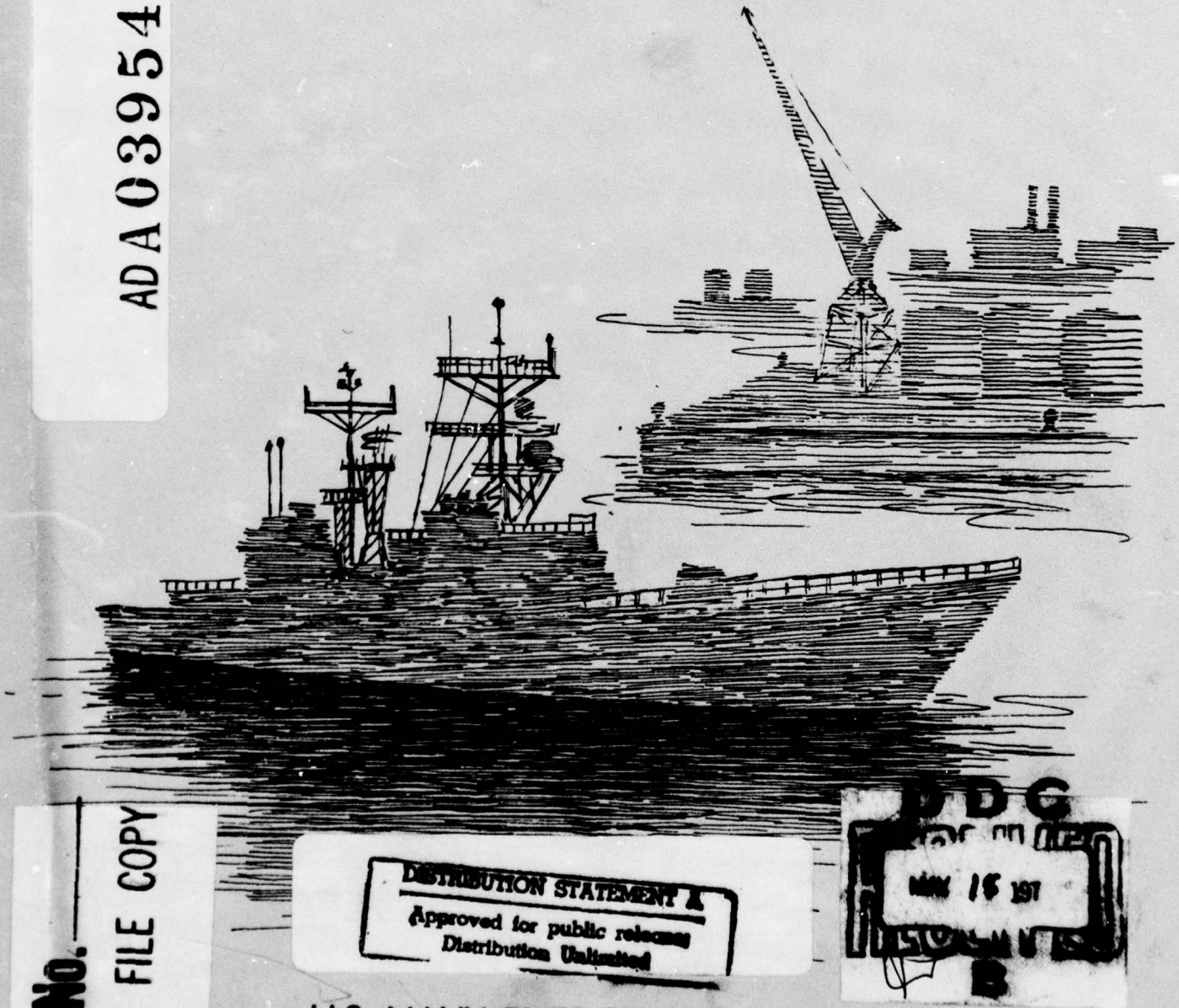
AD-A039 546 TETRA TECH INC ARLINGTON VA F/G 10/1
U.S. NAVY ENERGY R AND D PROGRESS OCTOBER 1976-MARCH 1977.(U)
APR 77 N00014-76-C-0239
UNCLASSIFIED TT-A-872-77-316 NL

1 OF 2
AD A039546



U.S. NAVY
ENERGY R&D PROGRESS

OCTOBER 1976-MARCH 1977



AD A039546

DISTRIBUTION STATEMENT A
Approved for public release;
Distribution Unlimited

DDC
MAY 16 197
B

AD No.
DDC FILE COPY

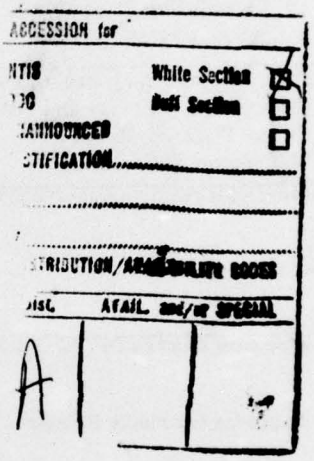
U.S. NAVY ENERGY AND NATURAL RESOURCES
RESEARCH AND DEVELOPMENT OFFICE

TT-A-872-77-316

April 1977

U.S. NAVY ENERGY R&D PROGRESS

October 1976-March 1977



Prepared by: ENERGY SYSTEMS DIRECTORATE

Prepared for: DIRECTOR, NAVY ENERGY AND
NATURAL RESOURCES OFFICE
NAVAL MATERIAL COMMAND
WASHINGTON, D.C. 20360

APPROVED FOR PUBLIC RELEASE – DISTRIBUTION UNLIMITED

TETRA TECH, INC.
1911 North Fort Myer Drive
Arlington, Virginia 22209

see 1473

Unclassified

SECURITY CLASSIFICATION OF THIS PAGE (When Data Entered)

REPORT DOCUMENTATION PAGE		READ INSTRUCTIONS BEFORE COMPLETING FORM
1. REPORT NUMBER	2. GOVT ACCESSION NO.	3. RECIPIENT'S CATALOG NUMBER
4. TITLE (and Subtitle) (6) U.S. NAVY ENERGY R&D PROGRESS October 1976-March 1977		5. TYPE OF REPORT & PERIOD COVERED (9) Technical rept.
		6. PERFORMING ORG. REPORT NUMBER (14) TT-A-872-77-316
7. AUTHOR(s) Energy Systems Directorate		8. CONTRACT OR GRANT NUMBER(s) (15) N00014-76-C-0239
9. PERFORMING ORGANIZATION NAME AND ADDRESS Tetra Tech, Inc. 1911 North Fort Myer Drive Arlington, Virginia 22209		10. PROGRAM ELEMENT, PROJECT, TASK AREA & WORK UNIT NUMBERS
11. CONTROLLING OFFICE NAME AND ADDRESS Director, Navy Energy and Natural Resources R&D Office Crystal Plaza #6, Room 606 Washington, D.C. 20360		12. REPORT DATE (11) Apr[illegible]77 13. NUMBER OF PAGES 129 (12) 142 p.
14. MONITORING AGENCY NAME & ADDRESS (If different from Controlling Office)		15. SECURITY CLASS. (of this report) Unclassified 15a. DECLASSIFICATION/DOWNGRADING SCHEDULE

16. DISTRIBUTION STATEMENT (of this Report)

Approved for Public Release -- Distribution Unlimited.

17. DISTRIBUTION STATEMENT (of the abstract entered in Block 20, if different from Report)

~~See~~ AD-A034340

18. SUPPLEMENTARY NOTES

19. KEY WORDS (Continue on reverse side if necessary and identify by block number)

Energy, Energy Research and Development, Energy Conservation, Synthetic Fuels, Energy Self-sufficiency, Energy Legislation, Shale Oil, Geothermal, Solar Energy, Wind Power

20. ABSTRACT (Continue on reverse side if necessary and identify by block number)

This U.S. Navy Energy R&D Progress report summarizes the progress and accomplishments of the Navy Energy R&D Program for the period from October 1976 through March 1977. This report complements the U.S. Navy Energy R&D Program Plan, FY 1977-FY 1982, published in October 1976.

388 403

DD FORM 1 JAN 73 1473 EDITION OF 1 NOV 65 IS OBSOLETE
S/N 0102-014-6601

Unclassified

SECURITY CLASSIFICATION OF THIS PAGE (When Data Entered)

PREFACE

This is the fourth in a series of periodic reports summarizing the progress of Navy energy research and development (R&D) projects active during the reporting period. The purpose of this report is to give a status review of energy-related projects sponsored by the Navy Energy and Natural Resources Research and Development Office (MAT-03Z) in energy conservation, synthetic fuels, and energy self-sufficiency. The project status descriptions are based on formal energy R&D quarterly reviews presented between October 1976 and March 1977 by the individual Navy systems commands. Because the Naval Sea Systems Command quarterly reviews were early in the review schedule, the progress reports for its conservation projects cover July 1976 through mid February 1977. All other progress reports cover October 1976 through March 1977.

Appendixes include a list of all Navy energy R&D projects, related R&D developments by industry and other government agencies during the reporting period, legislation enacted, national energy policy directly affecting the Navy, and a summary of the 100,000-barrel shale oil program.

The report complements the "U.S. Navy Energy R&D Program Plan, FY 1977-FY 1982."

CONTENTS

Executive Summary 1

Energy Conservation Projects 7

Synthetic Fuels Projects 47

Self-sufficiency Projects 57

Appendix A – Navy Energy R&D Projects A-1

Appendix B – Industry and Other Government R&D B-1

Appendix C – Legislation C-1

Appendix D – National Energy Policy Affecting the Navy D-1

Appendix E – Shale Oil Program E-1

EXECUTIVE SUMMARY

The Navy energy research and development (R&D) program was started in 1974. The goals of this program are to reduce the Navy's dependence on foreign energy supplies and minimize increases in operating costs resulting from higher fuel prices. Attainment of these goals relates directly to increasing the efficiency and reliability of energy-using systems without compromising flexibility, readiness, or performance, and ensuring that the Navy can respond to the national objective of converting from rapidly depleting, commonly used energy sources to synthetic fuels and renewable energy forms. To accomplish its goals, the Navy is sponsoring a variety of R&D projects. These involve three key strategies: energy conservation, evaluation of synthetic fuels, and promotion of energy self-sufficiency.

ENERGY CONSERVATION

Energy conservation is the most practical way of quickly reducing the Navy's dependence on foreign energy supplies and lowering operating costs resulting from increased fuel prices. In FY 1976, the Navy's energy conservation efforts resulted in a significant energy savings. Compared with the FY 1973 base year, energy savings increased at shore facilities from 4.6 million barrels of oil equivalent (BOE) in FY 1975 to 5.0 million BOE in FY 1976. Shipboard energy savings increased from 4.2 million BOE in FY 1975 to 6.8 million BOE in FY 1976, compared with the FY 1973 base year.

Following the policy recommendations of the Defense Energy Task Group, the Navy is concentrating its energy conservation R&D effort on shore-based and shipboard energy conservation. (Aviation energy conservation R&D is the responsibility of the Air Force, with support from the Naval Air Systems Command (NAVAIR).) The primary approach of the energy conservation R&D effort is directed toward the evaluation, development, and implementation of technologies or operational practices that will reduce energy consumption.

SHORE-BASED CONSERVATION

The Naval Facilities Engineering Command (NAVFAC) is responsible for energy conservation R&D at the Navy's shore facilities. The Energy Program Office at the Civil Engineering Laboratory (CEL) is the focal point for this effort.

The Navy is building an energy technology base, tailored to its needs, by assimilating advances made in the national energy program and by evaluating more efficient energy utilization and generation systems and applying the technology, where appropriate, to

shore-based facilities. Methods for eliminating wasteful fuel usage in Navy facilities are also being identified and developed. Energy requirements have been reduced by, for example, installing storm windows and doors, insulation, and other retrofit modifications where funds have been available.

Other ways of conserving energy at shore-based facilities are being studied. These include improved construction materials, methods, and designs; improved or advanced heating, ventilating, and air conditioning (HVAC) systems; improved lighting systems and single-building energy control systems; energy-loss detection and measurement; energy applications analyses, data compilation and reduction, and related supporting studies; energy monitoring and control systems; and improved or advanced power cycle and energy utilization systems.

During October 1976 through March 1977, work on construction materials included expansion and shrinkage tests on 20 concrete panels with mid-depth insulation (sandwich construction). A contract was awarded to develop insulation test panels and determine the characteristics of new insulation materials.

A study of alternative designs for HVAC systems was redirected to include additional systems variables. A preliminary design of a building cooling system using seawater was completed. The Navywide potential of air conditioning, based on seawater cooling, is being determined.

A lighting design criteria handbook was completed and is being reviewed by CEL; the LUMEN II lighting design computer program revisions neared completion. Lighting system experiments continued based on the Illuminating Engineering Society's parameters of visual comfort probability (VCP) and equivalent sphere illumination (ESI). In addition, a solid-state dimming ballast using microprocessor technology is being developed for fluorescent lighting.

To determine energy usage, control, and conservation within single buildings and small complexes, a contract was awarded to study state-of-the-art microprocessor technology as it relates to building energy control systems. The correlation between thermostat operating differentials and building energy consumption is also being studied.

Studies continued on detecting and measuring energy loss from buildings and pipelines by infrared and SF_6 tracer gas techniques. A study was started to determine methods of preventing heat loss from Navy aircraft hangars. Instrumentation packages to detect energy losses are being procured and assembled for field survey use.

CEL continued application engineering studies to provide technology transfer from CEL to NAVFAC and engineering field divisions. A mobile energy laboratory for on-site measurement of energy consumption was procured, and an analysis of space heating units was completed, along with an energy end-use analysis at the Pacific Missile Test Center.

Studies of energy economics included developing 20 general strategies to determine allowable capital expense premiums for energy-saving plant investment; advantages and

disadvantages of each of the strategies are being identified. The fuel and energy cost escalation report was completed; it provides projected costs for fuel oil, natural gas, coal, and electricity to 2020.

Energy monitoring and control systems work included effectiveness validation, study of expansion capabilities, determination of necessary evaluation criteria, and analysis of system economics.

A total/selective energy systems handbook was nearly completed. The Navy and ERDA are continuing discussions concerning a joint program for testing an organic Rankine bottoming cycle on Navy power plants. In addition, an RFP was issued for a study to review Navy policy governing central steam and electric power generation at Navy facilities.

SHIPBOARD CONSERVATION

The Naval Sea Systems Command (NAVSEA) has primary responsibility for shipboard energy conservation R&D. The R&D program focuses on reducing shipboard energy consumption through improved ship propulsion, more efficient auxiliary systems and operating procedures, improved hull-cleaning techniques, and improved hull coatings. The David Taylor Naval Ship Research and Development Center (DTNSRDC) is the primary Navy laboratory for conducting the shipboard energy conservation R&D program.

During July 1976 through mid February 1977, exploratory development (6.2) efforts focused on determining the potential for reducing fuel consumption by the future fleet through implementation of alternative propulsion and auxiliary subsystems. Alternative propulsion and ship service electrical systems concepts exhibiting superior fuel consumption characteristics are undergoing detailed analyses. Other major energy user's, such as lighting, pumping, HVAC, and pneumatic systems are also being studied. A computer program for a shipboard total energy model is being developed. The model will allow analysis of energy flow, from the prime movers to the loads, of combinations of propulsion, electrical generating, and auxiliary subsystems.

Hull maintenance activities were performed in both the advanced (6.3) and engineering development (6.4) programs. Underwater hull cleaning activities involved the continuing evaluation of rotary brush techniques. Methods for in situ cleaning of sea chests and propellers are also being evaluated. A fleet instruction on how to perform underwater hull cleaning is being drafted. A 2-year test program involving at-sea trials to determine the required frequency and the cost-effectiveness of underwater cleaning techniques was started.

Deliveries of the organometallic-polymer-based paint formulations for evaluation as antifoulant hull coatings began. Patch-panel static immersion tests on various combinations of the paints and standard Navy primers were started. The Navy Bureau of Medicine completed toxicological tests on six delivered paints and approved their use on ship hulls. Potential propeller antifoulant coatings and application methods are also being evaluated.

To reduce fuel consumption by the existing fleet, improved machinery alignment and operating procedures were tested at sea on the U.S.S. Holt (FF 1074). Preliminary results indicated the fuel consumption rate could be lowered significantly by using the improved procedures, particularly in the cruising range of the ship. Efforts are underway to extend the methodology to other ship classes.

Water resource management efforts are underway to determine techniques to improve the efficiency of freshwater production and utilization aboard ship.

SYNTHETIC FUELS

The Navy's main interest in synthetic fuels is directed at reducing its dependence on foreign oil. Synthetic fuels are being derived from oil shale, tar sands, and coal, which are considered inexhaustible through the next century. NAVFAC, NAVSEA, and NAVAIR, through cooperative programs with ERDA, are testing synthetic fuels to determine their usefulness as military fuels (JP-4, JP-5/Jet-A, DF-2/DMF, gasoline, and heavy fuel oil). Potentially useful fuels are being tested by the Navy in both small- and full-scale hardware to determine whether they are suitable for Navy needs and compatible with Navy equipment.

While the Navy is interested in evaluating all synthetic fuels—whether derived from oil shale, tar sands, or coal—the R&D program emphasizes tests of fuels derived from oil shale. Fuel derived from domestic tar sands will be tested when enough such fuel is available. Some coal-derived crude from the Char-Oil Energy Development project has been tested. Other fuels derived from coal will be tested when the synthetic crudes from coal processes become available in acceptable quantities.

During October 1976 through March 1977, tests continued to determine the effects of nitrogen on the storage stability of JP-5 derived from oil shale. Preliminary results indicated that a nitrogen concentration above 50 parts per million may not meet long-term storage stability requirements.

Heavy fuel oil derived from oil shale was tested in an open-air burner and in a 300-horsepower utility boiler. The purpose of the tests was to measure the heat-flux rate and study the firing performance of this synthetic fuel. Paraho indirect-fired crude was also tested during the period to study its suitability for use in Navy weapon systems.

The preliminary design of a central coal-gasification plant for a Navy base continued during the report period, as well as parametric analysis of two types of coal gasifiers.

Preliminary toxicological studies were started on both conventional and oil-shale-derived fuels.

Preliminary results of fuel flexibility studies indicated that, under certain conditions, there are some advantages to using off-specification fuels.

SELF-SUFFICIENCY

NAVFAC is responsible for energy self-sufficiency R&D; CEL is the Navy laboratory primarily responsible for conducting the self-sufficiency R&D projects. The Naval Weapons Center, China Lake, is the primary geothermal assessment research activity. The objectives of this R&D program strategy are to develop the capability of using local, renewable energy sources at both remote and domestic bases and, where possible, to replace liquid hydrocarbons at domestic bases with more abundant fuels, such as coal. The approach of the R&D effort is to demonstrate the technical feasibility of and collect cost and performance data for hardware and systems that will contribute to reducing dependence on liquid hydrocarbons and promoting the use of renewable energy sources. Specifically, the Navy is testing and evaluating energy systems being developed by other federal agencies or by the Navy in conjunction with other agencies, such as ERDA. Advanced HVAC, waste conversion, solar, wind, advanced power, and geothermal systems are being studied. The use of more coal at shore-based facilities is also being evaluated.

During October 1976 through March 1977, work on exploratory development (6.2) projects included further progress on the Advanced Energy Utilization Test Bed (AEUTB). The AEUTB shell was built, and contract requirements for additional components, such as mechanical, HVAC, and electrical systems, were readied for bid announcement.

Air-conditioning systems and heat pumps using solar energy are being studied:

- Solar-cooling demonstration projects were reviewed.
- Analyses have been performed on absorption, Rankine, and dessicant cooling systems.
- The conceptual analysis of a solar-augmented heat pump continued.

A technical memorandum on packaged heat-recovery incinerators was completed.

Additional data were assembled on the potential of using an anaerobic digestion process for producing gasoline.

Efforts continued on (1) acquiring, analyzing, and reducing solar, wind, and other energy-related meteorological data; (2) acquiring and analyzing waste material production and property data; and (3) surveying and assessing ocean and geothermal resource data.

A technical memorandum was written on solar heating of swimming pools. The report included heat loss equations and economic analysis procedures.

Tests continued on evaluating National Bureau of Standards solar collectors, as well as other flat plate and concentrating types. Chemical, dissolved-salt, and thermal stratification storage systems are also being studied.

The power-conditioning equipment for a 5-kw wind generator is being redesigned.

The generator will be installed at San Nicolas Island and connected to dehumidifying heaters inside a building.

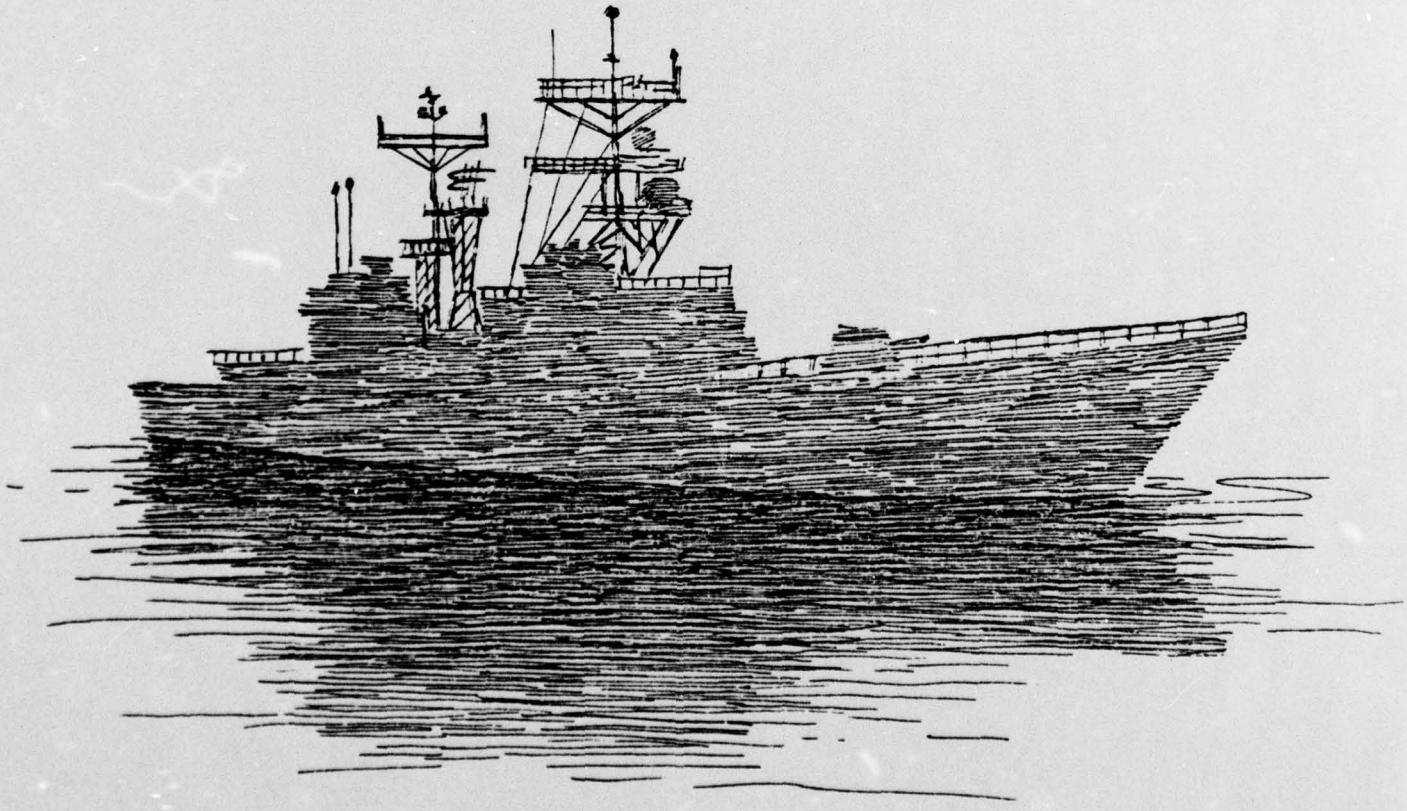
Preliminary results of geophysical studies at Adak Island, Alaska, indicated that a geothermal energy resource capable of supporting Navy facilities on the island is favorable.

At the Great Lakes Naval Training Center, the demonstration site for ERDA's fluidized-bed boiler, advances in fluidized-bed boiler technology are being monitored. New developments in coal beneficiation technology, primarily the removal of pyritic sulfur, are being investigated.

A variety of new self-sufficiency R&D projects were started during the report period:

- Identification of densified refuse-derived-fuel sources and hardware requirements.
- Assessment of the applicability of photovoltaic systems at advanced Navy bases.
- Review of the feasibility, cost-effectiveness, and performance of solar desalinization methods applied to Navy sites.
- Study of feasibility and economics of using small vertical-axis wind turbines for space heating.
- Monitoring of the development of 100- to 1,500-kw generators, and preliminary assessment of candidate sites for 100-kw wind generator field tests.
- Preparation of a handbook for application of wind power generators at Navy facilities.
- Identification and evaluation of geothermal resources at Navy sites.

ENERGY CONSERVATION



ENERGY CONSERVATION PROJECTS

SHORE-BASED CONSERVATION

CONCRETE SANDWICH CONSTRUCTION MATERIALS TESTS 10
Sponsor: NAVFAC Program Element 62765N
Performer: CEL

CONSTRUCTION METHODS AND MATERIALS 11
Sponsor: NAVFAC Program Element 62765N
Performer: CEL

HANDBOOK FOR COMPARING HVAC SYSTEMS 11
Sponsor: NAVFAC Program Element 62765N
Performer: CEL

LIGHTING DESIGN CRITERIA HANDBOOK FOR NAVY APPLICATIONS 12
Sponsor: NAVFAC Program Element 62765N
Performer: CEL

BUILDING CONTROL SYSTEMS FOR ENERGY EFFICIENCY 13
Sponsor: NAVFAC Program Element 62765N
Performer: CEL

MEASUREMENT OF BUILDING ENERGY LOSSES 15
Sponsor: NAVFAC Program Element 62765N
Performer: CEL

MEASUREMENT OF ENERGY LOSSES IN PIPELINES 16
Sponsor: NAVFAC Program Element 62765N
Performer: CEL

HANGAR HEAT LOSS PREVENTION 17
Sponsor: NAVFAC Program Element 62765N
Performer: CEL

APPLICATION ENGINEERING STUDIES 17
Sponsor: NAVFAC Program Element 62765N
Performer: CEL

ENERGY CONSERVATION HANDBOOK 19
Sponsor: NAVFAC Program Element 62765N
Performer: CEL

DATA COMPILATION FOR ENERGY CONSUMPTION AND FACILITY OPERATIONAL STATISTICS 20
Sponsor: NAVFAC Program Element 62765N and
Performer: CEL 65861N (Project Z0362)

ENERGY OPTIMIZATION HANDBOOK FOR NAVY BASE PLANNING 22
Sponsor: NAVFAC Program Element 62765N
Performer: CEL

FUEL COST ESCALATION STUDY 23
Sponsor: NAVFAC Program Element 62765N
Performer: CEL/NWC

STUDY OF CAPITAL EXPENSE PREMIUM TO BE ALLOWED FOR ENERGY SAVING PHYSICAL PLANT INVESTMENTS 24
Sponsor: NAVFAC Program Element 62765N
Performer: CEL/NWC

VALIDATION OF EXISTING MONITORING AND CONTROL SYSTEM EFFECTIVENESS 25
Sponsor: NAVFAC Program Element 62765N
Performer: CEL

EVALUATION CRITERIA FOR AVAILABLE MONITORING AND CONTROL SYSTEMS 26
Sponsor: NAVFAC Program Element 62765N
Performer: CEL

TOTAL/SELECTIVE ENERGY SYSTEMS HANDBOOK 28
Sponsor: NAVFAC Program Element 62765N
Performer: CEL

LOW-TEMPERATURE HEAT-RECOVERY POWER SYSTEMS 29
Sponsor: NAVFAC Program Element 62765N
Performer: CEL

REVIEW OF GUIDANCE GOVERNING CENTRALIZED STEAM AND ELECTRIC POWER GENERATION BY NAVAL INSTALLATIONS 30
Sponsor: NAVFAC Program Element 62765N and
Performer: CEL 65861N (Project Z0362)

LIGHTING SYSTEMS EXPERIMENTS 32
Sponsor: NAVFAC Program Element 63724N
Performer: CEL Project Z0829

INSTRUMENTATION PACKAGES FOR FIELD SURVEYS 34
Sponsor: NAVFAC Program Element 63724N
Performer: CEL Project Z0829

SEAWATER HEAT EXCHANGER FOR COOLING BUILDINGS 35
Sponsor: NAVFAC Program Element 64710N
Performer: CEL Project Z0371

ECONOMICS OF MONITORING AND CONTROL SYSTEMS 36
Sponsor: NAVFAC Program Element 65861N
Performer: CEL Project Z0362

SHIPBOARD CONSERVATION

ENERGY CONSERVATION ABOARD SHIP 36
Sponsor: NAVSEA Program Element 62765N
Performer: DTNSRDC

HULL MAINTENANCE 39
Sponsor: NAVSEA Program Element 63724N and 64710N
Performer: DTNSRDC Project Z0829 and Z0371

MACHINERY OPTIMIZATION 43
Sponsor: NAVSEA Program Element 64710N
Performer: DTNSRDC Project Z0371

WATER RESOURCE MANAGEMENT 44
Sponsor: NAVSEA Program Element 64710N
Performer: DTNSRDC Project Z0371

CONCRETE SANDWICH CONSTRUCTION MATERIALS TESTS

Sponsor: NAVFAC
Performer: CEL
Contact: J. R. Keeton

Program Element 62765N

OBJECTIVE

CEL is studying the structural and insulation characteristics of expanding concrete with insulation at mid-depth (sandwich construction). The purpose is to develop crack-free walls and roofs to reduce energy costs of new concrete structures by as much as 30 percent. The maintenance requirements and the costs of concrete sandwich construction materials are also being studied.



