered pinger system (Pinger Probe) has been developed, tested and evaluated. In some applications, use of the Pinger Probe can eliminate the necessity for a pre-installation site-survey, and can eliminate navigational errors resulting from attempts to reoccupy a favorable site (by providing the capability for simultaneous siting and installation). The Pinger Probe works like a bottom-finding pinger providing, in addition, data on subbottom reflectors. By monitoring the acoustic returns on the ship's precision depth recorder, the following data are provided in real time during the anchor implantment: (1) soil thickness over bedrock, (2) an indication of soil type, (3) sediment stratification and seafloor topography with better horizontal and vertical resolution than from surface-operated systems, and (4) a measure of anchor fluke embedment.

N-1524
Laser-Based Remote Measurement of Large Biaxial Deflections, Jul 1978, G. Warren, ADA058726

A laser-based displacement measurement package is being developed as a tool for continuous, remote monitoring of the dynamic response of slender, very low frequency (VLF) antenna towers. The displacement monitor is designed for use where instrumentation cables are prohibitive due to intense electric fields. The system has been tested on antenna towers 380 m in height to obtain biaxial displacement with a single sensor. Examples of results are presented with comparisons of results from velocity gages and accelerometers.

N-1525
Anacapa Island Split Pipe Inspection of June 1977 and April 1978, Sep 1978, W. R. Tausig, R. L. Brackett, ADA060323

The U.S. Navy currently maintains and operates numerous underwater power and signal cables. Most of these cables utilize split pipe systems to protect the cable from damage in the surf zone and when crossing exposed rocky seafloors. Past experience has shown that the hardware used to install the split pipe system lacks the reliability and maintenance-free operation required for the life of the cables. Based on previous experience with cable failures, the areas determined to be in greatest need of investigation are fasteners for holding the split pipe halves together, immobilization of the pipe, and cathodic protection for the entire system. As a result, CEL tested prototype and commercially available hardware components which appeared to be suitable replacements for the existing split pipe hardware. The candidate hardware was then used in a 300-ft-long test section of split pipe installed March 1976 at Anacapa Island, to be inspected during a five-year period. Results of the CEL hardware tests, Anacapa pipe installation, and first inspection are documented in TN-1498. This report is a follow-up to TN-1498 and presents the results of the test installation inspections for June 1977 and April 1978; the second and third inspections to be made since the March 1976 installation was completed.

N-1526
Performance of Lead-Acid Gelled Electrolyte Batteries in the Deep Ocean Environment, Sep 1978, W. D. Briggs, ADA060422

Standard lead-acid batteries with liquid electrolyte experience dramatic capacity losses when charged and discharged under deep ocean conditions. Recently developed commercial lead-acid batteries with gelled electrolyte were tested to determine their performance at high pressure and low temperature.

Batteries from three manufacturers were divided into control and test groups. The test groups were modified to allow pressure compensation with white mineral oil. The performance of the test batteries was not degraded by exposure to the mineral oil or high pressure (10,000 psig). An average loss of capacity of 10% was experienced when the batteries were cycled cold (32F) and at pressure (10,000 psig). However, this capacity loss is significantly less than the 35-70% loss experienced in previous tests with standard batteries in similar conditions. Thus, lead-acid batteries with gelled electrolyte were found to be suitable for use in deep ocean conditions in a pressure compensated mode.

N-1527
Improved Chemicals for Fiberglass-Reinforced Plastic Soil Surfacings - Field Evaluation, Sep 1978, M. C. Hironaka, ADA060094

A new chemical formulation was recently developed for constructing fiberglass-reinforced plastic surfacings for soils; it consists of a polyester resin, cumene hydroperoxide catalyst, and Vanadium Ten-Cem/N,N-dimethyl-p-toluidine solution promoter. This report documents the field testing of this new formulation with present Marine Corps spraying equipment. It was found that the new formulation is superior to the formulation used in the past because it: (1) provides surfacings with higher strength properties, (2) is easier to mix due to the constant ratio of 1.0 to 0.25 between catalyst and promoter for any temperature, (3) is more economical to use in temperatures below 110F, and (4) increases pumping/spraying reliability by eliminating the catalyst material that precipitates out of the emulsion during storage and eventually causes fouling of check valves and other pumping mechanisms. Furthermore, it was found that the resin used in this new formulation has a shelf life of more than 5 yr based on accelerated aging tests as compared to the previously used resin, which had a guaranteed shelf life of only 4 mo at the same temperatures.

N-1528
Sea/Lake Water Cooling for Naval Facilities, Sep 1978, J. Ciani, ADA062434

Seawater cooling was found to be economically feasible for a trial Naval facility in San Diego, Calif. Later, an operational test was performed at the Naval Security Group Activity (NSGA), Winter Harbor, Maine. A preliminary design and environmental impact assessment were performed for a seawater cooling system at NSGA. This work was supplemented with seawater temperature measurements in the adjoining bay, a study of biofouling and its prevention in this system, and land and offshore surveys at NSGA. A separate study found that the life cycle cost of this seawater cooling system was less than that of a conventional air conditioning system. It was concluded that a seawater cooling system for NSGA would cost about $150K, and annually save over 200 MWh of energy and $9,000. Also, a study of the Navywide potential of sea/lake water cooling found that if such cooling were installed at 25 Navy sites, 59×10^3 MWh and $3 million could be saved annually. This report recommends that: (1) a final design and installation of an operational test seawater cooling system for NSGA, Winter Harbor be made; (2) seawater temperatures be measured at Apra Harbor, Pearl Harbor, Chicago, and Point Mugu as potential sites; and (3) a parametric model be developed for estimating the capital and energy costs of sea/lake water cooling systems.

N-1529
An Assessment of Transportable Breakwaters With Reference to the Container Off-Loading and Transfer System (COTS), Sep 1978, D. B. Jones, ADA062432

A study covering three specific designs for a tethered float breakwater and simple and legged versions of the sloping float (inclined pontoon) breakwater has resulted in improved definition of certain aspects of the logistic burden connected with transportable breakwaters in military operations. Performance data reported for the two types were analyzed in order to determine the transverse cross-section dimensions required for 50% reduction of the significant wave height associated with the Pierson-Moskowitz wave spectrum with 7-second peak period. Specific designs with this capability were then examined to assess requirements for overseas transportation, installation, and cost. The stated performance requirement was drawn from an analysis of the Container Off-Loading and Transfer System (COTS). This analysis concluded that wave-induced motions of moored lighters, barges, and floating platforms (with natural periods between 2 and 7 seconds) could adversely affect cargo flow rates. Thus, a breakwater effective for 7-second waves could decrease the frequency and duration of occasions when the system is degraded by wave action. Bargeships, ships with well decks, or large ocean-going barges would be required to transport the modules of the various designs for a 7-second breakwater. A LASH bargeship is the most likely carrier for COTS breakwaters. LASH capacity varies from 750 to 3,600 lineal feet of breakwater, depending upon the particular vessel and the breakwater design. For the various points in the COTS where a breakwater would be beneficial, the length of breakwater required varies from 650 to 4,000 feet.

N-1530
Seismic Liquefaction Potential, Sep 1978, J. M. Ferritto, J. B. Forrest, ADA062433

This report presents a summary of the factors causing seismically induced soil liquefaction. The report presents the current procedures in use to compute the liquefaction potential of a site. Risk analysis procedures are presented to better estimate the probability of liquefaction.

N-1531
Effectiveness of Rust Removers for Use at Naval Shore Facilities, Sep 1978, E. S. Matsui, ADA062435

The Civil Engineering Laboratory has appraised the relative merits of some of the available rust removers and converters to ascertain their suitability for Naval use. The test results indicate that coatings applied to test panels treated with the rust removers provided corrosion protection as good as that of coatings applied to the sandblasted control panels. Therefore, the rust removers are judged satisfactory for Naval use. All three rust removers investigated provided poor protection against corrosion, and their use is not recommended at the present time.

N-1532
Investigation of Energy Saving Potential of Transient Suppressors, Sep 1978, R. I. Staab, M. N. Smith, ADB032391L

Investigations of energy savings due to transient suppressors have been completed by the Civil Engineering Laboratory. Energy consumption is reported for a load consisting of a cycling motor and a bank of fluorescent lights, both protected by transient suppressors and unprotected. The results of laboratory disassembly of three commercially available suppressor packages are also reported.

N-1533
Implementation of the Lead-Based Paint Poisoning Prevention Act at Navy Activities, Oct 1978, H. P. Vind, C. W. Mathews, R. L. Alumbaugh, G. W. Hamilton, ADA066187

The Civil Engineering Laboratory investigated ways to implement the Lead-Based Paint Poisoning Prevention Act (LBPPPA) in Navy housing. According to the act, cracked or peeling paint must be wire-brushed before repainting. There appears to be no pre-repainting requirement for the removal or covering of lead-based paint that is sound and tight, unless the integrity of the paint cannot be maintained. The maximum concentration of lead permitted in new paint is 0.06%. An inexpensive chemical kit and a lead-in-paint analyzer were both developed at CEL and were found potentially useful for implementing the LBPPPA. Recent amendments to the act appear to eliminate the necessity for, but not the desirability of, such field kits and instruments.

N-1534
Digest of Equipment for Converting Solar, Wind, and Geothermal Energy into Electric Power for USN Application Ashore, Nov 1978, W. R. Lorman, ADA066221

This document enumerates principal requirements of self-sufficient electric power conversional equipment under active consideration by CEL. Data pertain to financial requirements, physical characteristics, and potential outputs of solar, wind, and geothermal energy-conversion systems; these systems are part of USN shore energy research and development program. Data are intended for use by CEL systems analysts as input to mathematical model for planning and optimizing power systems throughout the Naval Shore Establishment.

N-1535
Mechanical Properties of Preservative Treated Marine Piles - Results of Limited Full Scale Testing, Nov 1978, M. L. Eaton, J. A. Drelicharz, T. Roe, ADA066258

Forty southern pine and thirty-five Douglas fir piles were destructively tested at the Forest Research Laboratory, Corvallis, Oregon. The forty southern pine piles represent eight different preservative treatments (including one lot untreated), five replicates each. One of these treatments was omitted for Douglas fir. The findings were, in general, a reduction in desirable wood characteristics stemming from preservative treatments; in particular, more reduction for dual treatment than for creosote. This, with the higher cost of dual treatment, suggests that before dual treatment can be recommended, it will require evidence of materially greater longevity for the use and environment intended.

N-1536
Emergency Exiting From Secure Navy Spaces: Studies of the Implications of the Life Safety Code, Security Regulations, and Human Factors Engineering, Dec 1978, H. Self, K. O. Gray, B. M. Cohn, W. E. Backes, ADB036124L

This Technical Note is an evaluation and summary of an investigation by Gage-Babcock and Associates (GBA) of Navy practices in emergency exiting from secure spaces. These practices are analyzed in terms of (1) the Life Safety Code of the National Fire Protection Association, (2) security regulations, and (3) human factors engineering considerations. Hardware for securing emergency exits from secure spaces is evaluated, and recommendations for new designs and changes in the Life Safety Code to improve both security and life safety are presented in the GBA reports. These reports are included in this note as appendices.

N-1537
Underwater Splicing of SD Coaxial Cable - FY78 Progress, Dec 1978, A. Inouye, ADA066128

Splicing of SD List 1 coaxial cable on the seafloor has been demonstrated to be feasible using a grease/gel filled coaxial splice. Experimental electrical models fabricated for underwater mating have been operated successfully at 6,000 VDC and 5,000 psig ambient pressure with leakage currents less than 1 μa. Impedance mismatches of the electrical models were about 0.4%. The search for a compatible dielectric grease for use with the SD cable splice identified a gelling agent (Cab-O-Sil) which can be used to gel liquids to a grease-like consistency. Castor oil, available in liquid form only, has some unique properties desirable for SD cable splicing applications. These are: (1) low water absorption (about 1%), (2) little or no change in dielectric constant with about 1% water absorption, compatibility with high density polyethylene, and ability to gel using Cab-O-Sil. Electrical splice models filled with gelled castor oil have been mated several times at 5,000 psig ambient pressure in seawater at 8°C. The splice was subjected to 6,000 VDC with no high voltage breakdown and leakage currents were less than 1 μa in each case. Due to lack of internal seals, the splice failed after a 30 day duration in the pressure vessel because seawater was forced in or migrated to the cable and splice interface area. The tests do show the feasibility of the underwater splicing concept of SD coaxial cables.

N-1538
1978 Inspection of Experimental Marine Piling at Pearl Harbor, Hawaii, Dec 1978, T. Roe, ADA066225

In 1978, a diver made the final inspection of the cooperative-, CEL-, and CEL/industry-treated piles at Pearl Harbor. The cooperative piles are performing satisfactorily, especially those with dual treatments. Satisfactory CEL- and CEL/industry-treatments were creosote which contained a specific toxic additive or additives and creosote-free treatments which were either a solution containing two toxic compounds, or a dual treatment.

N-1539
Airfield Marking Paints - A State-of-the-Art Report, Dec 1978, R. W. Drisko, ADA066145

A state-of-the-art summary has been prepared on the subject of airfield marking paints. Information is presented on the composition of such paints, federal specifications, available test methods, reflectorization methods, deterioration mechanisms, skid-resistance relationships, surface preparations, application requirements, and alternative marking systems. Information on traffic paints was used where it was relevant. A summary of recommended airfield marking practices was prepared to provide practical information to people responsible for airfield marking.

N-1540
Survey and Preliminary Feasibility Assessment for a Running Gear Module for a Deep Ocean Work Vehicle, Jan 1979, H. G. Herrmann, ADA066024

Background information impacting the technical feasibility of developing an active running gear system for use on a deep ocean vehicle is summarized along with preliminary conceptual configurations for such a system. Characteristics and available performance data on some 66 existing seafloor vehicles (none of which are designed for the environment or operating scenario/mission of interest to this study) are reviewed and summarized along with likely environmental conditions. It is concluded that either a rotor/screw or track running gear type will provide the best potential performance on the very weak and highly plastic cohesive soils to be encountered in the deep ocean. Draw bar pull forces of the order of 400 pounds are developable using an active running gear module which is lightweight (possibly neutrally buoyant in some cases) is compatible with, and relies on, its host vehicle for power and control functions. Potential areas of significant work capability enhancement using such an active running gear module are summarized along with identified technical deficiencies and plans for addressing/satisfying these.

N-1541
Determination of Oil in Water by Organic Carbon Analysis, Jan 1979, P. J. Hearst, ADA066302

A method was investigated for determination of oil in water by establishing the organic carbon content attributable to the oil and by converting this value to the oil content. Samples were homogenized with the aid of an emulsifier, and a correction was made for the carbon contributed by the emulsifier. Aliquots of 35 μl or less were injected into the organic carbon analyzer because larger samples were incompletely combusted and gave reduced recoveries. With corrections for the carbon content of the water or the seawater used to prepare the samples, samples containing 17 mg/l of white mineral oil or Navy distillate fuel gave recoveries of about 85% with standard deviations of about 10%. Samples of about 50 mg/l gave recoveries of about 65%. If the factor of 1.39, instead of the theoretical factor of 1.18, had been used to convert from carbon content to oil content, the calculated recoveries would have been 100% for 15 mg/l oil samples and 76% for 50 mg/l oil samples. The method will give only an upper limit for the oil concentration unless a correction is made for dissolved organic materials.

N-1542
Coefficients of Friction Between Calcareous Sands and Some Building Materials, and Their Significance, Jan 1979, P. J. Valent, ADA066297

Friction tests of a coralline and an oolitic sand and a foraminiferal sand-silt against smooth and rough steel and concrete surfaces were run in a modified soils direct shear machine. Friction test results for these calcareous materials did not differ markedly from the results for a quartz sand. These results indicate that there is nothing inherently different in the capability of these calcareous materials to develop frictional forces on typical building material surfaces - when compared to quartz-predominant sands - except that some calcareous materials experience large volume decreases during shear. These large volume decreases would impair the development of high effective normal stresses against the building material surface, resulting in low friction forces on piles, some anchors, and penetrometers in calcareous materials. This latter hypothesis is stated, but not directly addressed in this reported work.

N-1543
CEL Blast Wave Propagation Code for Air Ducts, Jan 1979, R. S. Chapler, R. H. Fashbaugh, ADA066259

Refinement of a CEL hydrodynamic code for prediction of air blast propagation in variable area ventilation ducts was completed. Code solutions are one-dimensional and achieved using a refined finite-difference pseudo-viscosity method in a Lagrange formulation for solution of either classical nuclear blast waves or general time variant pressure waves. Solutions for a single constant area duct with the effects of viscosity at the wall are included. An example case is presented with a description of the single duct geometry, the applied nuclear blast parameters, and the code input parameters, including their magnitudes and their sources. A 2-m-diam duct with a length of 200 meters subjected to a side-on 1,000 psi overpressure is analyzed, and the time histories of the blast parameters are presented for three locations in the duct. The effects of wall friction are demonstrated graphically for friction factors of 0.016 and 0.030. Sequential application of the code to each duct in a branched duct system provides solutions for complex air entrainment systems. A description of the modified CEL Blast Wave Propagation Code basic functions, input quantities, formats and outputs (including a sample input data card listing), input data listing, and an output listing sample are appended.

N-1544
Proposed Method for Placing Freshly Mixed Concrete in the Deep Ocean, Jan 1979, R. D. Rail, H. H. Haynes, ADA070855

Potential applications for placing concrete in the deep ocean are basically in three areas: in situ construction of seafloor structures, foundations and massive anchors for fixed ocean facilities, in situ hardening of objects on the seafloor, and containment of hazardous substances for environmental protection. This report presents a method for in situ placement of fresh concrete on the seafloor in which concrete is mixed on a surface platform and transported to the seafloor via a pipeline suspended from the platform. The proposed development integrates existing technologies of the concrete, oilwell, and marine industries and extends them to new applications in a new environment, and would require a modest development effort as well as simulated tests to verify engineering assumptions based on extrapolation of existing knowledge to the new conditions. The proposed method would greatly extend the Navy's capability to place concrete in the deep ocean for the above applications which would require concrete to be placed underwater in quantities of hundreds and thousands of cubic yards in water depths of many thousands of feet.

N-1545
Long-Term Holding Capacity of Statically Loaded Anchors in Cohesive Soils, Jan 1979, R. M. Beard, ADA070856

The Civil Engineering Laboratory has conducted model anchor tests, intermediate scale field tests, laboratory soil investigations, and finite element analyses to optimize procedures for estimating long-term holding capacity of statically loaded plate-like anchors embedded in cohesive seafloor soils. Also, work was done to determine relationships between long- and short-term holding capacity. This report presents the results of these tests and analyses. It is concluded that the long-term holding capacity in cohesive soils can be readily analyzed using drained strength parameters and holding capacity factors originally developed for cohesionless soils. It is also concluded that suction is an integral part of short-term holding capacity and that it should not be ignored. Procedures for estimating both long- and short-term holding capacity are given, and design factors of safety are recommended.

N-1546
Investigation of Chemical Binders for Beach Sand, Feb 1979, T. Roe, S. Tuccillo, R. Lorenzana, ADA070857

An additive was sought for seawater such that the mixture could be sprayed on beach sand to make a trafficable crust for amphibious warfare operations. None met all requirements, but a proprietary polyisocyanate met most. It could not be premixed with seawater, but it penetrated seawater-wet sand and produced a 6-inch-thick crust of 100 psi compressive strength in one hour at a cost of $8 to $10 for materials per square foot of sand stabilized.

N-1547
MARCORPS Laundry/Shower Module - Washing and Drying Test Program, Feb 1979, T. A. Kuepper, D. B. Chan, ADA070858

The washing and drying test programs conducted during FY-77 for the Marine Corps laundry/shower module project are described. A washing and drying method is chosen which allows continuous laundering of field utility clothing within a 5-minute retention time. Wastewater recycling alternatives are also described.

N-1548
Drydock Certification, Mar 1979, J. B. Forrest, J. M. Ferritto, ADA070859

No procedure is presently defined for reliably measuring the foundation condition of existing graving drydocks. Because of unknown or misunderstood soil and groundwater flow conditions, drydocks have not always continued to perform as designed. This report presents the initial year's effort of a longer term program to develop a systematic, defined evaluation routine for drydock foundations. The causes of a few previous drydock failures are discussed, and areas of potential difficulties are identified. Potential measuring devices and procedures for measurement are discussed briefly, and the need for advances in particular areas such as in void detection are noted.

A brief review of available analytical computer models dealing with groundwater flow is presented. Those models considered most appropriate for treating the subsurface flow regime beneath a drydock have been selected for application. Attention is also directed toward available soil-structure interaction computer models, and some of their shortcomings or deficiencies are identified.

This report singles out several critical categories for drydock analysis from a geotechnical viewpoint and recommends areas for further endeavor.

N-1549
User's Manual for FVSOLVR and FVPLOT: Field Solving and Plotting Computer Programs, Mar 1979, B. R. Milner, ADA070850

FVSOLVR and FVPLOT are, respectively, computer programs which solve and plot field distributions for problems that involve the solution of Laplace's equation. The programs were developed primarily for solving electric field and equipotential distributions, but may be adapted to solve problems such as temperature distributions or problems which involve the solution of Poisson's equation. They can also be used with either axisymmetric or two-dimensional geometries. This user's manual provides the detailed information required to implement problem solutions with these programs.

N-1550
Development of Supercorroding Alloys for Use as Timed Releases for Ocean Engineering Applications, Mar 1979, S. A. Black, ADA070860

A family of supercorroding magnesium alloys that react spontaneously and vigorously with seawater have been developed at CEL. Supercorroding alloys are so named because of their high corrosion rate in seawater. Investigations of several different alloy formulations show that the

alloys can be useful for generation of hydrogen for ocean buoyancy, fuel for thermodynamic engines and fuel cells, production of heat for divers and as self-destructing links for retrieval of oceanographic instruments.

Supercorroding alloys with magnesium as the anode material and with several different cathode materials were fabricated and tested to determine mechanical and corrosive characteristics. Alloys with 5 atomic percent iron cathode produce 950 ml of hydrogen per gram of alloy and 13.3 K joules of heat per gram. One gram is over 90% reacted within one minute from immersion. Compacting and sintering produces samples with 9 ksi shear and tensile strengths. Corrosion rates for sintered samples are approximately 9 x 10^{-3} inches per hour. Alloys with other cathode materials and different levels of cathode content were fabricated and tested. Sufficient data is available on several different formulations of supercorroding alloys to permit preliminary selection for specific applications.

N-1551
Radioisotope Tracer Technique of Measuring Adsorption of Paint Driers by Pigments, Mar 1979, E. S. Matsui, ADA070862

A sensitive radioisotope tracer technique to measure the amount of paint drier adsorbed on paint pigments has been developed. This technique was found to be very sensitive and precise, and reliability and reproducibility of the procedure were very good. The laboratory results indicated that paint driers were adsorbed by pigments during storage, and the amount of adsorption varied among the paints.

N-1552
Mathematical Theory of the Finite Element Method - Some Introductory Aspects, Apr 1979, T. A. Shugar, ADA070861

The mathematical prerequisities from functional analysis that enable the understanding of the mathematical theory of finite element are organized, presented, and explained. They begin with the definition of linear vector spaces and include all intermediate definitions up to the definition of Hilbert spaces. The Ritz approximate solution method for boundary value problems is developed so that the close similarity between it and the finite element method can be observed. Solutions given by the Ritz method are projections of the true solution vector onto a subspace defined by the governing differential equations and boundary conditions. Finite element shape functions are shown to be superior to classical Ritz functions as basis vectors in the Ritz process. The finite element and Ritz methods differ primarily in the choice of continuous functions for the basis vectors. The shape functions are therefore primarily responsible for the wide acceptance and popularity of the finite element method.