CONCRETE SANDWICH PANEL

TECHNICAL APPROACH

Concrete panels of various mix designs are being analyzed quantitatively. Thermal characteristics will be tested using a guarded hot box. The results of the analyses and tests will be used to establish design parameters for concrete sandwich construction.

PAST PROGRESS

Mix ratios were established, after several design changes, to allow a sticky mix and adequate expansion while curing. After investigating several curing methods, CEL adopted 2-day curing using fog and 2-day curing using wet blankets.

Several methods of instrumentation to measure expansion and subsequent shrinkage were studied. Mechanical strain gauges embedded in the concrete on screw inserts welded to the mesh reinforcement were chosen.

Twenty 1- by 2-foot expansive concrete test panels were instrumented and built using several sand-to-cement ratios. Expansion and shrinkage tests were started on these panels.

PROGRESS DURING OCTOBER 1976-MARCH 1977

Expansion and shrinkage tests continued on the 20 panels.

CONSTRUCTION METHODS AND MATERIALS

Sponsor: NAVFAC
Performer: CEL
Contact: E. R. Vinieratos

Program Element 62765N

OBJECTIVE

CEL is determining the information needed on the thermal properties, structural characteristics, fire economics, and moisture resistance of new construction materials. The actual versus theoretical values of insulation in Navy housing and buildings are also being determined. In addition, a new design concept for thermal buffer zones will be investigated to determine its applicability and costs for new and retrofit Navy construction.

TECHNICAL APPROACH

New construction materials are being surveyed to determine their energy-conserving properties and obtain fire-safety information. The thermal and moisture characteristics of new roofing and insulation materials will be determined, and new roof and wall configurations, including thermal buffer zone concepts, will be investigated.

Some Navy buildings will be surveyed to determine the effectiveness of existing insulation. Enough data will be obtained to allow extrapolation to all Navy buildings.

PROGRESS DURING OCTOBER 1976-MARCH 1977

A contract was awarded to Johns-Manville R&D Center, Denver, Colorado, to develop insulation test panels for Navy buildings. Tests to determine the characteristics of new insulation materials were started.

HANDBOOK FOR COMPARING HVAC SYSTEMS

Sponsor: NAVFAC
Performer: CEL
Contact: A. W. McClaine

Program Element 62765N

OBJECTIVE

CEL is preparing a handbook that will identify the most advantageous uses of local heat sources and sinks. The results will assist the design of HVAC systems for Navy buildings, resulting in minimizing HVAC system costs and maximizing the use of renewable resources.

TECHNICAL APPROACH

The economics and thermodynamics of available HVAC systems are being analyzed. Information on the trade-off between HVAC systems and different buildings and climates is also being obtained. The resulting handbook will be updated periodically to include new developments and changing variables, and will supplement the NAVFAC interim design criteria, "Technical Guidelines for Energy Conservation in New Buildings."

PAST PROGRESS

A literature survey of heat sources and sinks was completed, and investigators at ERDA and the Electric Power Research Institute involved with heat sources and sinks were contacted.

HVAC duct and tubing arrangements for the Advanced Energy Utilization Test Bed were designed.

A study of alternative designs for HVAC systems was started.

PROGRESS DURING OCTOBER 1976-MARCH 1977

Work on this project was redirected to include consideration of the many variables affecting HVAC system designs. Variables being considered are specific are requirements, fuel availability, building usage, building requirements, and climate. (Originally, all system variables, except performance and cost, were assumed constant.) A contract specification for the redirected project was written.

LIGHTING DESIGN CRITERIA HANDBOOK FOR NAVY APPLICATIONS

Sponsor: NAVFAC
Performer: CEL
Contact: W. Pierpoint

Program Element 62765N

OBJECTIVE

CEL is preparing a handbook on optimum standard lighting designs, including artificial lighting, natural daylighting, and electrical controls. CEL is also developing computer-aided design capability and performing economic analyses of lighting design applications.

TECHNICAL APPROACH

Lighting design criteria are being developed, based on equivalent sphere illumination (ESI) and visual comfort probability (VCP) standards from the Illuminating Engineering

Society (IES). An existing ESI and VCP lighting design computer program, LUMEN II, is being revised to include contributions of daylighting, economic analyses, and energy savings potential. A user's manual for the computer program and a lighting design applications handbook are also being produced.

Results of lighting systems experiments will be included in the handbooks.

PAST PROGRESS

A contract for preparing the lighting design criteria handbook was awarded to Lum-I-neering Associates, Inc., Boulder, Colorado, in May 1976. A draft of the handbook was completed in September and forwarded to CEL for review.

A contract to revise the LUMEN II computer program was awarded to Smith, Hinchman and Grylls Associates, Inc., Detroit, Michigan, in April 1976. The daylighting portion of the computer program was completed in September.

PROGRESS DURING OCTOBER 1976-MARCH 1977

The final version of the lighting design criteria handbook was completed and delivered to CEL.

The revision to the artificial lighting portion of the LUMEN II computer program was completed. Other work on the program and on the user's manual continued. The lighting design applications handbook was started.

BUILDING CONTROL SYSTEMS FOR ENERGY EFFICIENCY

Sponsor: NAVFAC
Performer: CEL
Contact: R. I. Staab

Program Element 62765N

OBJECTIVE

The potential for using control systems and sensors to increase the efficiency of energy consumption in individual buildings is being investigated.

TECHNICAL APPROACH

Building control systems and components are being studied, as well as the selection and placement of sensors and control elements, and the use of microprocessors to provide the necessary logic and flexibility to adjust for varying building occupancy and outdoor conditions. A microprocessor-based system will be designed and installed at a test site, and its capabilities evaluated to determine its potential for Navy applications.

PAST PROGRESS

A study was started to identify commercially available control systems and sensors suitable for single buildings or small complexes. Investigations of transient suppressor devices to reduce electrical energy consumption began.

PROGRESS DURING OCTOBER 1976-MARCH 1977

A contract was awarded in October to Harvey Mudd College Engineering Clinic, Claremont, California, to study the state-of-the-art of microprocessor technology as it applies to building energy control systems.

Tests to determine the energy savings potential of transient suppressor devices were completed. No energy savings were realized for the application chosen.

A technical memorandum on existing small-scale monitoring and control systems was completed.

The relationship between thermostat operating differentials and building energy consumption is being studied.

MEASUREMENT OF BUILDING ENERGY LOSSES

Sponsor: NAVFAC
Performer: CEL
Contact: J. C. King

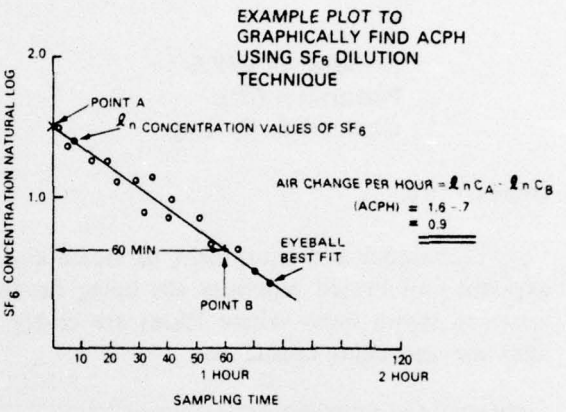
Program Element 62765N

OBJECTIVE

CEL is developing and testing techniques for measuring building infiltration losses and will investigate new aerial and ground infrared (IR) equipment and survey techniques.

TECHNICAL APPROACH

Quantifiable heat-loss information is being obtained from IR survey data. The equipment includes a temperature comparator, K-factor meter, and heat-flux meter. An analytical technique to be used accounts for wall and roof thermal transients. CEL also plans to obtain an IR system videotape adapter for field testing.



MEASUREMENT OF BUILDING ENERGY LOSSES

Detection and measurement of infiltration losses from buildings are also being studied. Pressurization equipment and gas chromatography SF_6 is being used to test component and total infiltration in typical Navy family housing units. Correlation analysis of the test results is being done to develop a simplified pressurization setup using components specifically sized for housing units.

PAST PROGRESS

Field tests of IR equipment and an IR survey of Sewells Point Navy Base, Norfolk, Virginia, were conducted. A methodology (transient heat-transfer measurements) was developed for determining thermal resistance values of existing structures. A manual was prepared on the use of heat-flux meters and the conditions under which heat-flux and temperature data must be taken.

Equipment for measuring infiltration losses, using SF_6 tracer gas and pressurization techniques, was procured. Limited tests conducted with SF_6 tracer gas showed that leaks can be detected in steam, compressed air, and natural gas lines.

PROGRESS DURING OCTOBER 1976-MARCH 1977

A contract was awarded in October to Systems, Science and Software (S^3), La Jolla, California, to develop procedures for measuring infiltration losses using an SF_6 tracer gas and pressurization equipment. S^3 started infiltration tests on a family housing unit at CEL to refine the procedures and illustrate the techniques to CEL personnel.

MEASUREMENT OF ENERGY LOSSES IN PIPELINES

Sponsor: NAVFAC
Performer: CEL
Contact: J. C. King

Program Element 62765N

OBJECTIVE

Techniques and equipment to locate and measure (or calculate) energy losses in both exposed and buried pipelines are being developed and evaluated. Measurement of energy losses in steam lines, where losses are costly, is being emphasized, but air, gas, and water lines are also being considered.

TECHNICAL APPROACH

SF_6 leak detectors will be extensively field tested to determine their capabilities. Attempts are being made to quantify leaks in underground lines by SF_6, infrared, or acoustic inspection. The effects of underground conditions (wet or dry soil, standing water, tunnel, direct burial, etc.) on locating leaks and measuring their size will be studied. Attempts will also be made to develop techniques and instrumentation for determining overall energy losses in a pipeline.

PROGRESS DURING OCTOBER 1976-MARCH 1977

Information was received from some Navy bases with suspected pipeline leaks, and was requested from others.

A lightweight SF_6 leak detector was procured and tested. Available literature on the safety aspects of SF_6 leak detection was reviewed; no safety problems were found, as the concentration of SF_6 needed for leak detection is low.

Information on acoustic detectors is being collected.

HANGAR HEAT LOSS PREVENTION

Sponsor: NAVFAC
Performer: CEL
Contact: A. W. McClaine

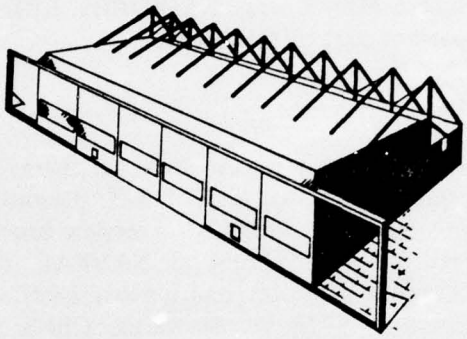
Program Element 62765N

OBJECTIVE

CEL will identify ways to reduce energy consumption in Navy aircraft hangars.

TECHNICAL APPROACH

A study will be performed by contract to evaluate existing technology for reducing heat loss from hangars while the doors are open.



PROGRESS DURING OCTOBER 1976-MARCH 1977

A contract specification for the study was written.

APPLICATION ENGINEERING STUDIES

Sponsor: NAVFAC
Performer: CEL
Contact: F. W. Herrmann

Program Element 62765N

OBJECTIVE

CEL is providing RDT&E assistance at Navy bases, NAVFAC headquarters, and engineering field divisions to coordinate a continuous flow of technological information from national energy programs to Navy programs to facilitate the application of conservation devices and installation of new power systems throughout the Navy.

TECHNICAL APPROACH

CEL engineers involved in energy conservation and advanced power systems are maintaining current technology bases, and requests for RDT&E in these areas are being coordinated with CEL.

Field representation is mandatory for the installation at a Navy base of a system being developed by CEL. At least one applications engineer is dedicated full time to coordinate the solution of technical problems in the field.

The liaison between CEL and NAVFAC field activities, NAVFAC engineering field divisions, Navy Energy R&D Office, ERDA, other federal agencies, and industry will be an important part of this project.

PAST PROGRESS

Transferring information on energy technology into the Navy energy program is a continuing responsibility of CEL personnel assigned to energy RDT&E. Information has been disseminated through overview brochures, the CEL energy newsletter, technical data sheets, progress reports to NAVFAC, detailed handbooks, and formal CEL technical memorandums, notes, and reports. Distribution of publications is controlled by NAVMAT Instruction 5720.7A. However, CEL's Energy Program Office has sought as wide a distribution as possible.

PROGRESS DURING OCTOBER 1976-MARCH 1977

CEL continued efforts to apply and relate RDT&E products to the field by means of a review of engineering field division survey reports and ERDA programs and demonstrations. CEL also:

- Completed 68 requests for assistance relating to RDT&E energy problems at Navy activities and other DOD and government agencies.
- Completed a technical memorandum summarizing RDT&E assistance for FY 1976.
- Reviewed photovoltaic cell application for cathodic protection of underground utility piping (special cases).
- Completed a contract report on improving heat transfer in air conditioning chiller condensers.
- Reviewed preliminary wind and solar data from Centerville Beach, California, and began compiling the data collected over 3 months, correlating it with local data to determine monthly and yearly averages.
- Began a load analysis for possible siting of a 20-kw wind generator at New London, Connecticut.

DOCUMENTATION

"Summary of RDT&E Energy Assistance for FY 76," TM-80-, December 1976.

ENERGY CONSERVATION HANDBOOK

Sponsor: NAVFAC
Performer: CEL
Contact: F. W. Herrmann

Program Element 62765N

OBJECTIVE

An energy conservation handbook is being prepared for Navy facility engineers.

TECHNICAL APPROACH

The National Bureau of Standards (NBS) is preparing energy conservation handbooks for the Air Force—one for retrofitting existing facilities and another for new construction. CEL is providing technical support to NBS, and is reviewing the handbook as it is formulated to determine if it meets the basic requirements of the Navy as well as the other military services. These handbooks are being refined as necessary to adapt them for Navy preliminary design applications, the energy conservation investment program, and new military construction.

PAST PROGRESS

CEL has consulted with the Air Force and Army on the energy conservation handbooks, and has reviewed an outline of the handbooks with NBS. CEL also worked on a products catalog for eventual inclusion in energy conservation handbooks, and provided the Air Force and NBS with Navy energy conservation publications, reference materials, sample Navy engineering field division survey team reports, and information on a method for measuring and calculating heat loss from buried steam mains.

The Air Force energy conservation handbook for retrofitting existing facilities was reviewed.

PROGRESS DURING OCTOBER 1976-MARCH 1977

NBS completed the final drafts of the Air Force energy conservation handbooks. CEL began reviewing the handbooks for adaptation into a Navy energy conservation handbook.

DATA COMPILATION FOR ENERGY CONSUMPTION AND FACILITY OPERATIONAL STATISTICS

Sponsor: NAVFAC
Performer: CEL
Contact: R. E. Bergman

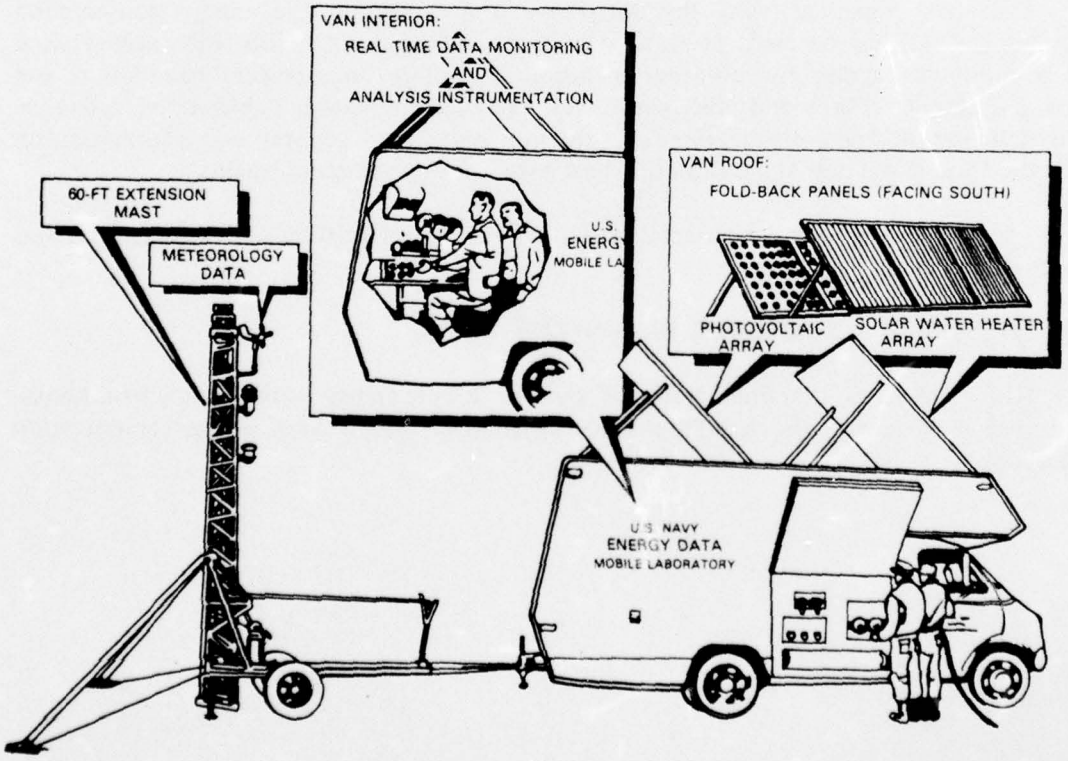
Program Element 62765N and
65861N (Project Z0362)

OBJECTIVE

CEL is compiling data on energy consumption and demand at Navy installations and is providing an energy profile characterization of Navy bases.

TECHNICAL APPROACH

Energy consumption data are being obtained from the Defense Energy Information System for Navy Utilities (DEIS-II) computer program. This program contains data on the consumption and cost of coal, petroleum products, electricity, steam and hot water, natural gas and propane or liquified petroleum gas, and the 1973 (baseline) consumption, by month, for each of 580 activities. These data are being analyzed and compiled by climate, geographical location, fuel transportation cost, and types of energy systems on base.



ENERGY DATA MOBILE LABORATORY

The actual breakdown in energy demand by end-use category is not available from DEIS-II. On-site monitoring and investigation are being done at typical Navy bases to estimate end-use energy consumption.

To compare new power systems with current systems, CEL is also obtaining data on the operating and maintenance costs and reliability of existing boilers, diesel engines, gas turbines, HVAC systems, and other power facilities.

PAST PROGRESS

CEL has continually acquired data on fuel and electrical power consumption and cost; collated and analyzed energy demand data for causal relationships; and inventoried shore activity power systems, compiling the performance, operating, maintenance, and reliability data for analysis.

Several computer programs were written to format DEIS-II data for use in several projects. The 580 activities were grouped by geographic locations and ranked by total energy expenditure at each site. Data on energy consumption at overseas sites were compiled, and Navy family housing was ranked by total energy costs and by number of family units.

Navy sites dependent on diesel generators for electric power were assessed for system and fuel costs.

An electrical energy monitor—a device capable of direct readout of real-time peak power, power factor, and energy consumption—was acquired, evaluated, and expanded to 100-channel capacity. A data-communications terminal was ordered for processing data from the monitor into computer-compatible form. Thermocouples with signal conditioners and cold-junction compensation, a liquid-flow meter, and a hot-wire anemometer for duct flow were procured for energy measurements in heating, cooling, and hot-water systems.

CEL started planning, designing, and procuring equipment and instruments for in situ measurement of energy consumption. Work to determine the end uses of energy at the Pacific Missile Test Center (PMTC), Point Mugu, California, was also started.

PROGRESS DURING OCTOBER 1976-MARCH 1977

CEL procured a mobile energy data laboratory. The laboratory will be outfitted with the energy monitor and other energy measuring instruments that have been procured. With this laboratory, CEL can expand the number of locations for making field measurements.

The data-communications terminal, liquid-flow meter, hot-wire anemometer, and a power inverter were delivered and tested.

An analysis of space heating energy usage and cost for about 90,000 family housing units (about 95 percent of those in use during FY 1975) at 113 Navy and Marine Corps sites was completed and reported to NAVFAC.

The study to determine the end use of energy at PMTC was completed, and a technical memorandum issued. Over 50 structures in all category codes were selected randomly, and the uses of energy estimated (eight uses of electrical power and the principal uses of natural gas). The data were analyzed mathematically to obtain estimates for the major category codes and for the entire base. The results indicated that 46 percent of electricity is used for lighting.

Planning for an energy engineering data bank was started. CEL's immediate need is for ready access to data on energy consumption, cost, location characteristics, and facilities. NAVFAC also needs such data. Access by time-share terminals is therefore considered necessary.

DOCUMENTATION

"Data Compilation for Energy Consumption Statistics for U.S. Navy Shore Installations," TM-52-76-12, September 1976.

ENERGY OPTIMIZATION HANDBOOK FOR NAVY BASE PLANNING

Sponsor: NAVFAC
Performer: CEL
Contact: C. E. Parker

Program Element 62765N

OBJECTIVE

CEL is preparing an energy handbook that will be used to determine optimum mixtures of power systems and energy conservation systems for Navy bases.

TECHNICAL APPROACH

The operational and economic characteristics of different power systems and energy conservation systems are being quantified. Technical inputs from engineers are forming the basis for establishing system characteristics.

The basic optimization procedure, which will be documented in the handbook, will use parametric curves and hand calculations. A computerized version for more sophisticated computation will also be developed. The handbook will be updated periodically.

PAST PROGRESS

A computer program was written to provide a method for estimating payback periods for energy-saving equipment and procedures. The Economic Analysis Handbook (NAVFAC P-442) was analyzed and programmed, and an interim simulation model was put into operation.

PROGRESS DURING OCTOBER 1976-MARCH 1977

Work to establish the critical characteristics of all available power systems and conservation devices continued.

FUEL COST ESCALATION STUDY

Sponsor: NAVFAC
Performer: CEL/NWC
Contacts: C. E. Parker and
E. E. Kappelman

Program Element 62765N

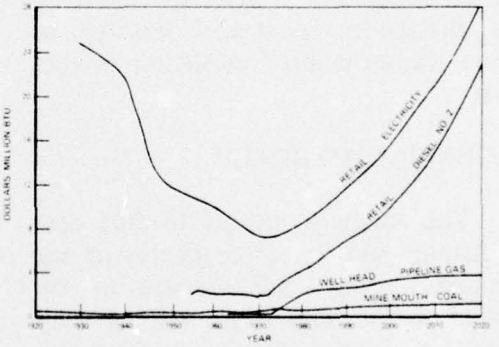
BEST AVAILABLE COPY

OBJECTIVE

CEL and NWC are examining national energy and price trends to provide a basis for projecting fuel and energy costs.

TECHNICAL APPROACH

Economic analysis of conservation devices and power systems requires projection of fuel cost over the expected lives of the candidate systems. Pessimistic, optimistic, and expected escalation rates are being estimated for the time frames of interest.



ENERGY PRICE PROJECTIONS (PROBABLE CASE)

PAST PROGRESS

Historical data on fuel and energy prices were obtained, as were predictions of future fuel and energy prices. The data were analyzed, and a fuel cost escalation report was drafted.

PROGRESS DURING OCTOBER 1976-MARCH 1977

Comments on the draft report were incorporated where appropriate, and the final

draft prepared and distributed. The prices that the Navy is expected to pay for coal, fuel oil, natural gas, and electricity were projected for the years 1975 through 2020. The projections included the optimistic, most probable (shown in the figure), and pessimistic cases.

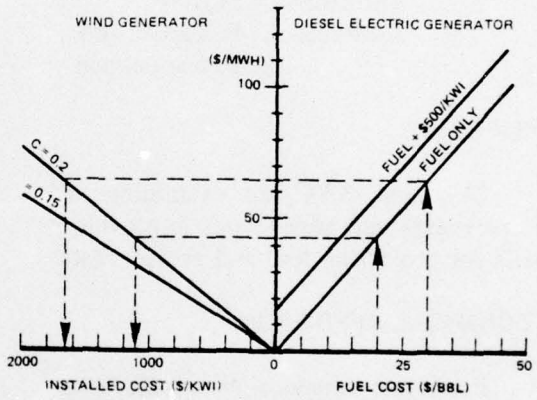
STUDY OF CAPITAL EXPENSE PREMIUM TO BE ALLOWED FOR ENERGY-SAVING PHYSICAL PLANT INVESTMENTS

Sponsor: NAVFAC
Performer: CEL/NWC
Contacts: C. E. Parker and
E. E. Kappelman

Project Element 62765N

OBJECTIVE

CEL and NWC are developing a method to compute the justified premium in capital expense for energy conservation or advanced power system physical plant investment. The accounting procedure will be used to determine the differential investment justified to offset the differential escalation of fuel costs.



EXAMPLE OF A CAPITAL PREMIUM (COST NOMOGRAM: WIND VS. DIESEL)

TECHNICAL APPROACH

This study is related to fuel cost escalations and the consequences of not achieving energy independence in the United States. This study will be completed after the fuel cost escalation study is completed, since much of its input is based on fuel pricing. The final result of both projects will relate to current Navy economic practices. Appropriate changes will be recommended.

PAST PROGRESS

The Economic Analysis Handbook (NAVFAC P-442) and the Shore Facilities Conservation Survey Program (NAVFAC INST 4100.6) were reviewed as guides to developing the methodology for this study.

The purchasing power of the U.S. dollar, based on both the consumer price index and the gross national product implicit deflator, was determined for 1900 through mid-1976.

PROGRESS DURING OCTOBER 1976-MARCH 1977

Twenty general strategies for determining the premium that should be allowed were listed, and work to identify the advantages and disadvantages of each was started.

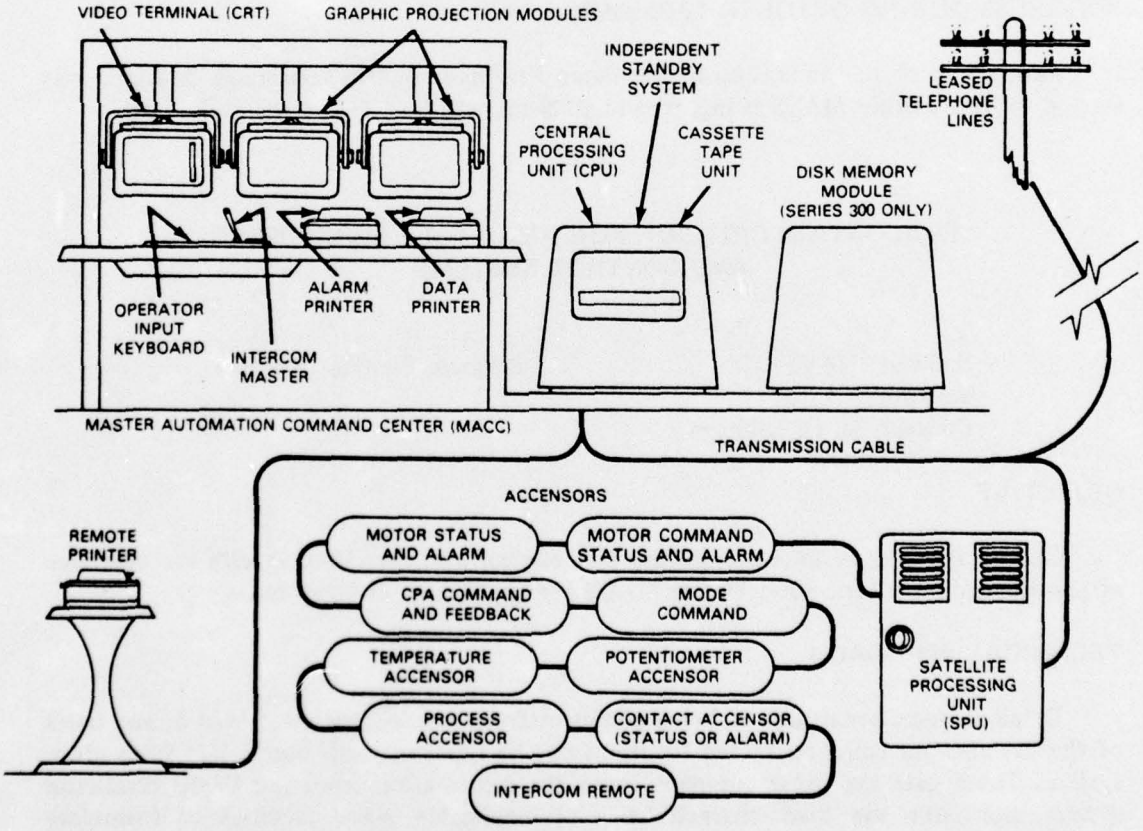
VALIDATION OF EXISTING MONITORING AND CONTROL SYSTEM EFFECTIVENESS

Sponsor: NAVFAC
Performer: CEL
Contact: D. H. Johnson

Program Element 62765N

OBJECTIVE

CEL is evaluating energy monitoring and control systems (MACS) to recommend whether additional similar systems should be installed.



MONITORING AND CONTROL SYSTEM

TECHNICAL APPROACH

MACS are being evaluated in terms of operational effectiveness and economic savings. The direct and hidden benefits are being studied to determine possible applications. Expansion possibilities are also being studied to establish the optimum monitoring and controlling capabilities needed for a facility like Camp Pendleton. Results will be reported in a technical memorandum.

PAST PROGRESS

The Honeywell Delta 2000 MACS at Camp Pendleton was evaluated, and the data were analyzed to determine the cost savings attributable to the installation of the system. A technical memorandum on the evaluation was issued. Although the Camp Pendleton Honeywell system was installed for maintenance and manpower savings, its ability to control energy usage and eliminate some wasteful practices resulted in a payback period of about one year. The capability of expanding the system to directly address energy management, including electricity consumption and demand, is also important. Monitoring of the expansion of the Camp Pendleton system was started. Significant findings on other MACS were summarized, and a data file of useful documents compiled.

PROGRESS DURING OCTOBER 1976-MARCH 1977

Monitoring of the expansion of the Camp Pendleton MACS continued. A search was started to locate other MACS being expanded. Some will be selected for evaluation.

EVALUATION CRITERIA FOR AVAILABLE MONITORING AND CONTROL SYSTEMS

Sponsor: NAVFAC
Performer: CEL
Contact: D. H. Johnson

Program Element 62765N

OBJECTIVE

CEL is assessing various monitoring and control systems (MACS) with the objective of recommending criteria for selecting MACS for application at Navy bases.

TECHNICAL APPROACH

Detailed operational data is being obtained from manufacturers of MACS, and users of the systems are being contacted for input on the types of loads best suited for a given system. These data are being compared with the information from the Camp Pendleton system and with the load characteristics of applicable Navy facilities to formulate recommendations for selection and use of MACS for the Navy.

PAST PROGRESS

Literature on available MACS was obtained from manufacturers, and a reference file established. Personal contacts were established with users or potential users in the Navy and other organizations.

PROGRESS DURING OCTOBER 1976-MARCH 1977

Design specifications for available MACS were obtained from the three major vendors who produce 80 percent of the systems. State-of-the-art technology has not been incorporated into these systems. Less prominent manufacturers or high-technology groups are, however, using state-of-the-art technology to produce MACS, and are achieving better results at one-tenth the cost of the three major vendors.

CEL began work to:

- Determine facility load patterns using Defense Energy Information System for Navy Utilities (DEIS-II) data tapes.
- Evaluate methods of determining the cost-effectiveness of MACS.
- Obtain energy costs and usage of facilities before MACS installation to determine system efficiencies.

TOTAL/SELECTIVE ENERGY SYSTEMS HANDBOOK

Sponsor: NAVFAC
Performer: CEL
Contact: E. E. Cooper

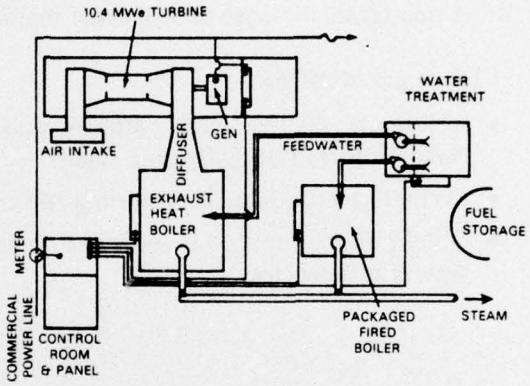
Program Element 62765N

OBJECTIVE

A handbook is being prepared to guide the selection and evaluation of total/selective energy systems for application at Navy facilities.

TECHNICAL APPROACH

Total/selective energy system applications at selected Navy facilities are being evaluated. An operating system is being instrumented and will be observed to establish the validity of preinstallation assumptions. The handbook is being prepared based on the study findings.



TOTAL/SELECTIVE ENERGY SYSTEM

PAST PROGRESS

The potential of using a total/selective energy system at a number of Navy sites was evaluated. Installing such a system at the Great Lakes Naval Training Center did not appear economically feasible, while installing a system at the Long Beach Naval Shipyard appeared to offer only marginal economic benefit. (A total/selective energy system could be installed and operated more economically, however, if utility company restrictions were not present.) Examination of the energy-consumption patterns at the San Diego Fleet Combat Direction Systems Training Center, Building 24, revealed such a low thermal load that a heat-recovery system would be beneficial only if absorption chillers replaced the compressor units. Other potential Navy sites for installing a total/selective energy system are being identified.

Preparation of the handbook was started, as was a report on the Long Beach systems analysis.

PROGRESS DURING OCTOBER 1976-MARCH 1977

The draft report on the Long Beach analysis was completed; preparation of the handbook continued.

A contract specification for determining the thermal and electrical load characteristics for total/selective energy system siting was prepared.

LOW-TEMPERATURE HEAT-RECOVERY POWER SYSTEMS

Sponsor: NAVFAC
Performer: CEL
Contact: E. E. Cooper

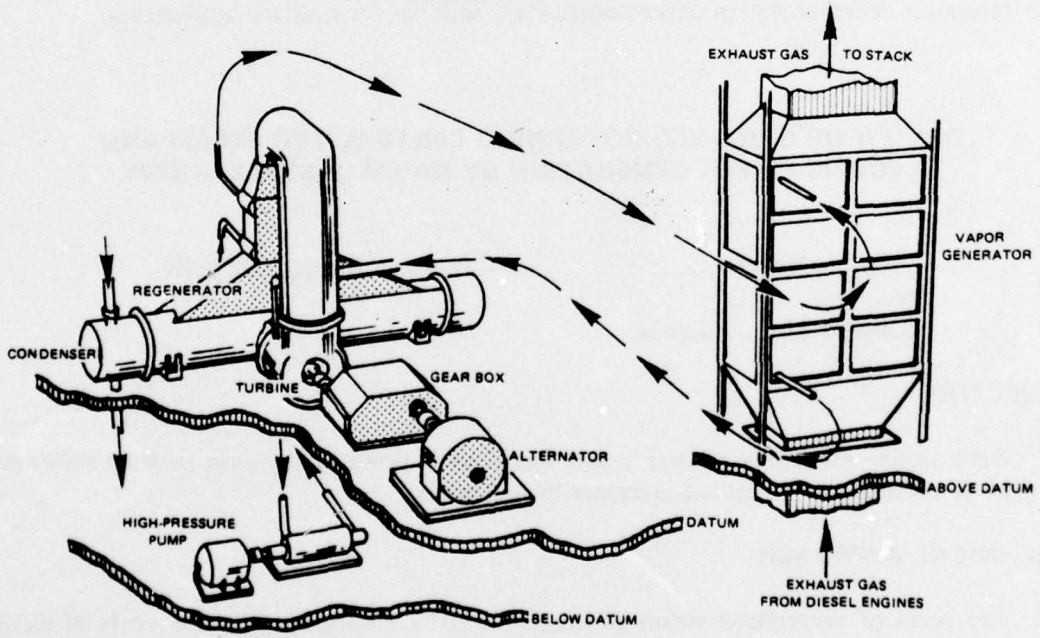
Program Element 62765N

OBJECTIVE

CEL is assessing the technical and economic feasibility of using organic Rankine bottoming cycles to improve the fuel economy of Navy diesel-electric power-generating stations.

TECHNICAL APPROACH

Operating characteristics of large Navy diesel-electric stations are being surveyed to determine whether bottoming cycles can be used. A bottoming cycle is being designed for



ORGANIC RANKINE BOTTOMING CYCLE COMPONENTS

a specific Navy station, and an economic analysis performed. CEL is also reviewing the results of ERDA-sponsored projects involving combinations of Rankine cycles and diesel systems and of low-temperature Rankine cycles and solar or wind energy systems.

PAST PROGRESS

Data on operating characteristics of large Navy diesel-electric stations were obtained and parametric economic analyses performed.

Preliminary design and economic analyses of a bottoming cycle for the Naval Radio Station in Cutler, Maine, were completed, and a technical memorandum published. The analyses showed that an organic Rankine bottoming cycle for low-temperature heat recovery at that site is feasible using current technology, and could be economically attractive.

CEL compiled a list of Navy diesel-electric power plants that could be used for testing one of ERDA's organic Rankine bottoming cycles.

PROGRESS DURING OCTOBER 1976-MARCH 1977

Navy and ERDA personnel continued discussions about the joint program for testing an organic Rankine bottoming cycle. Possible Navy plants for the tests were reviewed. Navy personnel initiated technical monitoring of the ERDA contractors to assess progress and determine whether design characteristics are suitable for military application.

REVIEW OF GUIDANCE GOVERNING CENTRALIZED STEAM AND ELECTRIC POWER GENERATION BY NAVAL INSTALLATIONS

Sponsor: NAVFAC
Performer: CEL
Contact: D. E. Williams

Program Element 62765N

OBJECTIVE

Navy policy governing central steam and electric power generation is being reviewed in light of current and projected increases in fuel costs.

TECHNICAL APPROACH

The costs of centralized steam generation will be compared with the costs of using many small existing boilers. CEL will also compare the costs of continuing to purchase electric power with the costs of central electric power generation at a Navy base. Since the Navy plans to convert from oil and natural gas to coal, this study will be based on a power-generation system using a conventional pulverized-coal unit with both particulate and sulfur dioxide control.

PAST PROGRESS

A contract statement-of-work for the study was prepared. The work will be done in three phases. Phase I, covering existing boilers and steam-turbine generators, will involve a general study of on-base electric power and steam generation and a site-specific analysis at two shipyards. Phase II will include preparation of preliminary designs and parametric analyses of system performance and cost for both new central and decentralized steam plants with flue gas desulfurization. Phase III calls for cost-effectiveness studies to determine if electric power should be generated in addition to heat and process steam at new central plants. Only Phase I will be done in FY 1977.

PROGRESS DURING OCTOBER 1976-MARCH 1977

An RFP for the study was advertised in January. The proposals in response to the RFP are being evaluated by CEL.

LIGHTING SYSTEMS EXPERIMENTS

Sponsor: NAVFAC
Performer: CEL
Contact: W. Pierpoint

Program Element 63724N
Project Z0829

OBJECTIVE

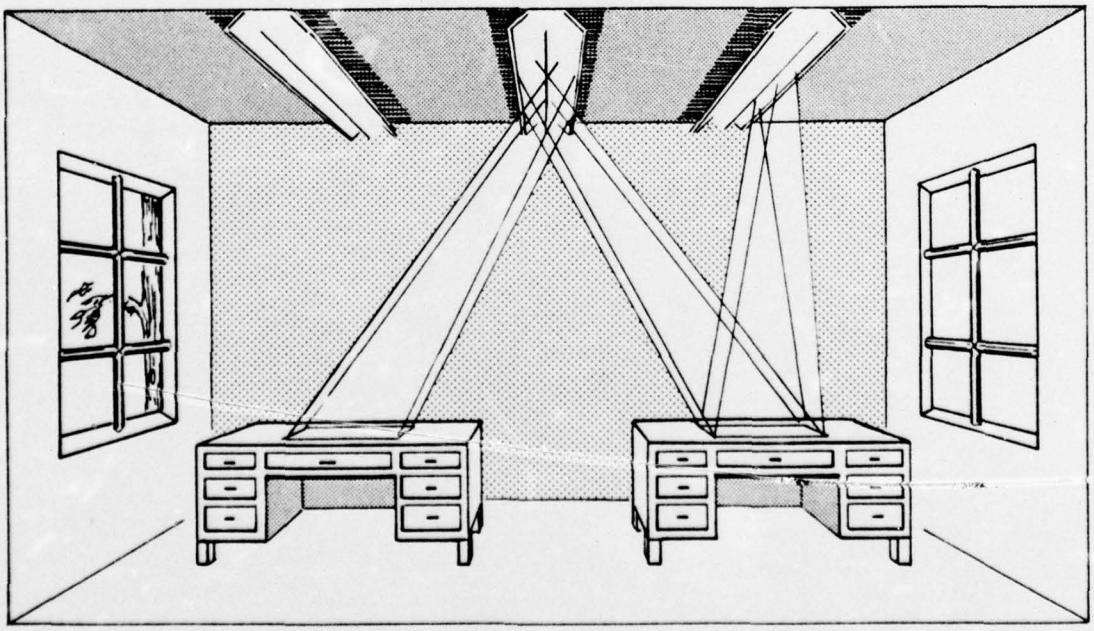
CEL is developing an experimental lighting control system that will automatically maintain specified lighting levels in offices, residences, and other areas at Navy shore facilities. The associated energy savings will also be determined.

TECHNICAL APPROACH

Offices, residences, and other areas are being simulated, and technological developments, such as task area lighting systems and multilevel ballasts, will be incorporated where applicable to optimize ceiling reflections. Control systems for integrating natural daylighting with artificial lighting will be investigated. The report on the lighting design will be revised to incorporate significant developments in lighting systems.

PAST PROGRESS

Lighting systems were surveyed and promising concepts selected. One commercially developed (General Electric) and two CEL-developed light-sensing and control systems



LIGHTING SYSTEMS EXPERIMENT

were evaluated. The General Electric system appears to be a cost-effective retrofit to existing lighting systems, such as those in hallway and storage areas. CEL's two-level light-sensing and control system can also be a cost-effective retrofit. CEL's constant-illumination-level controlling system was found to be an ideal lighting-control system for conserving energy, but would be cost-effective only on new construction.

Tests were conducted on low wattage and phantom fluorescent lamps to determine their cost-effectiveness, and the results reported.

Laboratory experiments on dimming and high-frequency lighting systems were started. A standard luminaire was connected to a variable frequency AC-AC convertor. Good dimming was achieved at 105 to 300 Hz with a standard ballast.

PROGRESS DURING OCTOBER 1976-MARCH 1977

Development of a solid-state dimming ballast was started. A microprocessor in such a ballast could be programmed to deliver optimum visibility and energy conservation based on photocell control.

A contract was awarded to Smith, Hinchman and Grylls Associates, Detroit, Michigan, to develop a visual comfort probability (VCP) meter. An equivalent sphere illumination (ESI) meter was procured. Coupled with the microprocessor-based illumination system, the ESI and VCP meters will allow evaluation of lighting systems. For a given room location and task, a correlation between raw footcandles and ESI and VCP can be computed.

DOCUMENTATION

"Evaluation of Energy Saving Lamps," TM-62-76-12, June 1976. Revised January 1977.

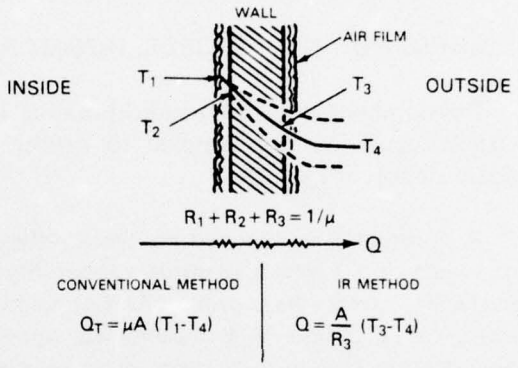
INSTRUMENTATION PACKAGES FOR FIELD SURVEYS

Sponsor: NAVFAC
Performer: CEL
Contact: J. C. King

Program Element 63724N
Project Z0829

OBJECTIVE

Qualitative energy-loss monitoring technology (developed as part of the exploratory development program) is being documented in a handbook. Suitable equipment for detecting and measuring energy losses is being assembled into instrumentation packages for field use by the engineering field divisions. A user's report on the applications of instruments for detecting and measuring energy losses at Navy facilities is also being prepared.



HEAT LOSS QUANTIFICATION

TECHNICAL APPROACH

Available instrumentation are being surveyed, and suitable units procured and tested. Based on the tests, CEL has selected instruments for inclusion in two instrumentation packages for field testing. An initial field survey for energy losses is being conducted with the instrumentation packages to train survey teams from engineering field divisions.

PAST PROGRESS

Infrared (IR) imaging systems and heat-flux meters were field tested, and techniques and technical specifications established.

PROGRESS DURING OCTOBER 1976-MARCH 1977

Work continued on selecting IR imaging systems to be included in the instrumentation packages.

The user's report was drafted and distributed for comment.

SEAWATER HEAT EXCHANGER FOR COOLING BUILDINGS

Sponsor: NAVFAC
Performer: CEL
Contact: J. B. Ciani

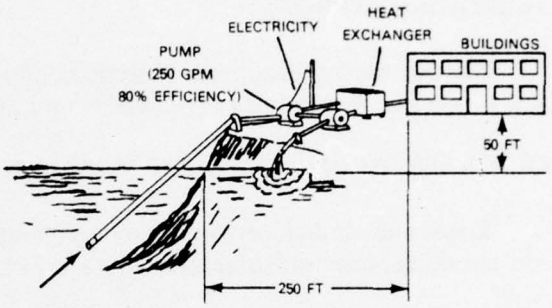
Program Element 64710N
Project Z0371

OBJECTIVE

A seawater air conditioning system will be designed, fabricated, installed, and tested at a Navy operating site.

TECHNICAL APPROACH

Preliminary and final designs of the seawater cooling system will be prepared by contract and analyzed by CEL. A model seawater cooling plant will be built and tested; test results will be analyzed to determine the potential for energy conservation. A specific demonstration site for testing the model will be selected. Other potential Navy sites will be investigated to determine the potential savings if seawater air conditioning is used.



SEAWATER HEAT EXCHANGER

PAST PROGRESS

Previous work (done as part of the exploratory development program) indicated that using seawater for cooling buildings and condensing moisture from humid air at Navy coastal facilities is technically and economically feasible.

PROGRESS DURING OCTOBER 1976-MARCH 1977

A contract was awarded in December to Tracor Marine, Port Everglades, Florida, to do the preliminary design. The preliminary design was completed in March and is being studied by CEL. Work was started to identify the Navy facilities where seawater air conditioning is practical and to estimate the total Navy payoff.

ECONOMICS OF MONITORING AND CONTROL SYSTEMS

Sponsor: NAVFAC
Performer: CEL
Contact: D. H. Johnson

Program Element 65861N
Project Z0362

OBJECTIVE

CEL is deriving methods of evaluating the economics of monitoring and control systems (MACS), and preparing an economic analysis design guide for MACS.

TECHNICAL APPROACH

State-of-the-art economic analysis methods for MACS will be surveyed and analyzed, and a cohesive methodology suitable for a design guide will be formulated.

PROGRESS DURING OCTOBER 1976-MARCH 1977

Economic studies performed by architectural and engineering firms and by computer and microprocessor manufacturers were reviewed.

ENERGY CONSERVATION ABOARD SHIP

Sponsor: NAVSEA
Performer: DTNSRDC
Contact: C. F. Krolick

Program Element 62765N

OBJECTIVE

DTNSRDC is studying the potential for reducing fuel consumption by the future fleet through the use of alternative propulsion and auxiliary subsystems. Evaluating and resolving the technical problems impeding hardware demonstrations in the advanced and engineering development programs is being given high priority. The goal is to improve the efficiency of individual systems by 15 to 70 percent, and to improve overall efficiency by at least 20 percent.

TECHNICAL APPROACH

Future powering requirements are being forecasted by projecting fleet characteristics to 2000.

Propulsion and auxiliary subsystem alternatives are being synthesized to identify energy-related design parameters and evaluated for their ability to reduce energy consumption and life-cycle cost, while satisfying operational requirements. The most promis-

ing systems for minimal fuel consumption will be analyzed on a total ship system basis; developmental problems and risks will then be identified.

Basic research projects are being monitored, and advanced research projects will be recommended based on study results.

PAST PROGRESS

To establish baseline characteristics that could be used to extrapolate the requirements of future ships and craft, energy-related design parameters and energy consumption characteristics of the major subsystems of destroyer and hydrofoil baselines were determined. Propulsion systems and ship service electrical systems alternatives were initially synthesized because the remaining auxiliary systems are dependent on their characteristics. Ninety propulsion systems and 48 ship service electrical systems were characterized by their fuel consumption over typical mission profiles. Detailed analyses of concepts that had superior fuel consumption characteristics were started.

PROGRESS DURING JULY 1976-FEBRUARY 1977

The results of the baseline vehicles propulsion and ship service electrical system analyses were coupled with analyses of major shipboard energy users. Total shipboard systems optimizations were then initiated to determine the energy conservation potential of the total ship system concepts. Developmental costs, risks, and time were compared to projected payoff and the systems were designated for implementation in the near, mid, or far term.

Future fleet characterization was started for ship propulsion powering, and electrical and thermal energy requirements. These requirements will be used to scale the baseline systems to projected future ship types. Based on anticipated populations of individual system components, the scaling will determine priorities for system development efforts.

A life-cycle-cost computer program was developed to compute the life-cycle-cost elements for a total class of ships over an extended procurement cycle. Near-, mid-, and far-term energy-efficient shipboard systems concepts will be analyzed using the program, and the results used to scale the baseline systems.

A preliminary life-cycle-cost analysis was done for near-term advanced propulsion system concepts. It was compared with the LM 2500 gas-turbine baseline system for the 1977 to 2004 projected ship construction schedule.

Results indicated that one attractive way to economize on fuel is to use a combination diesel or gas turbine (CODOG) propulsion system comprising two 9,000-horsepower diesel engines and two high-performance FT9 gas turbines. The diesel engines provide economical power for cruising, while the gas turbines provide the boost power and response requirement for full-speed operation. Indicated costs of RDT&E, acquisition and installation, manning, and logistics support associated with a CODOG system will be offset by fuel savings in less than 20 years. (The calculations were based on 1976 dollars

discounted at 10 percent per year and delivered fuel costs of $26 per barrel in 1975, with a $2 per barrel cost escalation per year.) Other combination propulsion systems, such as those using gas turbines with waste-heat steam plants for cruise operation (COGAS), more efficiently loaded cruise turbines, and larger cruise diesel plants were also considered. Life-cycle costs for these propulsion systems would not be offset by fuel savings for about 25 years and a much larger initial investment is required compared with the CODOG system.

To further define the CODOG potential, a detailed diesel propulsion noise analysis and a marine diesel reliability, maintainability, and availability study were started. Also, a CODOG ship design study was begun to determine the feasibility of using diesel propulsion on the projected future platforms.

Technical and preliminary life-cycle analyses of near-term and mid- and far-term advanced electrical generating system concepts were completed. Results indicated that a diesel generator with jacket water heat recovery can potentially reduce electrical generator system fuel consumption by as much as 40 percent, when compared with a conventional gas turbine with waste heat recovery. Development of a diesel generator procurement plan was started that will lead to the specification and procurement of a 2,000-kw diesel generator for test and evaluation. The diesel noise analysis will determine what actions are necessary to meet the low-noise requirements of ASW platforms. Since previous analyses considered only one level of heat recovery, a multiclass thermal study of diesels is being conducted to extend the results to include both exhaust heat and jacket water heat recovery. Procurement will follow these analyses.

An electrical load factor analysis is being performed to determine detailed load requirements under various conditions aboard ship.

Analysis of shipboard energy user's within auxiliary subsystems indicated that about 50 percent of the fuel consumed by the DD 963 electric plant is required for the heating and air conditioning systems and for pumps (25 percent of the total is for pumps alone). An additional 18 percent is required for lighting and ventilation systems. These results were obtained under seasonal operating conditions of 25 percent summer, 50 percent spring and fall, and 25 percent winter.

A lighting system load reduction study was completed in August 1976. Alternate lighting system recommendations from the load reduction study included using high-intensity discharge devices, high-frequency fluorescent lamps, and preset dimmers. A hardware suitability study of these alternate lighting systems was started.

A contract was awarded in July 1976 to J. J. Henry, Morristown, N.J., for analysis of alternate pumping systems. A variety of pump types and drives are being studied and the most promising will be recommended for specific hardware suitability studies.

Heating, ventilation, and air conditioning (HVAC) systems have been identified as the single largest electrical load requirement on a ship. An RFP has been prepared and

solicitation will be initiated to determine alternate HVAC cycles and distribution equipment. A contract award for this analysis is expected later this year.

The shipboard total energy analysis effort involves integrating and balancing all shipboard energy requirements to maximize use of primary energy sources. Specifically addressed are additional fuel consumption reductions that can be achieved by integrating the propulsion, electrical generating, and auxiliary systems analyses and the potential payoff (in dollars and fuel reduction) for the future fleet. This effort will ensure that suboptimum use of one subsystem at the expense of another does not occur and that the total energy efficiency of the ship is primary. To this end, the development of a total energy model computer program was started. The model will allow many combinations of propulsion, electrical generating, and auxiliary systems to be analyzed for energy flows from the prime movers to the loads.

Other shipboard subsystem studies were initiated for:

- Pumping systems,
- Pneumatic systems,
- Shipboard thermal insulation, and
- Shipboard energy storage.

In other related studies a computerized energy data bank for shipboard machinery is being compiled and an overview study and detailed impact studies of government regulation on projected new systems on ships were started.

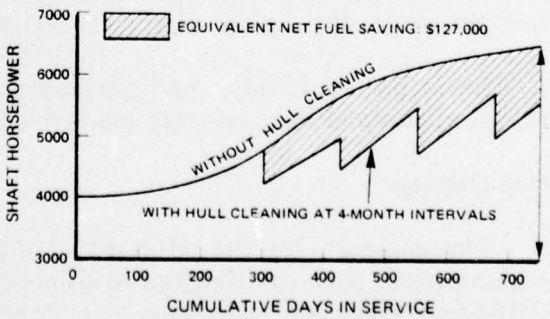
HULL MAINTENANCE

Sponsor: NAVSEA
Performer: DTNSRDC
Contact: C. F. Krolick

Program Element 63724N and 64710N
Project Z0329 and Z0371

OBJECTIVE

The hull maintenance project effort for both advanced development (6.3) and engineering development (6.4) is to improve underwater hull cleaning methods and antifoulant hull coatings. In the advanced development program, DTNSRDC is developing advanced techniques for the underwater removal of marine fouling with particular emphasis on reducing the labor-intensive diver-deployed cleaning methods now used. In addition, DTNSRDC is developing advanced anti-



EFFECT OF HULL CLEANING (50,000-DWT VESSEL)

fouling hull coatings, drag reducing hull coatings, and special application antifouling coatings for propellers and sonar domes. The engineering development program provides for at-sea tests of improved hull maintenance (cleaning and coating) technologies.

TECHNICAL APPROACH

Hull Cleaning

The basic approach for the hull cleaning effort is to determine how and when to conduct cleaning of underwater ship surfaces. To select candidate methods for sea-trial evaluations, cleaning technologies are being evaluated, by both laboratory and field investigations, on the basis of availability, cleaning effectiveness, and compatibility with paint systems.

Sea trials are being conducted on FF 1052 class ships to determine cost-effective hull-cleaning guidelines. A Phase I trial, emphasizing cleaning methods, involves pier-side shipboard instrumentation and hull cleaning, and underway testing. This phase determines the adequacy of the underwater hull-cleaning methods, the necessary instrumentation, and sea-trial requirements.

In Phase II, a two-year program, the cost effectiveness of underwater cleaning techniques will be studied and necessary cleaning frequencies determined. One reference ship and one test ship have been selected from the Atlantic Fleet and from the Pacific Fleet. The ships are being instrumented so that the effects of fouling can be monitored, based on power requirements. Initial sea trials are being conducted for all the ships shortly after they have been cleaned and painted in drydock to establish baseline power levels with cleaned hulls. The reference ships will not be cleaned again for the two-year test period.

Short power trials are routinely scheduled at about 30-day intervals and the collected data forwarded to DTNSRDC for analysis. When the power required for a given ship speed increases above a predetermined value, DTNSRDC personnel will assist in conducting a detailed power trial aboard the test ship. Underwater cleaning of the test ship will then be done and a post-cleaning power trial conducted to assess the effects of cleaning. Reference and test ship power levels will be compared during the two-year test period. This approach should give a realistic estimate of the relative fuel and cost savings that can result from regular underwater hull cleaning.

Based on results from the laboratory and field studies, fleet implementation guidelines for underwater hull cleaning will be prepared and issued.

Hull Coatings

The approach for the advanced antifouling hull coatings effort is to synthesize organometallic polymer (OMP)-based paints from previously synthesized OMP resins. The OMP-based paints are undergoing laboratory tests for compliance with current military

specifications. Small batch formulations are being procured for patch-panel static immersion tests and shipboard application evaluation. Up to 20 ships will have waterline-to-keel belly stripes applied with the OMP-based paints while drydocked as part of the normal overhaul schedule. The coatings will be monitored to determine their antifouling performance.

Special application coatings designed for use on propellers and sonar domes are being developed by chemically altering commercially available and laboratory-synthesized polyurethane and epoxy resins to incorporate OMP antifoulants. Once synthesized into paints, the performance of these coatings will be laboratory tested under conditions designed to simulate actual propeller and sonar dome operations. Concurrently, these special-application paints will be tested for compliance with current military paint specifications and will be evaluated for antifouling effectiveness through patch-panel static immersion tests. If acceptable, sufficient paint quantities will then be procured to conduct shipboard evaluations.

PAST PROGRESS

Hull Cleaning

The rotary-brush cleaning method was selected for evaluation as a result of a survey of hull-cleaning technologies, and the "how to clean" methods demonstrations done in early 1976. Two commercially available rotary-brush cleaning systems–Scamp and Brush Kart–were chosen for testing. A sea-trials program was approved and instrumentation was selected and procured for the shipboard trials.