N-1553
Multipurpose Expedient Paving System (MEPS) for Expeditionary Airfields - An Interim Report, Apr 1979, P. S. Springston, ADA078654

A Multipurpose Expedient Paving System (MEPS) is being developed to enable more rapid construction of Expeditionary Airfields (EAF's) by Marine Corps forces engaged in an amphibious landing. Previous investigations demonstrated the potential of FOMAT - a structural sandwich composed of a 20-pcf rigid polyurethane foam core with fiberglass-reinforced polyester resin (FRP) facings. FOMAT met F-4 aircraft static load, tailhook impact, and engine exhaust blast requirements. The FY-77 research effort, covered by this report, focused on pavement concepts more amenable than FOMAT to field construction. Investigations were made on alternative concepts of (1) mechanically locking prefabricated bottom facings to the core and (2) eliminating the bottom facing while adding fiberglass reinforcement to the foam. FIBERMAT (FRP bonded to a layer of fiberglass-reinforced rigid polyurethane foam) is rated as the more viable concept. FIBERMAT has been subjected to a series of laboratory tests to define response to stress fatigue and environmental cycling. Finite element techniques are utilized to design FIBERMAT pavement sections for EAF traffic areas and varying soil strengths. Costs and benefits are projected, project technical risks are discussed, ad major development milestones are outlined.

N-1554
Design Criteria for Vacuum Wastewater Transfer Systems in Advanced Base Applications, May 1979, E. P. Skillman, ADA073301

A search of existing vacuum wastewater transfer technology has been made and performance data analyzed. An experimental vacuum wastewater collection facility was designed, built and tested to determine fundamental principles, transport phenomena and conceptual effectiveness of this technology in various hydraulic configurations. A field prototype vacuum system has since been configured and field-tested at a selected site having the typical adverse conditions that influence the cost effectiveness and system reliability of conventional and pressure sewer systems. R&D efforts include development of design criteria for vacuum wastewater collection systems and identification of the benefits and relative merits of vacuum, gravity and pressure sewer systems in Naval applications. Specific findings include identification of a method to suction lift wastewater higher than the classical 25 ft, an energy requirements for pumping air that is higher than that necessary for pumping an equal volume of water, a design head limitation equal to the sum total of the positive slopes of the transport piping, and a resolution of the confusion surrounding the three different types of systems utilized.

This report also considers alternatives to conventional wastewater collection methods currently used by the Navy and focuses on: (a) compatibility with general terrain, (b) reduction of pipe size, (c) equipment and installation costs, and (d) operational manpower requirements.

N-1555
Seismic Soil Liquefaction at the Waterfront, May 1979, J. B. Forrest, J. M. Ferritto, ADA078618

The vulnerability of waterfront facilities to earthquake-induced soil liquefaction has been demonstrated during several recent earthquakes. A liquefaction threat analysis conducted by the Navy has suggested, however, that reliable procedures for precisely evaluating the extent of this hazard to waterfront structures are not currently available. As a part of a program to remedy this problem, the earthquake-induced liquefaction potential at a coastal Naval installtion was evaluated by means of cyclic triaxial testing of undistributed soil samples. This study shows that for the particular sensitive soil tested, the resistance to liquefaction as determined by laboratory testing of undisturbed samples is considerably larger than that determined using correlations with in situ penetration resistance tests. Both dynamic split spoon driving resistance and quasistatic friction cone resistance were measured in the tests. Field evaluation techniques are discussed, and those considered most promising are noted. Several total stress and effective stress computer codes are discussed, with particular attention to those incorporating pore water dissipating mechanisms. Several example solutions from the literature are presented.

N-1556
Solar-Powered Sun Tracker, Jun 1979, C. J. Ward, ADA078653

A solar-powered sun tracker believed to be capable of repositioning equipment to within 1 degree of the angle-of-incident radiation is described in this report. The proposed tracker is designed to reposition itself automatically after cloudy periods and should prove inexpensive as well as reliable. Included in this report are (1) a description of two tracker concepts, (2) a derivation of the heat-balance equation used to predict work available for equipment rotation, (3) a discussion of the experimental model fabricated

to prove concept feasibility, and (4) an economic analysis comparing the cost of generating steam with a solar-powered boiler with the cost of generating steam with a coal-fired boiler.

N-1557
Underwater Inspection of Fleet Moorings, Jul 1979, J. F Wadsworth, ADA079740

This report is a guide for divers engaged in underwater inspections of the Navy's Fleet moorings. These inspections are conducted to report the physical condition of the moorings. Engineering and maintenance assessments are made by engineers using the inspection data. Procedures and equipment to be used by the diver are given. Forms for documentation of the data with examples are included. It is strongly recommended that the diving inspection team be accompanied by the engineer responsible for writing the report recommending maintenance actions on the moorings.

N-1558
Intelligent Lighting Control Principles, Jul 1979, W. Pierpoint, ADA078619

It is generally recognized that compared to illumination from ceiling-mounted electric lighting, an equal amount of daylight illumination from windows can be about three times more effective in producing visibility. If this is true, then visibility-based lighting controls will result in greater energy conservation than will illumination-based lighting controls. A mathematical technique has been developed suitable for an intelligent microprocessor-based equi-visibility lighting control system. In an example room, a computer simulation compares the energy consumption for on-off, high-low-off, equi-illumination, and equi-visibility lighting control systems.

N-1559
DNA Magazine Door Relocking Hardware Development, Jun 1979, H. L. Self, ADB039628L

This Technical Note is a summary of the development, by the Civil Engineering Laboratory, of concepts for a propellant-driven relocker system for use on doors of nuclear weapons storage magazines and other sensitive ordnance and material storage structures.

N-1560
Performance of Uncoated and Coated Nonferrous Heat Exchangers in a Temperate Marine Environment for Two Years, Aug 1979, T. Roe, J. F. Jenkins, R. L. Alumbaugh, ADA081154

Twelve finned tube heat exchangers - four pieces of three different materials or material combinations - were operated in a marine environment (1) uncoated, (2) coated with an electrostatically applied polyester enamel, (3) coated with a specification alkyd system, or (4) coated with a zinc inorganic silicate material. Temperature drops across each exchanger were monitored for 24 months and heat transfer capacities were calculated for selected periods. Copper tube/copper fin exchangers coated with any of the three different coating systems were superior in thermal efficiency to the uncoated units. The opposite was true for the all aluminum units and for the copper tube/aluminum fin units. Based on 1978 prices, coating of copper tube/copper fin exchangers increases their cost from 48 to 60%. It is believed this can be justified on the basis of increased life expectancy alone.

N-1561
Shrinkage-Compensating Cement for Airport Pavement: Phase 2, Nov 1979, J. R. Keeton, ADA075739

Details of a research study on shrinkage-compensating concrete for airport pavements are presented. A total of 53 slab-type prisms 1 foot square and 8, 12, 16, or 20 inches thick were subjected to shrinkage, cooling, and heating. Concrete compressive stresses induced by expansion were calculated, as well as residual compressive stresses after losses due to shrinkage and cooling. The residual concrete compressive stresses, coupled with results from previous field applications of shrinkage-compensating concrete, are used as a basis for recommendation of transverse joint spacings up to 200 feet.

N-1562
Repair System for Damaged Coatings on Navy Antenna Towers - Part II, Oct 1979, L. K Schwab, R. W. Drisko, ADA085510

Coating materials and cleaning and application procedures and equipment were developed for use in the repair of damaged coatings on Navy steel antenna towers. Experimental coatings were screened by laboratory-accelerated testing before field exposure. In the initial field exposure, 19 of 32 different coating systems provided good protection from corrosion for 3 years to a steel antenna positioner in a marine atmospheric environment. In a later field experiment, 8 of 12 of the better-performing coating systems provided very good protection for 15 months on two steel vortex towers in a very corrosive marine atmospheric environment. Newly developed cleaning and application procedures and equipment were tested during the latter field study. Practices by the Civil Engineering Laboratory currently recommended for coating protection of antenna towers are also presented.

N-1563
Fiberglass-Reinforced Plastic Surfacing for Rapid Runway Repair by Naval Construction Forces, Oct 1979, P. S. Springston, ADA085357

This report documents exploratory research conducted to develop a preliminary concept for repairing bomb-damaged runways with prefabricated fiberglass-reinforced plastic membranes. The membranes would function as traffickable caps over backfilled craters. A structural analysis has been completed using the finite element method and a design is presented for a membrane to be traffic-tested under simulated F-4 aircraft wheel loads at the Rapid Runway Repair Test Facility of the Air Force Engineering and Services Center/Research Division at Tyndall AFB, Florida. Methods for joining panels to form large membranes and a tiedown method are discussed. A general concept for rapid runway repair by the Naval Construction Forces using table-of-allowance (P25 and P31) equipment is presented.

N-1564
A Thin Film Thermal Sensor for Measuring Ocean Currents, Nov 1979, T. R. Kretschmer, B. C. Streets, A. P. Smith, ADA085286

A thin film thermal sensor is being developed to improve U.S. Navy capablities for measuring ocean current profiles. Using the sensor, current velocity is determined by measuring the resistance changes in each of four platinum films positioned on the surface of the cylindrical sensor substrate. Development of this device into a practical ocean-going tool has involved overcoming substrate fragility, water leakage problems, and biofouling contamination. A high-strength ceramic substrate has been selected to improve ruggedness. New coating systems to prevent water penetration into the sensor are being developed and evaluated. An electrolytic hypochlorite generation technique has been developed to prevent biofouling indefinitely on the sensor surface. Tests have shown the sensor produces repeatable results in the laboratory and agrees well with commercial current meter measurements during ocean testing.

N-1565
Lightweight Concrete Using Polymer-Filled Aggregate for Ocean Applications - An Exploratory Investigation, Dec 1979, H. H. Haynes, W. V. Eckroth, ADA085287

A lightweight concrete specially suited for deep ocean applications was tested for its strength properties and compared to similar regular lightweight concrete. The new concrete used lightweight aggregate particles (expanded shale) which were filled with a polymeric material. The polymer-filled aggregate (PFA) was conventionally mixed with portland cement and water to make the lightweight concrete. Four concrete mixes were tested. In general, the PFA concrete, compared to regular lightweight concrete, has an equal unit weight in a seawater saturated condition and exhibited increases in compressive strength of 26%, split tensile strength of 4%, elastic moduli of 4% and an equal Poisson's ratio. The strongest mix for PFA concrete had a compressive strength of 6,580 psi, compared to 5,200 psi for regular lightweight concrete, at an age of 28 days under continuous fog curing. Both mixes have a weight savings of 40%, compared to that of normal weight concrete in a submerged, saturated conditon. A discussion of cost is presented and shows that the in-place structural cost of PFA concrete would be about 30% greater than normal concrete.

N-1566
Seismic Soil Liquefaction Studies, Dec 1979, J. B. Forrest, J. M. Ferritto, G. Wu, ADA081944

Earthquake-induced soil liquefaction is considered from the points of view of site evaluation technology, and computer-based analytical developments. In-situ expedient testing procedures are compared with the results of laboratory testing on undisturbed samples. Several types of friction cone penetrometer tests are described, and mechanical cone, electrical cone, and piezometric cone sounding data are compared. Recent developments on analytical effective stress soil models are discussed.

Liquefaction behavior is separated into two categories. (1) the inherently unstable situation wherein in-situ stress exceeds residual strength, and (2) the case where accumulation of deformation reaches unacceptable levels. It is suggested that the accumulated deformations category cannot be adequately evaluated using available experimental procedures, but must depend upon effective stress soil model development.

N-1567
A Test Procedure for Identification of Those MIL-P-43607D High Security Padlocks Subject to Spontaneous Unlocking by Rough Handling, Jan 1980, H. L. Self, K. O. Gray, ADB047687L

This document presents a detailed, step-by-step procedure for identification of certain types of defective MIL-P-43607D security padlocks. The procedure is written for field use by non-technical users.

N-1568
Sloping Float Breakwater: Interim Data Summary, Jan 1980, D. B. Jones, ADA085447

The sloping float breakwater consists of a row of bargelike pontoons moored so that, at rest, the shoreward ends, which are ballasted, rest on the seafloor while the seaward ends, which are buoyant, project slightly above the water surface. Ammi barges and NL pontoon structures have been proposed as breakwater modules.

The findings of all previously reported experiments and studies of this concept are brought together to provide an interim summary of data on wave attenuation, mooring forces, ocean transport, and installation. The sloping float concept has potential as a ship-transportable breakwater for relatively shallow water (coastal waters). Floats 90 feet long located in 30 feet of water reduce by about 50% the significant wave height of local-wind-generated waves (Pierson-Moskowitz spectrum) with a dominant (spectral peak) period of 7 seconds.

N-1569
Safe Underwater Electrical Power, Feb 1980, L. W. Tucker, F. E. Nelson, ADA091672

The Civil Engineering Laboratory is developing a unique and improved ground fault detection and diver protection system that will allow safe electrical power transmission underwater. The system is designed to sense and shut down all electrical power on ground fault currents of 4.5 mA or more in 10 ms. The shutdown is performed in two steps: (1) first a signal initiated by a leakage to ground in the transmission cable or load trips the main power circuit breaker, and (2) a set of triacs are turned on which are connected to short the power lines. The circuit breaker is backed up by conventional fuses that would blow quickly from the short circuit current if the breaker should fail. This sequence of events is designed to occur in approximately 10 ms. The design of the system is adaptable to electric power transmission systems supplying up to 100 kW.

The paper reviews electrical safety criteria relative to divers, describes the Civil Engineering Laboratory's protection concept, and presents laboratory test results from an experimental system protecting a 30-kW underwater load.

N-1570
Utilization of Navy-Generated Waste Oils as Boiler Fuel - Economic Analysis and Laboratory Tests, Feb 1980, T. T. Fu, R. S. Chapler, ADA085257

Feasibility of utilizing Navy-generated waste oils is reported. Estimates show that between 5% and 13% of the Navy boiler fuel requirements (excluding coal) may be met by utilizing waste oils. Based on the FY-77 Navywide average cost for fuel oils, fully utilizing the waste oils results in $9-23M annual fuel bill reduction for the Navy. Laboratory tests were conducted, and the results show that the Navy waste oils are substantially the same as regular fuel oils in boiler firing (providing the waste oils are reasonably free of water and solid contaminants). Only minor burner adjustments are sometimes necessary in order to achieve efficient combustion. Long-term tests in in-service boilers are recommended for development of guidelines for utilizing waste oils as boiler fuels.

N-1571
Anacapa Island Split Pipe Installation Inspection and Repair 1978-79, Feb 1980, W. R. Tausig, R. L. Brackett, ADA085449

The U.S. Navy currently maintains and operates numerous underwater power and signal cables. Most of these cables utilize split pipe systems to protect the cable from damage in the surfzone and when crossing exposed rocky seafloors. Past experience has shown that the hardware used to install the split pipe system lacks the reliability and maintenance-free operation required for the life of the cables. Based on previous experience with cable failures, the areas determined to be in greatest need of investigation are fasteners for holding the split pipe halves together, immobilization of the pipe, and cathodic protection for the entire system. As a result, CEL tested prototype and commercially available hardware components which appeared to be suitable replacements for the existing split pipe hardware. The candidate hardware was then used in a 300-foot-long test section of split pipe installed March 1976 at Anacapa Island, to be inspected during a five-year period. This report presents the results of the October 1978 inspection conducted 2-1/2 years after installation of the test system. Also discussed is the repair operation conducted in March 1979 to replace those sections of split pipe which were damaged during a severe storm in January 1978.

N-1572
Traffic Testing of a Fiberglass-Reinforced Polyester Resin Surfacing for Rapid Runway Repair, Feb 1980, P. S. Springston, ADA085288

This report documents traffic tests of a fiberglass-reinforced polyester resin (FRP) membrane, conducted at the Rapid Runway Repair Test Facility of the Air Force Engineering and Services Center at Tyndall Air Force Base, Fla. The membrane functions primarily as a trafficable cap, preventing foreign object damage to aircraft, over a backfilled bomb crater. The membrane also reduces rutting, from rolling aircraft wheels, in a 24-in.-thick crushed limestone base course overlaying backfilled debris. In the tests, applied traffic consisted of 150 and 20 coverages of load carts simulating F-4 and C-141 aircraft main gears, respectively. Experimentally recorded soil strain and surfacing deflection data are compared with predictions formulated previously, in which the finite element method of structural analysis was used. Recommendations are provided for further evaluation necessary for the certification of the concept for rapid runway repair.

N-1573
Antifouling Marine Concrete, Mar 1980, C. W. Mathews, ADA092899

Various toxic agents were investigated for their ability to prevent the attachment and growth of marine fouling organisms on concrete. Three methods of incorporating antifoulants into concrete were also studied. Porous aggregate was impregnated with creosote and bis-(tri-n-butyltin) oxide (TBTO) and then used in making the concrete. Cuprous oxide, triphenyltin hydroxide (TPTH), and 2-2-bis-(p-methoxyphenyl)-1,1,1-trichloroethane (methoxychlor) were used as dry additives. Two proprietary formulations were applied as coatings on untreated concrete. Test specimens were exposed at Port Hueneme, Calif., and Key Biscayne, Fla. Efficacy of toxicants was determined by periodically weighing the specimens and the fouling organisms that became attached. Concrete prepared with an aggregate impregnated with a TBTO/creosote mixture demonstrated the best antifouling performance of those specimens exposed for more than 1 year. The two proprietary coatings and the concrete containing methoxychlor, TPTH, and cuprous oxide as dry additives have exhibited good antifouling properties but have been exposed for a shorter time. Also, the strength of concrete prepared using the toxicants was acceptable, and the corrosion rate of reinforcing rods did not increase. The concentration of organotin compounds was essentially unchanged in a concrete specimen exposed 6-1/2 years in seawater.

N-1574
Concrete Sandwich Construction for Energy Conservation, Mar 1980, J. R. Keeton, ADA085446

An abbreviated research study on use of shrinkage-compensating expansive concrete in sandwich-type wall and roof panels containing insulation at mid-thickness is described. The use of expansive concrete is shown to be a technically viable concept for eliminating shrinkage cracking, thus preventing moisture penetration which can reduce insulation effectiveness, cause deterioration of the insulating material, and accelerate steel corrosion. Embeddable resistance strain gages proved to be reliable for measuring expansion and subsequent shrinkage of the experimental panels. As a result of this study, a comprehensive research program is proposed for experimental verification of design and field control measures that will permit the use of shrinkage-compensating cement mortars in sandwich panel construction.

N-1575
Solid State Transformer Concept Development, Apr 1980, J. L. Brooks, ADA089299

This report describes an effort made to determine the feasibility of developing a circuit using power semiconductor devices to duplicate the function of the power transformer. A circuit concept has been developed which duplicates the primary function of voltage stepup/stepdown but does not demonstrate the DC isolation characteristic of normal transformers. Several characteristics of the circuit appear very attractive, such as increased voltage regulation and relatively high efficiency.

N-1576
Characterization of Asbestos Construction Products at Naval Shore Facilities, May 1980, E. E. Lory, ADA093093

The potential health hazards to personnel from exposure to airborne asbestos fiber and the wide variety of asbestos-containing products used at Navy facilities prompted the Naval Facilities Engineering Command to task the Civil Engineering Laboratory to develop an inventory of and to characterize asbestos-containing construction materials. Two categories of asbestos-containing construction materials have been identified as potential asbestos fiber releasing threats: (1) friable insulating products and woven products and (2) nonfriable matrix-bonded composite products. This document takes a general and overall look at asbestos-related health concerns, asbestos fiber characteristics and applications, bulk material/analysis, suitable substitutes, and regulations applicable to asbestos exposure.

N-1577
Sea/Lake Water Air Conditioning at Naval Facilities, May 1980, J. B. Ciani, ADA089262

The sea/lake water air conditioning (AC) work at CEL and related efforts by others are summarized, along with annotated references. Computer models for estimating the capital costs and energy use for sea/lake water air conditioning (AC) systems are introduced, and the output from these models exercised on two Naval facilities are presented. It was found that (1) the computer models produced reasonable estimates of the capital cost and energy use of seawater AC systems; (2) the capital cost and energy use of such systems are sensitive to the pipeline length, which is dependent on the seawater temperature near the seafloor; (3) at a hypothetical typical Naval facility represented by the average of the two trial facilities, seawater AC requires 80% less energy than conventional AC, but the capital cost of seawater AC is 60% greater; and (4) at this typical facility the life cycle cost for seawater AC is 25% less than that of conventional AC. Sea/lake water AC is recommended for consideration as an alternative to conventional AC at Naval facilities that adjoin bodies of water, and it is also recommended that the computer models be used to make estimates of the capital cost and energy use of sea or lake water AC systems.

N-1578
Fiberglass-Reinforced Rigid Polyurethane Expedient Pavement Subject to Simulated F-4 Aircraft Traffic, May 1980, P. S. Springston, ADA089266

A multipurpose expedient paving system is being developed to enable more rapid construction of expeditionary airfields by Marine Corps forces engaged in an amphibious landing. Previous research has resulted in a conceptual pavement, FIBERMAT, which consists of a facing of fiberglass-reinforced polyester resin (FRP) bonded to a core of fiberglass-reinforced rigid polyurethane foam. FIBERMAT has been subjected to a series of laboratory tests to define response to stress fatigue and environmental cycling. A similar structural sandwich of FRP and rigid polyurethane foam has been tested and found to meet F-4 aircraft static load, tailhook impact, and engine exhaust blast requirements. This report documents the results of a traffic test conducted on a section of FIBERMAT having a 5-inch-thick fiberglass-reinforced foam core and a 1/4-inch-thick FRP facing. Distributed traffic was applied to the test section with a load cart which simulated a main gear of an F-4 aircraft. The cart was equipped with a 30-7.7, 18-ply-rating tire inflated to 265 psi and loaded to 27,000 pounds. The first failure within the test section was

recorded at 136 coverages (1,306 passes) of the load cart, and the entire test section was considered failed at 310 coverages (2,141 passes).

N-1579
Least-Total-Cost Analysis for Earthquake Design Levels, Jun 1980, J. M. Ferritto, ADA093078

This report presents a review and discussion of several procedures for designing structures to resist earthquake shaking. The cost of strengthening structures is presented, and the damage expected from earthquakes is discussed. A least-total-cost analysis is presented which leads to optimal design acceleration levels. Navy economic analysis techniques were used to evaluate present worth of damage and cost. Results are presented in terms of least-cost design levels as a function of site earthquake acceleration levels having a probability of not being exceeded in 50 years. Also given is the marginal cost per life saved for the present Naval Facilities Engineering Command design level over the optimal level. Results indicate that a reduction in design level is possible.

N-1580
Waste-Oil Boiler Firing Demonstration at NWC, China Lake, CA, Jun 1980, T. T. Fu, R. S. Chapler, ADA087321

The waste oil generated at Naval Weapon Center (NWC), China Lake, CA was fired in a 20,000-lb/hr steam boiler at NWC to determine the operational requirements for using it as a boiler fuel. Two series of tests were conducted using blends of this waste oil and commercial grade No. 6 fuel oil normally used for NWC boilers. The first series tested batch-blended oils, while the second series an in-line blending scheme. Six thousand gallons of waste oil was consumed and 440 boiler hours covering the full range of firing conditions were logged during the tests. Results show that the NWC waste oil can be satisfactorily fired either straigh' or in blends of any concentration with No. 6 fuel oil. Only minor adjustments to firing controls are sometimes required. No operational or environmental emission difficulties were encountered.

N-1581
Conventional Anchor Test Results at San Diego and Indian Island, Jul 1980, R. J. Taylor, ADA093088

The Navy has initiated a program to improve fleet mooring capability through tests of existing fleet moorings and a range of conventional anchors in use and projected for use. The results of site surveys and instrumented anchor and mooring tests at San Diego Harbor, Calif., and at Indian Island, Wash., are presented. Emphasis in the tests was on defining the applicability limits of the Navy's primary fleet mooring anchor, the Stockless anchor, through tests of single and tandem anchors. The Navy can use the data immediately for selection and sizing of anchors for sites typical of San Diego sand and Indian Island silty clay seafloors. Other anchors tested included the Navy STATO, BRUCK, Hook, and STEVIN anchors. Test data are presented primarily as plots of anchor penetration, holding capacity, and shank pitch and roll as functions of anchor drag distance. Tandem Stockless anchor arrangements were found that could be easily installed and that resulted in individual anchor efficiencies equal to or exceeding those determined through single-anchor tests. Several anchors were modified to achieve satisfactory performance in the test soils. Guidance for these changes is provided.

N-1582
Influence of Overland Transfer Hose Size/Number and Pump Set Choices on MARCORPS Amphibious Assault Fuel System, Jul 1980, J. R. Moreland, C. K. Smith, ADA093071

The bulk fuel needs of a Marine Amphibious Force (MAF) require that the overland transfer capability of the Amphibious Assault Fuel System (AAFS) be increased from 600 gpm (0.0379 m^3/sec) to 800 gpm (0.0505 m^3/sec). Different pump and hose line combinations are assessed in terms of technical and operational considerations, logistic burden, procurement costs, reliability and life cycle costs.