Phase I trials were conducted on the U.S.S. Holt (FF 1074) during May and June 1976. Ships for the Phase II trials were selected: U.S.S. Trippe as the reference ship and U.S.S. Blakely as the test ship from the Atlantic Fleet; and U.S.S. Whipple as the reference ship and U.S.S. Stein as the test ship from the Pacific Fleet.

Hull Coatings

Four OMP resins have shown satisfactory antifouling characteristics through four years of static immersion patch-panel tests. Five contracts were awarded in May 1976 for small-batch formulation of paints based on the four OMP resins (designed as OMP 1, 2, 4, and 5). The Bureau of Medicine (BuMed) began acute toxicological studies of OMP resins. In addition, the National Bureau of Standards (NBS) began degradation studies on the leach rates and DTNSRDC began marine toxicity and related characterization studies of the OMP resins.

PROGRESS DURING JULY 1976-FEBRUARY 1977

Hull Cleaning

DTNSRDC assisted in the evaluation of the Scamp and Brush Kart underwater hull cleaning systems. The Scamp system was used to clean the U.S.S. Tarawa (LHA-1) and

the U.S.S. Virginia (GGN-38). The Brush Kart was used to clean the U.S.S. Marvin Shields (FF 1066). Observations indicated that procedural precautions and post cleaning inspections are necessary to ensure safe conditions for the divers, maximum cleaning effectiveness, and minimum damage to the hull coating.

An interim fleet instruction on "how to clean" was drafted and is under review.

Studies of sea-chest fouling prevention using ultrasonics were started in November 1976 at the Navy Coastal Systems Laboratory in Panama City, Florida. Preliminary evaluation of several acoustic devices was completed. The devices were attached to steel test plates submerged for 50 days. Both continuous wave (CW) and pulsed signals at various frequencies were used. A 164 kHz, 10 watt, CW device did appear to retard marine growth; evaluations are continuing. Also, studies of sea-chest cleaning using high pressure jets were started.

Development efforts continued for an intermediate cleaning brush that is more effective in removing heavy marine fouling without removing excessive amounts of paint. In addition, a cleaning tool is being developed for use on propellers.

Phase II sea trials were started in August 1976. The status of the trials is shown below:

PHASE II HULL CLEANING TRIALS STATUS

Ship	Time Since Drydock[a]	Initial Trial	Underwater Hull Cleaning	Post-cleaning Trial
Atlantic Fleet				
U.S.S. Blakely (FF 1072)—Test	6 months	8/5/76	8/15/76	9/20/76
U.S.S. Trippe (FF 1075)—Reference	4 months	8/28/76		
Pacific Fleet				
U.S.S. Stein (FF 1065)—Test	4 months	12/3/76		
U.S.S. Whipple (FF 1062) Reference	11 months	11/18/76		

[a]Drydocking included hull cleaning and painting.

An evaluation of the Sperry Doppler ship's speed sensor to ascertain repeatability and accuracy was also initiated as part of the sea-trials effort.

Hull Coatings

Deliveries of the contracted OMP-based paint began during the report period and are continuing. Various combinations of the paints and Navy system primers were applied to patch panels and are undergoing static immersion tests in Miami, Florida and Pearl Harbor, Hawaii.

BuMed completed acute toxicological studies of the four OMP resins and started studies of the OMP 1 and 2 paints. Approval was issued in February by BuMed for

application of six of the OMP 1 and 2 paints to ship hulls. Leach-rate, marine toxicity, and related characterization studies of the OMP resins continued.

In special application coatings research, a bronze base plate of propeller stock was procured for conducting coatings tests. Potential propeller coatings and application methods were selected for various spray-coat processes on a bronze plate. Development was initiated for determining screening and scaling methods of the propeller coatings (polyurethanes, nylons, teflons).

MACHINERY OPTIMIZATION

Sponsor: NAVSEA
Performer: DTNSRDC
Contact: C. F. Krolick

Program Element 64710N
Project Z0371

OBJECTIVE

System and procedural modifications are being developed to reduce shipboard energy losses and increase system efficiencies in the near term. Energy-intensive machinery and operating procedures, and sources of energy losses are being identified by conducting heat-balance analyses and shipboard sea trials.

TECHNICAL APPROACH

Ship energy consumption and distribution patterns for the boiler plant and steam systems are being compared with ship design data; these data are being corroborated through using detailed operating logs, researching typical mission operating conditions, and documenting operational preferences. The analyses and supporting cost information are being used to develop procedural equipment modifications.

Initial sea trials are being conducted on the FY 1052 class since it is the largest ship class in the fleet and has a modern steam plant. Sea trials are being conducted in two phases: Phase I trials are being conducted at various speeds and under normal operating conditions to represent typical underway fuel consumption rates; Phase II trials are being conducted under controlled conditions to determine the amount by which fuel consumption can be reduced as a result of improved operating procedures.

PAST PROGRESS

Initial estimates have indicated that about 10 percent fuel savings could be realized through shipboard machinery system optimization. A 10 percent reduction in fuel consumption by the frigate fleet in FY 1976 would have resulted in a savings of about $3 million.

PROGRESS DURING JULY 1976-FEBRUARY 1977

Heat-balance analyses based on design data, technical documentation, previous sea trials, and certification data of a demonstration ship were completed for the FF 1052 class. The analyses were performed by adapting an existing computer program to the FF 1052 class steam cycle. A determination was made of the power plant operating characteristics and fuel consumption over the mission profile from 8 knots to full power, in 2-knot increments.

A sea-trial plan was developed and the necessary instrumentation was determined to quantitatively verify energy usage profiles at various steaming conditions. Phase I trials involve normal steaming power at various speeds with machinery aligned in accordance with standard operating procedures. Phase II trials involve steaming at the same power levels as Phase I, but with boiler excess air maintained at 15 to 20 percent; one ship service turbine generator on-line; one forced draft blower per boiler; standby main feed pumps taken off-line; and all pressures and temperatures set according to design conditions. For each phase, flow rates, shaft torque, boiler excess air, condenser vacuum, and subsystem temperature and pressures are measured at each speed.

Phase I and II trials were conducted September 27 through October 2, 1976, on the U.S.S. Holt (FF 1074). Preliminary results indicated that the fuel consumption rate in Phase II (controlled conditions using improved operating procedures) was significantly lower than the fuel consumption rate in Phase I (normal operating conditions) particularly in the cruising range of the ship. Phase II fuel consumption was 16.7 percent lower at 12 knots and 10.6 percent lower at 16 knots. Heat-balance calculations are being completed and a final report will be prepared detailing recommendations for energy-conserving equipment and procedural modifications.

Methodology is being developed to extend the FF 1052 class analyses to other ship classes.

WATER RESOURCE MANAGEMENT

Sponsor: NAVSEA
Performer: DTNSRDC
Contact: C. F. Krolick

Program Element 64710N
Project Z0371

OBJECTIVE

DTNSRDC is identifying freshwater flow patterns aboard ship, and is formulating water resource management techniques to improve the efficiency of freshwater production and utilization aboard ship.

TECHNICAL APPROACH

Existing processes, operations, and activities that consume fresh water are being analyzed for a FF 1052-class frigate and an aircraft carrier. The FF 1052 class was selected because it is the largest ship class in the fleet, and the carrier was selected because it demands the largest amount of fresh water. Areas in which water use can be reduced will be identified, and the impact of such a reduction will be assessed. Potential payoff will be studied, and specific equipment and procedural modifications for reducing water usage will be recommended. The proposed modifications will be implemented and their effectiveness measured.

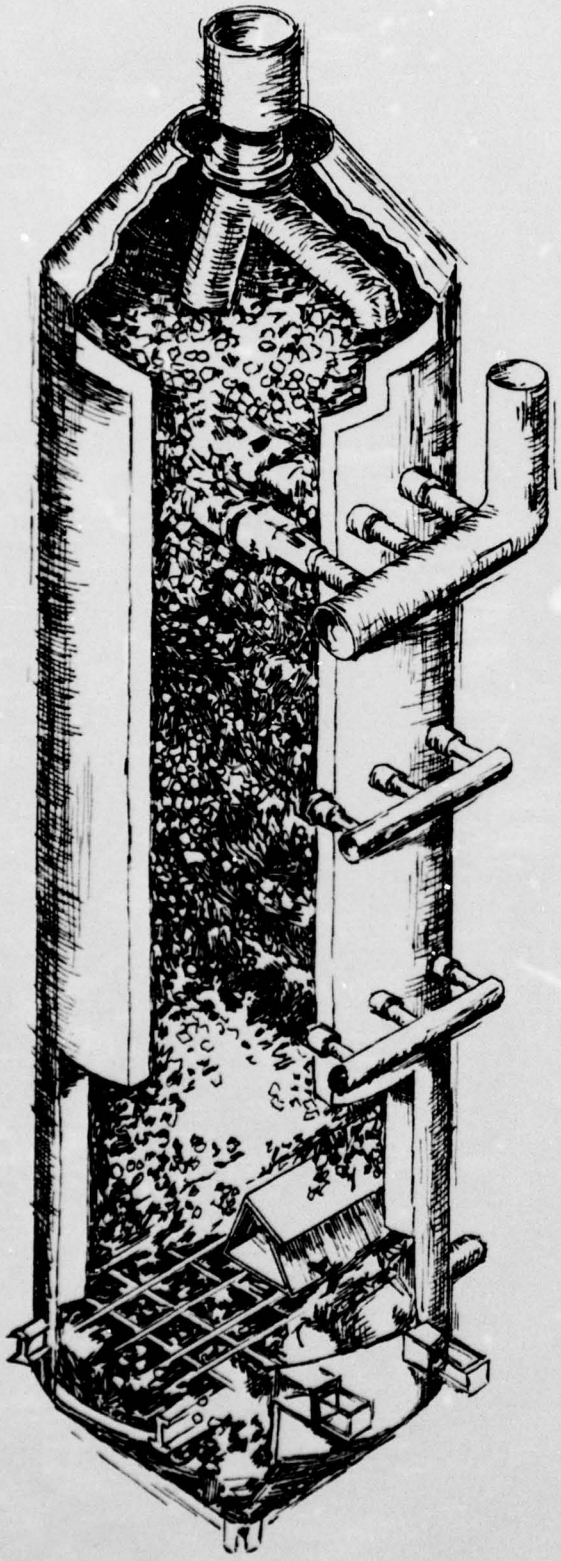
PAST PROGRESS

This project, started in the fourth quarter of FY 1976, is a follow-on to a project (performed within the exploratory development program during FY 1975) that calculated the cost of freshwater production on Navy ships. Work done as part of this engineering development program will include verification of the freshwater production costs.

PROGRESS DURING JULY 1976-FEBRUARY 1977

Shipboard freshwater use patterns identified by an existing water pollution data base are being extended to determine detailed energy use. Further determination will be made through the installation of 100 water flow meters on the U.S.S. Saratoga (CV 60) and 25 water flow meters on the U.S.S. McCandless (FF 1084). Flow meter installation is in progress.

A plan for testing and evaluating a commercially available laundry-water-recycling system was completed. In initial tests, laundry water was cleaned and recycled 50 times, reducing consumption of fresh water 88 percent, and consumption of chemicals, 50 percent. The system is now undergoing detailed laboratory investigation.



SYNTHETIC FUELS

SYNTHETIC FUELS PROJECTS

AIRCRAFT FUEL CHARACTERIZATION ANALYSES 48
Sponsor: NAVAIR Program Element 62765N
Performer: NAPTC/NRL

SYNTHETIC FUELS LABORATORY TEST PROGRAM 49
Sponsor: NAVFAC Program Element 62765N
Performer: CEL

NEW FUEL SOURCES FOR SHIPS 50
Sponsor: NAVSEA Program Element 62765N
Performer: DTNSRDC/A

SYNTHETIC FUELS TOXICOLOGY 51
Sponsor: NAVMAT Program Element 62765N
Performer: Naval Medical R&D Command

SMALL-SCALE TESTS WITH SYNTHETIC FUELS FOR FACILITIES 52
Sponsor: NAVFAC Program Element 63724N
Performer: CEL Project Z0838

COAL UTILIZATION SYSTEMS–CENTRAL COAL GASIFICATION PLANT 53
Sponsor: NAVFAC Program Element 63724N
Performer: CEL Project Z0838

LIGHT REFINED LIQUID FUELS FOR SHIPS 54
Sponsor: NAVSEA Program Element 63724N
Performer: DTNSRDC/A Project Z0838

LIGHT REFINED LIQUID FUELS FOR AIRCRAFT PROPULSION 56
Sponsor: NAVAIR Program Element 63724N
Performer: NAPTC Project Z0838

AIRCRAFT FUEL CHARACTERIZATION ANALYSES

Sponsor: NAVAIR
Performer: NAPTC/NRL
Contact: C. J. Nowack

Program Element 62765N

OBJECTIVE

NAPTC and NRL are evaluating the chemical and physical characteristics of synthetic JP-5 to determine whether it is suitable for use in aircraft propulsion systems.

TECHNICAL APPROACH

The physical and chemical characteristics of JP-5 fuels derived from coal, oil shale, and tar sands will be established and studied to determine whether they comply with military specifications. Characteristics peculiar to synthetic JP-5, including its safety, ease of handling, compatibility with military systems, and performance, will also be studied.

PAST PROGRESS

Syncrude derived from western Kentucky coal using the COED process was refined into 235 gallons of JP-5 (modified specification limits). Physical and chemical analysis of this material showed that it is generally equivalent to petroleum-based JP-5, but that its smoke point is low and it is deficient in hydrogen. Compatibility, electrostatic, and flammability tests indicated that this coal-derived fuel was equivalent to JP-5. Engine tests with the T63 indicated equivalent performance at sea-level conditions with equivalent exhaust emissions.

Studies of JP-5 derived from oil shale (from the 10,000-barrel experiment) showed that, by using urea extraction and acid treatment, specification-grade JP-5 can be obtained. Flammability of the JP-5 derived from oil shale is the same as petroleum-based JP-5, and standard extinguishing agents (such as film-forming foam) can be used. There is also a strong correlation between the freeze point and the concentration of normal hexadecane in the fuel. Electrostatic tests showed, however, that the electrical conductivity of fuel derived from oil shale and its charging tendency is higher than conventional fuels. Oil-shale-derived fuel exhibited characteristics similar to conventional fuels with antistatic additives. Tests with the T63 engine showed that the emissions of carbon monoxide and total hydrocarbons from the oil-shale-based JP-5 were equivalent to those of petroleum-based JP-5. More nitrogen oxide was emitted with the oil-shale-based JP-5, however, because the fuel contained 950 parts per million of fuel-bound nitrogen.

Electrostatic properties of synthetic aviation turbine fuels derived from tar sands were studied and found similar to those of fuels derived from petroleum.

PROGRESS DURING OCTOBER 1976-MARCH 1977

Combustor studies at the Army Fuels and Lubricants Laboratory (SWRI) were completed, and the results are being analyzed.

Studies of water coalescer performance and system compatibility (petroleum, elastomers, metals) were started. The methodology for studying fuel system performance was established, and long-lead-time test components were ordered.

The Arizona Fuels/Burma Oil tar sands product was assessed. The crude bitumen is being characterized chemically, and 1 or 2 barrels of the bitumen are being refined.

About half of the tests to determine the effects of nitrogen on storage stability were completed. Nitrogen levels in the fuel of 0, 50, 100, 500, and 950 parts per million at 100° F are being examined. The results, thus far, indicate that fuel with a nitrogen concentration above 50 parts per million may not meet storage stability requirements.

SYNTHETIC FUELS LABORATORY TEST PROGRAM

Sponsor: NAVFAC
Performer: CEL
Contact: T. T. Fu

Program Element 62765N

OBJECTIVE

The physical and chemical characteristics of synthetic residuals and fuel oils are being evaluated and compared with those of conventional fuels.

TECHNICAL APPROACH

CEL will characterize and analyze synthetic fuel samples to determine whether they can be used in land-based military power systems. The potential hazards associated with the use of synthetic fuels, as they apply to personnel, equipment, and the environment, will also be evaluated.

PAST PROGRESS

The open-flame test facility was used to study burning characteristics of the synthetic fuels (residuals) from shale. Synthetic heavy fuel oil was fired in a 30-horsepower fire-tube boiler.

Open-air-burner firing tests were conducted using heavy fuel oil with acoustic and steam atomization nozzles. Radiation heat-flux measurements indicated that, at a particular fuel firing rate, the heat flux was 43 percent greater using the synthetic heavy fuel oil from shale than it was using conventional No. 5 burner oil.

PROGRESS DURING OCTOBER 1976-MARCH 1977

Preparation of a handbook of technical data on nonspecification fuels in Navy boilers was started. The format for the handbook is being developed, and data assembled.

Turbulator tests in an operational boiler indicated that stack-gas temperature is reduced and boiler efficiency is increased. Up to 30 percent waste fuel was blended into clean fuel and fired successfully in conventional oil burners, and up to 60 percent waste JP-5 was blended with No. 2 fuel oil and fired successfully. Long-term boiler tests were planned. Storage and handling tests were completed, as were contractor-fuel combustion tests.

DOCUMENTATION

"Combustion Performance of Fuel Oil/Waste Oil Blends," CEL Contract Report No. CR 77.004, November 1976.

NEW FUEL SOURCES FOR SHIPS

Sponsor: NAVSEA
Performer: DTNSRDC/A
Contact: C. F. Krolick

Program Element 62765N

OBJECTIVE

DTNSRDC is conducting laboratory analyses of the physical and chemical properties of synthetic crude oils and fuels. The goal is determining the suitability of using these fuels in Navy shipboard systems.

TECHNICAL APPROACH

The physical and chemical properties of synthetic fuels will be analyzed. Potentially useful synthetic fuels will be tested in small- and full-scale engines in advanced development (6.3) and in sea trials in engineering development (6.4).

PAST PROGRESS

Synthetic fuels, synthetic crudes, and other synthetic products were tested. The samples were characterized on the basis of fuel specification tests and physical and chemical property analyses. Assay analyses were performed on the synthetic crudes to determine their potential distillate yield.

The possibility of upgrading certain synthetic fuels and the feasibility of using alcohols as substitute shipboard fuels were also studied.

Paraho indirect-fired shale oil was tested. Analysis indicated that this crude has improved properties (pour point, gravity, viscosity, etc.) over Paraho direct-fired shale oil.

PROGRESS DURING OCTOBER 1976-MARCH 1977

Oil-shale-based synthetic crude from ERDA's Laramie, Wyoming, Energy Research Center was analyzed.

The physical and chemical properties of synthetic DFM derived in the 10,000 barrel oil-shale experiment are being compiled. Results of materials compatibility, storage, and thermal stability tests are being included in the compilation.

SYNTHETIC FUELS TOXICOLOGY

Sponsor: NAVMAT Program Element 62765N
Performer: Naval Medical R&D Command
Contact: L. E. Doptis

OBJECTIVE

The Naval Medical R&D Command is conducting laboratory tests on the possible toxic and carcenogenic effects of natural and synthetic military fuels. The goal is to develop biomedical criteria needed to protect personnel from potential adverse effects resulting from contacting or inhaling synthetic fuels and their by-products.

TECHNICAL APPROACH

Quantitative chemical analyses of fuels will be reviewed, and the exposure of personnel to fuels will be studied. Animal toxicity studies will be done to characterize the acute and chronic effects of synthetic fuels.

PAST PROGRESS

Inhalation studies on natural fuels were completed, and work to establish baseline toxicological criteria for conventional fuels was started.

PROGRESS DURING OCTOBER 1976-MARCH 1977

Preliminary toxicological evaluation of synthetic JP-5 fuel from shale oil was begun. (The toxicology detachment was moved from Washington, D.C., to Wright-Patterson AFB, Ohio.)

SMALL-SCALE TESTS WITH SYNTHETIC FUELS FOR FACILITIES

Sponsor: NAVFAC
Performer: CEL
Contact: T. T. Fu

Program Element 63724N
Project Z0838

OBJECTIVE

Synthetic fuels are being tested in small-scale components to determine their acceptability for use in Navy shore facility boiler plants.

TECHNICAL APPROACH

Performance tests with small-scale components will include pollution emission measurements. Preliminary systems tests will be done using existing 200-horsepower boilers and auxiliary equipment. The possibility of modifying existing shore-based boilers to accommodate synthetic fuels (residuals) will be studied if other approaches to utilize synfuels fail.

PAST PROGRESS

A 300-horsepower (20,000 pounds per hour) Public Works Center utility boiler at the Naval Construction Battalion Center was fired using 15,000 gallons of synthetic heavy fuel oil from the 10,000 barrel oil-shale experiment. No_x emissions were about three times higher than federal standards allow. Other than the high emission of nitrogen oxides and the high pour point, the synthetic heavy fuel oil was superior to conventional No. 5 burner oil.

PROGRESS DURING OCTOBER 1976-MARCH 1977

Instruments for measuring stack-gas emissions were installed on a 200-horsepower boiler. Multiple fuel storage, metering, and transfer systems were also completed, and boiler shakedown tests conducted. The facility is now fully operational. Approximately 10,000 gallons of residual shale oil are on hand for testing.

DOCUMENTATION

"Residual Shale Oil Burning Tests," TM-63-76-13, September 1976.

COAL UTILIZATION SYSTEMS–CENTRAL COAL-GASIFICATION PLANT

Sponsor: NAVFAC
Performer: CEL
Contact: D. E. Williams

Program Element 63724N
Project Z0838

OBJECTIVE

Central coal-gasification plants are being studied to determine whether their use at Navy bases is feasible and economical. The production of a clean, sulfur- and particulate-free fuel gas would permit the use of existing oil- and gas-fired boilers, as well as existing steam-distribution systems.

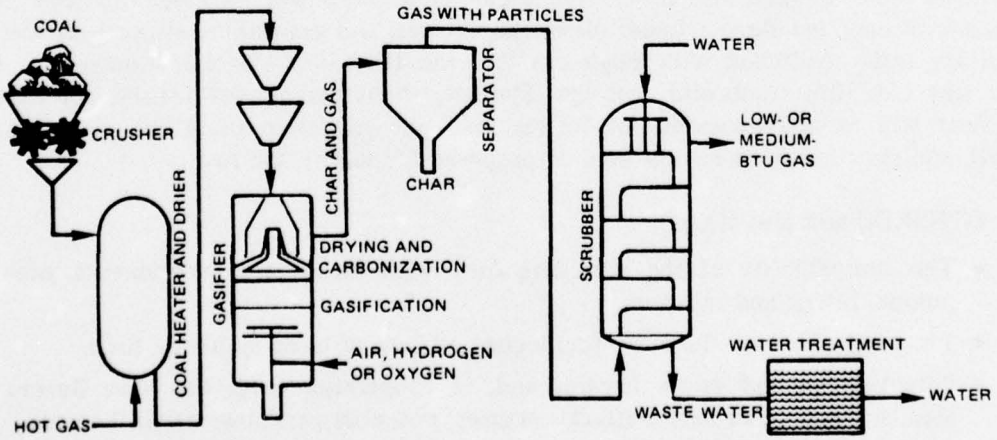
TECHNICAL APPROACH

A preliminary design and a parametric and cost analysis will be done for two types of coal gasifiers. The feasibility of using a central coal-gasification plant at specific sites (three or more Navy bases that have been directed to convert to coal) will also be studied.

PAST PROGRESS

The requirements for the gasifiers were determined:

Coal use	200 tons per day
Energy production	2,500 million Btu per day
Energy in gas	185-300 Btu per cubic foot



COAL GASIFICATION

PROGRESS DURING OCTOBER 1976-MARCH 1977

Studies done by Bechtel, Inc., indicated that two types of gasifiers could be used with a standard process for sulfur removal. These are a Winkler gasifier for oxygen- and air-blown fluidized-bed operation, a Koppers-Totzek gasifier for oxygen-blown entrained-bed operation, and the Purisol process for removing sulfur compounds from the fuel gas. Based on the estimated capital and operating costs of such a system, the gas produced would cost about $6 per million Btu.

Responses to an RFP for a feasibility study are being evaluated.

LIGHT REFINED LIQUID FUELS FOR SHIPS

Sponsor: NAVSEA
Performer: DTNSRDC/A
Contact: C. F. Krolick

Program Element 63724N
Project Z0838

OBJECTIVE

The suitability of using synthetic fuels aboard ship is being assessed. The feasibility of modifying current military fuel specifications to increase the availability and decrease the cost of conventional shipboard fuels is also being assessed.

TECHNICAL APPROACH

DTNSRDC will evaluate the performance of candidate synthetic fuels, using small-scale marine boilers, diesels, and gas turbines. Boiler evaluations will be based on tests conducted with a single-burner test rig, diesel evaluations will be based on tests conducted with one- and three-cylinder diesel test engines, and gas turbine evaluations will be based on tests conducted with single-can (for the DDA501K17) and annular (for the FT-9 and LM2500) combustor test rigs. Synthetic fuels that appear feasible for use by the fleet will be recommended for further test and evaluation using full-scale boilers, diesels, and gas turbines presently used or proposed for use by the fleet.

DTNSRDC will also study:

- The compatibility of the candidate fuels with fuel system components, such as pumps, filters, and injectors.
- The total effect on the Navy fuel logistic system of using synthetic fuels.
- Potential fire and safety hazards and, in cooperation with the Navy Bureau of Medicine and other health-effects agencies, potential personnel health hazards.
- The feasibility of adopting a multifuel capability without compromising fleet operational performance.

A computerized data-handling system will be developed to support the synthetic fuels test and evaluation programs and various comparison and correlation studies.

All test results obtained for each synthetic fuel studied will be reviewed to identify fuels acceptable for fleet use. Guidelines will be developed for implementing the use of these synthetic fuels, including a discussion of any necessary revisions to existing military fuel specifications.

PAST PROGRESS

System compatibility and special logistics and handling needs were analyzed, and a semiempirical technique based on shipboard and laboratory measurements was developed to predict shipboard exposure levels of potentially toxic compounds resulting from using synthetic fuels. An investigation of the effectiveness of present fire-fighting agents and techniques in extinguishing synthetic fuel fires was started.

DFM derived from Paraho shale oil was tested in a single-burner boiler, a three-cylinder diesel, and an NTCC-350 six-cylinder diesel engine. Its performance compared favorably with that of standard DFM.

Contracts for gas turbine tests using DFM derived from oil shale were awarded to Detroit Diesel, Allison, Pratt & Whitney, and General Electric. Results are reported in "Compilation of Oil Shale Test Results."

PROGRESS DURING OCTOBER 1976-MARCH 1977

Preliminary results of the fuel flexibility/availability study project indicated that:

- Use of off-specification conventional fuels may be advantageous under certain conditions; for example, when military specification fuels are not available and off-specification fuels can be used without compromising safety or performance.
- Shortages of JP-5 have occurred and the situation will be aggravated should the other services switch from JP-4 to JP-8 and by the introduction of Alaskan crude.
- If the flash point of shipboard fuels were lowered 4° F to 6° F, fuel availability could be increased significantly.

A draft of the synthetic fuels acceptance criteria was sent out to industry and government for review and comment.

Development of a computerized system for processing synthetic fuels data was nearly completed. Thus far, the computer storage/retrieval program and initial data correlation program have been completed.

In the ship atmosphere characterization project:

- A 12-point sampling system for monitoring the concentration of fuel vapors in shipboard compartments was developed.
- An in-house evaluation of a thermal desorption unit, portable gas chromatograph, and sorbent media for hydrocarbon vapors was started.
- Atmospheric studies aboard three ships (AO, CVA, FF 1052) were requested.
- Atmospheric studies in the fireroom, engine room, and around auxiliary machinery aboard U.S.S. Hewes (FF 1078) were completed.
- Laboratory chamber studies using petroleum-based DFM and oil-shale-based DFM (10,000 barrel experiment) were completed.

LIGHT REFINED LIQUID FUELS FOR AIRCRAFT PROPULSION

Sponsor: NAVAIR
Performer: NAPTC
Contact: L. Maggetti

Program Element 63724N
Project Z0838

OBJECTIVE

NAPTC is evaluating the suitability of JP-5 derived from nonpetroleum sources for use in Navy aircraft through engine, aircraft, and field tests.

TECHNICAL APPORACH

Three classes of engines will be tested with synthetic JP-5. These engines represent old (T-58), current (TF-34), and future (TF-30) technology.

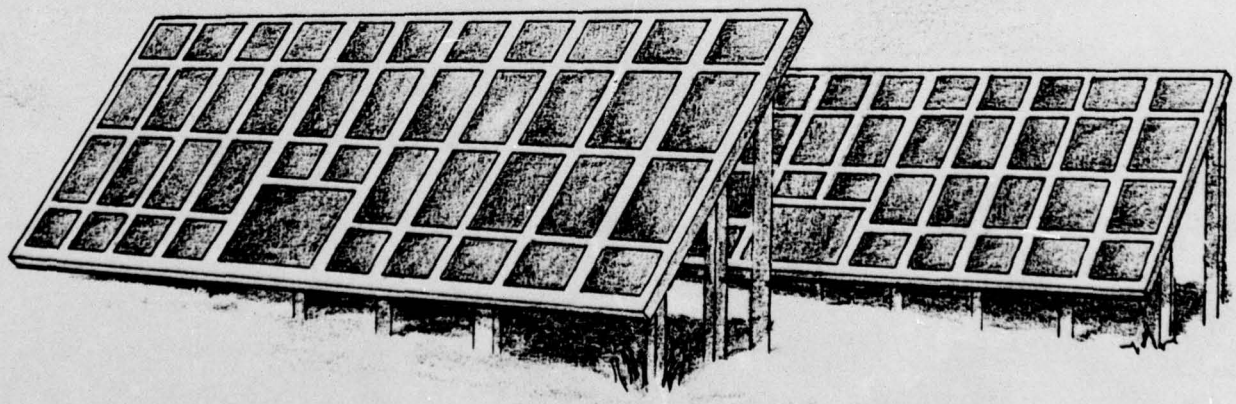
PAST PROGRESS

Preliminary engine tests were done in the exploratory development program.