N-1583
Natural Frequencies and Mode Shapes of Cables With Attached Masses, Aug 1980, S. Sergev, W. D. Iwan, ADA092960

An algorithm has been developed to calculate mode shapes and natural frequencies of taut cables with attached masses. The transcendental equations of motion are solved by an iterative technique that allows accurate calculation of extremely high mode numbers. The algorithm has been implemented as a FORTRAN program primarily as a tool in determining drag coefficients of submerged strumming cables; however, any taut cable can be analyzed. To assess the accuracy of the program, a simple experiment was conducted to determine the natural frequencies and mode shapes of a wire with attached masses driven sinusoidally by a shaker. The algorithm shows close agreement with the experiment data.

N-1584
DECEL1 Users Manual - A Fortran IV Program for Computing the Static Deflections of Structural Cable Arrays, Aug 1980, S. Sergev, ADA093356

DECEL1 is a Fortran IV program for computing the ocean current-induced static deflections of undersea structural cable arrays. As dimensioned, the program can handle arbitrarily configured arrays of up to 22 cables. The cables can be electromechanical, wire rope, or synthetic. Any number of discrete devices (buoyancy elements, current meters, tensiometers, etc.) can be incorporated in the array. An option for parametric studies is included in the program, as is an option for incorporating arbitrary current fields. As written, DECEL1 should be compilable on most Fortran IV compilers with Boolean algebra capabilities.

N-1585
Capability of Existing 6-Inch Bulk Fuel Delivery Systems to Transfer Fuel From Tankers 10,000-Ft Offshore, Aug 1980, J. Bayles, N. Clarke, C. Hoffman, J. Thayer, ADA092946

This report documents results of demonstration exercises in which two concepts utilizing existing equipment and vessels were tested to determine the capability of the Amphibious Construction Battalions to transfer fuel onshore from transports positioned 10,000 ft offshore in an amphibious assault. Data given include pumped seawater delivery rates and projected comparative fuel flow rates.

N-1586
Steam Separator Test and Evaluation: FY79, Aug 1980, G. L. Murphy, ADB053464L

The performance of steam separators for use in Navy shore steam distribution systems has been evaluated. The separators were assessed for their ability to improve the quality and purity of shore-to-ship steam and satisfy the Naval Ship's Technical Manual (NSTM) requirements for blanketing ship steam boilers. Separator test conditions included variations in steam flow rates (25 to 125% of separator ratings), system pressures (90 to 300 psig), impurity levels (up to 40x NSTM SPEC), and water injection rates (1 to 60% moisture). Effectiveness of the separators was based upon their ability to reduce sodium, silica, conductivity, and hardness levels in the stream. A comparison of separators' performance and a design procedure are presented.

N-1587
LASH Transported Anchor for a Tanker Mooring, Sep 1980, J. M. Atturio, ADAO96852

The Navy/Marine Corps Advanced Base Offshore Bulk Fuel System (OBFS) includes a tanker terminal facility. The feasibility of transporting and installing a large gravity anchor for a proposed Single Anchor Leg Mooring (SALM) for the terminal facility is investigated. It was assumed that advanced base, amphibious, and LASH (lighter aboard ship) assets are available for transporting and installing the anchor. A maximum horizontal force of 222 kips (from model tests) on a catenary-moored 50,000-dwt tanker in 65-ft water depth with a 4-knot current and 8-ft (significant height) seas was used to determine the required deadweight anchor size and weight. For sediment seafloors, the anchor would measure 61 ft x 62 ft x 10.5 ft and weigh 1,000 tons. An anchor for a rock seafloor would be approximately twice this size and weight. Either anchor is too large and heavy to be lifted as a single unit by the 500-ton-capacity LASH gantry crane. Instead the anchor is transported and offloaded as two (four for rock seafloors) standard 500-ton LASH barge-sized modules. The floating modules are joined after offloading, towed to the appropriate location, and sunk to provide the required anchorage. SALM anchor installation could probably be accomplished in one day, and terminal installation completed in less than 7 days. A comparable catenary-moored terminal facility is estimated to require an installation time of about 14 days. A Single Anchor Leg Mooring for the OBFS appears to be both feasible and practical. The primary development items are the hardware and techniques for mating the heavy anchor modules at sea.

N-1588
EMCS Modules/Intelligent Time Clock (ITC), Sep 1980, D. Shiroma, ADAO90828

CEL has developed a microprocessor-based intelligent time clock (ITC) for control of HVAC equipment. The ITC has the capability of operating as a stand-alone controller, or as part of a distributed large-scale Energy Monitoring and Control System (EMCS). The ITC has "intelligence" to monitor actual environmental conditions and to base actual control functions on these data. Evaluation of the ITC has demonstrated that such "intelligent" control devices can provide significant energy savings over conventional control devices.

N-1589
A Design Procedure for a Scour Jet Array, Sep 1980, J. A. Ballard, ADAO96854

A scour jet array consists of a number of submerged horizontal water jets that are uniformly distributed along the base of a pier or quay wall within a harbor. The purpose of the array is to prevent the deposition of cohesive sediment within its immediate area by scouring the bottom with its jets. Laboratory measurements have shown that the shear stress distribution of a submerged wall jet is a function of the jet diameter and its discharge velocity. A design procedure is developed in which an optimum system may be selected from all candidate systems. The parameter of optimization is the minimum annual cost. The design procedure requires using either a computer program or a number of graphs.

N-1590
Shock Spectrum Calculation From Acceleration Time Histories, Sep 1980, H. A. Gaberson, ADAO97162

The report mainly discusses, compares, and derives one new and improved and two popular shock spectrum computation methods. The new one is a single recursive equation method that approximates the acceleration as a straight line between the digitized values. The new method is easily derived without recourse to Z Transform theory and, thus, should contribute to improved understanding of the computations. A new source of low frequency error common to all of the calculation methods was found, and empirical testing of the coefficients was used to establish digitizing rules to avoid the error. A FORTRAN listing of a program using the new method is given in an appendix.

N-1591
Facility Hygiene Practices Associated With Asbestos Thermal Insulation, Oct 1980, E. E. Lory, ADA097120

Guidance on appropriate practices for cleaning workplaces that have significant amounts of asbestos-containing thermal insulation is presented. Recommended procedures for floors, walls, machinery and equipment, and overhead areas are provided. Recommended cleaning methods are given for HEPA-filtered vaccum cleaners, wet-cleaning with amended water, and chemical-impregnated equipment. As a general guide, overhead structures and walls should be vacuumed annually, and floors and equipment vacuumed on a regular cleaning schedule.

N-1592
Conventional Anchor Test Results at Guam, Oct 1980, R. J. Taylor, K. Rocker, ADA092958

The results of instrumented drag embedment anchor tests in Inner Apra Harbor, Guam, are presented. The Navy can use these data for selecting and sizing anchors for Guam as well as other similar sites. Test data for the Navy STOCKLESS and STATO anchors are presented principally as plots of anchor penetration, holding capacity, and shank pitch and roll as functions of anchor drag distance. The STATO anchor performed erratically in Inner Apra Harbor due to the presence of a few feet of soft clay over a corally sand subsurface, whereas the STOCKLESS anchor with fixed fully opened flukes performed stably in similar conditions. Test results highlight the sensitive nature of high efficiency anchors to seafloor conditions and suggest the need for anchor proof setting in areas with layered or anomalous seafloor conditions.

N-1593
Handling and Disposal of Asbestos-Containing Waste, Oct 1980, E. E. Lory, ADA097133

The potential health hazards to personnel from exposure to airborne asbestos fiber and the wide variety of asbestos-containing products used at Navy facilities prompted the Naval Facilities Engineering Command to task the Civil Engineering Laboratory to develop guidance on appropriate practices for handling and disposal of asbestos-containing products. Two categories of asbestos-containing construction materials have been identified as potential asbestos-fiber-releasing threats: (1) friable insulating products and woven products and (2) nonfriable matrix-bonded composite products. This document defines the hazard and safe asbestos-containing product handling and disposal practices for Category I and Category II products.

N-1594
Nondestructive Test Equipment for Wire Rope, Oct 1980, H. H. Haynes, L. D. Underbakke, ADA096853

Nondestructive test equipment for inspecting steel wire ropes was evaluated in laboratory and field tests. Individual AC/DC units and a unitized AC/DC unit were tested on wire rope to detect broken wires and loss of metallic area from wear and corrosion. The unitized AC/DC units used Hall effect sensors to pick up the defects as opposed to sensor coils used in the individual AC/DC units. The Hall effect sensors enabled less equipment to be used to conduct a complete inspection and also permitted the wire rope to be inspected at speeds from 0-500 fpm. It is recommended that Navy facilities requiring nondestructive test inspection capability for metallic wire rope inspection procure the unitized AC/DC unit.

N-1595
Propellant-Embedded Anchors: Prediction of Holding Capacity in Coral and Rock Seafloors, Nov 1980, J. F. Wadsworth, R. M. Beard, ADA103105

Propellant-embedded anchors have become an important asset in the Navy's mooring equipment inventory. They offer potential for anchoring in coral and rock seafloors where conventional anchors will not work or present logistic problems. Most operational installations of propellant-embedded anchors have been in coral seafloors and these anchors have usually been proof-loaded to their design capacity. The ultimate capacities of these installations have not been determined; hence, the full potential of propellant-embedded anchors in coral has not been determined. This report presents the results of a program of model and full-scale propellant-embedded anchor tests in coral and rock. The significance of the results and analysis of the data are presented. A promising equation for predicting holding capacity in coral is developed from the data. It is concluded that the data base of tests in rock is not sufficient for developing an equation for prediction of holding capacity.

N-1596
A Make/Buy Decision Analysis and Its Computer Program for Optimization of Cogeneration Plant Operation at Naval Submarine Base, New London, Connecticut, Nov 1980, T. Y. R. Lee, ADA103071

This report illustrates that cogeneration plant operation can be optimized through the use of a hand-held programmable calculator. The cogeneration system consiting of four high-pressure steam-generating units and three turbine generators at U.S. Naval Submarine Base, New London, CT, is analyzed. A computer program written for use on a TI-59 programmable calculator is therefore developed to provide the personnel of the power plant a rapid determination of the optimum operating settings for the turbine/generator sets at any given time. Economic figures are presented to emphasize that the implementation of this program would result in significant improvements in economics and efficiency of the cogeneration process, as the fuel price is expected to increase more rapidly than the utility rate. Although this computer program is initially developed for the application at SUBASE, New London, CT, its applicability to other similar cogeneration systems can be achieved by simple modification of the site-specific, subroutine functions.

N-1597
U.S. Navy Harbor Maintenance Dredging Atlas, Dec 1980, R. J. Malloy, ADA103072

Twelve Navy harbors in the Continental U.S. require maintenance dredging in excess of 0.1 M cu yd per year. They account for 78% of the Navy's annual 9M cu yd total. Two-thirds of the area dredged is located within quiet water berths, typically formed between rows of pile piers. About 87% of the material dredged is mud (silty clay or clayey silt) deposited by estuarine processes.

N-1598
Low-Energy Structures Concepts, Dec 1980, R. J. Odello, ADA103107

This report has discussed various concepts for energy conservation in Navy shore facilities which can be achieved through architectural and structural design decisions. These concepts include earth-sheltered structures, thermal mass concepts, passive solar designs, and exploitation of existing technology. Advantages and disadvantages of the systems were discussed in qualitative terms. Where possible, specific data and equations were presented to show how the benefits could be evaluated for specific designs. Sufficient information is available here and in the references to permit a designer to evaluate any of the concepts for applicability to a specific design case.

N-1561S
Shrinkage-Compensating Cement for Airport Pavement Addendum: Phase 3 - Fibrous Concretes, Jan 1981, J. R. Keeton, ADAO92945

Details of a research study on shrinkage-compensating fibrous concrete for airport pavements are presented. A total of 77 slab-type prisms 1 ft² and 4, 6, and 8 in. thick were subjected to shrinkage in 50% RH. Concrete mixes containing 5.5, 6.5, and 7.5 bags of shrinkage-compensating cement were used in the study. Fly ash was also used for better workability and later added strength. Fiber contents used were 1.0, 1.5, and 2.0% by volume of the concrete. Residual concrete compressive stresses are used as a basis for recommendation of transverse joint spacing of 150 ft for expansive fibrous concrete overlays

N-1599
Experimental Investigation of Earth-Coupled Heat Exchangers, Jan 1981, R. E. Kirts, ADBO58926L

An earth-coupled heat exchanger is a device designed to collect solar energy which has been stored as heat in the topsoil and deliver it for use as, for example, a source of heat for a heat pump. Experiments were performed to measure the heat transfer characteristics of a buried heat exchanger and the results were compared to the performance predicted by a simple mathematical model of the process. Experiments were performed for several soil conditions and heat exchanger geometries. Measured heat transfer coefficients were approximately 1 to 3 Btu/hr/°F/ft of heat exchanger length (or 3 to 8 Btu/hr/°F/ft² of pipe area). Good agreement was obtained between the experimental results and the results obtained from the mathematical model.

N-1600
Energy Factors and Temperature Distribution in Insulated Built-Up Roofs, Feb. 1981, J. R. Keeton, R. L. Alumbaugh, ADA103073

Surface temperatures of 4-ply built-up roofs insulated with (1) 1 inch of perlite (R=2.8) and 2-1/2 inches of urethane (R=19.2) and (2) 1 inch of urethane (R=7.1) and 1-7/8 inches of glass fiber (R=7.7) are presented. Energy factors are shown in terms of temperature-time areas defined as solar heat response, cooling (heating) required, radiative cooling, and insulation efficiency. Results indicate that for a black surface, solar heat response is significantly higher in the roof portion with the higher R-value. Solar heat response is directly affected by color of surfacing: lowest to highest values were found with white, white gravel, gray gravel, aluminum-gray, and black. Recommendations are given for reducing surface temperatures of insulated built-up roofs.

N-1601
Sloping Float Breakwater: Initial Model Tests and Handling Tests of Navy Lightered (NL) Pontoon Modules, Feb 1981, J. M. Atturio, D. B. Jones, ADBO58017L

A sloping float breakwater (SFB) composed of Navy Lightered (NL) pontoon causeway sections has been proposed for the Container Off-Loading and Transfer System, particularly for sheltering container transfer operations at the elevated causeway (ELCAS). Performance data presented in this report confirm previous data (for other float properties) that had indicated that an SFP would markedly increase container throughput at the ELCAS when operating in sea states 3 and 4. The new data from model tests of a ballasted causeway section in water depths of 25 ft and 35 ft, with wave heights of 6 ft and 10 ft, indicate 50% wave attenuation for 7-sec waves. The report also outlines modifications which are required to convert causeway sections into breakwater modules and gives results of the initial handling tests of two prototype modules in a harbor and in the ocean. The primary modifications are the additions of side-to-side connectors and a valved air manifold

for either venting or pressurizing twelve pontoons at the shoreward end of each causeway section. With the air system tested, a pair of causeway sections was satisfactorily ballasted down in 40 minutes and, with a 600-scfm compressor, deballasted (refloated) in 3 minutes. Divers are not required for installation.

N-1602
Underwater Surface Cleaning of Waterfront Structures, Feb 1981, C. Keeney, ADBO58916L

The inspection, maintenance, and repair of submerged waterfront structures requires an efficient method of removing marine fouling and corrosion from underwater surfaces. Several techniques exist to clean underwater structures. A series of tests was conducted to evaluate the capabilities and performance to typical commercially available underwater surface cleaning devices. The cleaning devices varied in priciple, design, and operation. The types of systems evaluated included high pressure water jets and mechanical tools. The high pressure devices utilized: abrasive injection; cavitation erosion; fan, straight and/or retrojet nozzles; various water pressures and flow rates; and different equipment configurations. The mechanical tools included a rotary abrading device and an hydraulic chipping hammer. Evaluation criteria consisted of diver safety, ease of use, performance and efficiency. It was concluded that a system is presently not available which combines the best safety and design features identified during the tests to completely satisfy the Navy's waterfront structure cleaning requirements. Test results are presented to aid in the selection of an appropriate commercially available cleaning system for a given set of cleaning criteria or a required final surface condition.

N-1603
Compressive Strength of Freshly Mixed Concrete Placed, Cured, and Tested in the Deep Ocean, Feb 1981, H. H. Haynes, L. D. Underbakke, ADBO58918L

Freshly mixed concrete, of low- and high-strength mix designs was placed in the Pacific Ocean in 6 x 12-inch (152 x 305-mm)cylindrical molds to attain initial and final set and cure at a depth of 1,830 feet (560 m). At age 11 months, the concrete specimens were retrieved and subsequently tested under unixial compression in a pressure vessel that simulated the ocean depth. The compressive strengths of the deep-ocean concrete specimens were compared with those of controlled concrete specimens cured in a fog room and also in a tank containing continuously circulating seawater.

N-1604
The 1980 CEL Mooring Dynamics Seminar, Mar 1981, P. A. Palo, ADBO58927L

This report describes the CEL Mooring Dynamics Seminar, which was held on 10-11 January 1980. Nine experts, selected to represent the major disciplines relevant to mooring analysis, were invited to attend and informally discuss the field of mooring simulation. These discussions resulted in identification of the present state-of-the-art and promising research topics in mooring simulation. Suggestions were also made towards advancing the state-of-the-art in nonlinear systems identification techniques. This report summarizes the discussions and presents overview papers and seminar conclusions contributed by each attendee.

N-1605
Evaluation of the Dracone for Amphibious Operations, Apr 1981, R. S. Highberg, ADBO59012L

During FY77 and 78, a Type L Dracone floating fuel bladder with 135,000-gallon capacity underwent evaluation at the Civil Engineering Laboratory for use in providing floating fuel storage and transport during amphibious operations. This work was sponsored by the Naval Facilities Engineering Command under the Offshore Bulk Fuel System program. The evaluation consisted of confirming operational capabilities advertised by the manufacturer, developing new methods of operations and handling, and refining hardware for greater ease in and reliability of offshore and onshore operations. As a result of the evaluation revised specifications were prepared to remedy the operational and reliability shortcomings of the Dracone and its hardware. The Type L Dracone, as modified in accordance with the revised specifications, is recommended for fuel shuttling during amphibious operations.

N-1606
Feasibility of Relocatable, Containerized, and Manually Erected Maintenance Hangars for Aircraft of F-4, CH-47, and P-3 Size, Apr 1981, R. H. Seabold, ADBO58928L

The Expeditionary Hangar System is a developmental large area tactical shelter system consisting of aircraft maintenance hangars of various sizes which can be set up without any construction equipment and taken down and packed in standard intermodal shipping containers for transport to another location. Completed development efforts were reviewed to predict feasibility at various desired levels of permance, to reaffirm or revise technical goals, and to assess the technical risks. Feasibility of the small (F-4) and medium (CH-47) hangars is virtually certain. The small and medium sized hangars are recommended for advanced development. Feasibility of the large (P-3) hangar was not successfully demonstrated, because the arch beam segments failed the snow load test. Additional exploratory development is recommended to improve the arch beam segments and then perform an erection demonstration of three arches, two bays of panels, and an end wall with its cable curtain hangar door to demonstrate the feasibility of the large-sized hangar. An investigation of other sizes and uses is recommended.

N-1607
Systems for the Protection of Divers from Electrical Shock Hazards, Apr 1981, L. Tucker, ADBO58944L

The use of electrical power underwater by divers requires that power systems be equipped with ground fault detectors. However, the off-the-shelf devices built for ground fault protection in terrestrial applications are not adequate for underwater systems. To meet this need, the Civil Engineering Laboratory (CEL) is developing an improved ground fault protection system for underwater power transmission. The system detects leakage currents of 5 mA or more and shuts down the power system in 10 msec. The control circuit design is adaptable to electric power systems supplying up to 100 kW. Divers inspecting piers or other underwater structures are also in danger of swimming into electric fields created by ground faults in the pier power system or from powered cathodic protection systems. To warn divers of the potential danger, a breadboard model of an underwater electric field detector was designed and built. The detector is designed to provide a warning signal to the diver if he enters an electric field of 0.2 volt/ft or more. This report reviews the adaptation of the ground fault protection concept to a 2.0-kVA portable power system and presents the laboratory test results from an experimental model. The design and test results for the electric field detector are also presented.

N-1608
The Strumming Vibrations of Marine Cables: State of the Art, May 1981, O. M. Griffin, S. E. Ramberg, R. A. Skop, D. J. Meggitt, S. S. Sergev, ADBO58929L

This report discusses recent findings on strumming of cables from the marine cable dynamics research program conducted by the Naval Facilities Engineering Command. Emphasis is placed on an understanding of the basic strumming phenomenon, the development of design procedures, the definition of hydrodynamics force coefficients applicable

in practice, and the specification of structural response parameters relevant to marine cable design. Strumming analysis methods for both taut and slack marine cables are described together with the computer codes that are available to implement the various analysis procedures. Although this report emphasizes marine cable systems, the results of the NAVFAC/CEL research effort are applicable to other marine structures as well. These applications are discussed in the report as appropriate.

N-1609
Lime-Stabilized Native Soil as Base Course for Light Aircraft Pavements, Oct 1981, R. B. Brownie, ADA102196

Present Federal Aviation Administration (FAA) policy does not recommend the use of lime-stabilized soil as base course for airport pavements. The potential savings in cost and materials by using this type of construction for light-duty airport pavements (aircraft gross weights less than 30,000 pounds) led to the use of lime-stabilized native soil in place of other base course materials at three airports in the Southwestern United States. Those airports are located at Chino, California; Big Bear Lake, California; and Payson, Arizona. The compositions of those base courses were determined by laboratory analyses of core borings and soil samples. Visual condition surveys were performed, and surface deflections under load were measured. Climatological data and aircraft traffic histories were obtained. All of those factors and the performance of the pavements were analyzed, and a suggested specification was prepared for constructing lime-stabilized base courses.

N-1610
Recycling of Portland Cement Concrete Airfield Pavements, Apr 1981, M. C. Hironaka, R. B. Brownie, G. Y. Wu, ADA110440

An investigation was conducted on recycling of Portland cement concrete (PCC) airfield pavements. Previous laboratory studies have shown that recycling of PCC pavements is technically and economically feasible. This has been demonstrated in reconstruction projects at Jacksonville Internal Airport (Florida), Love Field (Texas), and Coffeyville Municipal Airport (Kansas), where PCC was recycled into econocrete base and aggregate subbase, cement stabilized base, and part of the aggregate base course, respectively. Recycling of PCC for surface courses in airfield pavement construction has not yet been performed, but this should also prove to be beneficial as has been experienced by the Iowa DOT and other state highway agencies who have recycled PCC for surface courses. Equipment for recycling PCC pavements is currently available in the construction industry; however, these, along with the technology of PCC recycling, could be improved substantially. Recommendations for specific improvements are therefore made. Also published as Federal Aviation Administration Report FAA-RD-81-5.

N-1611
DOCB Cable-Following Technologies, Aug 1981, L. LeDoux, B. Farber, ADB062342L

This report summarizes investigations, developments, and tests of technologies suitable for automatic tracking of existing seafloor communication cables by an unmanned cable burial machine. The investigations covered metal detector systems, magnetometer/gradiometer systems, parametric sonar, an acoustic camera system, and two antenna systems. The recommended system induces an AC signal on the cable as the vehicle travels along the cable, and utilizes loop antennas to sense the cable left/right position. Other systems are suggested for backup use and topside monitoring.

N-1612
Evaluation of Pressure Vessel Integrity from Measurements of Material Damping, Aug 1981, R. Kruchowy, T. M. Ward, G. E. Warren, ADB062343L

The internal friction damping method for nondestructive evaluation of the integrity of simple structures has been demonstrated under laboratory conditions. The objective of this effort was to investigate the capabilities of the technique when applied to pressure vessels under field conditions. This was accomplished by conducting fatigue tests on two pressure vessels. A description of the vessels, equipment, procedures, and results is provided. It is concluded that the technique is not sufficiently developed to recommend it for field applications. While it is true that yielding and cracking will cause an increase in the specific damping capacity, other external effects, such as changes in the temperature, bolt torque, seal conditions, and the foundations, have similar effects. These external factors make interpretation of the data difficult.