PROGRESS DURING OCTOBER 1976-MARCH 1977

Funding, fuel, and fuel-storage requirements for the engine tests were analyzed in anticipation of the availability of additional synfuels from the 100,000-barrel shale oil project.

SELF-SUFFICIENCY



SELF-SUFFICIENCY PROJECTS

ADVANCED ENERGY UTILIZATION TEST BED 60
Sponsor: NAVFAC Program Element 62765N
Performer: CEL

ADVANCED AIR CONDITIONING SYSTEMS 61
Sponsor: NAVFAC Program Element 62765N
Performer: CEL

SOLAR/NIGHT RADIATION AUGMENTED HEAT PUMP ANALYSIS AND CONCEPTUAL DESIGN 63
Sponsor: NAVFAC Program Element 62765N
Performer: CEL

RECOMMENDATIONS FOR APPLICATION OF PACKAGED HEAT-RECOVERY INCINERATORS 64
Sponsor: NAVFAC Program Element 62765N
Performer: CEL

PRELIMINARY ANALYSIS OF COMBINED SOLID- AND LIQUID-WASTE PROCESSES 66
Sponsor: NAVFAC Program Element 62765N
Performer: CEL

SMALL-SCALE DENSIFIED REFUSE-DERIVED FUEL PROCESS EQUIPMENT 67
Sponsor: NAVFAC Program Element 62765N
Performer: CEL

DATA COMPILATION FOR SITE CHARACTERISTICS 68
Sponsor: NAVFAC Program Element 62765N
Performer: CEL

GUIDANCE ON SOLAR POOL HEATING 69
Sponsor: NAVFAC Program Element 62765N
Performer: CEL

SOLAR PROJECTS FOR THE ADVANCED ENERGY UTILIZATION TEST BED 71
Sponsor: NAVFAC Program Element 62765N
Performer: CEL

SOLAR COLLECTOR AND THERMAL STORAGE R&D 72
Sponsor: NAVFAC Program Element 62765N
Performer: CEL

DESIGN GUIDE FOR SOLAR HEATING AND COOLING OF BUILDINGS 74
Sponsor: NAVFAC Program Element 62765N
Performer: CEL

RECOMMENDATIONS FOR CENTRAL SOLAR-ELECTRIC POWER GENERATION AT NAVY BASES 75
Sponsor: NAVFAC Program Element 62765N
Performer: CEL

APPLICABILITY OF PHOTOVOLTAIC EQUIPMENT FOR ADVANCED BASES 76
Sponsor: NAVFAC Program Element 62765N
Performer: CEL

FEASIBILITY OF SOLAR DESALINATION APPLICATIONS AT NAVY SITES 77
Sponsor: NAVFAC Program Element 62765N
Performer: CEL

EVALUATION OF 5- TO 10-KW CAPACITY WIND GENERATORS TO SUPPLY POWER FOR BUILDINGS 78
Sponsor: NAVFAC Program Element 62765N
Performer: CEL

FEASIBILITY OF SMALL-SCALE VERTICAL-AXIS WIND MACHINES 80
Sponsor: NAVFAC Program Element 62765N
Performer: CEL

SITE SELECTION FOR INSTALLATION AND TESTING OF 100- TO 1,500-KW WIND GENERATORS 81
Sponsor: NAVFAC Program Element 62765N
Performer: CEL

HANDBOOK FOR APPLICATION OF WIND POWER GENERATORS AT NAVAL FACILITIES 82
Sponsor: NAVFAC Program Element 62765N
Performer: CEL

PRELIMINARY DESIGN OF OPEN-CYCLE SOLAR-ELECTRIC TURBINE GENERATOR 83
Sponsor: NAVFAC Program Element 62765N
Performer: CEL

ADVANCED POWER CYCLES FOR ADVANCED BASES 84
Sponsor: NAVFAC Program Element 62765N
Performer: CEL

NAVY GEOTHERMAL SITE ASSESSMENT 85
Sponsor: NAVFAC Program Element 62765N
Performer: NWC

ADAK GEOTHERMAL RESOURCE DEVELOPMENT 86
Sponsor: NAVFAC Program Element 62765N
Performer: NWC

COSO GEOTHERMAL RESOURCE EVALUATION 88
Sponsor: NAVFAC Program Element 62765N
Performer: NWC

GEOTHERMAL LEGAL AND INSTITUTIONAL STUDIES 89
Sponsor: NAVFAC Program Element 62765N
Performer: NWC

GEOTHERMAL UTILIZATION TECHNOLOGY FOR REMOTE NAVY SITES 90
Sponsor: NAVFAC Program Element 62765N
Performer: NWC

GEOTHERMAL IMPACT ON NAVY MISSIONS 91
Sponsor: NAVFAC Program Element 62765N
Performer: NWC

GEOTHERMAL CORROSION STUDIES 91
Sponsor: NAVFAC Program Element 62765N
Performer: NWC

EVALUATION OF NEW COAL-UTILIZATION TECHNOLOGIES 93
Sponsor: NAVFAC Program Element 62765N
Performer: CEL

ADVANCED ENERGY UTILIZATION TEST BED

Sponsor: NAVFAC
Performer: CEL
Contact: E. R. Vinieratos

Program Element 62765N

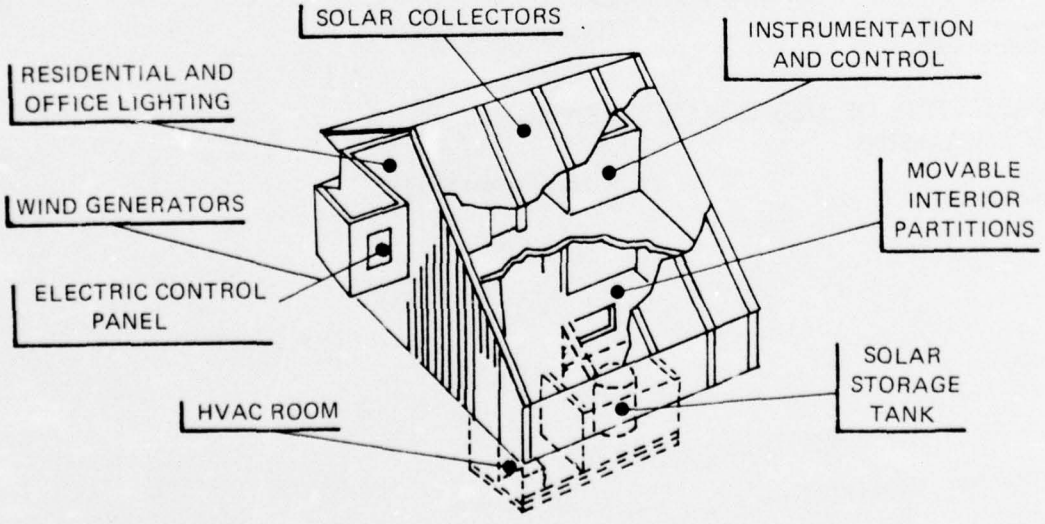
OBJECTIVE

CEL is designing and building an Advanced Energy Utilization Test Bed (AEUTB). Design and operational data on integrated solar, wind, HVAC, construction, and lighting systems are being obtained.

TECHNICAL APPROACH

The AEUTB is being designed to allow maximum flexibility. Specific features will include:

- HVAC equipment, sized and located to serve as a thermal buffer zone.
- Dual electrical systems, one for purchased electricity and one for wind-generated power.
- South-facing, triple-pane, collector windows for preheating solar-collector air.
- Full instrumentation.
- Computerized data reduction and extrapolation.



ADVANCED ENERGY UTILIZATION TEST BED

PAST PROGRESS

A design review was held by CEL during which mechanical and electrical documents were found to be deficient for inclusion in contract bid documents. The decision was made to build the AEUTB shell first and add other components (mechanical, HVAC, electrical, etc.) later under separate contracts.

A contract for Phase I, constructing the AEUTB shell, was awarded to McGall Constructors of Ventura, California. The Naval Construction Battalion Center worked closely with CEL engineers to complete the bid package. Plans and specifications for the HVAC, electrical, and instrumentation systems were reviewed and recommendations made.

PROGRESS DURING OCTOBER 1976-MARCH 1977

Phase I was completed, and the bid package for Phase II, adding components, was prepared. The requirements for a gas furnace, wall panels, fire alarm system, and dual wire commercial and wind electrical system are being formulated, and the test plan is being written.

ADVANCED AIR CONDITIONING SYSTEMS

Sponsor: NAVFAC
Performer: CEL
Contact: A. W. McClaine

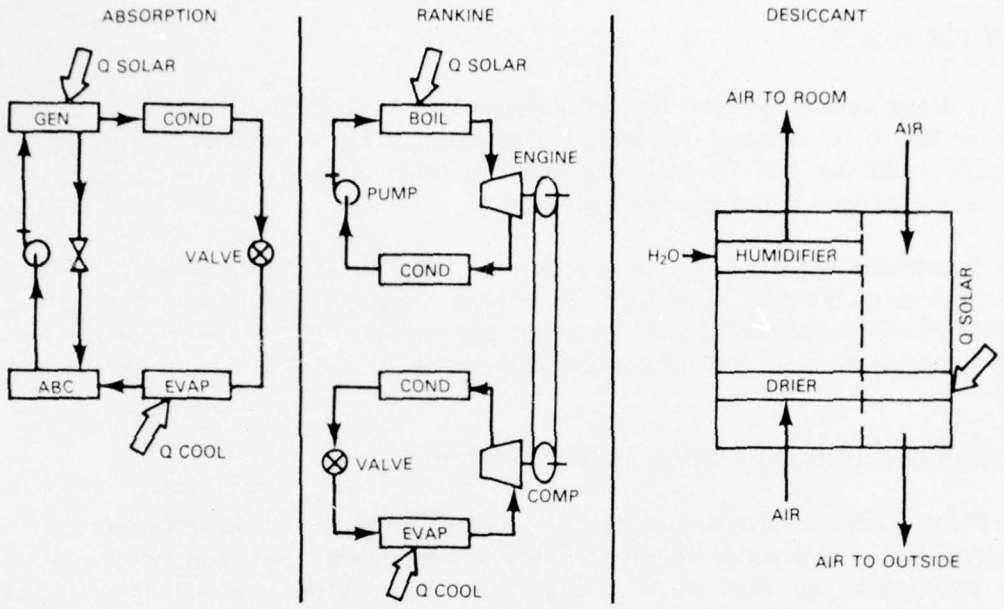
Program Element 62765N

OBJECTIVE

Several advanced air-conditioning systems for Navy use are being studied. Current work emphasizes an economic evaluation and comparison of solar-driven absorption air-conditioning systems.

TECHNICAL APPROACH

Existing absorption air-conditioning systems are being studied and compared with those under development. Research on absorption air conditioning is being performed, for example, by the University of Florida, which has been experimenting with the ammonia/water (absorption) cycle, and ERDA has several development contracts underway. These systems are being evaluated in terms of their economic and thermodynamic feasibility. An economic comparison of solar and conventional air-conditioning systems in seven geographic locations typical of Navy facilities in the United States is also being conducted.



ADVANCED AIR-CONDITIONING SYSTEMS

PAST PROGRESS

A contract was awarded in July 1976 to Arthur D. Little, Inc. (ADL), to study solar air conditioning. ADL identified major manufacturers of solar cooling equipment and characterized equipment performance, and began a review of existing and planned solar cooling projects.

Using an existing computer program, ADL characterized heating and cooling load profiles for typical dwellings in Chicago, Illinois, and Key West, Florida, and evaluated the performance of a single-effect lithium-bromide/water solar-powered cooling system using evacuated, tubular-type solar collectors.

PROGRESS DURING OCTOBER 1976-MARCH 1977

ADL characterized heating and cooling load profiles for typical office buildings in Chicago and Key West, and developed techniques for evaluating the performance of other system concepts in other geographic locations.

ADL completed its review of solar cooling projects and equipment performance characteristics, and obtained preliminary capital cost data for components. Absorption, Rankine, and desiccant systems were analyzed.

SOLAR/NIGHT RADIATION AUGMENTED HEAT PUMP ANALYSIS AND CONCEPTUAL DESIGN

Sponsor: NAVFAC
Performer: CEL
Contact: A. W. McClaine

Program Element 62765N

OBJECTIVE

CEL is investigating the concept of a heat pump, augmented by solar/night radiation, for reducing energy loads in Navy buildings. If economical systems can be identified, a test unit will be designed and tested in the Advanced Energy Utilization Test Bed.

TECHNICAL APPROACH

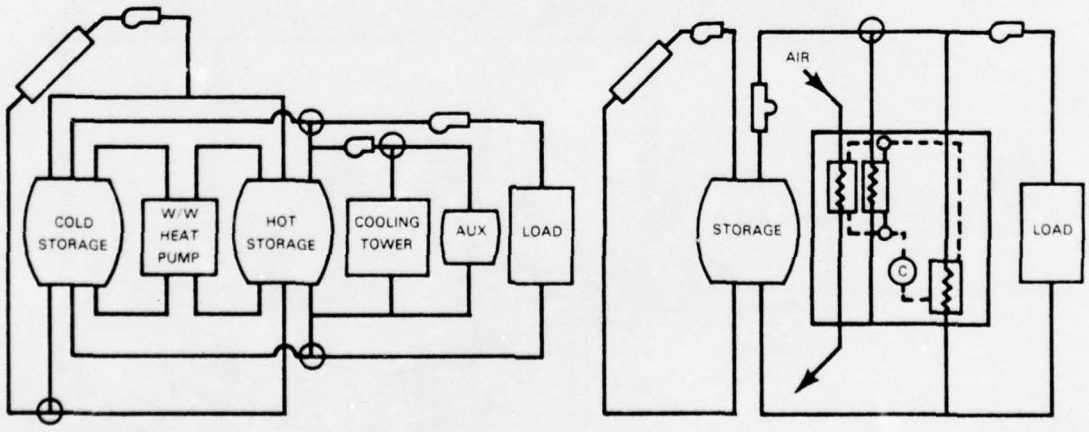
The concept of a heat pump, assisted by collected solar energy for heating and nighttime radiation for cooling, will be studied to determine the best arrangement and size of components for a demonstration system.

PAST PROGRESS

A literature survey was started, as was the conceptual analysis of designs of heat pumps augmented by solar/night radiation.

DUAL STORAGE SYSTEM

DUAL SOURCE HEAT PUMP SYSTEM



SOLAR-AUGMENTED HEAT PUMP

PROGRESS DURING OCTOBER 1976-MARCH 1977

The literature survey was completed, and work continued on the conceptual analysis. During this reporting period, the effort included contacting major organizations involved in heat pump work, identifying alternative heat pump systems, and performing a computer analysis of these systems. The most promising system will be the basis for designing an experimental model, which will be used to verify the results of the analysis and identify problems and variables not included in the analysis.

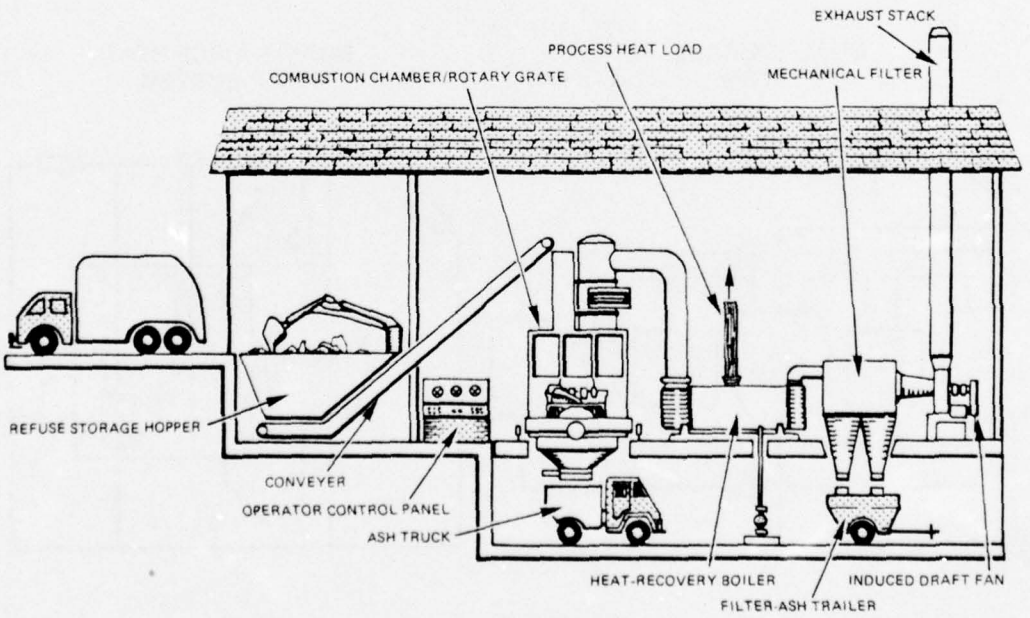
RECOMMENDATIONS FOR APPLICATION OF PACKAGED HEAT-RECOVERY INCINERATORS

Sponsor: NAVFAC
Performer: CEL
Contact: P. L. Stone

Program Element 62765N

OBJECTIVE

Packaged heat-recovery incinerators are being tested to obtain performance data and economic guidance for possible Navy use.



PYRO-CONE ROTARY GRATE FURNACE

TECHNICAL APPROACH

The burning capacity, overall efficiency, and other characteristics of controlled-air-incinerator systems are being tested under contract. In addition, new installations will be visited. The best available packaged incinerator will be recommended for installation as a basic demonstration prototype.

PAST PROGRESS

A cost analysis of packaged heat-recovery incinerators to date indicated that a system objective of 120 hours continuous operation on a regular weekly basis would be desirable to maximize energy recovery with minimum capital investment.

Under contract to CEL, SYSTECH ran a 48-hour continuous test of a packaged heat-recovery incinerator (the Kelly Company system) at the Columbus, Ohio, Xerox plant. This system was selected because the available waste is similar to that at Navy shore facilities and special test ports and instruments were easily installed. Although relatively new, the system operated well, with little operator attention. Heat-recovery efficiencies exceeding 60 percent were extrapolated from preliminary results through additional air controls, which are being designed.

CEL observed the operation of COMSUMAT Corporation's Model 1200 packaged heat-recovery incinerator, which runs semicontinuously. The system operated reliably with only one attendant; the automatic ash-removal subsystem functioned well; there were no glass slagging problems; and good air controls maintained stable temperatures.

Observations and tests to date indicate that packaged heat-recovery incinerators are reliable, and incinerators with a capacity of about 20 tons per day can be economical as long as optimal air and temperature controls are installed.

PROGRESS DURING OCTOBER 1976-MARCH 1977

A technical memorandum on packaged heat-recovery incinerators was written. Test data and analyses to date indicate two significant areas of potential high thermodynamic loss and consequent low heat-recovery efficiency: high excess air and incomplete combustion of refuse fuel. Further investigation of optimum continuous capacity versus volume is needed.

A contract bid package for a 72-hour continuous test of a heat-recovery incinerator was prepared.

Mass and energy balance data on a non-heat-recovery packaged incinerator were obtained. Losses and possible heat-recovery efficiency and economics were extrapolated.

DOCUMENTATION

"Energy Utilization of Solid Waste at Small Naval Bases–An Economic Decision Model and Comparison of Two Types of Systems," TN-1465, December 1976.

PRELIMINARY ANALYSIS OF COMBINED SOLID- AND LIQUID-WASTE PROCESSES

Sponsor: NAVFAC
Performer: CEL
Contact: P. L. Stone

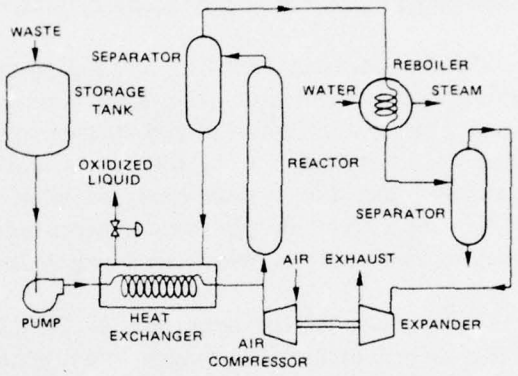
Program Element 62765N

OBJECTIVE

Data are being obtained and analyzed for use in designing and developing prototype solid- and liquid-waste-recycling systems for application at Navy bases.

TECHNICAL APPROACH

The net energy-recovery potential of slurry and dry (burning or decomposition) waste-recycling processes is being studied. The requirement for dewatering and/or evaporation in dry processes is also being analyzed based on typical Navy solid- and liquid-waste compositions. The analysis is being supplemented by several laboratory-scale experiments to obtain additional data on the Navy's waste composition and size of system required.



WET-AIR OXIDATION WASTE-RECYCLING SYSTEM

PAST PROGRESS

Information on wet-air oxidation and anaerobic digestion processes was acquired from ZIMPRO, Inc., and ERDA, respectively. The technology survey indicates that wet-air oxidation and anaerobic digestion processes, or a combination of the two, presently are good candidates to provide a net, direct-energy output from a low-capacity system. Data were obtained on a gasoline process that may use sewage sludge of proper solids concentration. Manufacturers of dewatering filters were also contacted.

PROGRESS DURING OCTOBER 1976-MARCH 1977

A technical memorandum on the technology survey was written.

CEL is investigating low technology, low capital concepts for retrofitting Navy waste-treatment plants to produce methane. Data are being obtained on Navy waste-treatment plants and on energy-recovery processes involving sludges or slurries. Additional data were assembled on the potential for using an anaerobic digestion process that produces synthetic gasoline.

DOCUMENTATION

"Identification of Alternative Power Sources for Dredged Material Disposal Operation," TM-80-76-5, October 1976.

SMALL-SCALE DENSIFIED REFUSE-DERIVED FUEL PROCESS EQUIPMENT

Sponsor: NAVFAC
Performer: CEL
Contact: M. Boogay

Program Element 62765N

OBJECTIVE

The characteristics of densified refuse-derived fuel (RDF) are being evaluated to determine if direct thermal conversion to energy in small packaged incinerators is feasible. RDF is potentially an excellent material for waste-energy-recovery processes, can significantly reduce storage costs per energy unit compared to any other form of RDF, and is amenable to fully automated storage and handling.

TECHNICAL APPROACH

Experimental equipment needed for combustion tests of various densified, processed, and unprocessed RDFs is being identified, and support equipment procured. Prototype design criteria are being developed for densified RDF process equipment.

PAST PROGRESS

The U.S. Army Civil Engineering Resource Laboratory was given a work request to investigate sources of RDFs and problems associated with small-scale combustion of RDF for direct thermal conversion.

PROGRESS DURING OCTOBER 1976-MARCH 1977

Hardware requirements and possible sources of RDFs for small-scale combustion tests in a packaged incinerator were identified. A test plan is being developed.

DATA COMPILATION FOR SITE CHARACTERISTICS

Sponsor: NAVFAC
Performer: CEL
Contact: R. E. Bergman

Program Element 62765N

OBJECTIVE

Energy-related data for Navy bases are being compiled for use by energy researchers and planners.

TECHNICAL APPROACH

Data related to the application of advanced power systems or self-sufficiency measures at Navy shore activities will be assembled, analyzed, reduced, indexed, and stored for ready retrieval. Existing records are being used where possible, and supplemented by on-site measurements. Data obtained in other Navy energy R&D projects, such as data on solid and liquid wastes, are also being used. The exact type of solar, wind, ocean, and geothermal data required is being determined as the program progresses.

PAST PROGRESS

The project emphasis was changed from analyzing existing data to recording solar, wind, and other data in a computer-compatible form.

Family housing sites favorable for solar heating and hot water were identified. Sites favorable for wind generation (primarily remote or island locations where energy cost is high) were also identified.

A potentially useful relationship between heating and cooling degree-days and climate was determined. Oceanic or maritime climates have significantly lower heating and cooling degree-days. In these climates, ambient air temperatures are determined almost exclusively by the nearby or surrounding oceanic water mass. These conditions prevail at island and windward side coastal locations. Inland and leeward continental temperate locations tend to have both higher heating and cooling degree-days. With this relationship, it should be possible to estimate missing cooling degree-days, given location and heating degree-day data. The relationship might also be used for classifying locations for energy demand as a function of climate and/or latitude.

PROGRESS DURING OCTOBER 1976-MARCH 1977

Work continued on acquiring, analyzing, and reducing solar, wind, and other energy-related meteorological data; acquiring and analyzing waste material production and property data; and surveying and accessing ocean and geothermal resource data. In addition, equipment and instrumentation for measuring energy-related meteorological data are being designed and produced.

The Solar Heating and Cooling Demonstration Act survey of family housing was extended from 47 to 121 family housing units.

An energy engineering data bank is being planned. The immediate need is for ready access by CEL to the available data on site characteristics.

A technical memorandum on results of pyrometer tests was issued.

DOCUMENTATION

"Data Compilation for Site Characteristics of U.S. Navy Shore Installations, FY 1976," TM-52-76-11, September 1976.

GUIDANCE ON SOLAR POOL HEATING

Sponsor: NAVFAC
Performer: CEL
Contact: J. M. Baker

Program Element 62765N

OBJECTIVE

CEL is designing and testing a solar-heated swimming pool to provide data and guidance for applying solar pool heating concepts to Navy bases.

TECHNICAL APPROACH

An experimental solar pond is being installed, and different solar-heating concepts tested. An experimental test stand is being constructed to test simple trickle collectors, various plastic collectors, black 55-gallon drums, used black fuel bladders, and multilevel (nonmiscible chemicals) solar ponds without plastic sheet barriers. Models of various convection- and evaporation-inhibiting methods for solar ponds are also being built and tested.

The best solar-heating concepts are being demonstrated in the Naval Construction Battalion Center (NCBC) Port Hueneme pool, and a technical note is being prepared describing the design of solar pool-heating systems.

PAST PROGRESS

An experimental solar pond, insulated with 4 inches of R-19 fiberglass, was installed with thermocouples for measuring temperature gradients. Construction of the test stand was started.

An experimental scale model of a solar pond was built using layers of mineral oil, allyl acetate, and water to prevent convection and evaporation. The water reached 113° F on a clear March day, 27° F hotter than a comparable control model filled only with water. There was no mixing or evaporation of the water between the layers, and dust fell completely through the model to the bottom; thus, the amount of light reaching the bottom of the pond did not decrease.

A large-scale, chemical-layer solar pond (with insulation on the walls but none underneath) was tested. The water reached 100° F to 110° F and absorbed approximately 180,000 Btu per day when the ambient air temperature was 80° F.

Simulation of the NCBC Port Hueneme pool indicated that solar heating was required with and without a pool cover. All commercially available pool covers were evaluated for lifetime, cost, and energy savings.

PROGRESS DURING OCTOBER 1976-MARCH 1977

Analysis of study results showed that evaporation accounts for more than half of the heat loss from a typical solar pool.

A technical memorandum on solar swim pool heating was completed. The report includes heat-loss equations and economic analysis procedures, a computer program to simulate pool response and calculate heat input required and water temperature, test analyses and descriptions of solar ponds for pool heating, an evaluation of commercially available pool covers, and a description of commercially available solar pool heaters.

A solar heating guide for swim pools is being prepared.

SOLAR PROJECTS FOR THE ADVANCED ENERGY UTILIZATION TEST BED

Sponsor: NAVFAC
Performer: CEL
Contact: H. S. Zwibel

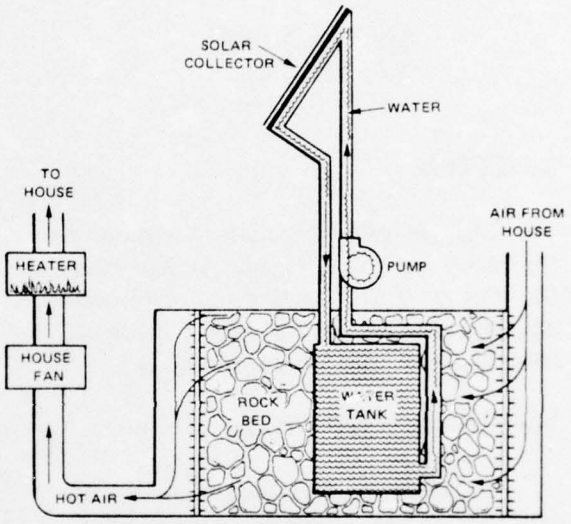
Program Element 62765N

OBJECTIVE

A full-scale solar collector and storage system, integrated with advanced HVAC systems, is being tested and evaluated.

TECHNICAL APPROACH

The Advanced Energy Utilization Test Bed (AEUTB), which is being constructed as part of another project, is being used for testing full-scale solar collectors, storage techniques, solar stills, and solar dryers, integrated with advanced HVAC systems. Promising solar collectors, storage systems, and other components are being analyzed and tested separately by contract. Component tests may precede application on the AEUTB.



SOLAR SPACE HEATING SYSTEM

PAST PROGRESS

The solar collectors and storage system for the AEUTB were designed. CEL determined that the AEUTB should be uninsulated initially so that there would be a significant heating load to test the collectors and storage system.

A checkout stand for testing the solar collectors was designed and built, and instruments for the stand ordered.

Four collectors—trickle, rollbond aluminum, and two types of focusing collectors—were ordered. The trickle collector was tested and the results documented.

PROGRESS DURING OCTOBER 1976-MARCH 1977

The test stand was damaged by wind and had to be repaired.

Initial evaluations were made of several flat-plate and concentrating-type collectors, and preparations are underway to evaluate a National Bureau of Standards collector. Instruments for measuring insolation were calibrated.

An improved data reduction procedure was developed. This procedure allows field data to be evaluated directly by the batch computer.

SOLAR COLLECTOR AND THERMAL STORAGE R&D

Sponsor: NAVFAC
Performer: CEL
Contact: H. S. Zwibel

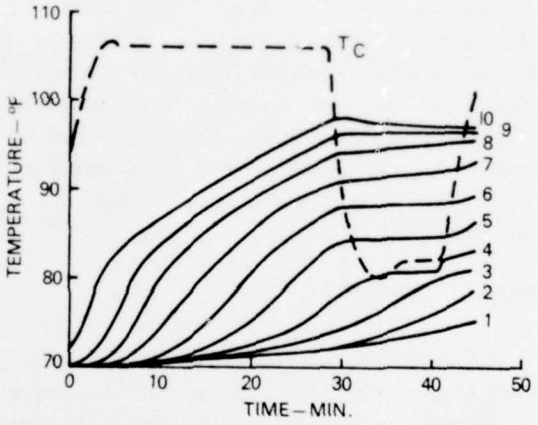
Program Element 62765N

OBJECTIVE

CEL is providing data to support the technology in the Solar Design Manual. Cel is also collecting data and conducting tests to support R&D involving solar collector and storage methods.

TECHNICAL APPROACH

Collector performance data necessary for design guidance is being compiled. Methods of inducing thermal stratification in storage tanks are being studied experimentally. High-temperature heating of boiler feedwater will also be examined, as will the use of supercooled liquids for long-term heat storage at room temperature. In addition, a long-term thermal-storage system based on chemical reactions and subsequent chemical separation will be studied.



PERFORATED MANIFOLD

PAST PROGRESS

Tests to evaluate the collector efficiency of the solar duplex at the Naval Ammunition Depot (NAD) in Hawthorne, Nevada were completed.

A library of brochures on collectors was assembled, and data on collector efficiencies gathered.

A literature search uncovered empirical formulations for evaluating slope factors. These formulations are adequate for most design studies using flat-plate collectors.

A technical memorandum was prepared providing an evaluation of the solar collector system at NAD Hawthorne, using criteria developed by the National Bureau of Standards (NBS). The heat calculations showed that each of the two solar arrays tested delivered 6 x 10^5 Btu per day, which is enough for most of the heating needs of the duplex. The daily heat output fluctuated widely because of freezing problems with the collector. Simulation of year-round performance using a computer program (TRNSYS) was attempted, but not completed because of insufficient data. In addition, some data were unreliable but could not be isolated because of nonuniform test procedures by the various manufacturers.

A collector checkout stand was built to test a wide variety of solar collectors.

Colorado State University was selected to study thermal stratification in water tanks. Indications are that system efficiency could be increased 3 percent or more by thermal stratification.

PROGRESS DURING OCTOBER 1976-MARCH 1977

During the report period:

- Instruments were installed on the collector checkout stand; the stand is now fully operational.
- Flow visualization experiments on thermal stratification were started in a larger tank.
- A schedule of work for studies of chemical and dissolved-salt storage was drafted.

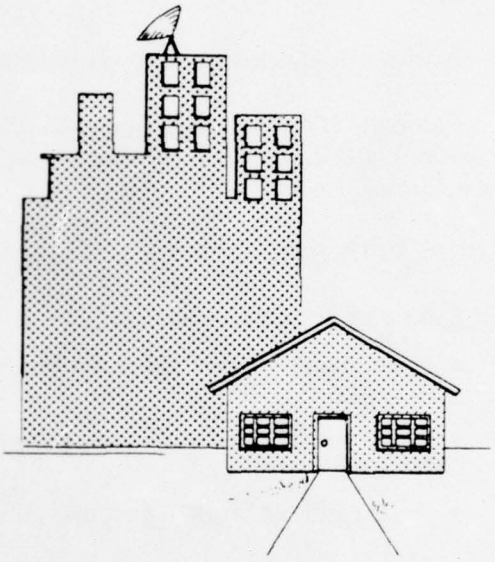
DESIGN GUIDE FOR SOLAR HEATING AND COOLING OF BUILDINGS

Sponsor: NAVFAC
Performer: CEL
Contact: H. S. Zwibel

Program Element 62765N

OBJECTIVE

CEL is providing technical guidance for evaluating solar systems at selected Navy sites and for selecting or designing equipment for the system.



TECHNICAL APPROACH

CEL is preparing a solar heating and cooling design guide applicable to all types of Navy buildings. The guide will be revised periodically.

PAST PROGRESS

The initial version of the solar design manual was completed and is being distributed. A computer program for modeling solar heat gains and losses was used in preparing the design guide.

PROGRESS DURING OCTOBER 1976-MARCH 1977

Data were obtained on solar collectors (efficiencies, etc.) from ERDA and other agencies. These data will be used for revising the design manual.

Data required to evaluate candidate Navy sites were determined. The data requirements of this project, along with the data requirements of other CEL projects, are being studied to determine the most suitable data acquisition method.

Systems evaluation to determine optimal collector size was initiated.

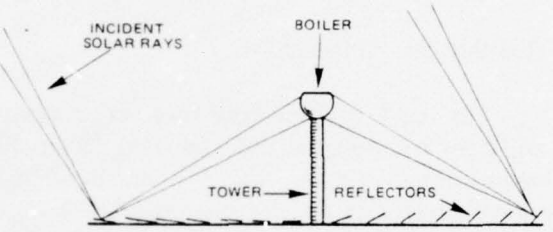
RECOMMENDATIONS FOR CENTRAL SOLAR-ELECTRIC POWER GENERATION AT NAVY BASES

Sponsor: NAVFAC
Performer: CEL
Contact: J. M. Slaminski

Program Element 62765N

OBJECTIVE

Central solar-electric power plants are being monitored and evaluated to determine whether such plants can be used at Navy bases.



TOWER TOP COLLECTOR

TECHNICAL APPROACH

CEL is working closely with industry and ERDA while monitoring power station operations. A systems analysis study is being done to define optimum solar-electric power-generation configurations needed to meet the Navy's electrical needs. CEL will prepare a technical note recommending specific central solar-electric power plants to be demonstrated.

PAST PROGRESS

Contacts were established with personnel in ERDA's Solar Thermal Branch.

Literature published by ERDA on central solar-electric power generation is being collected. CEL determined that ERDA-sponsored first-generation central receiver solar-electric power plants will use a conventional Rankine cycle. The first 10-Mw pilot plant is scheduled to go on line in 1980. The second-generation pilot plant will be some type of Brayton cycle and will go on line in 1982.

PROGRESS DURING OCTOBER 1976-MARCH 1977

A statement of work defining the optimum solar-electric systems for the Navy's needs is being prepared.

APPLICABILITY OF PHOTOVOLTAIC EQUIPMENT FOR ADVANCED BASES

Sponsor: NAVFAC
Performer: CEL
Contact: G. Beck

Program Element 62765N

OBJECTIVE

The applicability of photovoltaic systems at Navy advanced bases is being assessed.

TECHNICAL APPROACH

The cost and performance of currently available photovoltaic systems is being continually monitored and evaluated for applicability at Navy advanced bases, and limited testing done. A CEL report, updated annually, will document the findings and present recommendations for demonstration of a full-scale system in the engineering development program.

PROGRESS DURING OCTOBER 1976-MARCH 1977

Preparation of a bibliography on photovoltaic systems was started. The possibility of using a photovoltaic and battery system (in a standard 8- x 8- x 20-foot container) for portable pier lighting at advanced bases is being studied.

FEASIBILITY OF SOLAR DESALINATION APPLICATIONS AT NAVY SITES

Sponsor: NAVFAC
Performer: CEL
Contact: B. E. Swaidan

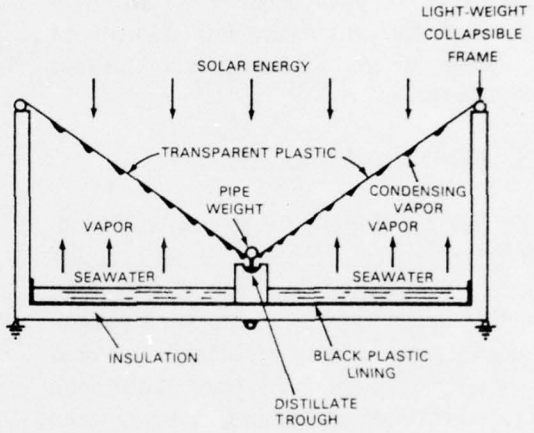
Program Element 62765N

OBJECTIVE

The feasibility, cost-effectiveness, and performance of solar desalination methods are being studied to determine their applicability to the Navy.

TECHNICAL APPROACH

Desalination methods are being studied to determine which are economical using solar energy, and the Navy base most suitable for a solar desalination plant will be selected. A systems study is being performed to determine the best desalination method to be used at the selected Navy installation.



LIGHT-WEIGHT SOLAR STILL

PROGRESS DURING OCTOBER 1976-MARCH 1977

A literature search and a review of the state-of-the-art of solar desalination systems were completed. Work to define the Navy's present fresh water demand profile was started. Preparation of a contract schedule of work for promising solar desalination methods was also started.

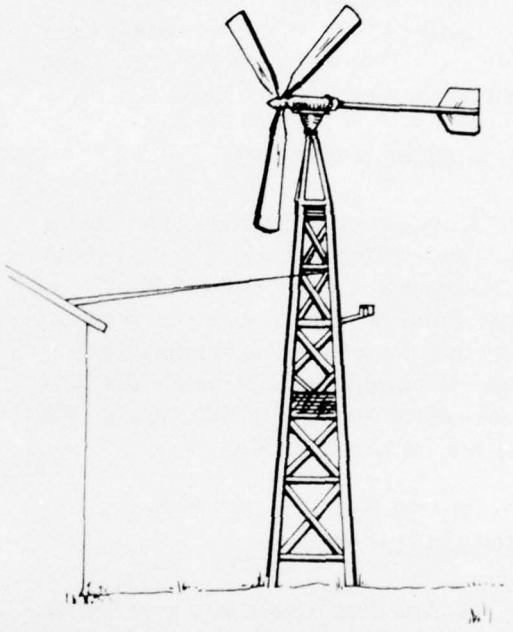
EVALUATION OF 5- TO 10-KW CAPACITY WIND GENERATORS TO SUPPLY POWER FOR BUILDINGS

Sponsor: NAVFAC
Performer: CEL
Contact: D. Pal

Program Element 62765N

OBJECTIVE

Methods are being developed and hardware evaluated for converting the output of small-capacity wind machines to heat for environmental control of buildings or to 60-Hz constant-voltage electricity.



TECHNICAL APPROACH

A horizontal axis, three-bladed, propeller-driven, three-phase AC generator, with a capacity of 5 kw, is being used in this project. Data on the wind generator's performance is being collected through extensive field tests. Automatic data recording equipment is being used for convenient analysis on a digital computer.

The 5-kw generator will be tested with the Advanced Energy Utilization Test Bed (AEUTB) to establish the feasibility of adding hardware to the system to:

- Heat for the heat-storage tank using an immersion-type electric heater.
- Operate a fan for attic ventilation.
- Illuminate buildings using fluorescent tubes.
- Operate a constant-speed heat pump.

The methods and hardware developed during the wind power research at AEUTB will be used to support a 4-year program to demonstrate a 10-kw wind generator (in the engineering development program).

PAST PROGRESS

The 5-kw wind generator with the load-switching system was installed and tested at

Laguna Peak, California. The generator's output was dissipated into resistive loads comprising heaters and light bulbs. An automatic data logger recorded the line voltage, load current, line frequency, and instantaneous power output in a digital format at 30-minute intervals. The data were analyzed to determine the output curve for the 5-kw wind generator. The estimates indicate that the site has an annual average wind speed of 10 miles per hour, and the generator would produce 7,200 kw per hour annually.

An economic analysis was done comparing the cost of wind energy to that of present energy systems at 11 sites recommended for future demonstrations by NWC, China Lake, California. The cost of wind power generation compared favorably with the present energy cost at Grand Turk, Barrow, Eleuthera, San Nicolas, and Adak Islands.

PROGRESS DURING OCTOBER 1976-MARCH 1977

The propeller on the 5-kw wind generator failed in November because of a faulty weld in one of the blade connections. The propeller was redesigned. Currently, the power conditioning equipment is being redesigned for optimum utilization of the variable output of the generator.

The setup is being planned for connecting the 5-kw generator to a dehumidifying heater in a building on San Nicolas Island.

DOCUMENTATION

"Study of Electrical Power Generation from the Wind with Small-Scale Plants at Navy Remote Sites," TN-1460, October 1976.

FEASIBILITY OF SMALL-SCALE VERTICAL-AXIS WIND MACHINES

Sponsor: NAVFAC
Performer: CEL
Contact: D. Pal

Program Element 62765N

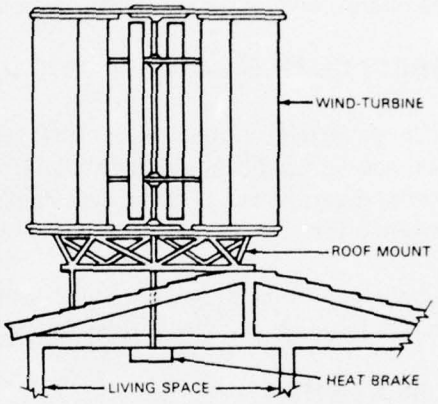
OBJECTIVE

Small-scale vertical-axis wind machines are being evaluated to determine whether they can provide a feasible and economical way to convert wind energy directly into heat or electricity.

TECHNICAL APPROACH

A variety of vertical-axis wind machines, such as Darrieus and gyro-mill, are being studied, and four 1-kw capacity machines are being tested extensively. Test results will be used for developing a 10-kw generator in the NAVFAC advanced development program.

The NASA/ERDA program for development of 10-kw vertical-axis wind machines is being monitored.



WIND TURBINE UNIT

PAST PROGRESS

A statement-of-work for the procurement of a wind turbine and its installation at a selected Navy site was prepared. A survey for a suitable site for the space heating experiments was conducted.

PROGRESS DURING OCTOBER 1976-MARCH 1977

A contract was awarded in November to Wind Harvest Company, Inc., Ventura, California, for procurement and installation of a 1-kw wind generator for space heating. A two-bedroom house at NWC, China Lake, California, was selected for the field demonstration. The 1-kw machine was installed, and field tests started.

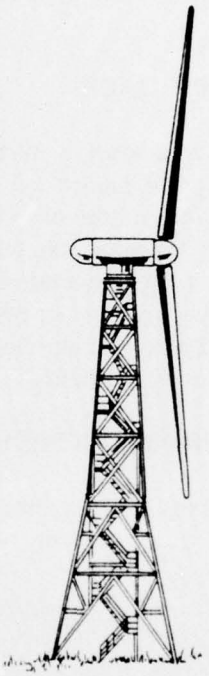
SITE SELECTION FOR INSTALLATION AND TESTING OF 100- TO 1,500-KW WIND GENERATORS

Sponsor: NAVFAC
Performer: CEL
Contact: D. Pal

Program Element 62765N

OBJECTIVE

CEL is selecting a site to install and test an ERDA-developed 100- to 1,500-kw wind generator.



TECHNICAL APPROACH

Candidate sites for testing ERDA's 100- to 1,500-kw wind generator are being assessed, based on cost-effectiveness. Long-term field measurements are being made at each site to determine local wind characteristics, and the results are being analyzed to select the best site for a 100-kw unit. (Installation and testing of a 100-kw wind generator will be done as part of NAVFAC's FY 1979 engineering development program.)

PROGRESS DURING OCTOBER 1976-MARCH 1977

CEL started monitoring the development of the 100- to 1,500-kw wind generators. The preliminary investigation to select candidate sites for field tests of the 100-kw wind generator was also started.

HANDBOOK FOR APPLICATION OF WIND POWER GENERATORS AT NAVAL FACILITIES

Sponsor: NAVFAC
Performer: CEL
Contact: D. Pal

Program Element 62765N

OBJECTIVE

A handbook on the application of wind power generators to Navy facilities is being prepared.

TECHNICAL APPROACH

Data collected during tests of the 5-kw wind generator are being analyzed to determine the performance of the generator and of the power-conditioning hardware required for practical use of wind power. A handbook is being written describing the computation of design parameters, such as power coefficient, specific power output, and cost of wind energy generation for a wind power system at a given location. The handbook will be updated as results become available from field demonstrations (in the advanced and engineering development programs) of 10-kw wind generators and 100- to 1,500-kw wind power systems.

PROGRESS DURING OCTOBER 1976-MARCH 1977

Computer routines for analyzing test data on the 5- and 10-kw wind generators were written. The program uses site wind data to compute power duration curves and energy patterns.

PRELIMINARY DESIGN OF OPEN-CYCLE SOLAR-ELECTRIC TURBINE GENERATOR

Sponsor: NAVFAC
Performer: CEL
Contact: E. E. Cooper

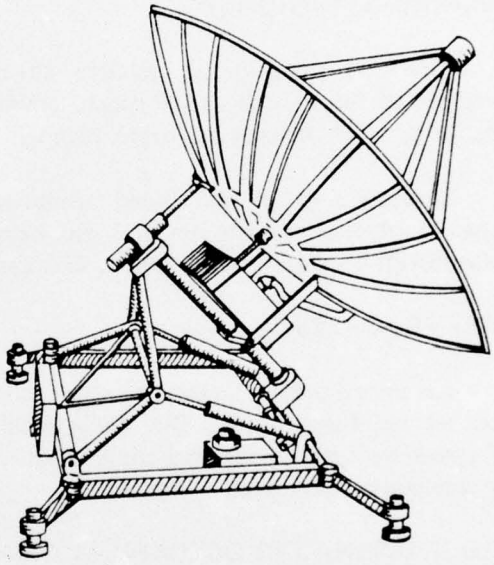
Program Element 62765N

OBJECTIVE

CEL is conducting preliminary studies involving the development and testing of a tactical solar-to-electric energy converter for Navy advanced bases. Such a converter would be used to reduce the logistical burden associated with petroleum fuels.

TECHNICAL APPROACH

A preliminary design of an air-driven solar-electric turbine generator is being developed. CEL will compare the solar turbine generator with other generators. If the preliminary design is completed successfully and the solar-electric generator proves to be economically feasible, a unit will be built and tested under the advanced development program.



PRELIMINARY SYSTEM DESIGN USING SOLAR ENERGY

PAST PROGRESS

A contract for the preliminary design study of an air-driven solar-electric turbine generator was awarded in May 1976 to Arthur D. Little, Inc. (ADL).

PROGRESS DURING OCTOBER 1976-MARCH 1977

The preliminary design study was completed. ADL's contract was modified to include computation of annual overall performance of candidate 10-kw systems.

A statement-of-work for the detailed design of an air-driven solar-electric turbine generator was prepared.

ADVANCED POWER CYCLES FOR ADVANCED BASES

Sponsor: NAVFAC
Performer: CEL
Contact: E. E. Cooper

Program Element 62765N

OBJECTIVE

CEL is investigating the feasibility of using alternative fuels at advanced Navy bases, and evaluating system changes resulting in reduced logistical burden of petroleum fuels.

TECHNICAL APPROACH

The performance and relative advantages of engines and burners operating on synthesized fuels (such as hydrogen, ammonia, and methanol) are being studied, as is the possibility of producing hydrogen through thermochemical and electrolytic processes.

Systems will be developed using solar energy for producing synthetic fuels to generate electricity. The systems are being assessed based on scenarios comprising the transportation, storage, conversion, and use of energy at remote or advanced bases.

PAST PROGRESS

An experimental facility to study combustion of hydrogen, ammonia, and methanol was set up. Literature on thermochemical hydrogen generation and on the performance of synthetic fuels in internal-combustion engines was reviewed, and energy requirements for advanced bases were estimated.

PROGRESS DURING OCTOBER 1976-MARCH 1977

Hydrogen-generation processes are being evaluated, and a technical memorandum on the findings is being prepared.

NAVY GEOTHERMAL SITE ASSESSMENT

Sponsor: NAVFAC
Performer: NWC
Contacts: R. D. Fulmer and C. F. Austin

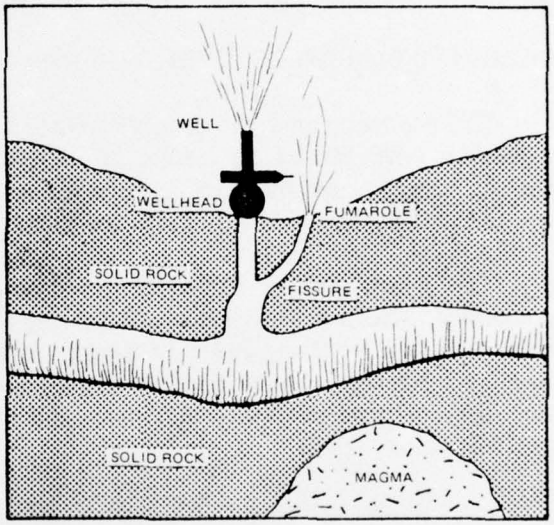
Program Element 62765N

OBJECTIVE

Geothermal resources at Navy sites are being identified and evaluated.

TECHNICAL APPROACH

A survey is being conducted to identify possible Navy geothermal resource sites. These sites are being analyzed and ranked according to their potential. (Applicable computer programs are being surveyed to determine those that can be used to aid geothermal assessments.) Geological, geophysical, and geochemical studies necessary to evaluate the identified geothermal resources will be performed.



GEOTHERMAL WELL

PROGRESS DURING OCTOBER 1976-MARCH 1977

Results of a study by ONR on remote Navy bases and their energy needs were obtained and reviewed.

The geothermal potential of Guam was studied. Although no surface geothermal manifestations are present and the volcanic rocks are older than generally considered favorable for a geothermal heat source, Guam has geothermal possibilities. NWC formulated a short test program to better define these resources. A short memorandum on the Guam study was written.

User's manuals for computer programs being developed by the University of California and Battelle Northwest were acquired. These computer programs are concerned with the preliminary design of geothermal power plants and associated economics.

A list of Navy sites with possible geothermal potential was compiled. The sites are being evaluated and ranked according to their geothermal potential.

mile. This resource, near Mount Adagdak, is within useful range to provide electricity and heating fluids for all Navy facilities on the island.

NWC established preliminary environmental criteria, identified land status, energy use, and potential for geothermal products for the Adak facilities, and delineated the support facilities on the island.

A study of the utilization economics of the geothermal resources on Adak was started. Data are being gathered for a USGS study that will compare the use of geothermal energy for heating and for electrical power with that of present power and heat generation techniques and other alternative energy options.

PROGRESS DURING OCTOBER 1976-MARCH 1977

USGS documented the results of Phase I geophysical studies, and submitted working papers to NWC. Based on results of the work to date, USGS proposed two additional experiments to pinpoint locations for exploratory drilling near Mount Adagdak. Funds for this work were provided, and field work will be done during spring 1977.

The study of the utilization economics of the geothermal resources on Adak progressed. The cost for geothermal heating and electric power is being compared to that associated with updating and maintaining (1) the present fossil fuel energized system, (2) a wind/hydrostorage system, and (3) a tidal power installation. The preliminary designs for the different systems are well underway, and economic data on equipment and construction costs are being gathered.

Preparations were made for beginning Phase II geophysical studies during spring 1977.

ADAK GEOTHERMAL RESOURCE DEVELOPMENT

Sponsor: NAVFAC
Performer: NWC
Contacts: R. D. Fulmer and
C. F. Austin

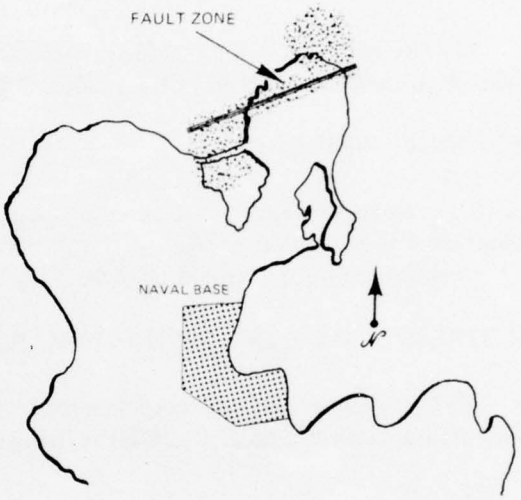
Program Element 62765N

OBJECTIVE

The geothermal resources at Adak, Alaska, are being studied to determine their potential for providing electricity and space heating for the Navy facilities at Adak.

TECHNICAL APPROACH

NWC is assessing the energy needs for the Naval Station at Adak, how those needs can be served by geothermal energy, economic trade-offs with other types of power sources, and legal and institutional constraints associated with development of the area's geothermal potential.



EARTHQUAKE ACTIVITY ON ADAK

The geological, geophysical, and geochemical characteristics at Adak are being examined to determine whether further exploration is warranted and, if so, where exploratory drilling should occur. Small-diameter (slim) holes will be drilled into the reservoir area to locate the geothermal fluids and ascertain their composition and character. Production-size wells will then be drilled to evaluate fluid dynamics. Fluid corrosion experiments are being done to determine suitable material for the particular environment. As soon as the reservoir and fluid dynamics are known, additional utilization and economic studies will be conducted to define the potential for the Navy.

Participation by other government agencies, such as ERDA and USGS, and industry is being sought.

PAST PROGRESS

NWC and USGS completed Phase I geological and geophysical studies of Adak. This work included geologic mapping, petrologic analysis, chemical/isotopic analysis of hot spring water, studies of gravity energy and andiomagnetotelluric/magnetotelluric surroundings, and telluric and self-potential profiling. The studies indicated a potential geothermal resource with an estimated temperature of 300° C and a drilling target of about 1 square

COSO GEOTHERMAL RESOURCE EVALUATION

Sponsor: NAVFAC
Performer: NWC
Contacts: R. D. Fulmer and
C. F. Austin

Program Element 62765N

OBJECTIVE

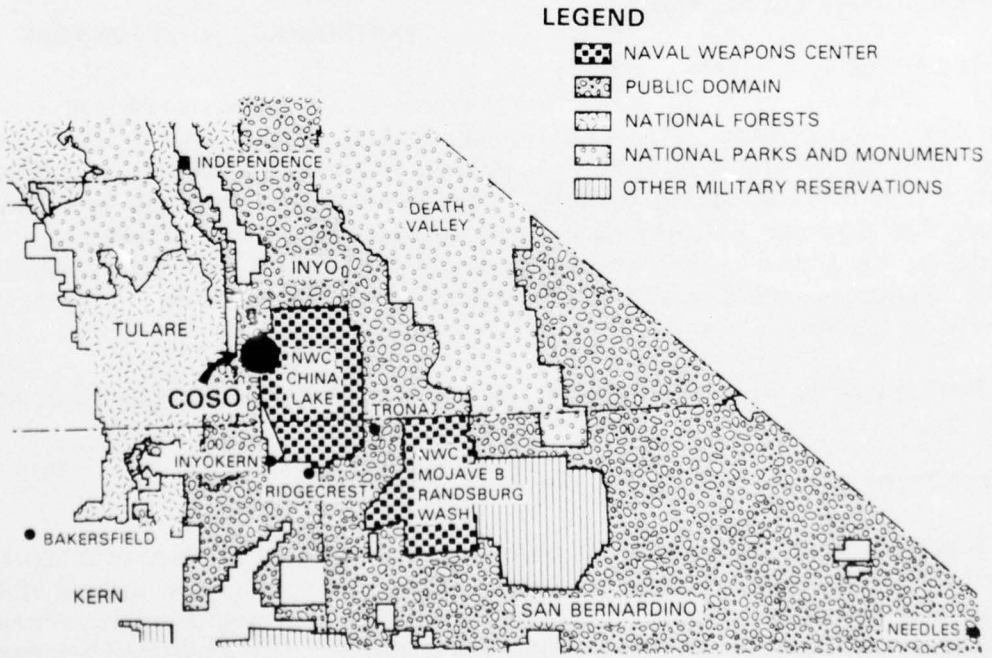
ERDA- and USGS-sponsored, geological and geophysical studies of the Navy's Coso Thermal Area (CTA) at NWC, China Lake, California, are being evaluated.

TECHNICAL APPROACH

The results of slim-hole drilling are being analyzed to determine the CTA's geothermal potential. The results of exploratory production drilling will also be analyzed with respect to the geothermal reservoir and possible Navy utilization.

PROGRESS DURING OCTOBER 1976-MARCH 1977

NWC obtained data on temperatures in the slim-hole well and on the composition of drill cuttings from the hole. The CTA is being modeled, and Navy uses are being assessed.