N-1613
Wind Power Utilization Guide, Sep 1981, D. Pal, ADA110337

This report presents general information covering site wind potential and characteristics, specific design, system design, and siting requirements for utilization of wind energy conversion systems (WES) at Navy installations. The objective of this report is also to provide a method for performing economic analysis to plan and justify a WECS in a particular Navy application. The information presented here is sufficient to enable an engineer to prepare a system's design or to conduct a feasibility study for a given application of WECS. Most Navy applications of wind power will involve generation of electricity using small wind turbine generators (less than 60 kW size), with or without storage, located at remote Navy sites. Larger (over 100 kW size), WECS will, generally, be integrated with a base grid located on remote overseas or CONUS bases. This report, however, deals only with guidance for applying small WECS at Navy installations. The subject matter is divided into five parts dealing respectively with wind behavior and its determination with wind-driven turbines, power conditioning requirements, siting requirements, and the economics of wind power under different conditions. Three examples are given to demonstrate use of these sections in developing the required feasibility or design information for a given application.

N-1614
Intermediate Size Containers: Advanced Development Testing (DT-I), Sep 1981, J. H. Seabold, J. Z. Oak, L. J. Woloszynski, ADB062544L

Intermediate size containers consisting of inserts, PALCONS, a PALCON rack, QUADCONS, and a QUADCON rack were tested to validate their design. Proof-load and functional tests were performed at the fabricator's plant, structural and weathertightness tests were performed by an independent contractor, and cold environment tests were performed by NCEL in the environmental chamber at the Navy's Pacific Missile Test Center. All structural tests were passed, but there was some distortion of holes in the base plate of a PALCON. Dimensional controls in terms of configuration, flatness, squareness, fit, and tolerance were generally good. All dimensional deficiencies were present before testing; none originated under test loads or during test operations. Specimens were loaded and unloaded, coupled and uncoupled, lifted and exercised, in warm and cold environments. The only functionally unsatisfactory component was the vertical latch pin of the PALCON. Performance of materials was generally excellent, but the QUADCONs had poor quality corner fittings, and the specified tubes for QUADCON corner posts were not available and had to be simulated by plates. Recommendations include design modifications to improve all the products and engineering development tests to validate them.

N-1615
Development of Improved Testing Equipment and Procedures for the Type XIA Aircraft Power Check Facility Tiedown, Sep 1981, G. Y. Wu, T. K. Lew, ADB064444L

A grabber load test system was developed and evaluated in the field to improve the testing procedures for Type XIA aircraft power check facility tiedowns. The field test results indicate that there are no potential operational problems with the grabber load test system. The testing procedures developed are adequate and simple for determining the strength of the Type XIA tiedown fittings. A standard drawing of the grabber load test system has been prepared. Based on the results of structural analyses, it is recommended that all power check runups using Type XIA tiedowns be limited to one engine at a time so that the minimum operating factor of safety of 2 can be maintained. The Type XIA tiedowns should be inspected and load-tested annually using qualified personnel under the supervision of a responsible structural or civil engineer. For tiedowns other than Type XIA, the T-56 mooring eyes and the Type XIII tiedowns are designed adequately, and only annual visual inspection is required.

N-1616
A Mathematical Model of the Performance of Combustion Turbine/Exhaust Heat Boiler Systems, Oct 1981, E. E. Cooper, ADB062345L

A procedure is presented for analyzing the off-design performance of combustion turbine/exhaust heat boiler cogeneration systems. Using design point data and the relationship between engine output and fuel consumption, the analysis procedure allows computation of off-design performance, accounting for such effects as part-load operations, ambient temperature change, and altitude change. A program of the analysis procedure written for the TI-59 is also presented.

N-1617
Development of a Low Cost EMP Protection Concept for Emergency Operations Centers, Jan 1982, D. B. Clark, ADA114320

Electromagnetic pulse (EMP) shielding, isolation, and protection for emergency operations center type communications equipment have been reduced to a minimum size and cost through development testing, utilizing a concept of shielding, single entry, and in-line transient voltage protection. Shielding for direct induced EMP is balanced against protectors for direct connected EMP to result in EMP voltages at equipment input connections on the order of 5 to 10 volts peak with simulated EMP fields on the order of 10 kV/m and direct connected EMP of thousands of volts peak.

N-1618
Waste-Oil Burner Firing Demonstration at NAS Miramar, San Diego, Calif., Jan 1982, T. T. Fu and R. S. Chapler, ADA114323

The waste oils generated in the San Diego area were tested in boilers at NAS Miramar, San Diego, Calif. Approximately 4 million gallons of waste oils have been consumed during a period of more than 3 years. Results show that all four types of waste oils tested can be successfully fired in the same manner as commercial grade No. 2 fuel oil if they are reasonably free of water and sediment. No modifications for existing boiler equipment or changes in standard operating procedures are necessary. No unacceptable environmental emissions were observed. Due to the contaminants in the waste oils, more than normal effort is sometimes required to clean the oil strainers and the boilers' fireside surfaces. The existing practice for processing waste oils is reasonably satisfactory. Heating the waste oils to further remove water and sediment appears to be only an added cost and may be eliminated when a minimum specification for the waste oil is developed.

N-1619
SNAPLD User's Manual, a Computer Program for the Simulation of Oceanic Cable Systems, Jan 1982, F. C. Liu, ADB065623L

SNAPLD is a Fortran IV computer program which simulates the dynamic response of two-dimensional, series-connected cable structures deployed in the ocean. The program calculates the static equilibrium configuration and dynamic tension and motion responses to forced large displacements at the surface end with or without surface-motion compensation devices. Cable payout and reel-in, current profiles, in-line packages, ship speed, water surface and seafloor boundaries, payload propulsion, and slack cable elements can be simulated. The program uses a lumped mass model. The differential equations based on this model are solved by a finite difference technique. The computer program is an effective tool for the design of cable deployment procedures for undersea arrays and lift lines.

N-1620
Energy Data Mobile Laboratory, Feb 1982, R. J. Tinsley, R. E. Bergman, ADA116594

The Naval Civil Engineering Laboratory (NCEL) has developed and tested a prototype Energy Data Mobile Laboratory (EDML) housed in a specially designed truck/van. The vehicle tows a trailer-mounted telescoping tower designed for meteorological instrumentation sensors. The prototype EDML provides a secure air conditioned base for flexible energy consumption and environmental measurements. A description and drawings of the EDML are provided, and its capabilities, method of operations, instrumentation, testing program and operational potential are discussed.

N-1621
Motion Compensation with Linked Spar System or Ram Tensioner, Mar 1982, W. D. Briggs, F. C. Liu, ADB064443L

Based on NAVFAC's load handling requirements, a study was undertaken to analyze and compare existing (operational) and conceptual ocean load handling/motion compensation systems. Data on various systems were gathered and analyzed to identify the systems most likely to satisfy NAVFAC's needs. This report presents the results of a detailed performance analysis on two of those systems, a linked spar buoy and a ram tensioner. This report discusses the methods of analysis, results of computer simulations, and an assessment of the effectiveness of these two motion compensation systems in alleviating the effects of ship motions and the resulting line dynamic tension and load motions.

N-1622
Simplified Shock Design for Installation of Equipment, Mar 1982, H. A. Gaberson, R. A. Eubanks, ADA114331

A simplified shock design method has been developed and is set forth. The method employs the shock spectrum as the fundamental measure of both the "severity" of a shock environment and the "hardness" of a particular piece of equipment (the "hardness" is the equipment's capacity to survive a shock environment). Both the severity and the hardness are given as shock spectrum plots on "four-coordinate paper" and are thus directly comparable. The method uses a tracing method of recording the fact that the hardness exceeds the severity and thus equipment survival is assured. The report collects the extensive set of equipment hardnesses measured during the Safeguard Program and presents them in catalog form. References to other catalogs' hardnesses are given.

N-1623
Measurements of Winter Electrical Consumption at Sewell's Point Naval Complex, Mar 1982, R. E. Bergman, R. J. Tinsley, ADB065575L

This report documents the winter energy profiles of selected facilities at Sewell's Point Naval Complex, Norfolk, Va. Measurements were taken primarily during the calendar year 1980. The measurement system used and the facilities measured are described. The data and the techniques for displaying the data and deriving useful information are given. Illustrations of the utility of the data profiles are given by the amount and types of information inferred from the patterns of variation of power consumption levels. A high background level of power consumption (a high minimum compared to the average) is characteristic of the facilities measured and implies that there is a high potential for energy savings through conservation. This potential can be detected by systematic measurement of the type described.

N-1624
Underwater Inspection of Waterfront Facilities: Inspection Requirements Analysis and Nondestructive Testing Technique Assessment, Mar 1982, R. L. Brackett, W. J. Nordell, R. D. Rail, ADB065622L

More than two-thirds of the facilities of the Naval Shore Establishment are over 30 years old, there is a backlog of maintenance and repair of these facilities exceeding half a billion dollars. Maintenance and repair funds must be allocated to the highest priority projects to minimize the adverse impact of facility conditions on Fleet operational readiness. The key to improved maintenance and repair management, readiness assessment, and prevention of catastrophic failure is improved facility inspection and condition assessment. The underwater inspection of waterfront facilities is largely limited to visual observations. Hidden deterioration cannot be identified until it is revealed by an abnormal surface condition or by structural failure. Specialized inspection equipment and techniques are required to gather, in a concise and objective manner, data which may be used to determine the condition of critical waterfront facilities. As the first step in meeting this requirement, the Naval Civil Engineering Laboratory (NCEL) conducted an investigation to identify the types of waterfront facilities, structural elements, and construction materials encountered in an underwater inspection. The major defects and types of deterioration most often found in waterfront structures were reviewed and from this an analysis of inspection data requirements was developed. Nondestructive testing technology was assessed to provide an identification of technology deficiencies. NCEL investigators recommend additional research and development to provide the means to obtain the required data.

N-1625
Container Offloading and Transfer System (COTS): Technical Evaluation of Temporary Container Discharge Facility (TCDF), Mar 1982, J. J. Traffalis, ADB065667L

The report gives the results, findings, conclusions, and recommendations of a Technical Evaluation of the TCDF crane; describes the equipment, preparations, and tests required for Technical Evaluation of the TCDF crane; and also presents a chronology of events leading from the desired TCDF configuration of two cranes on a suitably sized hull to a single crane on a deactivated LSD hull for Technical Evaluation.

N-1626
An Energetics Total Load Sediment Transport Model for a Plane Sloping Beach, Apr 1982, J. A. Bailard, ADA116588

Bagnold's energetics-based total load sediment transport model for streams is used as a basis for the development of a total load model of time-varying sediment transport over a plane sloping bed. In both the bedload and suspended load, the transport rate vectors are found to be composed of a velocity-induced component directed parallel to the instantaneous velocity vector and a gravity-induced component directed downslope. The model is applied to idealized surfzone conditions, leading to estimates of the local longshore and on-offshore sediment transport rates as well as the equilibrium beach slope, as a function of the local wave and current conditions. The model is combined with a nonlinear longshore current model and is spatially integrated to obtain predictions of the total longshore transport rate as a function of the incident wave conditions. The results support the general form of the wave power equation except that the wave power coefficient is no longer constant but is instead a complex function of the incident wave and beach characteristics.

N-1627
Interaction of Anchors with Soil and Anchor Design, Apr 1982, R. J. Taylor, ADA116597

The report provides a practical up-to-date guide that enables the practicing engineer to select and size common anchor types, including direct-embedment anchors, deadweight anchors, drag-embedment anchors, and pile anchors. For each anchor type, the report includes site survey recommendations, a brief description of various anchors within each anchor category, methods for determining anchor performance and, in certain cases, suggestions for improving poor anchor behavior. Sources for additional information are suggested where the treatment of a broad topic is necessarily limited.

N-1628
Wind-Induced Steady Loads on Ships, Apr 1982, R. Owens, P. Palo, ADA119984

Methods are presented for predicting the lateral and longitudinal steady wind drag forces and yaw moment versus incident wind angle for various ship types. These methods were developed based on experimental model data for 31 ships compiled from six independent tests. Except for hull-dominated ships, which are considered separately, the longitudinal wind drag force is computed using a constant headwind coefficient that has an accuracy of 12%. This coefficient can be modified depending on the ship's underwater and above deck features. Over the [illegible] of the incident wind directions the coefficients are based on curve fits to the data. The lateral force coefficient is also derived from a curve fitted to the data and is based on a peak value with a 10% deviation; the coefficient is dependent on mean heights and projected areas of the hull and superstructure. Determination of the recommended moment response is based on an inspection and interpolation of existing experimental data. Recommendations from other investigations are also presented for comparison, and a sample problem is included.

N-1629
Guidelines for Designing Facilities to Reduce Losses and Damage Caused by Criminal Acts, Apr 1982, T. L. Pickett, ADB065574L

This report explores the potential for providing improved protection for assets and sensitive materials that the Navy is accountable for through better facility design. A general design philosophy is presented along with guidelines. Finally, an example of the technique (using a hospital design) is presented along with suggested aides and recommendations for further work.

N-1630
SEADYN User's Manual, Apr 1982, R. L. Webster, P. A. Palo, ADA116589

This report describes the input structure and general use of the nonlinear cable dynamics computer model SEADYN. This program performs static, time and frequency domain dynamic, and modal analyses for arbitrarily configured cable-truss structures. Significant capabilities

include: multi-materials, bottom interaction, nonlinear material properties, material damping, payout reel-in, strumming effects, spatially varying current fields, imposed motions, and random wave loading. Results can be saved and reused during the current execution or at a later date. A free-field input reader is used.

N-1631
Traffic Testing of a Fiberglass-Reinforced Polyester Surfaced and Reinforced Crushed Limestone Base Course for Rapid Runway Repair, May 1982, P. S. Springston, ADB065621L

This report documents traffic tests of a rapid runway repair (RRR) method utilizing dual membranes of fiberglass-reinforced polyester resin (FRP). The test was conducted at the Rapid Runway Repair Test Facility of the Air Force Engineering and Services Center at Tyndall Air Force Base, Fla., during September 1980. A lower membrane, which is field fabricated at the debris-base course interface, reinforces the base course and prevents aggregate from being worked into the crater debris during trafficking. An upper prefabricated membrane functions primarily as a trafficable crater cap, preventing foreign object damage (FOD) to aircraft. The upper membrane also reduces rutting from rolling aircraft wheels in a 12-in.-thick crushed limestone base course overlying backfilled debris. The repair method for medium to large craters consists of the removal of upheaved pavement, backfilling the crater with usable debris to within 12 in. of the runway surface, field fabrication of the lower membrane concurrently with placement of 12 in. of crushed limestone, compaction and grading of the limestone, and positioning and anchoring of the FRP cover. In the tests, applied traffic consisted of 150 and 70 coverages of load carts simulating fully loaded F-4 and C-141 aircraft main gears, respectively. The upper FOD cover anchoring system was successfully tested and found to be capable of withstanding repeated horizontal loadings of 54,000 lb. Recommendations are provided for further evaluation necessary for the certification of the concept for rapid runway repair.

N-1632
Evaluation of NDT Equipment for Specialized Inspection, Jun 1982, G. Warren, ADB068191L

Surveys and evaluations were made of commercially available portable systems for nondestructive test (NDT) applications to the specialized inspection areas of waterfront facilities, cables and wire rope, built-up roofs, and utility/POL distribution and storage facilities. Some success was achieved by adaptation of equipment and techniques used in other NDT applications (e.g., nuclear moisture meters for roofing inspection, ultrasonics for measuring metal thicknesses of underwater structures, and magnetic induction for wire rope and cable inspection). However, NDT equipment state-of-the-art is deficient for providing capability to assess condition of wooden underwater structures, trackage foundations, and POL/utility distribution and storage facilities.

N-1633
An Assessment of State-of-the-Art Methods for Calculating Current Loads on Moored Ships, Jun 1982, P. Palo, R. Owens, ADB068225L

This report presents an examination of techniques for computing current-induced forces and yaw moment on moored vessels based on experimental data or procedures from nine independent sources. No validated full-scale data were located, so only relative evaluations were possible. For the lateral and longitudinal current forces, the nine sources were applied directly (or scaled) to two representative hull types. This comparison shows extreme differences among the nine methods. It is concluded, based on these differences, that the present uncertainty in these state-of-the-art current force predictive methods is ±80% for head currents (longitudinal force) and ±50% for beam currents (lateral force). Comparisons are also presented for the current-induced yaw moment and water depth (blockage) correction factor. The differences among these latter two are even greater than those for the lateral and longitudinal forces. The Navy's DM-26 approach was found to be inconsistent and can be in error by a factor of 5; the latest draft (90%) of the ongoing revision of that manual (DM 26.6) was considered acceptable except for the longitudinal forces. Because of uncertainties in the scaling criteria, full-scale measurements are recommended to allow proper evaluation of these various methods.

N-1634
STATMOOR - A Single-Point Mooring Static Analysis Program, Jun 1982, J. V. Cox, ADA119979

STATMOOR is a static mooring analysis program written in BASIC language and is one program in a hierarchy of programs developed at the Naval Civil Engineering Laboratory for mooring analysis. STATMOOR analyzes the static response of a single-point moored vessel and hawser. The MENU arrangement of the program lends itself to a user-oriented conversational mode. The user has the option to enter, review, edit input, and obtain calculated results in printed tabular, video tabular, or video graphics form. Steady current, wind, and wave loads are considered. Wind load estimates are considered to be as accurate as the user's knowledge of the wind environment; current and wave loads are in a preliminary form and merit further refinement. STATMOOR was written to demonstrate the utility and ease of use of conversational mode programs and the potential for computer programs to replace bound design manuals. It is unique in that it incorporates recently developed wind load information, can confidently be used with little or no training, and is easily adaptable to most desk top computers.

N-1635
Drag Embedment Anchor Tests in Sand and Mud, Jun 1982, R. J. Taylor, ADB068224L

This report provides the results of conventional temporary and permanent mooring anchor tests in dense fine sand at Port Hueneme and normally consolidated silty clay at Indian Island, includes a preliminary analysis of the data, and provides suggested modifications to improve anchor performance. The data provided can be used to quantify anchor capacity, to guide anchor selection, to improve the understanding of anchor behavior, and to guide the formulation of empirically and theoretically founded schemes to define anchoring capacity. Although the number of tests performed on each anchor during the recent anchor tests in sand and mud was limited, the repeatability of the data was excellent and correlations with previous NCEL tests provided added insight into the specific behavior of the tested anchors and into general anchor and chain behavior. Data for the Two-Fluke Balanced, STATO, MOORFAST, BRUCE Twin-Shank, STEVFIX, PRISMA, and WISHBONE anchors are presented principally as plots of anchor penetration, holding capacity, and shank pitch and roll as functions of anchor drag distance.

N-1636
Dewatering Cofferdam for the TRIDENT Submarine Drydock, Jun 1982, J. B. Forrest, ADA120023

The dewatering cofferdam for the TRIDENT nuclear submarine drydock at Bangor, Washington, presented many challenges. These included water depths up to 25 meters, artesian pressures 10 to 13 meters above mean sea level, difficult pile driving conditions, and the potential for seismically induced liquefaction of the fill in the cofferdam cells. Design ground motions of 0.15g dictated that fill densities exceed 75% density index. Deep compaction was achieved using a large vibratory probe. Inclinometer, strain gage, and optical survey measurements on the sheet piles and extensive piezometric data were obtained. Significant observations were that (1) deep cell compaction can

markedly increase fill density without increasing lateral cell pressures unduly, and (2) maximum interlock tension may be well below the one-quarter height of exposed sheeting as often assumed in design.

N-1637
Desert Water Supply, Jun 1982, J. Crane, ADB068233L

Water supply, treatment, storage, and distribution requirements were assessed in relation to national Marine Corps structures and hypothetical desert scenarios to determine required capabilities and potential shortfalls in current assets. Pieces of equipment currently in inventory or in the procurement cycle were found to be suitable considering the Marine Corps mission and deployment methods. Shortfalls were identified, and recommendations were provided concerning transfer hose, beach intake well points for reverse osmosis treatment, thermal protection for storage and distribution equipment, and ground water acquisition capabilities.

N-1638
100K Propellant Anchor Technology Transfer - Diego Garcia Fleet Mooring Installation, Jul 1982, J. C. Miller, ADB068192L

The Naval Civil Engineering Laboratory (NCEL) has been developing and operating propellant embedded anchors since 1968. Beginning in 1979 this technology was transferred to a field division of the Naval Facilities Engineering Command (NAVFAC) to support fleet operations. In 1980-81, this technology was used to install eleven fleet moorings in the coral bottom of the Lagoon at Diego Garcia B.I.O.T. Ninety-seven anchors were fired; eight failed to hold the required proof load, 100,000 or 150,000 pounds, and one failed prior to proof loading. Data on all shots are presented along with a discussion of operating procedures. The report also documents the technology transfer process.

N-1639
Test and Evaluation of the Magnograph^{TM} Unit - A Nondestructive Wire Rope Tester, Jul 1982, L. D. Underbakke, H. H. Haynes, AD

The nondestructive wire rope test device, a unitized AC/DC Magnograph, was tested for operational characteristics prior to acquisition by Naval field activities and start of inspection programs. The Magnograph was tested for loss of metallic area (LMA) and local fault (LF) detection accuracy. Wire ropes 1/2, 3/4, 1-1/8, 1-1/2, 2, and 2-1/2 inches in diameter were tested on a wire rope test track to find the accuracy of the unit. Two mining wire ropes, guy wires of a 1,000-ft-tall tower, and wire rope for 400-, 250-, and 30-ton cranes were used to determine operational characteristics of the Magnograph.

N-1640
An Economic Analysis of Earthquake Design Levels, Jul 1982, J. M. Ferritto, ADA120024

This report presents data on the cost of increasing the seismic design strength of buildings for three strengthening concepts: moment frame, braced frame, and shear wall. Damage is related to drift and acceleration of key elements of the structure. A damage matrix was constructed relating damage to design level and applied loading. An economic analysis was performed evaluating cost of strengthening, the present worth of expected damage, and the probability of site acceleration levels.

N-1641
Operating and Maintenance Experience with a 6-kW Wind Energy Conversion System at Naval Station, Treasure Island, California, Jul 1982, D. Pal, ADA119389

This report describes in detail the experience gained and lessons learned from the 6-kW grid-integrated Wind Energy Conversion System (WECS) demonstration at Naval Station, Treasure Island, San Francisco Bay. The objective of this demonstration was to develop operating experience and maintenance information on the 6-kW WECS using a combination of permanent magnet alternator with a line commutated synchronous inverter. The on-site measurements conducted during the demonstration indicate that the WECS site has annual average windspeeds of about 8 to 10 mph. The test results to date indicate a satisfactory performance of the WECS except for two failures involving arcing at the electrical terminals located on the yaw shaft. Due to wind characteristics encountered at the site, the performance data collected to date are at windspeeds of 20 mph or lower. For evaluating the WECS performance at all windspeeds, location at a windier site with annual average windspeeds of 14 mph or higher is recommended.

N-1642
An Economic Evaluation of Alternative Methods of Utilizing Available Landfill Gas to Cogenerate Power at NAS Miramar, Aug 1982, C. A. Kodres, AD

The Naval Air Station at Miramar contains the largest active sanitary landfill in San Diego County. It is estimated that the anaerobic decomposition of the organic refuse in this fill is producing sufficient methane to completely satisfy the energy requirements of the base if some means can be found to efficiently utilize this gas as a fuel. An economic evaluation of alternative methods of employing the landfill gas is presented. Among the alternatives examined is the use of the methane as a gas turbine fuel to cogenerate both electricity and steam.

N-1643
Thermal Conductivity of Weathered Polyurethane Foam Roofing, Sep 1982, D. A. Zarate, R. L. Alumbaugh, AD

An investigation of the decay in the thermal conductivity of polyurethane foam (PUF) with time is presented. The polyurethane foams studied included samples removed from sprayed PUF roofing systems on structures at Guam, Marianas Island; Subic Bay, Republic of the Phillipines; Denver, Colorado; Clifton, New Jersey; and Port Hueneme, California. Thermal conductivity results closely agree with those predicted for a foam aged at 25°C in a controlled atmosphere. Results also indicate that the foam can provide good insulation characteristics in spite of poor application.

N-1644
Improved Field Performance for Reverse Osmosis Systems, Sep 1982, T. A. Kuepper, AD

The report describes two test programs: the first one involved the physical cleaning of reverse osmosis (RO) membranes by means of flow surging and ultrasonic cavitation. The objective was to clean RO membranes in situ without using chemical additives. It was shown that ultrasonic cleaning is an effective method for removing ferric oxide, calcium carbonate/sulfate scale, and bentonite clay deposits from individual pieces of RO membranes. However, ultrasonic cavitation was not effective when applied to RO membranes in a spiral-wound configuration. Flow surging proved to be an effective method for cleaning spiral-wound RO modules in the preliminary test program conducted. A second test program involved the evaluation of a tubular fabric filter which has the potential of replacing conventional mixed media filters with substantial weight and filter housing area savings. During the test program the filter removed over half of the turbidity of the feedwater used without any chemical additives and could be cleaned intermittently by backwashing.

N-1645
An Automatic Pump Control for MARCORPS AAFS/TAFDS Pump Sets, Sep 1982, J. Moreland, AD

An automatic pump control has been developed for Marine Corps POL pump sets. The automatic pump control is designed to increase Amphibious Assault Fuel System fuel

throughput while reducing manpower and equipment requirements at pump sets deployed for cross-country transfer of bulk fuel. The Tactical Airfield Fuel Dispensing System will benefit from the automatic pump control because of reduced operator skill level and improvements in personnel and equipment safety.

N-1646
Summary Report of Partial Validation of the Surfzone Transition Analytical Methodology Using the Surfzone Test Vehicle, Sep 1982, J. Miller, AD

Results from field tests of the full-size tracked surfzone test vehicle (STV) at two sandy beach/nearshore sites were used to investigate some key vehicle performance prediction relations in the trafficability submodel of the computerized surfzone transition analytical methodology (STAM). Analysis of the STV test results demonstrated that STAM equations for predicting the drawbar pull and total motion resistance of tracked vehicles are adequate and, in fact, slightly conservative for nearly all coarse-grained soil/tracked vehicle/ vehicle submergence conditions. Finally, suggestions were presented for needed model and prototype testing to validate prediction relations in STAM's other two submodels--the water force calculations and vehicle stability submodels--as well as prediction relations in yet unvalidated parts of STAM's trafficability submodel (primarily relations for obstacle override and for tracked vehicle operation in fine-grained soil nearshore areas).

N-1647
Microbiological Defacement of Navy Buildings, Oct 1982, R. W. Drisko, T. B. O'Neill, J. R. Moses, AD

A survey was made of mildew problems at selected Naval activities in Hawaii and the Western Pacific. A list of factors affecting mildew growth was developed along with recommended practices to control the growth. A list of EPA-approved mildewcides is presented.

N-1648
Longevity of Propellant-Embedded Anchor Downhaul Cables: Initial Tests of Rope and Chain, Nov 1982, D. B. Jones, AD

The propellant-embedded anchor is a projectile that is driven vertically into the seafloor by a propellant charge in a gun. Anchors with nominal capacities of 10, 20, and 100 kips (45, 90, and 450 Newtons) have been developed. The downhaul cable is the length of line that connects the buried anchor to the rest of the mooring leg. The service life of this line is controlled by the varying degrees of corrosion, abrasion, and fatigue to which it is subject. Operational experience has provided little information on the service life of wire-rope downhauls, the only kind used thus far.

Laboratory tests were initiated to identify resistant downhaul cable materials. In these tests, the degrading processes in a seabed of quartz sand were simulated. For wire-rope specimens, loss of material through abrasion appeared to be important; however, failures occurred because of bending fatigue, compounded by corrosion. Nylon-rope specimens with and without surface coverings failed through external abrasion; a polyurethane sleeve provided the best abrasion protection.

Firing tests of 7/8-inch chain downhauls, proposed for the 10- and 20-kip anchors, showed that the chain can withstand the large acceleration experienced during firing of the projectile. However, the use of chain requires redesign of the projectile to balance the inertial load.

N-1649
A Model for On-Offshore Sediment Transport in the Surfzone, Dec 1982, J. A. Bailard, AD

An energetics-based surfzone sediment transport model is evaluated for its ability to predict on-offshore sediment movements using nearshore sediment transport study current meter and beach volume measurements. The magnitude and distribution of pertinent wave velocity moments are also evaluated from the same data set. The latter were found to be linear functions of the significant wave height. Results of the study showed that the current meter data were of insufficient length to evaluate the sediment transport model's validity. A simplified version of the model coupled with estimated wave velocity moment regression equations was found to mimic observed beach volume variations as a function of wave height.

CR 78.011
Thermal Stratification Enhancement for Solar Energy Applications, R. I. Loehrke et al, Fort Collins, Colo, Mechanical Engineering Dept., Colorado State Univ., Jul 1977, N68305-76-C-0036, ADA055918

A study is presented that shows methods to enhance stratification in liquid storage tanks. The report focusses on the development of a passive inlet distributor which minimizes mixing between incoming and stored fluids at unlike temperatures. Theoretical analyses and scale model tests were performed. Computer simulations were used to compare mixed storage with stratified storage in a solar space heating system. Test results showed that in some cases nearly ideal stratification can be obtained and the computer simulations indicated that the load carrying capability of a solar system may be increased 5-10% through the use of stratified storage.

CR 78.012
Materials Study for High Pressure Sea Water Hydraulic Tool Motors, B. Bhushan, S. Gray, Latham, N.Y., Mechanical Technology Inc., Feb 1978, N68305-77-C-0001, ADA055609

The objective of the program was to conduct a comprehensive materials study for a small, compact, positive displacement hydraulic motor which will use pressurized sea water as the working fluid. Gear, vane and piston-type motors were selected for the study. The design analysis of the critical components of each motor type were conducted using a baseline motor size of 10 gpm at 100 psi and 5.8 input horsepower in order to establish the loading and speed requirements. Based on materials requirements, an extensive literature search was conducted of published test data on materials, data relevant to seawater lubricated conditions. In the event that test data on materials was not available, tests were conducted to obtain friction, wear and corrosion data under simulated conditions. Two test rigs were prepared for the studies, one a continuous sliding tester capable of up to 2,000 psi at 1,500 fpm, and the other a reciprocating tester capable of up to 1,500 psi and 250 fpm average speed. The material combinations tested included plastic-metal, metal-metal and nonmetal-metal categories. Submersion tests in sea water were conducted to study corrosion resistance of selected metals and metal couples. Particularly successful combinations in the material testings were: Torlon 4301 (polyamide-imide with fillers) versus Inco 625, and high purity alumina versus plasma sprayed tungsten carbide.

In the continuing design analysis of the motor types, techniques for balancing the internal loads to reduce the contact requirements, and techniques for self-adjustments for wear rate were studied and developed. In the overall assessment of suitability to sea water operation, top ranking was given to the double entry vane motor, this followed by the double row axial piston multi-lobe cam design. The materials evaluated in the study were particularly well matched to the vane motor.

Future work recommendations for continuing sea water motor development included: building and developing a double entry vane motor, an experimental and analytical study of rolling and rolling-plus-sliding contact conditions under sea water lubrication conditions, and further studies of a more basic nature of the lubrication improvements possible with very small quantities of soluble additions and those from reactive motor materials.

CR 78.013
Reducing Vandalism in Naval Bachelor Enlisted Quarters, vol. 1: Project Summary, C. Brady, M. Brill, Buffalo, N.Y., Buffalo Organization for Social & Technological Innovation (BOSTI), Apr 1978, N68305-77-C-0018, ADA058858

Results of a study on the extent of vandalism in Naval BEQs are presented in three "stand-alone" volumes. Volume 1 summarizes vandalism damage which was found to be a problem of high incident rate and high maintenance cost. Volume 2 focuses on concepts for remedial programs to combat the problem. Volume 3 proposes administrative measures to deal with the problem.

CR 78.014
Cogeneration at Navy Bases, Navy Energy Guidance Study, Phase I, A. I. McCone et al, San Francisco, Calif, Bechtel National Inc., May 1978, N68305-77-C-0003, ADA057405

This report analyzes the cost effectiveness of electric power generation at two Navy bases using existing boilers and turbine-generator systems. This study focused on cogeneration which occurs when steam from the power generation turbine can be used to satisfy heating and process steam demands. It was found that cogeneration is the most cost effective means of electric power generation. In contrast, condensing generation is less efficient than power supply from a public utility, and it is usually more expensive. However, occasional use of condensing generation for peak shaving is warranted because it reduces the demand charge. Application of these findings at Philadelphia Naval Shipyard could save up to $800,000 per year in fuel plus electricity purchases. Capital, operating and life cycle costs for new facilities show that it is not economical to install new electric power generation facilities at Navy bases if oil is used.

CR 78.015
Determination of Types and Quantities of Solid Waste Associated With Marine Amphibious Force (MAF) Operations, Long Beach, Calif, SCS Engineers, Feb 1978, N68305-77-C-0039, ADB030562L

The MARCORPS requires a system to manage and dispose of solid waste generated in a Marine Amphibious Force (MAF) environment. This report identifies the types, quantities and generation rates of MAF solid wastes associated with current MAF operations and provides a basis upon which to develop state-of-the-art disposal practices.

CR 78.016
Reducing Vandalism in Naval Bachelor Enlisted Quarters, vol. 2: Demonstration and Design Guidelines, C. Brady, M. Brill, Buffalo, N.Y., Buffalo Organization for Social and Technological Innovation (BOSTI), Apr 1978, N68305-77-C-0018, ADA058028

Results of a study on the extent of vandalism in Naval BEQs are presented in three "stand-alone" volumes. Volume 1 summarizes vandalism damage which was found to be a problem of high incident rate and high maintenance cost. Volume 2 focuses on concepts for remedial programs to combat the problem. Volume 3 proposes administrative measures to deal with the problem.

CR 78.017
Reducing Vandalism in Naval Bachelor Enlisted Quarters, vol. 3: Project Methods and Results, C. Brady, M. Brill, Buffalo, N.Y., Buffalo Organization for Social and Technological Innovation (BOSTI), Apr 1978, N68305-77-C-0018, ADA058144

Results of a study on the extent of vandalism in Naval BEQs are presented in three "stand-alone" volumes. Volume 1 summarizes vandalism damage which was found to be a problem of high incident rate and high maintenance cost. Volume 2 focuses on concepts for remedial programs to combat the problem. Volume 3 proposes administrative measures to deal with the problem.

CR 78.018
Fabrication of Fiberglass Reinforced Plastic Surfacing Under Wet Conditions, T. J. West, Walnut Creek, Calif, Dow Chemical U.S.A., Sep 1978, N68305-77-C-0005, ADA059698

The purpose of this investigation was to develop a system to be used in the construction of fiberglass-reinforced plastic surfacings for soil under wet conditions. The effect of water in the substrate and in the fiberglass mat, on laminate properties, has been defined and solutions have been developed for some of the problems. A system of chemical components has been developed for the field placement of the reinforced plastic soil surfacings under wet

conditions, that is superior to that presently used and is usable with the basic spray equipment now used by the Marine Corps.

It was established that the resin viscosity should be less than 100 cps at the temperature of application for optimum flexural strength. The incorporation of a surfactant into the wet fiberglass mat was found to result in improved resin penetration into the woven roving and increased flexural strength. The addition of 15 percent styrene to the presently used Port Hueneme resin (Selection RS50338) and the incorporation of Triton X100 into the water in the fiberglass mat results in flexural strengths of 25,000 psi - a considerable improvement over the 4,000 psi obtained with undiluted Port Hueneme resin.

DERAKANE (trademark of The Dow Chemical Company) 510-A-40 when diluted with 15 percent styrene and, used with Triton X100, gives laminates having flexural strengths of 30,000 psi, meeting the 28,000 psi flexural strength specification. This resin does not have the desired five year shelf life.

CR 78.019

Gasification at Navy Bases, A. J. McCone et al, San Francisco, Calif, Bechtel National Inc., Jul 1978, N68305-77-C-0021, ADA060475

The work described in this report was performed under Contract N68305-77-C-0021 with the Civil Engineering Laboratory (CEL) at the Naval Construction Battalion Center at Port Hueneme, CA. The title of the contract was "Coal Gasification Feasibility Study." Coal gasification is recognized as a way to produce a clean burning boiler fuel from coal within acceptable environmental limits. The study was to assist the Navy in determining how coal might best be utilized, by comparing gasification with central direct coal-fired boiler systems at each of five bases. Bechtel showed in a previous study for CEL that gasification plants could be economically attractive at Navy bases. Gas from a plant producing 250 x 10^6 Btu/hr with a load factor of 90 percent was shown to have a lower life cycle cost than continued use of fuel oil. This second study examined plants as they would actually be operated. A conceptual design study comparing coal gasification with central direct coal-fired boilers at five bases was performed. The major finding at the five bases studied was that actual load factors are 36 percent or below. Because gasification plant capital costs are high, the reduced load factor makes gasification less attractive. The results showed that coal gasification offers lower life cycle costs than central coal-fired boilers at only one of the bases studied, Camp Pendleton. Installations at Mechanicsburg, PA; Great Lakes, IL; and at Norfolk and Quantico, VA, were not shown to be favorable candidates for coal gasification. A design optimization study for a coal gasification plant at Camp Pendleton was recommended as the next step.

CR 78.020 - Cancelled

CR 78.021

Reducing Vandalism in Naval Bachelor Enlisted Quarters, vol. 4: Analysis of Theft and Theft-Related Property Damage, C. Brady, M. Brill, Buffalo, N.Y., Buffalo Organization for Social and Technological Innovation (BOSTI), Jul 1978, N68305-77-C-0018, ADA062988

Results of a study on the extent of vandalism in Naval BEQs are presented in four "stand-alone" volumes. Volume 1 summarizes vandalism damage which was found to be a problem of high incident rate and high maintenance cost. Volume 2 focuses on concepts for remedial programs to combat the problem. Volume 3 proposes administrative measures to deal with the problem. Volume 4 is an analysis of theft and theft-related property damage.

CR 79.001

A Land Management Technique for the Optimal Placement of Facilities in an Amphibious Objective Area (AOA), New York, N.Y., Ford, Bacon & Davis, Oct 1978, N68305-77-C-0032, ADA064858

At present, a number of separate maps, charts, and tables are required, and manual techniques are used to estimate construction effort and determine where facilities should be placed in an AOA. Present techniques are time consuming, which makes it difficult to optimize placement of facilities within operational constraints to minimize the construction effort and avoid relocation of facilities at a later time.

A methodology is developed which is expected to reduce horizontal construction effort by 20%; included are depictions of significant attributes of terrain, facilities, and their interrelations. The methodology was successfully exercised in a near-operational, MAF-size example.

Automation of the methodology and of the construction effort computations to produce a computerized system is presently underway.

CR 79.002

Dead Band Controls Guide, J.P. Paoluccio, La Jolla, Calif, Joseph Paoluccl, Consulting Engineers, Nov 1978, N68305-78-C-0011, ADA064771

The purpose of this guide is to show methods of reducing energy consumption in new and existing heating, ventilating and air conditioning (HVAC) systems by using the Dead Band control strategy.

Dead Band control strategy and its application to HVAC systems is discussed for three representative climatic zones in the continental United States. Computer modeling techniques provide predictions on energy savings due to control system modifications for six types of HVAC systems and two types of building construction: thermally heavy and thermally light.

The operation of six HVAC systems is described and illustrated for existing and Dead Band control strategy. Computer simulation of these various systems demonstrates that substantial energy savings can be achieved by employing Dead Band control strategy. Bar graphs are provided illustrating relative energy used for each HVAC system. Engineering guidelines for the design of Dead Band control systems are presented in form of control schematics and logic diagrams for each HVAC system. Economic guidelines include techniques for estimating construction and maintenance cost, and performing economic analysis for each system.

CR 79.003

72-Hour Operating Test of a Packaged Heat Recovery Incinerator, L. W. Anderson, Xenia, Ohio, Systems Technology Corp., Aug 1978, N68305-77-C-0037, ADA065415

The performance of the North Little Rock, AR, municipal heat recovery incinerator installation was monitored over a 4-day period. The average energy contents of the solid waste, as fixed, was 3,800 Btu/lb. The average conversion efficiency over the 4-day period was found to be 50.7% based upon the low heating value of the solid waste.

CR 79.004

Fire Tests of Polyurethane Foam Roof Deck Construction on Steel Decks, K. Rhodes, Northbrook, Ill., Underwriters Laboratories, Inc., Dec 1978, N68305-78-C-0010, ADA065403

Fire tests were conducted on built-up roof assemblies specified by the Navy consisting of spray-applied polyurethane foamed plastic covered with specified elastomeric coatings. The Standard UL 790 entitled "Tests for Fire Resistance of Roof Covering Materials," was utilized to measure the resistance to fire originating from sources outside a building on which they may be installed. A 20 ft by 100 ft building ("White House") was used to evaluate the ability of the built-up roof assembly to resist spread of fire on the underside as a result of fire originating from interior sources. Prior to the White House test, 25 ft

tunnel tests and small-scale furnace tests were conducted to (1) provide data for screening and selection of candidate systems likely to perform successfully in the "White House" test and (2) provide additional data on underdeck spread of flame and damage for comparison with performance characteristics of "Fire Classified" assemblies.

As a result of these fire tests and comparisons with previous results for other assemblies, three candidate systems are eligible for Underwriters Laboratories Inc.'s Classification and Follow-Up Service as "Fire Classified" Roof Deck Construction.

CR 79.005
Coal Energy Conversion Options for Navy Bases, A. I. McCone et al., San Francisco, Calif., Bechtel National, Inc., Mar 1979, N68305-78-C-0036, ADA067463

An overview evaluation of technologies through which coal may replace oil or gas as the primary fuel at Navy bases was performed. Four technologies for manufacturing and utilizing synthetic fuels were considered commercial. These were: low-Btu gas, medium-Btu gas, synthetic natural gas (SNG), and methyl fuel. These technologies were compared with boilers firing cleaned coal or Western coal and with boilers plus scrubbers firing high sulfur Eastern coal. The comparisons were made for a Navy base with a single central 250×10^6 Btu/hr boiler station, and for four other Navy base configurations with decentralized boilers. The clean coal firing technology led to lower costs than the synthetic fuel technologies in all cases. Medium-Btu gas offers lower costs than coal-fired boilers plus scrubbers in the most decentralized scenario. Fluidized bed combustion, judged to be a future technology, appears to be the lowest cost technology in central plants. Future environmental regulations may preclude burning cleaned or Western coals without SO_2 removal.

CR 79.006
Experimental Study of the Dynamics of Variable-Length Cable Systems, T. M. Ward, Pasadena, Calif., Graduate Aeronautical Laboratories, California Insitute of Technology, Apr 1979, N68305-76-C-0033, ADA068332

Laboratory experiments on the dynamics of variable length cable systems are described. The prototype situation that these experiments simulate is the deployment of retrieval of a heavy object at sea. A winching mechanism attached to an electromechanical oscillator was mounted over a 65 ft (20 m) deep tank of water. A mass suspended by elastic and inelastic cables was payed-out and reeled-in at specified velocities and accelerations while being oscillated in the vertical plane. Cable tension data are provided as a function of cable direction, length, velocity, acceleration, and the frequency and amplitude of the oscillator.

CR 79.007
Experimental Study of the Dynamics of Variable-Length Cable Systems, Supp. Vol. I, T. M. Ward, Pasadena, Calif., Graduate Aeronautical Laboratories, California Institute of Technology, Apr 1979, N68305-76-C-0033, ADA068748

Laboratory experiments on the dynamics of variable length cable systems are described. The ptototype situation that these experiments simulate is the deployment of retrieval of a heavy object at sea. A winching mechanism attached to an alectromechanical oscillator was mounted over a 65 ft (20 m) deep tank of water. A mass suspended by elastic and inelastic cables was payed-out and reeled-in at specified velocities and accelerations while being oscillated in the vertical plane. Cable tension data are provided as a function of cable direction, length, velocity, acceleration, and the frequency and amplitude of the oscillator.

CR 79.008
Experimental Study of the Dynamics of Variable-Length Cable Systems, Suppl. Vol. 2, T. M. Ward, Pasadena, Calif., Graduate Aeronautical Laboratories, California Institute of Technology, Apr 1979, N68305-76-C-0033, ADA068690

Laboratory experiments on the dynamics of variable length cable systems are described. The ptototype situation that these experiments simulate is the deployment of retrieval of a heavy object at sea. A winching mechanism attached to an alectromechanical oscillator was mounted over a 65 ft (20 m) deep tank of water. A mass suspended by elastic and inelastic cables was payed-out and reeled-in at specified velocities and accelerations while being oscillated in the vertical plane. Cable tension data are provided as a function of cable direction, length, velocity, acceleration, and the frequency and amplitude of the oscillator.

CR 79.009
Experimental Study of the Dynamics of Variable-Length Cable Systems, Suppl. Vol. 3, T. M. Ward, Pasadena, Calif., Graduate Aeronautical Laboratories, California Institute of Technology, Apr 1979, N68305-76-C-0033, ADA068691

Laboratory experiments on the dynamics of variable length cable systems are described. The ptototype situation that these experiments simulate is the deployment of retrieval of a heavy object at sea. A winching mechanism attached to an alectromechanical oscillator was mounted over a 65 ft (20 m) deep tank of water. A mass suspended by elastic and inelastic cables was payed-out and reeled-in at specified velocities and accelerations while being oscillated in the vertical plane. Cable tension data are provided as a function of cable direction, length, velocity, acceleration, and the frequency and amplitude of the oscillator.

CR 79.010
Quantification of Explosion Probabilities for Navy Tidewater Scenarios, J. D. Collins, J. Haber, Redondo Beach, Calif., J. H. Wiggins, Apr 1979, N68305-78-C-0051, ADA074504

This report presents results of an initial effort to establish a procedure for estimating the probability of occurrence of all possible yields of inadvertent explosions in the Navy tidewater hazard scenario. The procedure is intended for ultimate use in a risk-decision model that will aid the Navy in the management of risk at activities supporting the ammunition logistics system. The procedure involves first constructing an ordnance logistical sequence diagram that simulates the sequence of events composing each type of possible ordnance transaction. Each event in the diagram is an opportunity for a mishap that could lead to a detonation or fire. The probability of occurrence of possible mishaps in each event is derived from historical records of mishaps. The conditional probabilities of an explosion (given a mishap) and sympathic communication of an explosion to other stores of ordnance are based on scientific and historical data base. The mathematical approach allows for the use of Bayesian statistics when the data base is inadequate and keeps track of uncertainty in the predictions.

CR 79.011
Bathythermographic Surveys Near Naval Facilities at Point Mugu, CA, and Pearl Harbor, HI, R. M. Hansen, San Diego, Calif., Intersea Research Corporation, May 1979, N68305-78-C-0018, ADA071673

The use of naturally cold sea or lake water in place of mechanically chilled water in air conditioning systems was found to be a feasible and energy saving concept for Naval facilities like those at Point Mugu, Calif., and Pearl Harbor, Hawaii. The economic feasibility of this type of air

conditioning at these sites depends on the distance and the water depth of the cold water source at the sites. In order to determine these distances and these depths, surveys were conducted which involved (1) assembly of existing data on seawater temperatures and (2) measurement of these temperatures with expendable bathythermographs (XBT). A summary of these existing data and the results of these measurements are given in this report. On the basis of these data and these measurements, estimates were made of the profiles of maximum annual seawater temperature which are also given. It was found that the maximum annual bottom water temperature at the Point Mugu site can be expected in November; it is 10°C (50°F) at a depth of 190 m (620 ft) 1.4 nautical miles offshore. This temperature at the Pearl Harbor site can be above 10°C at a depth of 420 m (1,380 ft) 4.0 nautical miles offshore.

CR 79.012
Coal-Fired Boilers at Navy Bases, Navy Energy Guidance Study, Phases 2 and 3, A. I. McCone et al., San Francisco, Calif., Bechtel National, Inc., May 1979, N68305-77-C-0003, ADA073026

Conceptual design and parametric cost studies of steam and power generation systems using coal-fired stoker boilers and stack gas scrubbers in several sizes were performed. Central plants containing four equal-sized boilers and central flue gas desulfurization facilities were shown to be less expensive than decentralized facilities with the four boilers plus scrubbers at diverse sites. Life-cycle costs of steam generation in new central coal-fired facilities were shown to be lower than those for continued burning of fuel oil in existing boilers, when coal costs $30/ton ($1.41/10^6 Btu) and oil costs $3.16/$10^6$ Btu. It is cost-effective to add extra facilities to cogenerate electric power along with steam in new coal-fired systems, compared to purchasing electricity at a price of $0.033 (33 mills) per kilowatt-hour, because of the low cost per unit of coal energy. High steam-transmission pressures (600 psia) lead to lower-cost piping systems than lower pressures (300 psia and 100 psia). Coal and waste haul costs are small compared to other system costs.