COSO GEOTHERMAL RESOURCE AREA

GEOTHERMAL LEGAL AND INSTITUTIONAL STUDIES

Sponsor: NAVFAC
Performer: NWC
Contact: R. D. Fulmer

Program Element 62765N

OBJECTIVE

The legal, institutional, and operational considerations involved in exploring and developing geothermal resources on Navy property are being studied to provide guidelines to the Navy in the use and management of these resources.

TECHNICAL APPROACH

The legal and institutional problems confronting the Navy in geothermal development on Navy property are being identified and categorized. Each problem will be examined in detail, and, through interpretation of statutes, regulations, court decisions, or precedents, a defendable position will be developed for the Navy. In situations where directions are undefined, the alternatives available will be outlined, and the advantages and disadvantages delineated.

PAST PROGRESS

A search for documents pertinent to the legal and institutional study was completed; the documents are being analyzed.

NWC decided to study institutional problems as they apply to preliminary exploration, exploration drilling, field development, production, and closedown (the stages for developing a geothermal resource). The government agencies and institutions that the Navy must contact for approval and liaison at each development stage were identified, and each agency's cognizant area established.

The major scenarios covering alternative situations that might confront the Navy in geothermal exploration and development were formulated, and the legal and institutional aspects identified. An interim report describing the scenarios is being prepared.

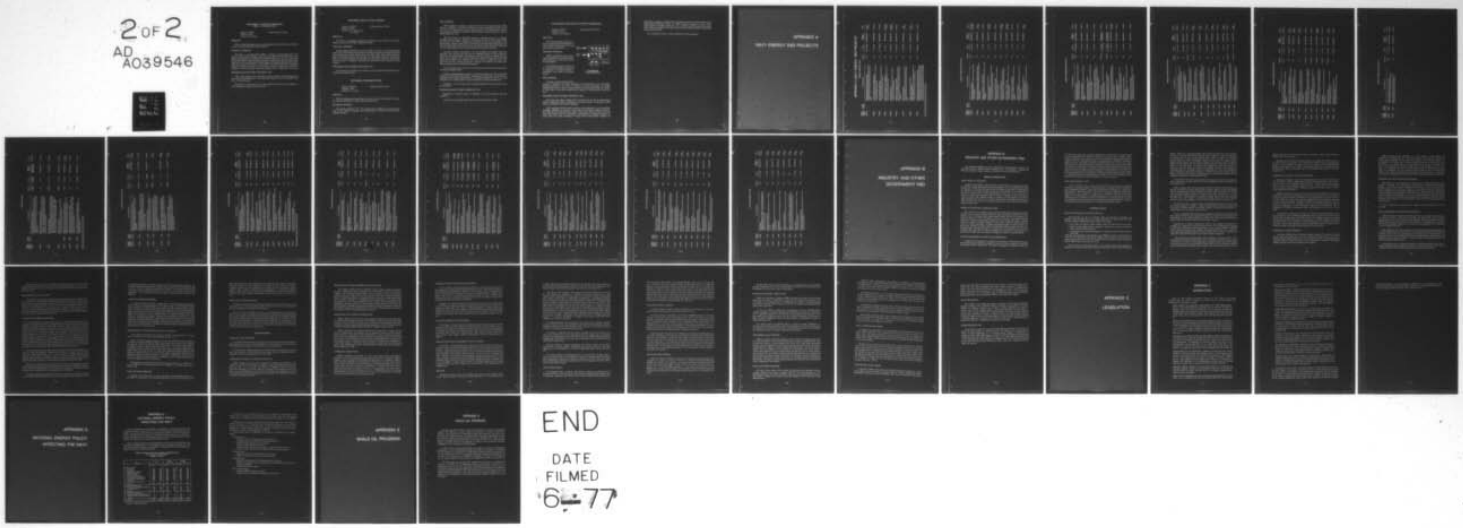
PROGRESS DURING OCTOBER 1976-MARCH 1977

Study of geothermal development on Navy land at Lualualei, Hawaii, indicated additional legal and institutional aspects. The legal and institutional problems are being analyzed, and the Navy's options are being identified and cataloged.

An outline for the final report was prepared, and work started on the summary report.

AD-A039 546 TETRA TECH INC ARLINGTON VA F/G 10/1
U.S. NAVY ENERGY R AND D PROGRESS OCTOBER 1976-MARCH 1977.(U)
APR 77 N00014-76-C-0239
UNCLASSIFIED TT-A-872-77-316 NL

2 OF 2
AD A039546



END

DATE FILMED
6-77

GEOTHERMAL UTILIZATION TECHNOLOGY FOR REMOTE NAVY SITES

Sponsor: NAVFAC
Performer: NWC
Contact: R. D. Fulmer

Program Element 62765N

OBJECTIVE

NWC is identifying ongoing Navy energy technology efforts applicable to geothermal systems, and testing potentially useful equipment.

TECHNICAL APPROACH

The Navy, in its energy R&D program, is studying and developing devices and systems needed to harness different types of energy. Many of these devices, such as heat pumps and absorption air-conditioning equipment developed for use with solar energy systems and Rankine power generators developed for diesel waste heat bottoming cycles, could also be used with geothermal energy systems. Potentially applicable devices will be tested on geothermal fluids from a well in NWC's Coso Thermal Area (CTA). Additional equipment needed for successful use of geothermal energy at remote Navy sites will be identified, and where required, development programs will be established in these areas.

PROGRESS DURING OCTOBER 1976-MARCH 1977

CEL's energy programs were examined to identify hardware that might possibly be used with the low-temperature (143° C) geothermal fluids from the CTA. Results of the survey were documented.

Discussions were held with CEL on the hardware status and on the possibility of CEL cooperation in testing devices at the CTA.

GEOTHERMAL IMPACT ON NAVY MISSIONS

Sponsor: NAVFAC
Performer: NWC
Contacts: R. D Fulmer and
C. F. Austin

Program Element 62765N

OBJECTIVE

The effect of geothermal exploration, development, and utilization on the basic missions of Navy shore facilities is being documented.

TECHNICAL APPROACH

Tapping geothermal deposits can have a number of effects. For example, gases and aerosols can corrode electronics equipment downwind of geothermal collection/processing areas, pipelines can restrict ground travel, and water vapor from cooling towers can aggravate fog problems. These and other aspects of geothermal exploration, development, and use are being identified and cataloged, and the possible effects on various Navy missions defined. A handbook noting possible problems and their resolution is being prepared.

PROGRESS DURING OCTOBER 1976-MARCH 1977

The outline for the handbook was prepared, and the geothermal-characterization and mission-impact studies started.

GEOTHERMAL CORROSION STUDIES

Sponsor: NAVFAC
Performer: NWC
Contact: C. F. Austin

Program Element 62765N

OBJECTIVE

NWC is exploring and documenting the causes and nature of corrosion of construction materials resulting from contact with geothermal fluids.

TECHNICAL APPROACH

Test samples corroded in FY 1976 and test arrays installed in the Coso slim-hole wells will be analyzed chemically and metallurgically to determine corrosion causes, products, and rates.

PAST PROGRESS

NWC established a cooperative program with the Naval Postgraduate School (NPS), Monterey, California, to examine test samples in detail, using scanning electron microscopy and x-ray fluorescence, and do trace analyses for toxic metals (mercury, arsenic, and antimony) using atomic absorption. NPS completed corrosion studies of a few test samples during FY 1976.

NWC has focused on identifying corrosion compounds found on test samples, observing cleaned samples to identify the major kinds of corrosion present, and establishing corrosion rates. NWC examined nine different metallic and nonmetallic, 2-inch diameter pipe materials, tested with three different kinds of geothermal fluids under both low- and high-oxygen concentrations. These nine materials were also joined together and tested to examine galvanic and coupling effects between dissimilar materials.

Crystalline corrosion compounds on the nine materials were identified using x-ray diffraction, and corrosion types and rates were established based on visual examination. (Corrosion rate measurements were imprecise, however, because the samples were too large to allow precision.) The materials were given to NPS for detailed examination. NPS completed its studies of the cleaned surfaces and corrosion compounds on the copper pipes and the trace analysis for mercury. (Analyses for antimony and arsenic were delayed pending purchase of additional equipment.)

A stress corrosion test was done on 33 ductile and brittle metals and nonmetals with one kind of geothermal fluid.

Detailed micrometallographic analyses of sectioned materials were done to establish hydrogen embrittlement, stress corrosion, cracking, and microstructure corrosion patterns. Additional stress corrosion experiments in an acid-sulfate environment were set up, using conventional test coupons that were precision weighed to establish corrosion rates.

Preparation of new corrosion arrays to evaluate fluids from the deep, slim-hole wells at Coso started.

PROGRESS DURING OCTOBER 1976-MARCH 1977

Preparation of corrosion arrays for installation on the Coso slim-hole wells was completed.

A report on the corrosion studies done in FY 1976 by NPS was written.

EVALUATION OF NEW COAL-UTILIZATION TECHNOLOGIES

Sponsor: NAVFAC
Performer: CEL
Contact: D. E. Williams

Program Element 62765N

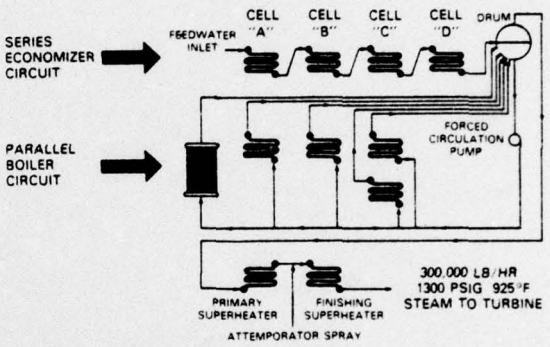
OBJECTIVE

New coal technologies are being evaluated to determine their applicability to Navy facilities. The goal is to use new coal systems as soon as practicable.

TECHNICAL APPROACH

ERDA's fluidized-bed boiler project will be monitored and evaluated to determine whether such a boiler could be used by Naval facilities.

CEL will also evaluate the use of coal in conventional steam plants and advances in techniques for reducing emission of particulates, sulfur oxides, and nitrogen oxides.



FLUIDIZED-BED STEAM GENERATOR

PAST PROGRESS

The scope of the fluidized-bed boiler analysis was broadened to include evaluation of demonstrations of new technologies potentially applicable to the Navy. An example of the new technologies is a flue-gas-desulfurization system, which is being marketed by Chiyoda International. The smallest of these could be used with a boiler having a capacity of 25,000 pounds of steam per hour.

PROGRESS DURING OCTOBER 1976-MARCH 1977

The Great Lakes Naval Training Center was selected as the site for demonstrating ERDA's fluidized-bed boiler. Techniques for reducing emission of particulates, sulfur oxides, and nitrogen oxides will be investigated.

CEL investigated several projects involving new developments in coal beneficiation technology, primarily the removal of pyritic sulfur. These projects included a demonstration plant (Environmental Protection Agency, Pennsylvania Electric Company, and New York State Electric and Gas Corporation), demonstration of magnetic separation of pyritic sulfur and thermal separation of organic sulfur (Georgia Power Company and

ILOK Power Company), demonstration of the Meyers process for leaching pyritic sulfur (Environmental Protection Agency and TRW), magnetic separation of pyritic sulfur (Indian Head Naval Ordnance Station), and a process for leaching organic and pyritic sulfur (Battelle Northwest). CEL also contacted General Motors about its double-alkali scrubber at Parma, Ohio.

CEL continued its study of retrofit fluidized-bed boiler applications.

APPENDIX A

NAVY ENERGY R&D PROJECTS

APPENDIX A–NAVY ENERGY R&D PROJECTS

ENERGY CONSERVATION

Program Element Number	Project Number	Title and Description	Performer	Contact	Telephone Number	Status
62765N		**Heating and Cooling Loads Computer Simulation** Develop Loads and Systems Simulation (LASS) model to provide an accurate method of evaluating building heating and cooling loads.	CEL	E. R. Vinieratos	(805) 982-5134	Starts FY 1978
62765N		**Concrete Sandwich Construction Materials Tests** Examine characteristics and potential benefits of insulated expansive concrete sandwich construction.	CEL	J. R. Keeton	(805) 982-5793	In progress
62765N		**Construction Methods and Materials** Determine thermal, structural, safety, and related characteristics of new construction methods and materials.	CEL	E. R. Vinieratos	(805) 982-5134	In progress
62765N		**Seawater Heat Exchanger for Cooling Buildings** Determine if seawater cooling is a feasible alternative for air conditioning applications at Naval facilities.	CEL	J. B. Ciani	(805) 982-4642	Completed FY 1976
62765N		**Metal Hydride Heat Pump** Develop and test a heat pump, using a selected intermetallic hydride, for Navy HVAC applications.	CEL	A. W. McClaine	(805) 982-4207	Completed FY 197T
62765N		**Handbook for Comparing HVAC Systems** Identify the most advantageous uses of local heat sources and sinks, and formulate the results into guidelines, promulgated in a handbook.	CEL	A. W. McClaine	(805) 982-4207	In progress
62765N		**Dessicant Cooling Systems** Examine the feasibility of using dessicant cooling systems to reduce the latent heat load on air conditioning systems in humid areas.	CEL	A. W. McClaine	(805) 982-4207	Starts FY 1979
62765N		**Design Analysis of Advanced HVAC Systems for Remote Base Applications** Perform conceptual studies and develop preliminary design of an efficient HVAC system suitable for such applications.	CEL	A. W. McClaine	(805) 982-4207	Starts FY 1978
62765N		**Lighting Design Criteria Handbook for Navy Applications** Develop standardized, optimal lighting criteria, including the use of natural lighting, and promulgate in handbook format. Modify the existing LUMEN II computer program to include daylighting contributions and economic analyses in support of the handbook.	CEL	W. Pierpoint	(805) 982-5778	In progress

Note: All projects in progress are summarized in this report.

ENERGY CONSERVATION (Cont'd)

Program Element Number	Project Number	Title and Description	Performer	Contact	Telephone Number	Status
62765N		**Task Performance and Lighting** Perform experimental research in support of the Lighting Design Criteria Handbook.	CEL	W. Pierpoint	(805) 982-5778	Completed FY 1976
62765N		**Adaptation of Building Systems to Alternative Energy Sources** Design and fabricate DC-powered and high-frequency experimental lighting systems.	CEL	R. I. Staab	(805) 982-5778	Starts FY 1978
62765N		**Building Control Systems for Energy Efficiency** Investigate availability of monitoring and control systems for single building use.	CEL	R. I. Staab	(805) 982-5778	In progress
62765N		**Instrumentation and User's Guide for Field Surveys of Energy Usage** Select, test, evaluate, and formulate user's guide of instrumentation for conducting field surveys of energy losses.	CEL	J. C. King	(805) 982-5973	Completed FY 197T
62765N		**Measurement of Building Energy Losses** Evaluate and employ instrumentation to locate and measure energy losses from buildings.	CEL	J. C. King	(805) 982-5973	In progress
62765N		**Measurement of Infiltration Losses** Conduct preliminary investigation of SF_6 leak detection techniques in support of building energy loss measurements.	CEL	J. C. King	(805) 982-5973	Completed FY 1976
62765N		**Infrared Detection of Energy Losses** Test and evaluate portable IR systems in support of building energy loss measurements.	CEL	J. C. King	(805) 982-5973	Completed FY 1976
62765N		**Measurement of Energy Losses in Pipelines** Evaluate instrumentation for detecting leaks in various types of pipelines.	CEL	J. C. King	(805) 982-5973	In progress
62765N		**Hangar Heat Loss Prevention** Identify optimum methods for reducing energy consumption of Navy aircraft hangars.	CEL	J. C. King	(805) 982-5973	In progress
62765N		**Detection and Measurement of Energy Losses in Electrical Distribution Systems** Evaluate instrumentation and procedures for measuring losses in electrical distribution systems.	CEL	J. C. King	(805) 982-5973	Starts FY 1978

ENERGY CONSERVATION (Cont'd)

Program Element Number	Project Number	Title and Description	Performer	Contact	Telephone Number	Status
62765N		**Application Engineering Studies** Provide RDT&E assistance to coordinate technology flow between national and Navy energy programs.	CEL	F. W. Herrmann	(805) 982-5562	In progress
62765N		**Energy Conservation Handbook** Prepare an energy conservation handbook for use by base-level engineers.	CEL	F. W. Herrman	(805) 982-5562	In progress
62765N		**Data Compilation for Energy Consumption and Facility Operational Statistics** Compile on-site statistics and data related to energy demand and consumption at Naval installations.	CEL	R. E. Bergman	(805) 982-5377	In progress
62765N		**Energy Optimization Handbook for Navy Base Planning** Prepare handbook for predetermining optimum mixtures of environmentally driven power systems and energy conservation systems for planning Naval applications.	CEL	C. E. Parker	(805) 982-4326	In progress
62765N		**Fuel Cost Escalation Study** Provide a firm basis for projecting fuel/energy costs by examining national energy and price trends.	CEL/NWC	C. E. Parker/ E. E. Kappelman	(805) 982-4326 (714) 939-7334	In progress
62765N		**Study of Capital Expense Premium To Be Allowed for Energy-Saving Physical Plant Investments**	CEL/NWC	C. E. Parker/ E. E. Kappelman	(805) 982-4326 (714) 939-7334	In progress
62765N		**Building Monitoring and Control System Effectiveness Study** Analyze economic and operational effectiveness of building monitoring and control systems.	CEL	D. H. Johnson	(805) 982-5795	Completed FY 197T
62765N		**Validation of Existing Monitoring and Control System Effectiveness** Provide follow-on support for building MACS study to determine effectiveness in larger (facility) applications.	CEL	D. H. Johnson	(805) 982-5795	In progress
62765N		**Evaluation Criteria for Available Monitoring and Control Systems** Provide recommendations for selection and application of MACS at Naval installations.	CEL	D. H. Johnson	(805) 982-5795	In progress
62765N		**Total/Selective Energy Systems Handbook** Provide guidance for selection and evaluation of total/selective energy systems applications for Navy facilities.	CEL	E. E. Cooper	(805) 982-4207	In progress

ENERGY CONSERVATION (Cont'd)

Program Element Number	Project Number	Title and Description	Performer	Contact	Telephone Number	Status
62765N		**Low-Temperature Heat-Recovery Power Systems** Assess the technical and economic feasibility of organic Rankine cycle bottoming systems for improved fuel economy.	CEL	E. E. Cooper	(805) 982-4207	In progress
62765N		**Review of Guidance Governing Centralized Steam and Electric Power Generation by Naval Installations**	CEL	D. E. Williams	(805) 982-4207	In progress
62765N		**Energy Conservation Aboard Ship** Identify the potential for reduced fuel consumption in future ships through alternative propulsion and auxiliary systems.	DTNSRDC	C. F. Krolick	(301) 267-2674	In progress
63210N	WSLXX	**Energy Conservation in Aircraft** Study the fuel use patterns in various Naval aircraft and identify possible conservation areas with related experimental tasks.	NAVAIR	E. Lichtman	(202) 692-2518	Starts FY 1978
63724N	Z0829	**Concrete Sandwich Construction Materials Development** Perform advanced development of concrete sandwich insulated construction materials and elemental design preceding the demonstration phase.	CEL	J. R. Keeton	(805) 982-5793	Starts FY 1979
63724N	Z0829	**Lighting Systems Experiments** Develop and test an experimental automatic lighting control system.	CEL	W. Pierpoint	(805) 982-5778	In progress
63724N	Z0829	**Advanced HVAC System for Remote Base Demonstration** Develop final design and construct and test a full-scale demonstration unit.	CEL	A. W. McClaine	(805) 982-4207	Starts FY 1979
63724N	Z0829	**Instrumentation Packages for Field Surveys** Select, procure, and assemble instrumentation packages for detecting and measuring energy losses.	CEL	J. C. King	(805) 982-5973	In progress
63724N	Z0829	**Navy Modular Integrated Utility System (MIUS) Study** Perform system analysis of MIUS concept for Navy applications.	CEL	C. E. Parker	(805) 982-4326	Starts FY 1979
63724N	Z0829	**Hull Maintenance** Develop advanced techniques for waterborne removal of hull fouling and develop advanced antifouling and drag reduction hull coatings.	DTNSRDC	C. F. Krolick	(301) 267-2674	In progress
63724N	Z0829	**Advanced Ship Components** Provide model tests and hardware demonstration of machinery systems and components for the present and future Fleets.	DTNSRDC	C. F. Krolick	(301) 267-2674	Starts FY 1978

ENERGY CONSERVATION (Cont'd)

Program Element Number	Project Number	Title and Description	Performer	Contact	Telephone Number	Status
64710N	Z0371	**Seawater Heat Exchanger Development** Design and construct a test model unit for air conditioning applications.	CEL	J. B. Ciani	(805) 982-4642	In progress
64710N	Z0371	**Demonstration of Monitoring and Control Concepts** Procure, test, and evaluate MACS in applications at Naval facilities.	CEL	D. H. Johnson	(805) 982-5795	Starts FY 1978
64710N	Z0371	**Low-Temperature Heat-Recovery Power Systems** Test an organic Rankine bottoming cycle in combination with a diesel-electric unit.	CEL	E. E. Cooper	(805) 982-4207	Starts FY 1979
64710N	Z0371	**Fuel/Water Emulsions** Examine the feasibility of using fuel/water emulsions in those facility boilers that are now operating inefficiently to reduce fuel consumption.	CEL	T. T. Fu	(805) 982-5975	Starts FY 1978
64710N	Z0371	**Machinery Optimization** Identify energy-intensive machinery systems in the present Fleet and optimize through equipment and procedural modifications.	DTNSRDC	C. F. Krolick	(301) 267-2674	In progress
64710N	Z0371	**Water Resource Management** Formulate procedures and techniques to improve efficiency of freshwater production and utilization aboard ship.	DTNSRDC	C. F. Krolick	(301) 267-2674	In progress
64710N	Z0371	**Operator Training** Disseminate factual information on energy usage patterns and personal responsibility for conservation to all operating personnel.	DTNSRDC	C. F. Krolick	(301) 267-2674	Completed FY 1976
64710N	Z0371	**Hull Maintenance** Perform at-sea testing of hull cleaning and hull coatings development efforts.	DTNSRDC	C. F. Krolick	(301) 267-2674	In progress
64710N	Z0371	**Advanced Ship Components** Qualify full-scale propulsion, electrical, and auxiliary systems for the present and future Fleets.	DTNSRDC	C. F. Krolick	(301) 267-2674	Starts FY 1978
65861N	Z0362	**Data Compilation for Energy Consumption and Facility Operational Statistics** Provide energy profile characterization of Navy bases.	CEL	R. E. Bergman	(805) 982-5377	In progress

ENERGY CONSERVATION (Cont'd)

Program Element Number	Project Number	Title and Description	Performer	Contact	Telephone Number	Status
65861N	Z0362	**Economics of Monitoring and Control Systems** Derive methods of evaluating the economics of MACS.	CEL	D. H. Johnson	(805) 982-5795	In progress
65861N	Z0362	**Review of Guidance Governing Centralized Steam and Electric Power Generation by Naval Installations**	CEL	D. E. Williams	(805) 982-4207	In progress

SYNTHETIC FUELS

Program Element Number	Project Number	Title and Description	Performer	Contact	Telephone Number	Status
62765N		**Aircraft Fuel Characterization Analyses** Evaluate physical and chemical characteristics of synthetic JP-5 including reactivity, storage stability, and conformity to specifications. Investigate compatibility, performance, safety hazards, and handling requirements.	NAPTC/ NRL	C. J. Nowack/ R. Hazlett	(609) 882-1414 (703) 767-3559	In progress
62765N		**Synthetic Fuels Laboratory Test Program** Perform laboratory tests to compare the synthetic residuals and fuel oils to their conventional counterparts in terms of physical and chemical characteristics, conformance to specifications, performance in equipment, and potential hazards.	CEL	T. T. Fu	(805) 982-5975	In progress
62765N		**New Fuel Sources for Ships** Evaluate synthetic DFM as suitable fuel for Navy weapon systems by laboratory analyses of specifications, physical and chemical characterization, and upgrading investigations. Perform assay analyses of synthetic crude for DFM and alternative product yields. Investigate other synthetic fuel sources. Conduct fuel flexibility studies.	DTNSRDC	C. F. Krolick	(301) 267-2674	In progress
62765N		**Synthetic Fuels Toxicology** Conduct laboratory tests on the possible toxic and carcenogenic effects of natural and synthetic military fuels.	BuMED	L. E. Doptis	(202) 295-1140	In progress
63724N	Z0838	**Small-Scale Aircraft Engine Testing with Synthetic Fuels** Determine actual engine performance and emissions characteristics using synthetic JP-5 in tests with T63 and TF34 engines.	NAPTC	E. Lichtman	(202) 692-2518	Status FY 1978
63724N	Z0838	**Small-Scale Tests with Synthetic Fuels for Facilities** Conduct small-scale evaluation of synthetic residual and heating oil performance and emission characteristics in 200-hp boilers. Investigate possible boiler modifications.	CEL	T. T. Fu	(805) 982-5975	In progress
63724N	Z0838	**Coal Utilization System—Central Coal-Gasification Plant** Develop preliminary design and perform feasibility study for fuel gas plant for Navy bases.	CEL	D. E. Williams	(805) 982-4207	In progress

Note: All projects in progress are summarized in this report.

SYNTHETIC FUELS (Cont'd)

Program Element Number	Project Number	Title and Description	Performer	Contact	Telephone Number	Status
63724N	Z0838	**Full-Scale Tests with Synthetic Fuels for Facilities** Evaluate synthetic residual and heating oil in an operational Navy system adapted for comprehensive analysis of emissions and performance.	CEL	T. T. Fu	(805) 982-5975	Status FY 1978
63724N	Z0838	**Light-Refined Liquid Fuels for Ships** Perform studies on synthetic fuel impact in terms of system compatibility, logistics and handling problems, fire and safety hazards, and toxicological effects. Consider broader synthetic fuel specifications to allow greater fuel flexibility.	DTNSRDC	C. F. Krolick	(301) 267-2674	In progress
63724N	Z0838	**Light-Refined Liquid Fuels for Aircraft** Evaluate the suitability of JP-5 derived from nonpetroleum sources for use in Navy aircraft by engine, aircraft, and field testing.	NAPTC	L. Maggetti	(609) 882-1414	In progress
64710N	Z0347	**Sea-Going Flight Tests of Synthetic Fuels in Navy Aircraft** Perform final qualification of synthetic JP-5 fuel verifying compliance with maximum performance requirements under conditions of actual carrier-dependent aircraft operations. Develop handling and safety expertise.	NAVAIR	Unassigned	–	Starts FY 1977
64710N	Z0347	**Endurance Testing of Synthetic Fuels in Shoreside Systems** Investigate synthetic fuel performance under extended, full-scale operational conditions. Determine requirements for Navy-wide implementation and operation.	CEL	T. T. Fu	(805) 982-5975	Starts FY 1980
64710N	Z0347	**Sea Trials of Synthetic Fuels for Navy Ships** Perform final sea-trial qualifications of synthetic DFM for Fleet-wide use, including identification of handling and personnel training requirements and evaluation of long-term effects on the operational environment.	DTNSRDC	C. F. Krolick	(301) 267-2674	Starts FY 1979

SELF-SUFFICIENCY

Program Element Number	Project Number	Title and Description	Performer	Contact	Telephone Number	Status
62765N		**Advanced Energy Utilization Test Bed** Perform integrated energy systems testing of building construction methods and materials, building support equipment, and alternate energy sources for building power supply.	CEL	E. R. Vinieratos	(805) 982-5134	In progress
62765N		**Optimum Energy Utilization Demonstration (OEUD) Conceptual Design** Demonstrate future construction designs and energy-conserving systems.	CEL	E. R. Vinieratos	(805) 982-5134	Starts FY 1979
62765N		**Advanced Air Conditioning Systems** Perform economic evaluation and comparison of solar-driven absorption air conditioning systems.	CEL	A. W. McClaine	(805) 982-4207	In progress
62765N		**Solar/Night Radiation Augmented Heat Pump Analysis and Conceptual Design** Perform analytical study and develop conceptual design for solar/night radiation augmented heat pump for heating and cooling.	CEL	A. W. McClaine	(805) 982-4207	In progress
62765N		**Recommendations for Application of Packaged Heat-Recovery Incinerators** Assess economic and technical feasibility.	CEL	P. L. Stone	(805) 982-4207	In progress
62765N		**Preliminary Analysis of Combined Solid- and Liquid-Waste Processes** Demonstrate feasibility of a small prototype system for recycling waste combinations to energy.	CEL	P. L. Stone	(805) 982-4207	In progress
62765N		**Small-Scale Densified Refuse-Derived-Fuel (RDF) Process Equipment** Determine parameters desirable in densified RDF for direct thermal conversion to energy in small, packaged units.	CEL	M. Boogay	(805) 982-4173	In progress
62765N		**Data Compilation for Site Characteristics** Assemble energy-related environmental data at Navy bases where alternative sources may be used.	CEL	R. E. Bergman	(805) 982-5377	In progress
62765N		***Guidance on Solar Pool Heating*** Test various concepts of solar heated swimming pools.	CEL	H. S. Zwibel	(805) 982-5119	In progress
62765N		**Solar Projects for the Advanced Energy Utilization Test Bed** Test solar collector and storage methods integrated with HVAC systems.	CEL	E. R. Durlak	(805) 982-4207	In progress
62765N		**Solar Collector and Thermal Storage R&D** Evaluate current systems for applicability to Navy use.	CEL	H. S. Zwibel	(805) 982-5119	In progress

Note: All projects in progress are summarized in this report.