CR 79.013
Evaluation of Alternate Vanadium Compounds for Use in Fiberglass-Reinforced Plastic Soil Surfacing, T. J. West, Walnut Creek, Calif., Dow Chemical Co., Sep 1979, N68305-77-C-0005, ADA074871

The purpose of this investigation was to develop an alternate vanadium compound for the previously used *vanadium neodecanoate* (Vanadium Ten Cem) in formulating fiberglass-reinforced plastic surfacings. The study was limited to commercially available products. It was found that Accelerator VN-2 can be used in place of Vanadium Ten Cem under dry conditions but is not usable under wet conditions. Vanadyl and vanadium acetylacetonate and vanadyl naphthenate were also evaluated and were ineffective under wet conditions and inferior to Accelerator VN-2 under dry conditions. The flexural strengths of laminates prepared using Accelerator VN-2 at 32°F and 75°F substantially exceeded contract specifications.

CR 79.014
Development of a Demonstration Program to Evaluate Rehabilitation Concepts for Reduction of Vandalism of Navy Bachelor Enlisted Quarters, P. Clayton, C. Raeke, Alexandria, Va., Space for Social Sciences, Apr 1979, N68305-78-C-0048, ADA073002

This study develops concepts and design for a field demonstration experiment for reducing vandalism and cost of damage repair to Naval BEQ sleeping room doors, door hardware, and hallway ceilings. The experiment is designed to be conducted at specific BEQs at two Naval stations. Data will be collected over a long term period and statistically analyzed for design effectiveness on reducing vandalism and repair cost. The design concepts combine *the philosophy of occupant behavior modification with target* hardening techniques.

CR 79.015
Lighting Design Handbook, R. N. Helms, J. M. McGovern, Boulder, Colo., Lum-I-Neering Associates, Aug 1979, N68305-76-C-0017, ADA074836

With the advent of increasingly more efficient light sources, interior lighting levels have continued to rise dramatically. However, in many cases these higher lighting levels caused more complaints than the previously lower lighting levels. This was because many of the lighting engineers who designed the newer lighting layouts ignored, or were ignorant of, many parameters that need to be considered other than illumination levels. A knowledgeable background of lighting fundamentals includes a thorough understanding of such topics as equivalent sphere illumination, visual comfort probability, daylighting, and controls.

CR 79.016
User Manual for Programs VISICE and VISFIT, M. G. Katona, Notre Dame, Ind., Department of Civil Engineering, Univ. of Notre Dame, Jun 1979, N68305-78-C-0025, ADA077868

This study transforms an original finite element computer program into a simplified user-format that is readily usable by design and field engineers to determine the structural capacity of a floating sea ice sheet to surface loads. Included with the program development is an instruction manual that provides step-by-step instruction for data input and output interpretation. The computer program permits solving problems of elastic and viscoelastic description.

CR 80.001
Building Insulation Materials Compilation, J. G. Bourne et al., Cambridge, Mass., Dyantech R/D Company, Sep 1979, N68305-79-C-0008, ADA082737

This document is intended to provide a ready source of the thermal characteristics, availability, safety, and other pertinent information for the selected types of insulation. The compilation covers all commonly used types of products whose primary purpose is to provide thermal resistance to heat flow through the building envelope. Due to the importance of controlling the migration of moisture to the insulating material, vapor barriers are also presented.

Where possible, the generic properties of a particular insulating material are presented to allow the designer to draw comparisons between types. In addition, where data are available, the variation of conductivity with temperature and/or density is given for each generic material.

CR 80.002
Naval Facility Energy Conversion Plants as Resource Recovery System Components, A. G. Capps, Menlo Park, Calif., SRI International, Oct 1979, N00123-78-C-0868, ADA081232

This interim report addresses concepts for recovering energy from solid waste by using Naval facilities steam plants as principle building blocks of candidate solid waste/resource recovery systems at Navy installations. The Navy steam plants were first characterized in terms relevant to firing or cofiring waste derived fuels (WDF). The steam plants and their boilers were then classified in a simple, eight-class scheme. Size (designed heat input capacity, 10^6 Btu/hr) and type of primary fuel were the basic parameters of the classes. Four size classes and two types of primary fuel burning capabilities (coal, noncoal) were selected, and distributions of plants planned for 1985 were plotted for each of the eight classes.

Four alternative means for utilizing WDF - adding incinerators, replacing boilers, modifying existing boilers, and making hybrid conversions - were considered for each class. Incineration and modification of existing boilers were emphasized. These alternatives appeared to be the most feasible ones for near-term implementation.

Problems encountered, system modifications required, and costs associated with the alternatives in the classes were defined as clearly as the accuracy of the available data would allow.

The major conclusions of this portion of the project are:

· Although it is technically feasible to adapt Navy energy conversion systems to fire WDF in one or more of its forms, the optimal form selected should be a site-specific total system.

· Near- to intermediate-term programs should probably continue to give first consideration to waterwall incinerators and to the cofiring of solid WDF in coal-capable plants because these options are the ones most completely developed and documented.

· Package incinerators and conversions of oil burning plants to fire a fluff form of solid waste fuel may be the options with the greatest potential for the intermediate term because waterwalls would be uneconomical in many small plants and because the majority of medium-sized oil-burning plants will not be converted to burn coal.

· Pyrolytic processes to produce gaseous and liquid fuels have not been sufficiently developed as yet to be specified for commercial operation. However, these forms of WDF have widespread potential applicability. If they (liquids in particular) become available, they could become the most cost-effective alternatives; using them would minimize the necessary modifications of existing energy conversion systems. Probably 5 years or more of development and testing will be needed before the future of pyrolysis is clear.

CR 80.003

Characterization of Navy Solid Waste and Collection and Disposal Practices, R. E. Freeman, A. G. Capps, Menlo Park, Calif., SRI International, Oct 1979, N00123-78-C-0868, ADA080322

The 1976 Resource Conservation and Recovery Act encourages the recovery of material and waste derived fuels to the maximum extent practicable at federal facilities, while complying with all state and local requirements as well. The Navy's Solid Waste research project is designed to identify and develop cost effective alternatives for meeting RCRA requirements. To meet this objective, an immediate need of the project was to quantify and characterize the recoverable material contained in the Navy waste stream and to compile information on how these materials are handled at typical Navy installations. The work was concentrated in two areas: compiling and analyzing available data about Navy solid waste composition and generation, and developing a set of realistic descriptions of typical Navy solid waste handling practices.

For waste composition and generator rate, data available from the NACWIS data base, including R^4 surveys conducted under the direction of the Naval Environmental Support Office (NESO), were compiled and analyzed. Navy facilities were listed in classes according to the amount of waste.

A simplified technique was examined for estimating quantities of the various recoverable resources generated by a Navy installation. This technique was tested against data obtained from the R^4 surveys mentioned above. The test was aimed at evaluating this relatively low-cost technique for possible use in augmenting Navy solid waste data to enable adequate field planning, selection, and preliminary sizing of Navy resource recovery systems. The technique requires a series of field observations of the volumes of waste generated and the waste's origin to estimate weight and composition. Once the bulk densities are thus derived, a few periodic volume observations will establish trends and cycles.

Existing information concerning current Navy practices for handling its solid waste was also derived from R^4 survey results obtained by the Navy. The information includes an indication of the type of personnel involved in the collection, the type of disposal methods used, useful life of landfill sites, and whether the landfill is on Navy property. The format in which the data are compiled was intended to enable the establishment of classes for collection and disposal methods and the indication of the number of Naval installations in each class.

This report also includes a brief analysis of how Navy and all other landfills will be affected by RCRA and the Safe Drinking Water Act (SDWA).

CR 80.004

Survey of Naval Port Fender Systems, Oxnard, Calif., VSE Corporation, Dec 1979, N00123-78-C-0391, ADA080564

A survey of Navy pier fender systems was conducted to evaluate the need for an RDT&E program leading to improved fender systems. Eighteen major activities were surveyed by mail, and on-site visits were made to activities in San Diego and Norfolk. The survey revealed:

a. An overall poor to fair condition for pier fender systems except where repair by replacement was being accomplished by large-scale projects.
b. A trend towards increasing costs and a declining quality of timber materials.
c. An overriding concern for the frequency and magnitude of damage by ships and craft.
d. A uniformity in problems, damage, and level of maintenance costs but a lack of uniformity in approaches to improvements and solutions.
e. Improvements in design and materials for timber pile fender systems in San Diego that may well be applicable to general purpose berthing at most other locations.
f. A need for concentrated, centralized work to improve camel and fender designs for submarines, carriers, and certain special use berthing.

Recommendations resulting from the survey include:

a. That no RDT&E effort is needed for general purpose berthing, but coordinated facilities acquisition and management efforts are needed to evaluate and implement certain specific improvements in timber pile systems.
b. RDT&E work in the near timeframe for dedicated submarine, CV/LHA, and certain special use berthing.
c. Initiation of a long-range study that looks to the time when wood products may not be available in the quantity and quality now depended upon for ship fendering.

CR 80.005

Waste Fuel Utilization in Existing Boilers on U.S. Naval Bases, H. I. Hollander, J. E. Broderick, J. G. Klett, Reading, Pa., Gilbert Associates Inc., Jan 1980, N00123-78-C-0868, ADA081261

The 1976 Resource Conservation and Recovery Act encourages the recovery of material and energy from waste to the maximum extent practicable at federal facilities while complying with state and local requirements. The Navy's solid waste research project is designed to identify and develop cost effective alternatives for meeting RCRA requirements. Additionally, to reduce Navy dependence on dwindling supplies of natural gas and fuel oil, the Navy has issued guidelines concerning the construction of intermediate and larger boiler plants requiring the capability to burn solid forms of fuel, including waste derived fuels as well as coal.

This report provides perspective on the ramifications of firing solid forms of waste derived fuel, separately or in combination with conventional fossil fuels for existing or new installations. The report is divided into two parts.

The first part presents a general discussion of typical characteristics of proposed waste fuels and the potential of utilizing these fuels in existing Navy boilers. The second part is a case study addressing a typical installation, and assesses the changes, capital costs, and potential problem areas that may be encountered in accommodating waste fuel firing.

Based on a site inspection at a three-boiler Navy plant, a conceptual retrofit layout was prepared of a practical system to cofire a waste fuel with the existing fossil fuel. The boiler plant selected routinely fired natural gas and fuel oil. The waste fuel selected was a solid form of shredded waste (nominally 2-in. particle size with most glass, metals, and other inerts removed) The case study revealed that if the wastes were suitably prepared, approximately 60 TPD could routinely be consumed with 120 TPD total system capability based on the waste fuel providing 20% of the Btu input requirements during full load operation.

Base loading two retrofitted boilers at their design capacity and accommodating all steam load swings with the conventional fuel fired third boiler could displace more than 200 barrels of oil per day. At 35 cents per gallon, the annual savings in 1978 fuel costs would amount to over $1,000,000. Not only is there a potential fuel cost avoidance of more than $1,000,000, but there should also be some disposal cost avoidance, although counterbalanced at least in part by the costs for producing RDF. With the significant volume reduction of wastes to be landfilled, the effective life of the land area for this purpose will be materially increased.

CR 80.006
Application Potential of Energy Systems at Navy Sites, vol 1: Methodology and Results; vol 2: Navy Energy Siting (NES) Computer Program User's Manual, S. J. Anderson, M. D. Jackson, S. J. Chaump, Mountain View, Calif., Acurex Corporation, Oct 1979, N68305-78-C-0009, ADA081381 (vol 1), ADA081384 (vol 2)

Application of renewable and nonrenewable energy conversion technologies are forecast for the Navy's ten largest industrial locations and four smaller locations. Data are obtained from an optimization model that determines the least, life-cycle cost energy supply system for an industrial location. Optimal solutions were composed of integrated combinations of energy conversion technologies. Besides being more cost effective than status quo systems fired exclusively on fuel oil, the optimal integrated systems displace a significant percentage of fuel oil.

Energy conversion technologies that participate in the optimal supply systems for large Naval industrial locations include fluidized-bed coal combustion, cogeneration, oil-fired systems, with smaller contributions from refuse derived fuel systems. Oil-fired systems participate only in a peaking capacity wherever coal combustion is permitted. Otherwise, the status quo systems are forecasted to prevail.

Renewable energy conversion systems were not competitive in plant-size configurations at nine of the ten large Naval industrial locations studied, Pearl Harbor being the exception.

CR 80.007
Study of Forced Entry Resistant Doors and Other Barriers for Openings into Secure Structures: Intermediate-Size Doors for Secure Structures, R. Munk, La Jolla, Calif., Science Applications, Inc., Feb 1980, N62474-79-C-5444, ADB048843L

Functions requiring the use of secure facilities are identified and categorized. Door designs constituting the minimum acceptable deterents to forcible entry for the various categories of secure areas are identified. Recommendations are made regarding the selection of doors for secure facilities. Entry denial, containment of compromising signals, and design of compartmented security facilities are discussed.

10CR 80 008
Study of Forced Entry Resistant Doors and Other Barriers for Openings into Secure Structures: Barriers for Secure Structure Penetrations, R. Munk, La Jolla, Calif., Science Applications, Inc., May 1980, N62474-79-C-5444, ADB048844L

The mandated requirements for barriers on windows and vents for the various secure facilities at Naval Shore Establishment installations are identified and compared. The penetration delays provided by the various barrier designs are documented. Recommendations are presented relating to windows and vents in secure structures.

CR 80.009
Study of Forced Entry Resistant Doors and Other Barriers for Openings into Secure Structures: Ordnance Structure Doors, R. Munk, D. Warne, La Jolla, Calif., Science Applications, Inc., May 1980, N62474-79-C-5444, ADB048845L

Doors used on earth covered magazines and other arms, ammunition, and explosives (AA&E) storage structures are described and categorized on the basis of the penetration delay provided when subjected to attacks using various classes of tools. Design features that produce susceptibilities to forcible entry are identified. Factors to be considered in the design of penetration resistant doors are identified.

CR 80.010
Architectural Planning for Crime and Loss Prevention as Applied to Major Hospital Complexes, G. P. Morse et al., Silver Spring, Md., George P. Morse and Associates, Apr 1980, N68305-78-C-0046, ADB047419

Concepts are presented for the reduction of crime related losses in Naval hopitals. Security design techniques which should be introduced prior to construction are discussed and recommendations made. Loss prevention management and security equipment are also discussed.

CR 80.011
Validation of a Freezer Concept for a Desalination Unit, Andover, Mass., Concentration Specialists, Inc., Apr 1980, N68305-78-C-0021, ADA085612

Validation of a smooth-tube, indirect-contact freezer concept was conducted toward inclusion in the design of a modular 20,000-gpd freezing desalinator for use at Naval Advanced Bases. A 500-gpd model freezing desalinator consisting of freezers, crystal growth tank, wash column, melter, and refrigeration system was used to test several flow schemes and freezer configurations having either three or five concentric tube freezer elements. Simplicity in operating mode coupled with low pressure drop (low pumping costs) and high ice production rates (high heat transfer coefficients) was sought.

To provide continuous operation, each of the freezer elements was periodically defrosted while the other elements were refrigerated. Brine was recirculated between the paralleled freezer elements and a crystal growth tank. Ice crystals accumulating at the top of the crystallizer were washed and scraped into an indirect contact melter prior to recombination with the brine stream from the wash column. The combined streams were then returned to the freezer/crystal growth tank recirculation loop.

Flow schemes were utilized with three and five freezer elements paralleled, with refrigerant forced circulation at two velocities, without refrigerant circulation, and with six different brine velocities from 6.0 fps to 18.9 fps. Reynolds' numbers varied from 11,600 to nearly 69,000. Tube side heat transfer coefficients were calculated to be from 784 Btu/hr-ft^2°F to 2,360 Btu/hr-ft^2°F with temperature differences between 6.8°C and 3.3°C, respectively.

Freezer element icing and plugging were encountered even at the highest Reynolds' numbers attained, i.e., >60,000. Defrosting was found to be required.

Positive results were obtained, in that ice in the form of a soft mass of small crystals similar to that produced in direct contact freezing processes was produced.

Inclusion of smooth-tube freezer design parameters developed in this effort into the preliminary design and sensitivity and economic analyses of a 20,000-gpd containerized freezing desalinator was not performed as originally planned, because it was judged that the fluidized bed freezer alternative would be less prone to freeze-up without significant increase in either pumping costs or system complexity.

CR 80.012
A Study of the Effects of Insulation Gaps on Building Heat Loss, Denver, Colo., Johns-Manville Sales Corp., Apr 1980, N68305-78-C-0056, ADA085222

The scope of the program included testing of a wall panel designated Type I and a second designated Type II. The Type I panel consisted of 2 x 4-inch studs spaced 16 inches on center and insulated with R-11 fiberglass insulation. Tests were conducted in a Guarded Hot Box operated in accordance with ASTM C236-66 (reapproved 1971). Thermal resistance values were determined at mean temperatures of approximately 45°F, 75°F, and 95°F. After these values were determined, insulation areas amounting to 5%, 10%, and 15% of that originally installed were cut out from the mid-height of the test metering area and the tests repeated at each condition. The cut outs were to simulate omissions or errors in installation of the insulation.

The second wall panel, designated Type II, was constructed to simulate 2 x 6-inch studs spaced 24 inches on center and insulated with R-19 fiberglass insulation. The test program duplicated that performed on the R-11 insulated wall in order to determine whether the greater thickness gave similar changes in measured heat flow with increasing insulation void areas.

The test results showed heat flows significantly greater than the percentage of gaps in the insulation. At 45°F mean temperature, the loss in thermal resistance was more than three times the gap percentage up to a 5% gap for 2 x 4-inch stud walls. For 2 x 6-inch stud walls, the loss was more than four times the gap percentage. For a 15% gap at 45°F, the loss increased to 38%.

CR 80.013
Development of a Physical Security Data Management System, 3 vols in 1, J. Caldwell, P. Benner, D. Solomonson, Santa Barbara, Calif., Mission Research Corporation, Nov 1979, DNA001-79-C-0182, ADA084840

Vol 1 presents a review of candidate manual information storage and retrieval systems and the identification of a manual system to suit the needs of CEL and its user community. Systems examined were (1) Edge-Notched Cards, (2) Peek-A-Boo Cards, and (3) Scan Match Cards. Each manual system is analyzed with respect to advantages and disadvantages for CEL needs.

Vol 2 is a user's manual describing the procedures for utilization of the Physical Security Data Management System developed for CEL. The Physical Security Data Management System is an information storage and retrieval system that was designed for in-house use by CEL staff. The manual presents (1) an overview of the Data Management System's hardware and software capabilities, including a description of the systems configuration, (2) user instructions for completion of the input sheet, (3) user instructions for entry of data into the on-line system, (4) description of batch outputs, and (5) user instructions for execution of data file searches in an interactive batch mode.

Vol 3 presents the system outputs of the Physical Security Data Management System. Three separate outputs are presented: the Master List, the Keyword Index, and the Keyword Count. Each individual record consists of a full bibliographical citation, a keyword list, technical annotations relating to physical security, and an abstract.

14CR 80.014
Linings for Concrete Fuel Storage Tanks, T. A. Corboy, Temple City, Calif., Advanced Coatings and Chemicals, Jun 1980, N68305-78-C-0006, ADB053480L

A state-of-the-art survey of commercially available coating and lining materials was made. Thirty-five coating systems were applied to clean and/or oil-treated concrete specimens. These specimens, along with lining materials, were immersed in an aromatic-enriched aviation fuel plus a simulated microbial solution, or in a 50:50 mixture of diesel fuel marine and JP-5 plus a simulated microbial solution, for 90 days at 130°F. Four coating systems which had been applied to oil-soaked concrete had greater peel strengths than the present Navy system. Two lining materials directly exposed in the test fuels performed as well as the Pirelli Fix membrane which has a successful record of use by the Navy Fuel Systems Command.

CR 80.015
Development of a Seawater Hydraulic Vane Motor for Diver Tools, Annapolis, Md., Westinghouse Electric Corp., Oceanic Div., Apr 1980, N00123-78-C-1057, ADA084920

A compact efficient hydraulic vane motor capable of operating with pressurized seawater as the working fluid has been successfully developed for use with diver tools. The motor occupies a volume of 23 in^3 and weighs less than 5 pounds. With 1,000-psi seawater at 6-gpm flow rates, the motor delivered 3.3 hp at 1,585 rpm with 80% overall efficiency. The motor operated for 50 hours without component failure. Results of the design and development effort are presented

CR 80.016
Cargo Fire Hazards and Hazard Control for the Offshore Bulk Fuel System (OBFS), Norman, Okla., Energy Analysts, Inc., Jun 1980, N68305-79-C-0021, ADA087282

This study evaluates potential cargo fuel spills, spill fires, and equipment available to mitigate fuel spill hazards at an offshore bulk fuel supply installation. Potential cargo spill sources, probabilities, and volumes are calculated. Consequences of these spills assuming spill ignition are quantified. Existing fire protection equipment aboard tankers is evaluated to determine the ability of this equipment to control identified spill fire conditions. Where existing firefighting systems are found to be inadequate, additional fire mitigation systems are recommended. Logistic support, manpower, and training needed to maintain the recommended spill control systems are detailed.

CR 80.017
Study of Forced Entry Resistant Doors and Other Barriers for Openings into Secure Structures: Venting Provisions in Earth Covered Magazines, R. Munk, D. Warne, La Jolla, Calif., Science Applications Inc., Jul 1980, N62474-79-C-5444, ADB049261L

Vents constitute the weakest link in the physical security of earth covered magazines for conventional arms, ammunition, and explosives. The question as to whether or not vents were necessary in earth covered magazines was addressed in this study, which entailed a literature review and solicitation of expert opinions on the subject. While not totally conclusive, the results indicate that vents are not necessary for a very large part of the conventional stockpile; the study also reveals that removal of vents actually improves the thermal stability of earth covered magazines.

CR 80.018
Evaluating the SEADYN Model: Mooring Dynamics Experiment Five, D. B. Dillion, Washington, D.C., EG&G Washington Analytical Services Center, Inc., Jul 1980, N00014-78-C-0273, ADA082165

The computer model of ocean cable structures, SEADYN, was used to calculate the anchor-last deployment of the sixth mooring (experiment five) of the Mooring Dynamics Experiment (MDE) conducted in Hawaiian waters in 1976. Comparisons were drawn with measurements of configuration and tension made during the deployment. The SEADYN configuration correlated well with the experimental data when an anchor drag coefficient of 0.78 was used. This value was precalculated to produce the terminal velocity experienced in the MDE.

The MDE provided exceptionally detailed tension data at four points along the mooring. SEADYN reproduces the general features of these measurements with remarkable accuracy.

The SEADYN tension traces include spurious oscillations that mask details of the tension history. These oscillations are believed to result from the omission of material damping in the SEADYN algorithm. Inclusion of hysteresis in the material stress-strain function is expected to remove the oscillations.

Modeling the MDE mooring occurs in two steps. SEADYN is a general cable dynamics computer model using the finite element method. The SEADYN user is also modeler as he reduces the physical mooring to equivalent elements and spherical or cylindrical nodes. This requires considerable technical skills and intuition when, for example, the physical object at the node is a pile of sandbags on a pallet.

CR 80.019
Mooring Dynamics: Computer Models and Experiments at a Sixty Foot Scale, D. B. Dillon, Washington, D.C., EG&G Washington Analytical Services Center, Sep 1980, N00014-78-C-0273, ADA086854

The U.S. Navy Civil Engineering Laboratory is conducting a series of dynamic cable experiments in order to evaluate computer models of cable systems used in the ocean. The results of an experiment using 60-foot cables are compared to two computer simulations in this report. Other experiments at scales of 6 feet and 2,500 feet have been performed.

Three cases from the experiment conducted in the hydroballastics tank of the Naval Surface Weapons Center in 1976 are compared to the SNAPLOAD and SEADYN computer models. Two of the runs simulate the anchor-last deployment of a mooring; the third shows the relaxation of a mooring displaced laterally, then released.

The quality of the experimental data is evaluated by comparing each case to the static, elastic catenary equations at the start and finish of each run. The measured positions of points along the static catenaries are found typically to agree with the catenary calculations within 1% to 2% of the cable length. Tension measured at the fixed end typically agrees with the calculated value within about 12%.

The SEADYN and SNAPLOAD computer models are found to reproduce all the significant motion and forces observed in the experiment. The "handbook" drag coefficients programmed in these models allow the cable motion sometimes to lead the data, sometimes to lag behind. More specific coefficients must be used when the rate of the dynamic motion is critical.

Neither model included elastic hysteresis. The SEADYN program gave somewhat erratic tension values in the mooring line because tension waves were not damped by hysteresis. The SNAPLOAD model eliminated the tension variation through artificial damping.

CR 80.020 - Cancelled

CR 80.021 - Cancelled

CR 80.022
Assessment of the Morison Equation, Houston, Tex., Woodward-Clyde Consultants, Jul 1980, N68305-80-C-0007, ADA088185

A critical assessment of the Morison equation is provided. The Morison equation is used to calculate the loading on offshore structures due to ocean waves. The assessment covers both the original equation and the modifications currently in use by industrial designers. A review of the literature is provided.

It is concluded that the Morison equation provides an adequate design tool provided careful consideration is given to the selection of the fluid kinematic representation and the empirical coefficients. Improvements in the accuracy of the operation can be achieved through research leading to (1) improved descriptions of the sea state, (2) better representations of the water particle velocities and accelerations in combined wave-current flows, (3) improved quantification of the drag and inertia coefficients, and (4) inclusion of the fluid-structural interaction.

CR 80.023
Flue Gas Desulfurization at Navy Bases, Navy Energy Guidance Study, Phase IV, A. I. McCone, San Francisco, Calif., Bechtel National, Inc., Aug 1980, N68305-77-C-0003, ADA089146

A study of the availability, costs, and operating performance of industrial-sized flue gas desulfurization (FGD) systems for coal-fired boilers was performed for the Civil Engineering Laboratory at the Naval Construction Battalion Center at Port Hueneme, CA. A generic overview analysis showed that conventional soda liquor scrubbing offered lowest costs and highest performance when environmental permits can be obtained for disposal of liquid wastes. When wastes must be in solid form, the lowest costs are offered by conventional limestone, lime, and double alkali calcium-based throwaway processes. Several processes still under development were identified as promising but not yet proven. A site specific study identified three industrial-sized FGD installations with inherent availabilities in excess of 98%.

CR 80.024
Cargo Fire Hazards and Hazard Control for the Supplement Fuel Supply Assembly (SFSA), Norman, Okla., Energy Analysts, Inc., Aug 1980, N68305-79-C-0021, ADA089335

This study evaluates potential fuel spills, spill fires, and fuel spill hazards at a supplemental fuel supply installation. Potential fuel spill sources, probabilities, and volumes are calculated. Consequences of these spills assuming spill ignition are quantified. Logistic support, manpower, and training needed to maintain the recommended spill control systems are detailed.

CR 80.025
Testing and Evaluation of Attack Resistance and Hardening Retrofits of Marine Barrack Construction Types to Small Arms Multiple Impact Threat, J. B. Patton, A. B. Wenzel, San Antonio, Tex., Southwest Research Institute, Aug 1980, F41608-79-D-A011-0008, ADB051196L

The increased potential of coordinated attacks on various sensitive military areas has generated the requirement to provide an increased measure of protection for selected targets. The threat in this case has been defined as 25 rounds of 7.62 NATO ball ammunition fired from an M-60 machine gun at a range of 25 yards. This attack threat is termed Small Arms Multiple Impact Threat or SAMIT. In order to test the SAMIT against various types of standard construction materials, specimens were constructed of 6-, 8-, and 10-inch reinforced concrete, 8- and 12-inch grout filled concrete blocks and hollow concrete blocks protected by a specially designed steel and plywood layered barrier.

All specimens failed the first round of testing; however, successful penetration resistance was eventually achieved through the application of thin sheet steel (10 gage) to the front or front and back of the specimens.

CR 80.026
Design Criteria for Deflection Capacity of Conventionally Reinforced Concrete Slabs, Phase 1: State-of-the-Art Report, M. Iqbal, A. T. Derecho, Skokie, Ill., Construction Technology Laboratories, Portland Cement Association, Oct 1980, N68305-79-C-0009, ADA091738

In this Phase I report, data obtained from a literature search of static and dynamic tests on uniformly loaded reinforced concrete one-way and two-way slabs are tabulated. Analytical methods for predicting incipient collapse deflection are summarized and compared to the test results. A method for predicting incipient collapse deflection, when tensile membrane resistance can be developed, is recommended for further study in Phase II of a three-phase study. The recommended relationship gives incipient collapse deflection as a function of the short span of the slab and the rupture strain of the reinforcing steel.

CR 80.027
Design Criteria for Deflection Capacity of Conventionally Reinforced Concrete Slabs, Phase 2: Design and Construction Requirements, T. Takayanagi, A. T. Derecho, M. Iqbal, Skokie, Ill., Construction Technology Laboratories, Portland Cement Association, Oct 1980, N68305-79-C-0009, ADA091517

Incipient collapse deflection data and an analysis method, reported in Phase I of this study, were used to propose an incipient collapse deflection criteria for one-way and two-way slabs. A relationship for the incipient collapse deflection of slabs, when tensile membrane action can be developed, is given in terms of the short span and steel rupture strains. Structural design details, to insure that membrane action can be developed, are discussed and experimental verification tests are recommended. The Phase III report will recommend a design procedure for one-way and two-way slabs subjected to blast loads.

CR 80.028
Design Criteria for Deflection Capacity of Conventionally Reinforced Concrete Slabs, Phase 3: Summary of Design Criteria and Design and Construction Details - Design Examples, T. Takayanagi, A. T. Derecho, Skokie, Ill., Construction Technology Laboratories, Portland Cement Association, Oct 1980, N68305-79-C-0009, ADA091616

A design procedure is given for one-way and two-way standard reinforced concrete slabs allowed to respond to incipient collapse under blast loads. When tensile membrane action can be developed, larger incipient collapse deflections can be used in design than are currently allowed in the design manual NAVFAC P-397 ("Structures to Resist the Effects of Accidental Explosions" also TM 5-1300 and AFM 88-33). Design and construction requirements are specified to insure adequate tensile membrane resistance. A supplement is proposed for consideration as a supplement to P-397.

CR 81.001
Civil Engineering Laboratory Cogeneration Analysis Program: CELCEP User Documentation, P. Bradford, Oxnard, Calif., Two D Engineering, Mar 1981, N00123-78-D-0392, ADA097870

This report documents input requirements for the CEL Cogeneration Analysis Program (CELCAP) and includes reference material from which much of the input data can be drawn. A sample of each card is provided. No program listing or output listing is included, however.

CELCAP analyzes the performance and economics of cogeneration systems utilizing combustion turbines, diesels, or steam turbines. The effects of engine combinations, engine size, control mode, use of peaking engines, utility rate structure, sale of power to the utility grid, fuel type, fuel price, and future cost escalations can be determined by varying the input. The program computes design point engine performance, compares thermal and electrical loads against engine output, adjusts engine output according to the assumed control mode, and calculates the resulting instantaneous and life cycle costs of operation.

The program is written in FORTRAN IV for execution on CDC systems with 60 bit words.

CR 81.002
Integration of Physical Strategies for Crime and Loss Prevention into the Naval Facilities Planning and Design Cycle, G. P. Morse, R. F. Morse, A. L. Schreiber, Silver Spring, Md., George P. Morse and Associates, Nov 1980, N68305-78-C-0046, ADB053484L

Naval Facilities Planning and Design cycle are analyzed to identify those functions during which security design requirements should be specifically addressed. Security design procedures and documents are identified which should be integrated within the facilities' planning and design cycle. Specific recommendations are developed concerning security design activities which should be performed and security design documents which should be developed or utilized.

CR 81.003 - Cancelled

CR 81.004
Procedures for Removing Blind Oversize Mechanical Fasteners, P. Thorn, Santa Barbara, Calif., AMETEK/ ORED, Jan 1981, N68305-80-C-0016, ADB054239L

Assembling structural elements with fasteners is one of the most common work functions performed by underwater construction divers. Problems have been reported with threaded fasteners loosening and falling out when the structure is subjected long-term cyclic wave forces. Results of laboratory tests and subsequent long-term underwater exposure tests indicate that a commercially available blind hole fastener manufactured by Huck Manufacturing Co. offers several advantages over standard threaded fasteners. The lack of adequate techniques to remove the blind hole fastener once installed has presented a major obstacle in utilizing these fasteners for actual underwater construction operations.

This report presents an engineering analysis of several concepts for removing the blind hole fastener from underwater structures. The results of this analysis identified a hollow end mill concept as being the most likely to meet the specified performance criteria. Results of laboratory testing to demonstrate the feasibility of the hollow end mill removal concept as well as a preliminary design layout and operating scenario for a diver tool to perform the fastener removal operation are also presented.

CR 81.005
A Study of Cable Strumming Suppression, J. Kline, A. Brisbane, E. Fitzgerald, Rockville, MD, MAR, Inc., Apr 1981, N68305-78-C-0049, ADB056270L

Three types of strumming suppression devices were studied in an effort to determine predictive performance criteria. The three device types studied were: helical wrap, helical fringe, and segmented airfoil, these were compared to various bare cable results. The segmented airfoil was the only device that both suppressed strumming and reduced drag. Both the helical fringe and wrap reduced strumming but increased drag. Partial spanwise coverage (25-50 percent) of the helical fringe also proved effective in reducing strumming. Attempts to determine predictive performance criteria failed because of a lack of correlation in geometric scaling results. Future testing

(not currently planned) may show the reduced damping parameter to be a valid method of characterizing strumming suppression effectiveness.

CR 81.006
Finite Elements Based Upon Mindlin Plate Theory with Particular Reference to the Four-Node Bilinear Isoparametric Element, T. J. R. Hughes, Stanford, Calif., Thomas J. R. Hughes, Feb 1981, N62583-80-MR-468, ADB055332L

Concepts useful for the development of Mindlin plate elements are explored. Interpolatory schemes and nodal patterns which are ideal according to the proposed criteria are found to be somewhat more complicated than desirable for practical applications. However, these ideas are found to be useful as starting points in the development of simplier elements. This is illustrated by the derivation of a new four-node bilinear quadrilaterial which achieves good accuracy without ostensible defect.

CR 81.007
Solution of Nonlinear Finite Element Equations by Quasi-Newton Methods, R. L. Taylor, B. NourOmid, Berkeley, Calif., Department of Civil Engineering, University of California, Feb 1981, N62583-80-MR-479, ADB055330L

Among several iterative algorithms for solving the nonlinear finite element equations, a quasiNewton method emerges as the most promising technique. It was compared against the full Newton method and the conventional modified Newton method using a small viscoplastic frame finite element problem and found to be faster and more economical. The specific algorithm is limited to positive definite matrices and equires extension to handle non-positive definite systems. It also required further evaluation in large problems.

CR 81.008
Bounding Surface Plasticity for Soil Modeling, R. Herrmann, Y. F. Dafalias, J. S DeNatale, Davis, Calif., Department of Civil Engineering, University of California, Feb 1981, N62583-80-MR-478, ADB055335L

A bounding surface plasticity model for cohesive soil has been formulated, coded, and evaluated. It its more general form it requires the apriori determination of approximately 17 parameters. With limited experimental stress-strain data on laboratory soil samples the model checks out very well for normally consolidated soil and reasonably well for higher over consolidated ratios. Results thus indicate further development with more extensive experimental data is required.

CR 81.009
Survey of Techniques for Underwater Maintenance/ Repair of Waterfront Structures (and Amendment P00001), K. Childs, Jr., Medfield, MA, Childs Engineering Corporation, Apr 1981, N68305-79-C-0026, ADB056552L

More than two-thirds of the facilities of the Naval Shore Establishment are over 30 years old and there is a backlog of maintenance and repair exceeding $535 million (1978). It is imperative that the allocation of maintenance and repair funds be optimized in order to minimize the adverse impact of facility condition on Fleet Operational readiness. This report presents the results of an initial effort to assess commercial maintenance and repair capabilities and identify deficiencies requiring further research and development.

Defects typically encountered in waterfront structures constructed of wood, concrete and steel are identified. For each type of defect the state-of-the-art of commercially available maintenance and repair techniques is discussed, including a brief description of the technique and how it is implemented, a list of specialized tools or work requirements, and any potential problems associated with using the particular technique. Each technique is then analyzed to determine if it is suitable for the intended maintenance or repair function. Types of deterioration for which there is no suitable technique are identified. A life cycle cost estimate for each maintenance/repair technique is presented to assist in selection of the most desirable techniques

CR 81.010
Shear Response of One- and Two-Way Elements Subjected to Blast Loads, W. Stea, N. Dobbs, F. E. Sock, New York, New York, Ammann & Whitney, Mar 1981, N68305-77-C-0035 ADB056254L

An investigation into the shear response of one- and two- way structural elements subjected to blast loads was conducted in order to quantify the magnitude of dynamic increase factors to be used for design of structures to resist such effects. An analytical model is presented for representation of the dynamic shear response of both one and two-way members with selected validation by the finite element method on the basis of these data, a design procedure is presented.

CR 81.011
Investigation of Future Fire Protection and Firefighting Requirements in Marine Corps Assault Operations, M. Cohn, D. Behn, A. Campbell, Elmhurst, IL, Gage-Babcock & Associates, Apr 1981, N68305-80-C-0017, ADB056784L

A study of fire protection/firefighting technology was made for Marine Corps' fuel handling operations in amphibious assault operations. Fuels included in the study were gasoline, JP-5 and diesel fuel stored in containers up to a maximum of 20,000 gallons in collapsible fabric tanks and transferred by means of huselines. The need for strict precautions in handling gasoline is pointed out.

CR 81.012
Test and Evaluation of the Heat Recovery Incinerator System at Naval Station, Mayport, Florida, Xenia, Ohio, SYSTECH Corporation, May 1981, N68305-80-C-006, ADA099559

This report describes test and evaluation of the two-ton/hr heat recovery incinerator (HRI) facility located at Mayport Naval Station, FL, carried out during November and December 1980. The tests included: (1) Solid Waste characterization, heating value, and ultimate analysis, (2) Ash: moisture, combustibles, and heating values of both bottom and cyclone ashes; EP toxicity tests on leachates from both bottom and cyclone ashes; trace metals in cyclone particulates, (3) Stack Emissions: particulates (quantity and size distribution), chlorides, oxygen, carbon dioxide, carbon monoxide, and trace elements, and (4) Heat and Mass Balance: all measurements required to carry out complete heat and mass balance calculations over the test period.

The overall thermal efficiency of the HRI facility while operating at approximately 1.0 ton/hr was found to be 49% when the primary Btu equivalent of the electrical energy consumed during the test program was included. For additional details, contact Dr. S. C. Garg, (805) 982-4675.

CR 81.013
A Man-Machine Interface for Energy Monitoring and Control Systems, B. B. Wise, Atlanta, Ga., Georgia Institute of Technology, Electronics and Computer Systems Lab, Engineering Experiment Station, June 1981, F33615-77-C-2004, ADA099884

Energy monitoring and control systems (EMCS) man-machine interface (MMI) requirements are defined. Existing EMCS MMI are reviewed along with current MMI technology. Recommendations for an improved EMCS MMI are made

CR 81.014
Trends in Navy Waste Reduction and Materials Markets, Washington, DC, Gordian Associates, Inc., June 1981, N68305-80-C-0064, ADA100765

A review of available information on current Navy solid wastes, national laws and policies and the application, demand and economics of using secondary materials recovered from solid waste. Quantitative conclusions for the Navy solid waste stream are based on statistical projects of the size of the Navy and per capita waste generation. While paper and packaging segments of the solid waste streams are emphasized, detailed presentations are made for each of the identified constituents of the waste stream with market projections for the secondary materials. National and Navy statistics are presented and projected through the 1980's time frame.

An extensive bibliography on available information pertinent to the Navy solid waste stream is provided.

CR 81.015
Reliability Maintainability Availability (RAM) Analysis - Earthmover Automatic Blade Control System, R. Hansen, Oxnard, CA, VSE Corp., July 1981, P. O. 80-MR-755, ADA101379

Report contains Reliability Availability Maintainability (RAM) analysis of the earthmover automatic blade control system developed by NCEL. Purpose of the analysis is to investigate RAM aspects of control system and prepare plan to validate mean-time-between-failures (MTBF) of system.

CR 81.016
Nearshore Pipeline Installation Methods, Houston, Texas, DMJM, Pipeline and Marine Division, Aug 1981, N68305-80-C-0056, ADA102888

The primary purpose of the study is to provide the Naval Civil Engineering Laboratory with recommendations for existing or new construction methods which are: (1) within present UCT/NMCB capabilities and are the most resource efficient, (2) state-of-the-art methods which are practical for the UCT/ NMCB but currently beyond their capabilities due to the team's lack of technological or equipment resources, and (3) not state-of-the-art but which have potential for providing a more resource efficient method for use by the UCT/NMCB. Information for the study comes from a thorough literature search and review, in-house expertise and evaluation, and communications with qualified experts in the fields of marine pipeline construction, with material vendors and manufacturers, and with engineering and construction consultants.

CR 81.017
Assessment of Alternatives for Upgrading Navy Solid Waste Disposal Sites, Vol. 1, McLean VA, JRB Associates, Inc., Aug 1981, N68305-79-C-0036, ADA103431

The Naval Civil Engineering Laboratory as part of the NAVFAC Solid Waste R&D Program performed an assessment for upgrading Navy solid waste disposal sites. The purpose of this effort was threefold: (1) to determine the extent the Navy may have to modify its current solid waste disposal practices to enable compliance with RCRA, (2) define the technological concepts that represent upgrading techniques, and (3) to identify research priorities concerning the technologies for solid waste disposal. This procurement consists of three volumes. This volume (1) contains the criteria for classification of solid waste disposal facilities and practices. These findings are intended to assist engineering field divisions and public works personnel in characterizing the problems facing their disposal facility or practice.

CR 81.018
Assessment of Alternatives for Upgrading Navy Solid Waste Disposal Sites, Vol. 2, McLean, VA, JRB Associates, Inc., Aug 1981, N68305-79-C-0036, ADA103432

The Naval Civil Engineering Laboratory as part of the NAVFAC Solid Waste R&D Program performed an assessment for upgrading Navy solid waste disposal sites. The purpose of this effort was threefold: (1) to determine the extent of this effort the Navy may have to modify its current solid waste disposal practices to enable compliance with RCRA, (2) define the technological concepts that represent upgrading techniques, and (3) to identify research priorities concerning the technologies for solid waste disposal. This document consists of three volumes. This volume (2) provides a compilation of available technological alternatives for upgrading Navy disposal sites to comply with the criteria and associated costs for implementation of these technologies. The results of this effort are intended to assist engineering field divisions and public works personnel in identifying cost effective technology to upgrade existing land disposal sites.

CR 81.019
Assessment of Alternatives for Upgrading Navy Solid Waste Disposal Sites, Vol. 3, McLean VA, JRB Associates, Inc., Aug 1981, N68305-79-C-0036, ADA103433

The Naval Civil Engineering Laboratory as part of the NAVFAC Solid Waste R&D Program performed an assessment for upgrading Navy solid waste disposal sites. The purpose of this effort was threefold: (1) to determine the extent of this effort the Navy may have to modify its current solid waste disposal practices to enable compliance with RCFA, (2) define the technological concepts that represent upgrading techniques, and (3) to identify research priorities concerning the technology for solid waste disposal. This document consists of three volumes. This volume (3) presents the general observations and findings of the study and projected impact of the Federal regulations on the Navy.

CR 81.020
Historical Review of VLF Insulator Tests, A. N. Smith, San Diego, CA, Electrospace Systems, Inc., July 1981, N62583-81-MR-302, ADA102473

This report presents a historical overview of the intense VLF test program conducted from 1972 to 1976 at NAVCOMSTA Lualualei, Hawaii. The report details the rationale for each test conducted and presents technical descriptions of the test items and reasons why some tests were incomplete, terminated, finished and/or modified during the test program.

CR 81.021 - Cancelled

CR 81.022
Recommended Revisions to Navy Facility Planning Procedures to Incorporate Physical Security Engineering, W. Buch, B. Dyer, Edmonds, WA, Security Design Associates, Aug 1981, N68305-80-C-0037, ADB059235L

This document presents suggested revisions to U.S. Navy facility planning procedures in order to incorporate physical security engineering into those procedures. These suggestions were developed in early 1981 by Security Design Associates, Inc., under contract to the Naval Civil Engineering Laboratory.

This report first summarizes Navy facility planning procedures (as given in various Naval Facilities Engineering Command instructions), and then suggests what are seen to be the needed revisions to these directives in order to firmly ensure timely and appropriate physical security engineering during Navy facility acquisition. The report then discusses a proposed methodology to accomplish these requirements.

A hypothetical facility acquisition scenario is presented to demonstrate use of the revised procedures.

The report concludes with identification and recommendation of additional efforts which will be required to fully implement and integrate the revised system into the operational facility acquisition process.

CR 81.023
Variable Length Cable Dynamics - Evaluating the SEADYN and SNAPLOAD Computer Models, L. A. Kahn, Rockville, Md., EG&G Washington Analytical Services Center, Inc., Aug 1981, N68305-80-C-0020, ADB058946L.

Two computer models, SEADYN and SNAPLOAD, were used to simulate several test runs of a variable length cable experiment conducted by the Naval Civil Engineering Laboratory. This experiment is one of a series of experiments conducted to form a data base for evaluating cable dynamics computer models.

The experimental results were used to judge the model's ability to simulate cable payout and reel-in and to evaluate the recent addition of material damping capabilities to SEADYN. The experiment provided tension time histories for each run. These were compared against the simulated tension output to evaluate each model. Three runs used a soft silicon rubber cable. The other three employed a nearly inelastic nylon cord.

SEADYN produced excellent results for all six test cases. The material damping coefficient was selected to give good results for one run of each material. Further investigation of material damping is indicated.

SNAPLOAD was able to accurately model five of the six cases when input parameters were adjusted to compensate for model limitations. SNAPLOAD can remove nodes from a cable in order to simulate extended periods of reel-in. For payout, SNAPLOAD inserts nodes, but at virtually zero tension, which renders the computation unstable. This condition is caused by the small scale of the test and other users who have modeled ocean scale cable lengths have not had this difficulty. A program limit prohibits modeling of very elastic materials such as the experimental rubber cable.

Both computer models indicate the ability to model variable length cable systems accurately. SNAPLOAD in its present form contains several problem areas that need to be corrected before the program can be used as an engineering tool for modeling certain variable length cable problems. Provisions for maintaining and updating both codes are needed.

CR 81.024
Improved Amphibious Assault Fuel System and Tactical Airfield Fuel Dispensing System All-Weather Capability, E. A. Gilbert, Cambridge, MA, Arthur D. Little, Inc., Sept 1981, N68305-80-C-0063, ADB060633L.

The purpose of this work is to determine the effects of extreme hot and cold weather on the operation and performance of the Marine Corps AAFS and TAFDS fuel systems. The results disclose that credible limits for MARCORPS operations range from 120°F to an extreme low of -60°F. The current fuel handling equipment and components, except to some degree fuel monitors and filter separators, can operate effectively at temperatures between +120°F and -25°F. The principal components requiring continuing or initial development are: pump drives and starting devices; elastomeric materials for hoses and storage tanks; and flexible gaskets, seals and O-rings.

CR 81.025 - Cancelled

CR 81.026
CEL-1 Lighting Computer Program - User's Guide, W. F. Brackett, New York, NY, The F&K Group, Sept 1981, N68305-80-C-0012, ADA105444.

The Conservation of Electric Lighting Computer Program, Version 1.0 (CEL-1), aids the illumination engineer in designing energy efficient rooms. CEL-1 contains a design synthesizer which selects from among a set of user specified luminaire locations the subset which best satisfies user's design criteria. Lighting metrics which may be calculated include illuminance, luminance, equivalent sphere illuminance, and visual comfort probability. Energy profiles resulting from lighting controls which respond to daylight can be evaluated using CEL-1. This user's guide is divided into seven sections:

1. Overview of Computer Concepts
2. Basic Structure of CEL-1
3. Application and Examples
4. Comprehensive Reference of Input Data Required
5. Auxiliary Files
6. Using CEL-1 from Batch Terminal
7. Using CEL-1 from Interactive Terminal

CR 82.001
Resource Recovery Technology Application Document, Long Beach, Calif., SCS Engineers, Oct 1981, N68305-80-C-0055, ADA120639.

This document is intended to provide guidance to Naval shore facilities in planning and selecting solid waste management and resource recovery technology. The document consists of a state-of-the-art review of technology available for materials and energy recovery based on information and data from latest published research and documented practical experience. The technologies presented include both Navy scale (40 TPD) and municipal scale (up to 2,000 TPD) systems. The document is arranged to provide a large amount of data in a concise format and, therefore, makes liberal use of tables and charts. Systems are grouped into three categories: material recovery systems, fuel recovery systems, and combustion systems. The unit operation making up systems in each of these areas are fully described in the appendixes to the document. The document is presented in loose leaf format to allow updating as new information is developed.

CR 82.002
Design Calculation Procedure for Passive Solar Houses at Navy Installations in Regions with Cold Climate, Vol. I, M. Lumsdaine, E. Lumsdaine, Las Cruces, NM, New Mexico State University, Oct 1981, N62583-79-MR-585, ADA108382.

These reports present design calculation procedures for passive solar houses. A "worksheet" approach is used in that the user may work through an example passive solar design by following the text in the report. Included are tables for heating degree days, solar heat gains, building R factors, orientation factors, roof overhang designs, etc. Performance is calculated on a monthly basis. The reports are presented for five (5) geographical regions with content and text format similar, differing only in the appropriate regional factors. This volume gives appropriate designs for Navy installations in regions with cold climate.

CR 82.003
Design Calculation Procedure for Passive Solar Houses at Navy Installations in East Coast Regions with Temperate Climate, Vol II, M. Lumsdaine, E. Lumsdaine, Las Cruces, NM, New Mexico State University, Oct 1981, N62583-79-MR-585, ADA108383.

These reports present design calculation procedures for passive solar houses. A "worksheet" approach is used in that the user may work through an example passive solar design by following the text in the report. Included are tables for heating degree days, solar heat gains, building R factors, orientation factors, roof overhang designs, etc.

Performance is calculated on a monthly basis. The reports are presented for five (5) geographical regions with content and text format similar, differing only in the appropriate regional factors. This volume gives appropriate designs for Navy installations in East Coast regions with temperate climate.

CR 82.004
Design Calculation Procedure for Passive Solar Houses at Navy Installations in Regions with Warm, Humid Climate, Vol III, M. Lumsdaine, E. Lumsdaine, Las Cruces, NM, New Mexico State University, Oct 1981, N62583-79-MR-585, ADA108384

These reports present design calculation procedures for passive solar houses. A "worksheet" approach is used in that the user may work through an example passive solar design by following the text in the report. Included are tables for heating degree days, solar heat gains, building R factors, orientation factors, roof overhang designs, etc. Performance is calculated on a monthly basis. The reports are presented for five (5) geographical regions with content and text format similar, differing only in the appropriate regional factors. This volume gives appropriate designs for Navy installations in regions with warm, humid climate.

CR 82.005
Design Calculation Procedure for Passive Solar Houses at Navy Installations in the Pacific Northwest, Vol IV, M. Lumsdaine, E. Lumsdaine, Las Cruces, NM, New Mexico State University, Oct 1981, N62583-79-MR-585, ADA108385

These reports present design calculation procedures for passive solar houses. A "worksheet" approach is used in that the user may work through an example passive solar design by following the text in the report. Included are tables for heating degree days, solar heat gains, building R factors, orientation factors, roof overhang designs, etc. Performance is calculated on a monthly basis. The reports are presented for five (5) geographical regions with content and text format similar, differing only in the appropriate regional factors. This volume gives appropriate designs for Navy installations in the Pacific Northwest.

CR 82.006
Design Calculation Procedures for Passive Solar Houses at Navy Installations in Warm California Climates, Vol V, M. Lumsdaine, E. Lumsdaine, Las Cruces, NM, New Mexico State University, Oct 1981, N62583-79-MR-585, ADA108386

These reports present design calculation procedures for passive solar houses. A "worksheet" approach is used in that the user may work through an example passive solar design by following the text in the report. Included are tables for heating degree days, solar heat gains, building R factors, orientation factors, roof overhang designs, etc. Performance is calculated on a monthly basis. The reports are presented for five (5) geographical regions with content and text format similar, differing only in the appropriate regional factors. This volume gives appropriate designs for Navy installations in warm California climates.

CR 82.007
A Passive Solar Retrofit Study for Concrete Block Buildings, W. O. Wray, C. R. Miles, C. E. Kosiewicz, Albuquerque, N.M., Department of Energy, Albuquerque Operations Office, Los Alamos National Laboratory, Jan 1982, N68305-81-MP-10003, ADA110189

A passive solar retrofit study has been conducted for the Navy at the Los Alamos National Laboratory. The purpose of the study was to determine the energy savings obtainable in concrete block buildings from several passive solar heating and conservation strategies. A procedure involving the use of test cell data and computer simulation was employed to assess the merits of six retrofit options. The six strategies selected were chosen on the basis of providing a series of options that will deliver increasing energy savings at the cost of correspondingly increased levels of commitment.

CR 82.008
Morison's Equation and the Wave Forces on Offshore Structures, T. Sarpkaya, Carmel, CA, Dr. Turgut Sarpkaya, Dec 1981, N68305-80-C-0053, AD

The origin and limitations of the Morison-O'Brien-Johnson-Schaff (MOJS) equation, the nature and decomposition of the time-dependent in-line force, the speculative generalizations of the MOJS equation to body shapes other than circular cylinders, to yawed cylinders, to wave-current combination, and to dynamice response of structures are discussed in detail. The background and the limitations of the existing data are reviewed and the data from sinusoidally-oscillating planar flow about smooth and rough circular cylinders are chosen to critically assess the MOJS equation. Six methods are examined to delineate the limitations of the MOJS equation and to devise a new force expression. The final method used (the Fourier analysis of the residues) led to the formulation of a three-term and a four-term MOJS equation. It is shown through numerous examples that the new MOJS equation reduces the residue significantly for both smooth and rough circular cylinders, particularly in the drag-interia dominated regime. Finally, the applicability of the new equation to the ocean conditions and the effect of spanwise coherence are discussed and numerous research projects are recommended for consideration. The suggesting is made that further improvement and understanding of the MOJS equation rest not only with carefully conducted laboratory investigations but also with additional ocean tests designed to shed light on several complicating influences such as the spanwise coherence of vortices and vortex interactions

CR 82.009 - Cancelled

CR 82.010
A Review of Added Mass and Fluid Inertial Forces, C. E. Brennen, Sierra Madre, Calif., C. E. Brennen, Jan 1982, N62583-81-MR-554, ADA110190

This report reviews the existing state of knowledge concerning the evaluation of the forces imposed on a body in a fluid due to acceleration of either the body or the fluid. It concentrates on those fluid inertial forces due to acceleration rather than on the drag/lift forces due to steady motion. The first part of the report presents a survey of the analytical background including the definition of added mass, the structure of the added mass matrix and other effects such as the influence of viscosity, fluid compressibility and the proximity of solid and free surface boundaries. Then the existing data base from experiments and potential flow calculations is reviewed. Approximate empirical methods for bodies of complex geometry are explored in a preliminary way. The possible dramatic effects of the proximity of the ocean bottom are further highlighted. The confused state of affairs regarding the possibly major effects of viscosity in certain regimes of frequency and Reynolds number is discussed. Finally a number of recommendations stemming from ocean engineering problems are put forward.

CR 82.011
Economic Analysis of Airfield Pavement Rehabilitation Alternatives - An Engineering Manual, J. A. Epps, C. V. Wootan, Bryan, Tex., J. A. Epps, Consulting Engineer, Mar 1982, N62583-81-MR-328, ADA112550

The manual describes a method for evaluation of pavement rehabilitation alternatives based on a present worth or present value economic model. Methods for selecting pavement rehabilitation, recycling and maintenance alternatives are presented together with a method for determining thickness requirements for overlay on airfield pavement facilities.

Guidelines are presented to allow the engineer to select an appropriate discount rate, analysis period and salvage values for use in the life cycle cost calculations. Prices

and costs of pavement rehabilitation and recycling maintenance techniques are given and are suggested for use if costs of these operations are not available from historical records. Cost updating procedures are also defined.

Two example problems are included in the manual to illustrate the techniques of present worth life cycle costing. (Also published as DOT/FAA/RD-81/78.)

CR 82.012
A Newton-Lanczos Method for Solution of Nonlinear Finite Element Equations, B. Nour-Omid, Berkeley, Calif., Department of Civil Engineering, University of California, Feb 1982, N62583-82-MR-419, ADA112043

The finite element method reduces nonlinear continuum problems to nonlinear discrete problems which take the form of systems of nonlinear algebraic equations. Attention is devoted to procedures which may be employed to solve the resulting nonlinear algebraic systems. The general class of continuum problems of interest include both material and geometric nonlinearities.

Newton's method, modified Newton methods, and quasi-Newton methods are reviewed. However, the technique which has been given focus is the Newton-Lanczos method which is a member of the class of solution methods that employ an iterative, linear equation solver in an inner loop within Newton's method.

The Newton-Lanczos algorithm is shown to not only require fewer factorization steps than either the quasi-Newton or modified Newton methods but also possesses more robust convergence characteristics when dealing with nearly singular Jacobian matrices and indefinite systems.

CR 82.013
A Verification Study for the Bounding Surface Plasticity Model for Cohesive Soils, L. R. Herrmann et al., Davis, Calif., Department of Civil Engineering, University of California, Mar 1982, N62583-81-MR-320, ADA113673

Results of drained and undrained, triaxial compression and extension, and thick-walled cylinder laboratory tests are given for a laboratory prepared kaolin soil. For the soil in question, a portion of the data is used to calibrate a "bounding surface plasticity model" for cohesive soils. The model is used to analyze the remaining tests and the results are compared to the measured values with good agreement.

CR 82.014
Test Cases for SEADYN Verification, P. E. Nordstrom, H. Ottsen, Oxnard, Calif., Western Instruments Corp., Apr 1982, N68305-80-C-0004, ADA114978

This report includes actual input decks and associated outputs for demonstration of the SEADYN cable dynamics computer model. The input problems are intended to allow for the verification of the model if it is transferred for operation on non-CDC® computers.

CR 82.015
Validation of Computer Models of Cable System Dynamics, D. B. Dillon, Rockville, Md., EG&G Washington Analytical Services Ctr., Apr 1982, N68305-80-C-0020, ADA114957

Comparisons are made between measurements taken during four series of dynamic cable experiments and simulations of the experimental events using two computer models, SEADYN and SNAPLOAD, under the sponsorship of the Naval Civil Engineering Laboratory. Three of the experiments were conducted in laboratory water tanks using an elastically stiff nylon cord and a soft silicon rubber cable.

The first experiment used cables 6 feet long. Five distinct geometries were measured, including simulation of the anchor-last deployment of a single mooring leg, the relaxation of a subsurface mooring from a displaced condition, and the response of a load suspended along a cable fixed at one end and moved around a circle at the other. The deployment and relaxation simulations were repeated in the second experimental series, using cables 60 feet long. The tension was measured during the third series while a weight suspended from the nylon or rubber cable was payedd out or reeled in from a small winch. The winch base could be oscillated vertically to simulate wave action.

The fourth experiment was the deployment of a full-size instrumented subsurface mooring in 2,500 feet of water off Kauai, Hawaii as part of the joint Mooring Dynamics Experiment (MDE) conducted in late 1976.

SEADYN is a general three-dimensional model of the dynamic response of cable networks to environmental changes using a nonlinear finite element technique in the time domain. SNAPLOAD uses the lumped parameter method to model the dynamics of serially connected cables suspended in a vertical plane. Both models are shown to reproduce all the significant motions and forces in the modeled events, but tensions are introduced in both models by the inaccurate hydrodynamic drag coefficients that they use.

Material damping caused by elastic hysteresis in the cable material is found to play a significant part in smoothing the computation of cable tension, even though it has little overt relation to the overall event. Small amounts of material damping are sufficient to prevent undesirable oscillations between model nodes, larger values enable SEADYN to accurately model the forced oscillation of the anchor as the length of the suspension cable was varied through resonance.

The laboratory experiments were restricted to serially connected cables and special buoys or anchors suspended in a vertical plane in still water in order to make the data useful for comparing simple computer models as well as stances by comparing equilibrium and steady-state conditions to results obtained from elementary theory. The data from all four experiments are available for evaluating other models.

CR 82.016
SEAPLOT: A Graphics Post-Processor for the SEADYN Program, R. L. Webster, Brigham City, Utah, Dr. R. L. Webster, Consulting Engineer, Apr 1982, N62474-81-C-9391, ADA114961

This report describes the computer program named SEAPLT, which is a graphics post-processor to the general purpose cable dynamics computer model named SEADYN. The program is written with CALCOMP® compatibility for use with the CDC-Cybernet® program UNIPLOT.

CR 82.017
A Compendium of Tension Member Properties for Input to Cable Structure Analysis Programs, J. F. Wadsworth, Oxnard, Calif., Western Instruments Corp., Apr 1982, N68305-80-C-0004, ADA115019

This report is a collection and condensation of cable properties used in computer simulations of cable dynamics problems. Data were taken from a variety of sources, and include weight per foot (in air and immersed), elastic modulus, breaking strength, cross-sectional area, and drag and added mass coefficients. Cable types include chain, wire rope, synthetic and electromechanical.

CR 82.018
SEADYN: Programmer's Reference Manual, R. L. Webster, Brigham City, Utah, Dr. R. L. Webster, Consulting Engineer, Apr 1982, N62474-81-C-9391, ADA115011

The internal workings of the SEADYN cable, truss, and mooring program are detailed. Descriptions are given of the overall program structure and logic. Storage features, such as COMMON, data files, and variable dimensions are discussed. Descriptions are given for each of the subroutines and the major variables used. The information provided is intended to augment the general description of the program provided in the User's Manual and Mathematical

Models and provide a programmer with assistance in understanding the internal workings of the SEADYN programming. Instructions for converting the program to various machines and for modifying the program are also provided.

CR 82.019
SEADYN Mathematical Models, R. L. Webster, Brigham City, Utah, Dr. R. L. Webster, Consulting Engineer, Apr 1982, N62474-81-C-9391, ADA114994

This manual presents the theoretical background material for the SEADYN cable, truss, and mooring program. SEADYN uses the finite element method for modeling the cables, trusses, and mooring lines. Two elements are treated: the one-dimensional Simplex (truss) element and a bottom-limited catenary. Lumped parameter concepts are used in treating buoys, anchors, floats, etc. Rigid body models are used for ships, platforms, mooring buoys, etc. A cartesian 3-D geometric space is used throughout. Besides describing the element and body equations for submerged responses with large displacements, this manual discusses the various static and dynamic solution methods employed.

CR 82.020
A Viscoplastic Plane Frame Beam-Column Element for Program FEAP, J. H. Slater, R. L. Taylor, Berkeley, Calif., University of California, May 1982, N62583-81-MR-439, ADA114461

A two-dimensional viscoplastic beam element was developed for the computer program FEAP. The element is suitable for small displacements or moderate rotations with negligible shear. The element is formulated in moment-thrust space which will improve modeling of concrete beams. The viscoplastic formulation provides time dependent effects such as the influence of the strain rate upon the yield strength.

CR 82.021
A Viscoplastic Algorithm for CAP75, M. G. Katona, M. A. Mulert, Notre Dame, Ind., Department of Civil Engineering, University of Notre Dame, May 1982, N68305-80-C-0031, ADA114460

A viscoplastic formulation based on Perzyna's elastic/viscoplastic theory is developed for geological materials using the Sandler and Rubin CAP75 plasticity model. The numerical strategy employs a one parameter Crank-Nicolson time integration scheme which provides options for explicit and implicit algorithms. A computer program called VPDRVR exercises these algorithms for arbitrary states of stress or strain.

CR 82.022
A Systematic Procedure for Calculating the Average Illuminance on a Work Plane from Skylights Located in a Pitched Roof, J. B. Murdoch, J. E. Nettleton, Durham, N.H., Department of Electrical Engineering, University of New Hampshire, May 1982, N62583-81-MR-307, ADA115523

A systematic design procedure has been developed to calculate the average horizontal illuminance upon a work plane due to skylights in a pitched roof. The calculation procedure allows for pitched roofs with slopes up to 30 degrees from horizontal, and for both clear and overcast sky conditions. The procedure is divided into two basic steps: (1) the calculation of total external daylight illuminance upon the sloped skylight surface, and (2) the calculation of average horizontal illuminances upon an interior workplane due to the sloped skylights. Worksheets are used to systematically step through the procedure. All necessary tables and equations are included.

CR 82.023 - Cancelled

CR 82.024 - Cancelled

CR 82.025
Development of a Seawater Hydraulic Tool System, R. Graham, G. G. Hastings, Annapolis, Md., Westinghouse Electric Corp., Oceanic Division, May 1982, N00123-80-C-1271, ADA114960

The Naval Civil Engineering Laboratory is developing a diver-operated hydraulic tool system that uses seawater as the working fluid. The program was initiated in 1976 with the subsequent development of an experimental balanced vane by 1980. Late in 1980 a contract was awarded to improve the performance of the experimental vane motor and make it reversible, to couple the motor to a rotary impact mechanism with appropriate control to form a diver-operated impact wrench, and to develop a diesel-operated portable power supply for operating the tool. This report describes the successful development of this experimental seawater hydraulic tool system.

CR 82.026
Appendix to Development of a Seawater Hydraulic Tool System, R. Graham, G. G. Hastings, Annapolis, Md., Westinghouse Electric Corporation, Oceanic Division, May 1982, N00123-80-C-1272, ADB063681L

The Naval Civil Engineering Laboratory is developing a diver-operated tool system that uses seawater as the working fluid. In the fall of 1978, work began on the development of an experimental vane motor capable of powering diver-held tools. Material requirements for the vane motor components were investigated in detail, and an engineering model of the motor was designed and fabricated using the most promising materials. The best results were obtained by using Torlon 4275, a high-strength thermoplastic, for the vanes, side plates, and bearings, and Inconel 625, a high-nickel-based alloy, for the housing and rotor. Based on the results of engineering development, an experimental vane motor was fabricated and tested in the laboratory. The motor, with a volume of about 25 $in.^3$, weighs 5 pounds, and produces 3.3 hp at 1,600 rpm with 80% overall efficiency when supplied with 7 gpm of seawater at 1,000 psi. More than 60 hours of full-power operation have been achieved. The results to date of the development and testing are presented in this report.

CR 82.027
Energy Monitoring and Control Systems Operator Training - Recommended Qualifications, Staffing, Job Description, and Training Requirements for EMCS Operators, C. Cornelius, B. Wise, Atlanta, Ga., Newcomb & Boyd, Consulting Engineers, Jun 1982, N62474-81-C-9405, ADA116835

This report includes a review of: (1) operator training provided by EMCS contractors, (2) the requirements for training by the Tri-Service Specifications, and (3) the present operation of several functioning EMCS installations.

From the information gathered, recommendations were made in regard to qualifications, staffing, job description, and training requirements for a competent EMCS operator.

It is recommended that training be given in four phases: (1) Shop Rotation, (2) EMCS Operator Training Course, (3) Vendor Training, and (4) On-the-Job Training.

Detailed objectives, course outline, and manual outline for the proposed EMCS Operator Training Course are provided in Section 3 of this report.

CR 82.028
Controlling Energy Consumption in Single Buildings, J. Rees, Atlanta, Ga., Newcomb & Boyd, Consulting Engineers, Jul 1982, N62583-81-MR-593, ADA118898

This report contains guidelines for using microprocessor-based equipment to control energy in buildings. Energy conservation control strategies are discussed and simplified energy savings calculations explained. The results of a survey of currently available equipment suitable for use as energy controllers are included as well as selection guidance for which class of equipment will provide the needed features.

CR 82.029
Reliability, Maintainability, Availability; Thermal Efficiency; and Cost Effectiveness Evaluation of Naval Station Mayport Heat Recovery Incinerator, Oxnard, Calif., VSE Corporation, Jul 1982, N00123-82-D-0149, ADA118523

This report addresses the long-term evaluation of the Mayport heat recovery incinerator program. Operational data were collected from 29 Sep 1980 to 28 Sep 1981 and then analyzed for reliability, availability, maintainability, thermal efficiency, and operating cost.

CR 82.030
Standardized EMCS Energy Savings Calculations, C. Cornelius, Atlanta, Ga., Newcomb & Boyd, Consulting Engineers, Sep 1982, N62474-81-C-9382, ADA123383

This report describes standardized methods for determining energy savings obtainable from EMCS applications programs using manual and computerized algorithms. The methods will provide reasonable approximations of savings but not detailed energy analyses of building operations.

CR 82.031
Conceptual Design of Navy Floating Pier, San Francisco, Calif., T. Y. Lin International, Sep 1982, N62474-81-C-9404, ADA121865

An innovative concept for a floating pier to serve Navy surface combatants has been developed. The prestressed concrete pier is 1,200 feet long and 75 feet wide and offers a number of advantages over conventional pile supported piers. These advantages include:

(a) A constant deck elevation with respect to berthed ships which results in decreased need to tend utility and mooring lines.
(b) A full interior deck which doubles the available length of ship-to-pier interface.
(c) A clear top deck with all utility lines located under the deck and accessible from the lower interior deck.
(d) A modern cell-type fender system.

In addition, the floating pier has significant merit when used to replace an existing deteriorated pier. The floating pier can be constructed in modules offsite while the old pier is demolished, the modules then floated into position, and the construction completed at the original pier site. Using the floating pier approach, the Navy would have an operational pier at least 12 months sooner than would be the case with a fixed pier. The initial cost for a floating pier has been estimated to be about 14% higher than that for a comparable pile supported pier.

CR 82.032
Reliability Engineering Analysis - Small-Scale Heat Recovery Incinerator Installations, Oxnard, Calif., VSE Corporation, Sep 1982, N00123-82-C-0149, ADA122408

This report addresses the reliability prediction conducted on the two Navy owned and operated heat recovery incinerator systems. The prediction was based on a part counts method and the original designs of the two HRI systems. Based on this prediction, long term data collected at Mayport and Jacksonville HRI systems and mission requirements, testing procedures for HRI systems have been identified. Included in this report is a failure modes and effects analysis conducted at these HRIs.

CR 82.033
Safety and Human Factors Engineering Analysis - Heat Recovery Incinerator Installation, Oxnard, Calif., VSE Corporation, Sep 1982, N00123-82-C-0149, ADA122638

This report contains a safety and human factors analysis of the Navy's heat recovery incinerator (HRI) systems. These requirements were based on current military standards and an evaluation of the HRI's at NAS, Jacksonville and NS, Mayport, FL. The data collected were used to develop preliminary design criteria for future HRIs.

The safety analysis lists specific areas where problems can occur and what should be done to prevent injury to plant personnel. The human factors design criteria section lists steps that can be taken to improve personnel and plant operating efficiency. Finally, specific problems that are occurring at NAS, Jacksonville and NS, Mayport are given.

CR 82.032
Energy Storage Criteria Handbook, J. R. Hull, R. L. Cole, A. B. Hull, Argonne, Ill., Argonne National Laboratory, Oct 1982, N68305-81-MP-10027, AD

The purpose of this handbook is to provide information and criteria necessary for the selection and sizing of energy storage technologies for use at U.S. Naval facilities. The handbook gives Naval base personnel procedures and information to select the most viable energy storage options to provide the space conditioning (heating and cooling) and domestic hot water needs of their facility. The handbook may also be used by contractors, installers, designers, engineers, architects, and manufacturers who intend to enter the energy storage business.

The handbook is organized into three major sections: a general section, a technical section, and an example section. While a technical background is assumed for the latter two sections, the general section is simply written and can serve as an introduction to the field of energy storage. The technical section examines the following energy storage technologies: sensible heat storage, latent heat storage, cold storage, thermochemical storage, mechanical storage, pumped hydro storage, and electrochemical storage. The example section is limited to thermal storage and includes examples for: water tank storage, rockbed storage, latent heat storage, and cold water storage.

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