SELF-SUFFICIENCY (Cont'd)

Program Element Number	Project Number	Title and Description	Performer	Contact	Telephone Number	Status
62765N		**Design Guide for Solar Heating and Cooling of Buildings** Provide technical guidance for site selection and evaluation of solar systems.	CEL	E. R. Durlak	(805) 982-4207	In progress
62765N		**Recommendations for Central Solar-Electric Power Generation at Navy Bases** Evaluate possible applications of solar-electric power generation at Navy bases.	CEL	E. E. Cooper	(805) 982-4207	In progress
62765N		**Applicability of Photovoltaic Equipment for Advanced Bases** Investigate and recommend systems for generating electrical power at advanced bases.	CEL	H. S. Zwibel	(805) 982-5119	In progress
62765N		**Feasibility of Solar Desalination Applications at Navy Sites** Determine the most suitable method of desalination for Navy needs and the most applicable Navy site for demonstration.	CEL	B. E. Swaiden	(805) 982-5978	In progress
62765N		**Evaluation of 5- to 10-kw Capacity Wind Generators to Supply Power for Buildings** Establish applicability of wind generators in this power range to supply thermal or electrical energy to Navy buildings.	CEL/NWC	D. Pal	(805) 982-4207	In progress
62765N		**Feasibility of Small-Scale Vertical-Axis Wind Machines** Determine feasibility and economics of this type of wind machine for providing thermal or electrical energy at Naval facilities.	CEL	D. Pal	(805) 982-4207	In progress
62765N		**Site Selection for Installation and Testing of 100- to 1,500-kw Wind Generators** Determine candidate sites where ERDA-developed large wind machines are cost effective. Collect and analyze field data to establish site characteristics for installation of candidate systems.	CEL	D. Pal	(805) 982-4207	In progress
62765N		**Handbook for Application of Wind-Power Generators at Naval Facilities** Develop performance parameters and design data for wind generators and associated power conditioning and control equipment required for practical utilization of wind power.	CEL	D. Pal	(805) 982-4207	In progress
62765N		**Preliminary Design of Open-Cycle Solar-Electric Turbine Generator** Develop preliminary design of a tactical solar-to-electric energy convertor for advanced base operations.	CEL	E. E. Cooper	(805) 982-4207	In progress

SELF-SUFFICIENCY (Cont'd)

Program Element Number	Project Number	Title and Description	Performer	Contact	Telephone Number	Status
62765N		**Advanced Power Cycles for Advanced Bases** Evaluate the feasibility, applicability, and costs of generating and utilizing synthetic fuels, such as hydrogen, at remote Navy bases.	CEL	E. E. Cooper	(805) 982-4207	In progress
62765N		**Lubricant Recovery and Recycling** Provide guidance and recommendations for lubricant recycling.	CEL	C. W. Anderson	(805) 982-5226	Completed FY 1976
62765N		**Solvent-Recovery Systems** Provide guidance and recommendations for solvent recovery.	CEL	C. W. Anderson	(805) 982-5226	Completed FY 1976
62765N		**Navy Geothermal Site Assessment** Identify and rank geothermal potential at Navy sites and recommend geological and geophysical studies required to assess its potential.	NWC	R. D. Fulmer/ C. F. Austin	(714) 939-7412 (714) 939-2206	In progress
62765N		**Adak Geothermal Resource Development** Assess the potential of Adak geothermal resources to provide thermal and electrical power for Navy facilities on Adak Island.	NWC	R. D. Fulmer/ C. F. Austin	(714) 939-7412 (714) 939-2206	In progress
62765N		**Coso Geothermal Resource Evaluation** Evaluate results of USGS and ERDA geological and geophysical studies at the Navy's Coso thermal area.	NWC	R. D. Fulmer/ C. F. Austin	(714) 939-7412 (714) 939-2206	In progress
62765N		**Geothermal Legal/Institutional Studies** Identify and explore the legal, institutional, and operational interface considerations that exist in the exploration/development of geothermal resources on Navy property. Provide guidelines to the Navy in the use and management of such resources.	NWC	R. D. Fulmer	(714) 939-7412	In progress
62765N		**Geothermal Utilization Technology for Remote Navy Sites** Identify ongoing Navy energy technology efforts applicable for use in geothermal systems and conduct experiments using this technology.	NWC	R. D. Fulmer	(714) 939-7412	In progress
62765N		**Geothermal Impact on Navy Missions** Identify and document the impact of geothermal exploration, development, and utilization on the basic missions of Navy shore facilities.	NWC	R. D. Fulmer/ C. F. Austin	(714) 939-7412 (714) 939-2206	In progress
62765N		**Geothermal Corrosion Studies** Explore the causes and nature of corrosion of construction materials resulting from contact with various geothermal fluids.	NWC	C. F. Austin	(714) 939-2206	In progress

SELF-SUFFICIENCY (Cont'd)

Program Element Number	Project Number	Title and Description	Performer	Contact	Telephone Number	Status
62765N		**Evaluation of New Coal-Utilization Technologies** Monitor ERDA fluidized-bed boiler demonstration and other developments in new coal systems technology.	CEL	D. E. Williams	(805) 982-4207	In progress
63724N	Z0840	**Absorption Air Conditioning** Evaluate a solar-driven absorption air conditioning system for Naval facilities.	CEL	H. S. Zwibel	(805) 982-5119	Starts FY 1978
63724N	Z0840	**Packaged Waste Heat-Recovery Systems** Evaluate applicability of small-capacity systems to service Navy bases.	CEL	P. L. Stone	(805) 982-4207	Starts FY 1978
63724N	Z0840	**Solid and Liquid Waste to Fuel** Demonstrate a small prototype system for recycling combinations of solid and liquid wastes to make gaseous fuels (methane).	CEL	P. L. Stone	(805) 982-4207	Starts FY 1978
63724N	Z0840	**Energy Storage** Develop economical methods of storing energy generated by time-dependent (solar, wind, etc.) sources to allow complete replacement of existing fossil fuel requirements.	CEL	H. S. Zwibel	(805) 982-5119	Starts FY 1979
63724N	Z0840	**Solar-Electric Power Generation** Develop a central solar-electric power generator at a selected Navy site.	CEL	H. S. Zwibel	(805) 982-5119	Starts FY 1978
63724N	Z0840	**Photovoltaics** Develop a full-scale photovoltaic system at an advanced Navy site.	CEL	H. S. Zwibel	(805) 982-5119	Starts FY 1978
63724N	Z0840	**Solar Desalination** Design, build, test, and evaluate a full-scale desalination system at a Navy site.	CEL	H. S. Zwibel	(805) 982-5119	Starts FY 1979
63724N	Z0840	**Development of a 10-kw Vertical-Axis Wind Generator** Develop a 10-kw vertical-axis wind generator for electricity and space heat applications at a Navy facility.	CEL	D. Pal	(805) 982-4207	Starts FY 1978
63724N	Z0840	**Application of ERDA-Developed 200- to 1,500-kw Wind Generators** Collect cost and performance data to determine applicability of ERDA-developed wind generators for bulk power supply at Navy bases.	CEL	D. Pal	(805) 982-4207	Starts FY 1979
63724N	Z0840	**Solar-Air Turbine** Evaluate the economic justification for use of a small solar-air turbine for remote Navy sites.	CEL	E. E. Cooper	(805) 982-4207	Starts FY 1977

SELF-SUFFICIENCY (Cont'd)

Program Element Number	Project Number	Title and Description	Performer	Contact	Telephone Number	Status
63724N	Z0840	**Advanced Power Systems** Demonstrate reciprocating engines, gas turbines, fuel cells, and other power systems using hydrogen-derived fuels produced with local energy sources.	CEL	E. E. Cooper	(805) 982-4207	Starts FY 1981
63724N	Z0840	**Geothermal Energy** Develop a known geothermal resource area on a Navy site for generation of electric power and/or for heating buildings.	NWC	C. F. Austin	(714) 939-2206	Starts FY 1977
63724N	Z0840	**Fluidized-Bed Boiler** Develop capability to use new coal technologies at Navy sites and support ERDA demonstration of fluidized-bed boiler at the Public Works Center, Great Lakes Naval Training Center.	CEL	D. E. Williams	(805) 982-4207	Starts FY 1978
63724N	Z0840	**Municipal and Agricultural Waste to Gasoline** Develop and demonstrate the capability to economically generate gasoline from organic municipal and agricultural waste.	NWC	R. D. Fulmer	(714) 939-7412	Starts FY 1978
63724N	Z0840	**Self-Sufficiency of Selected Navy Base** Develop entire base self-sufficiency concepts, systems, and emerging technologies.	NWC	R. D. Fulmer	(714) 939-7412	Starts FY 1979
64710N	Z0350	**Absorption Air Conditioning** Develop and demonstrate a solar-driven absorption air conditioning system for Naval facilities.	CEL	H. S. Zwibel	(805) 982-5119	Starts FY 1979
64710N	Z0350	**Solar-Augmented Heat Pump** Build, test, and evaluate a demonstration solar/night radiation augmented heat pump HVAC design.	CEL	H. S. Zwibel	(805) 982-5119	Starts FY 1978
64710N	Z0350	**Packaged Waste Heat-Recovery Systems** Demonstrate the applicability of packaged incinerator systems to Navy bases.	CEL	P. L. Stone	(805) 982-4207	Starts FY 1979
64710N	Z0350	**Solid and Liquid Waste to Fuel** Demonstrate a small prototype system for recycling combinations of solid and liquid wastes to energy.	CEL	P. L. Stone	(805) 982-4207	Starts FY 1981
64710N	Z0350	**Refuse Derived Fuel** Demonstrate the feasibility and usefulness of a facility to process refuse into several types of combustible fuels in existing Navy boilers.	NAVFAC	S. Hurley	(703) 325-8569	Starts FY 1977

SELF-SUFFICIENCY (Cont'd)

Program Element Number	Project Number	Title and Description	Performer	Contact	Telephone Number	Status
64710N	Z0350	**Energy Storage** Demonstrate economical methods of storing energy generated by time-dependent sources (solar, wind, etc.) to allow complete replacement of existing fossil fuel requirements.	CEL	H. S. Zwibel	(805) 982-5119	Starts FY 1982
64710N	Z0350	**Solar-Electric Power Generation** Demonstrate a central solar-electric power generator unit at a selected Navy site.	CEL	H. S. Zwibel	(805) 982-5119	Starts FY 1981
64710N	Z0350	**Photovoltaics** Demonstrate the applicability of a full-scale photovoltaic system at an advanced Navy site.	CEL	H. S. Zwibel	(805) 982-5119	Starts FY 1981
64710N	Z0350	**Solar Desalination** Design, build, test, and evaluate a full-scale desalination system at a Navy site.	CEL	H. S. Zwibel	(805) 982-5119	Starts FY 1981
64710N	Z0350	**Testing of 10-kw Wind Generators** Test 10-kw wind generators in 4-year evaluation project at various Navy sites.	CEL	D. Pal	(805) 982-4207	Starts FY 1981
64710N	Z0350	**Application of ERDA-Developed 200- to 1,500-kw Wind Generators** Collect cost and performance data to determine applicability of ERDA-developed wind generators for bulk power supply at Navy bases.	CEL	D. Pal	(805) 982-4207	Starts FY 1981
64710N	Z0350	**Solar-Air Turbine** Design, build, test, and evaluate a solar-air turbine generator for application at advanced Navy bases.	CEL	E. E. Cooper	(805) 982-4207	Starts FY 1979
64710N	Z0350	**Self-Sufficiency of Selected Navy Base** Demonstrate and integrate systems using local energy sources into a self-sufficient Navy base system.	NWC	R. D. Fulmer	(714) 939-7412	Starts FY 1979

APPENDIX B

INDUSTRY AND OTHER GOVERNMENT R&D

APPENDIX B
INDUSTRY AND OTHER GOVERNMENT R&D

This appendix highlights the major energy R&D accomplishments by industry and government agencies during October 1976-March 1977. The appendix is organized by the Navy strategies of energy conservation, synthetic fuels, and self-sufficiency.

ENERGY CONSERVATION

JOINT CRUDE-OIL STOCKPILE

Canada's Energy Minister, Alastair Gillespie, told the House of Commons in November that the Canadian government favors an arrangement with the United States for joint development of a strategic oil storage facility in abandoned coal mines in Newfoundland. Mr. Gillespie said he had discussed the proposal with officials of the Department of Commerce and the Federal Energy Administration (FEA). He felt the scope of the project was beyond the economic ability of Canada to handle by itself, but hoped it could be a joint facility. Strategic storage of petroleum in Newfoundland would place a major stockpile much closer to the heavily oil-dependent New England states than the Gulf Coast salt domes. The move could satisfy some of the critics of the sites selected for strategic storage of oil.

REMOVAL OF METHANE FROM COAL SEAM

DOI entered into a $76,640 contract with the Emerald Mine Corporation to extract methane from a 125-acre coal seam in Greene County, Pennsylvania. This will be the first attempt to recover methane before mining actually begins. The seam is scheduled to be mined in about two years. According to DOI, the procedure is primarily aimed at reducing the danger of methane gas explosions, but it could add more than 245 million cubic feet of gas to the area's supplies. One mine safety expert has estimated that the amount of natural gas trapped in existing coal deposits equals the total of known U.S. gas reserves. Emerald has already drilled 8 small-diameter holes vertically into the seam, through which a fluid will be pumped to fracture the coal, allowing the methane to be recovered. DOI and others have been investigating the extraction of methane from coal seams both for safety and as a method of extending the nation's natural gas supplies.

OXYGEN ENRICHMENT OF FOSSIL FUEL COMBUSTION

A method for enriching the air required for combustion of fossil fuels with oxygen while reducing energy demands in combustion systems has been developed by Chemetron Corporation, Hanover, Pennsylvania. The system is designed for combustion systems that

use natural gas, wood, coke, and oils in processes such as blast furnaces, cupola furnaces, and other high-temperature operations. The device, an oxygen ratio controller (ORC), combines electronic and pneumatic controls for automatic regulation and control of oxygen content in an air-oxygen mixture at a prespecified level. The ORC is intended to replace the more cumbersome mechanical flow-monitoring devices, which must be manually adjusted to change flow rates with production variations. With the Chemetron ORC, the percentage of each gas in the mixture is adjusted automatically rather than manually. In tests, the use of 3 percent to 4 percent oxygen enrichment yielded a fuel savings of 13 percent to 33 percent with natural gas. The increase of available Btu's of a given volume of natural gas depends on the percentage of oxygen enrichment and the process temperature. Chemetron spokesmen indicated that the ORC can be used successfully in many combustion processes where accurate regulation of oxygen is required.

PIPELINE BOTTOMING CYCLE

A more extensive study of the use of waste-heat recovery devices in pipeline pumping or compression stations is being planned by the Energy Research and Development Administration (ERDA). Earlier work by Mechanical Technology, Inc., suggests that the potential of bottoming cycles to save energy in pipeline applications is quite high. ERDA plans to issue a request for proposal for a preliminary cost-plus-fixed-fee study leading to the demonstration of a pipeline bottoming cycle. The first phase of the study should take about 9 months. It will cover the selection of a demonstration site, design of the preliminary system, assessments of environmental and operational matters, an analysis of industrial potential, and preparation of a detailed demonstration program.

SYNTHETIC FUELS

SENATE HEARINGS ON AVIATION SYNFUELS

After receiving two days of testimony before the Aerospace, Technology, and National Needs Subcommittee of the Senate Committee on Aeronautical and Space Sciences, Chairman Wendell Ford (D-Ky) offered this summary:

- The civilian and military aviation industry will need synthetic fuels in the future.
- Future aircraft engines must be designed to operate on a variety of fuels with large variations in their properties.
- A national policy governing development of alternative fuels for aviation must be formulated.

Testimony was presented by representatives from DDR&E, the Navy, the Air Force, the Army and other government and industry organizations in response to the Committee's questions about the nation's need for alternative fuels for aviation and the existing and planned R&D programs to provide these fuels.

The first day of the hearings focused on the options available for development of alternative or synthetic fuels and the needs for such fuels by both civilian and military

aviation. There was a consensus among those testifying that alternative fuels would be necessary in the near future. DOD indicated that as a customer it must be prepared to use synthetic fuels as they enter the national supply system. To achieve this end, R&D will be required to ensure compatibility between the new fuels and weapon systems, logistical supply systems, the environment, and personnel. Testimony from the American Institute of Aeronautics and Astronautics outlined the phased introduction of alternate fuels from four approaches: (1) exploring the possibility of using wider fractions of current jet fuels by raising freeze-point and lowering flash-point specifications, (2) continuing pursuit of technology needed for widespread use of coal- and shale-derived fuels, (3) long-term planning for utilization of nonfossil energy sources such as synthetic liquid hydrocarbons and cryogenic high-energy fuels such as liquid hydrogen, and (4) assessing the potential for nuclear-powered aircraft.

General Electric Company recommended that programs be initiated to design aircraft engine combustors and fuel systems that will be compatible with the characteristics of new synthetic fuels.

Based on studies, tests, and data collected from contractors and advisory panels, the National Aeronautics and Space Administration (NASA) suggested that the most feasible option is development of synthetic liquid fuels. Shale oil was characterized as being the most promising immediate source for alternative fuels while coal was seen as a more long-term source. NASA presented a summary of studies being conducted to determine the effects on aircraft engines of raising fuel freezing points, using fuels with high aromatic content, and adapting to the other differing characteristics of synthetic fuels.

On the second day of hearings, Senator Jennings Randolph (D-WVa) noted that the $12.5 billion required to establish a 1 billion barrel emergency petroleum stockpile could be diverted to provide synthetic fuel facilities capable of producing the equivalent of 1 million barrels of oil per day for at least 20 years.

Exxon recommended that NASA be given the lead in working with the aviation and fuels industry, DOD, and other government agencies to define new, wide-range jet fuel specifications for use in R&D programs to provide new aircraft with the flexibility to operate safely and efficiently with jet fuels from many sources.

Standard Oil of Indiana reiterated the need for the immediate development of synthetic fuels, initially from oil shale and later from coal. This development, according to Standard, is impossible without elimination of price controls; financial cooperation between government and private industry; recognition that problems such as cost overruns, long process debugging periods, and plant redesign will occur; and a mechanism for withdrawal of government support when a process becomes commercial.

The Government Accounting Office (GAO) defended its criticism of H.R. 12112, the Synthetic Fuels Demonstration Plants bill, by pointing out that the primary purpose of the bill was to promote commercialization of synthetic gas with only a small program to develop modular-sized, noncommercial oil-shale plants. GAO also stated that while its recent report did not specifically address aviation fuels, nothing in the report in any way

suggested delaying the development of a domestic capability to produce both natural and synthetic fuels for aviation use.

Through a review of those fossil energy programs now under way, ERDA focused on the work currently being done in the production of synthetic fuels, the upgrading and refining of coal syncrudes and shale oil, and the synthetic fuels commercialization program. Responding to GAO, ERDA stated that although there is disagreement about the amount of synthetic fuel needed, there is almost universal agreement on the need for synthetic fuels.

COMMERCIALIZATION OF OIL-SHALE SYNFUELS

Production of shale oil is closer to commercial acceptance than are other liquid fuel processes, Philip C. White of ERDA told the Senate Fuels Subcommittee. Shale production, he says, is also technically simpler than other synfuel choices, emits a smaller amount of solids to the atmosphere, requires less water, disturbs the land less, and should cost less. But two major factors are stalling development of oil-shale resources: environmental problems and economics.

ERDA's estimates of the economics of oil shale show that a modified in situ process would require the lowest investment and give the lowest production cost for shale oil; investment would be $5,000 to $7,000 per barrel, and production cost would be $8 to $11 per barrel. The in situ process—and the multimineral approach based on dawsonite recovery, with an investment of $7,000 to $9,000 per barrel and production cost of $9 to $12 per barrel—would be competitive with the cost of foreign oil. Surface retorting should be competitive in a few years, given rising costs for imported oil, with an investment of $14,000 to $23,000 per barrel and production cost of $16 to $25 per barrel.

An important economic issue has been the increase in front-end construction costs. For example, the cost of building a 50,000 barrel per day extraction plant has increased sharply over the past 3 years, from $400 million to $1.2 billion. Costs may be trimmed by leveraging the 100 percent equity financing used in the ERDA estimates to generate the above figures. Also, modified in situ processing might be combined with surface retorting to reduce costs and increase recovery. Government, however, should provide the economic setting to encourage shale development, ERDA maintained.

MICHIGAN OIL-SHALE PROGRAM

In October, ERDA and Dow Chemical Company entered into a program to develop Antrim shale into low-Btu gas by in situ combustion. Antrim shale is a part of the kerogen-bearing Devonian shale found in the eastern United States. The Michigan Energy Resources Research Association aided Dow in assembling a consortium of Michigan organizations and scientists to participate in the program.

ERDA and Dow agreed informally to a 4-year program to which ERDA will contribute $13.9 million. Dow will contribute an 80-acre site in which the company has invested about $900,000. The two parties have signed a letter contract calling for an expenditure of $1.9 million over 4 months, primarily for the cost of drilling wells, while the specifics of the total contract are being negotiated. The goal of the project is to develop the technology for extracting energy from the lean (10 gallons of oil per ton) shale in situ. Although one site has been prepared through the fracturing stage and is ready for combustion tests, the work will include testing of three other fracturing concepts. The contract also provides for retorting tests to be performed in conjunction with whichever fracturing process provides the best permeability and space distribution.

SUSPENSION OF WHITE RIVER SHALE PROJECT

DOI approved a 1-year suspension of operations for the White River Shale Project effective 1 November 1976. White River is a joint venture of Phillips Petroleum, Sohio Petroleum, and Sunoco Energy Development. White River asked for the suspension because spokesmen for the project claimed the Utah tracts cannot meet federal air quality standards even in their undeveloped state. The suspension granted is identical to the ones granted to the leaseholders of the Colorado C-a and C-b tracts. The terms of the suspension permit the companies to defer their remaining lease payments, but require them to continue their environmental monitoring. The companies are permitted to buy equipment and technology to speed development, which costs can be applied against the lease payments.

The oil companies have paid about $72 million of the $120,703,200 they bid for the tracts.

SHELL WITHDRAWAL FROM OIL-SHALE PROJECTS

Shell Oil Company announced its withdrawal from two Colorado oil-shale projects: the federal C-b lease, a joint venture of Shell and Ashland Oil; and the Colony Development Group, a joint venture of Shell, Ashland, ARCO, and TOSCO. (ARCO and TOSCO withdrew from the C-b lease in December 1975, leaving Shell as the operator. The four firms originally awarded the C-b lease have paid approximately $70.5 million of the $117.8 million bonus bid.)

Shell spokesmen said, "Our evaluation of economics, politics and environmental and technical considerations in the near term led us to this decision. However, Shell still views oil shale as one of the many potential sources for future energy." Shell will retain its Colorado oil-shale leases on other lands but does not contemplate any development in the foreseeable future. Shell has stated it is more interested in developing coal and solar energy as alternative energy sources.

Occidental Petroleum Corporation indicated it will join Ashland Oil in the C-b lease. Ashland spokesmen said Occidental will receive a 50 percent interest in the tract in exchange for the use of Occidental's modified in situ extraction technology.

Ashland will take over the environmental monitoring previously done by Shell. Ashland and Occidental plan to use the 1-year lease-suspension period to work out a new detailed development plan. The plan must be approved by DOI before full-scale development can resume.

RIO BLANCO AIR QUALITY STUDY

An air quality tracer study covering about 500 square miles in the C-a oil-shale tract was conducted by the Rio Blanco Oil Shale Project. Walter T. Herget, president of the project, told a meeting of federal, state, and local officials in Denver in January that the study shows pollutant dispersion is much more effective than originally predicted by a computer model developed for flat terrain. But the dispersion still is not enough to remove high background levels of certain pollutants unrelated to any development on the tract, Mr. Herget said. He added that the air quality problems that prompted Rio Blanco to request the lease suspension remain unsolved.

OIL-SHALE DEVELOPMENT PROBLEMS

In a hearing before the Senate Subcommittee on Minerals, Materials, and Fuels, spokesmen from DOI and ERDA, and representatives from Ashland and Occidental oil companies and White River and Rio Blanco oil-shale projects, testified on oil-shale development. Industry witnesses claimed that there is nothing wrong with the nation's oil-shale program that government incentives and an easing of environmental restrictions would not cure. They added that, despite these problems, shale oil is still one of the most promising ways to reduce the nation's dependence on foreign oil. The four prototype leases, auctioned in 1974, recently received 1-year suspensions primarily because natural background levels of pollutants in some of the lease areas already exceed federal air quality standards. According to DOI, legally there can be no permit approvals and no development, so long as these standards are exceeded. However, if Congress does not resolve this problem, EPA might administratively change some of the geographic boundaries of the air quality standards to permit development of the leases.

Further testimony revealed that what is also needed is legislation permitting the lessees to build processing-plant facilities and to dispose of the spent shale from lease areas onto nearby federal lands. If this problem and the air quality problem can be resolved, it would then be possible to test the economic feasibility of the oil-shale program. DOI and ERDA are optimistic shale oil will be economically competitive with world market crude oil by the time the leases begin producing in the early 1980s.

White River and Rio Blanco officials did not share the government's optimism. Citing estimated demonstration plant construction cost increases of $900 million over the past 2 years from $600 million to $1.5 billion, they contended that federal financial assistance must be supplied in the construction phase of the project.

Occidental and Ashland remained confident that they could soon produce shale oil in an environmentally safe manner and at a price competitive with world market crude

oil. Occidental acquired a 50 percent interest in the C-b lease when Shell withdrew. The Occidental-Ashland development plan, which will be submitted to DOI for approval early next year, calls for commercial production to begin in 1981. Officials reasoned that production could not begin sooner because of the "lack of responsiveness of the federal government . . . there has been no sense of urgency, no high priority assigned to this program."

UTAH TAR SANDS DEVELOPMENT

In October, Howard R. Ritzma, Assistant Director of Utah Geological and Mineral Survey, stated that the development of the Utah tar sands is minimal despite the fact that an estimated 25 million barrels of oil are present in 50 tar sands deposits in eastern Utah. At this time, there are only three projects underway. An Arizona Fuels process, using warm water and a solvent to extract oil, is in the pilot plant stage at Asphalt Ridge. ERDA's fire-flood project, also at Asphalt Ridge, has suspended operation after completion of its program last winter. Although this experiment produced less oil than expected, a follow-up experiment is being proposed. The University of Utah is the third organization experimenting with tar sands in the state. The current cost of extracting oil from Utah tar sands has been estimated at $15 to $20 per barrel. This is higher than the present price of natural crude oil. Guardian Chemical has announced plans for testing its extraction process on Utah tar sands.

NEW CANADIAN TAR SANDS AND HEAVY-OIL VENTURES

The Canadian government and oil industry increased their commitment to develop recovery methods for tar sands and heavy-oil deposits early in 1977.

Amoco Canada Petroleum Company, Ltd., and the Alberta Oil Sands Technology and Research Authority (AOSTRA) started work to test in situ recovery in the Athabasca tar sands. The total outlay for the research will probably be about $71 million. Amoco and AOSTRA signed a 50/50 contract last month. The project calls for using Amoco's combination forward combustion and water flood technique. About $46 million could be spent between now and the end of 1980, with production probably reaching 1,000 barrels of bitumen per day. A second 4-year phase, costing $25 million, may be undertaken after the joint pilot phase is completed in 1980. Since an estimated 80 percent of Alberta's tar sands deposits lie too deep for surface mining, Amoco feels that the in situ technique is the key to recovery.

The Saskatchewan provincial and Canadian federal governments set 31 March 1977 as the deadline for receiving proposals to test methods for recovering heavy oils in Saskatchewan.

ERDA TAR SANDS PROGRAM

Opening a new phase of its tar sands exploration program, ERDA asked private companies for proposals for field demonstration projects to recover oil from U.S. tar

sands without major surface disturbance. The proposal forms, issued 11 February, requested estimates for cost-sharing projects covering 4 years of work on sites the companies identify and make available. The companies were also requested to identify reservoirs where recovery operations could be expanded to a commercial operation. ERDA estimates that there is a potential of 30 billion barrels of crude from tar sands in 22 states. The largest deposits are in Alabama, California, Kentucky, New Mexico, and Utah.

SASOL COAL GASIFICATION UNIT

The South African Oil and Gas Corporation (SASOL) reported in October that using the Lurgi process, it has successfully gasified 6,500 tons of coal from its Bosjesspruit mine in the southeastern Transvaal of South Africa.

The success of the experiment opens the way for enlarged gasifiers, which are being built for the expansion of SASOL's existing plant. The project will cost $46 million and increase plant capacity by 40 percent. The enlarged gasifiers are to be installed at SASOL 88, a new unit being built to lessen South Africa's dependence on oil imports and to relieve the country's balance of payments. It will consume about 12 million metric tons of coal per year after the unit comes on stream in 1981. The reduced dependence on imported crude will save the country an estimated $402 million per year in foreign exchange by 1983 (at current exchange rates).

SELF-SUFFICIENCY

SOLAR CELL COST DECREASE

In October, ERDA announced a reduction in the cost of solar cells. Six months ago, ERDA paid $21 for a solar cell that produced 1 watt of electricity. In a recent purchase for a demonstration program, a price of $15.50 per watt was reported.

The reduction is considered significant, but ERDA officials contend that the price of solar cells must drop to $0.50 per watt before solar voltaics can compete with other energy forms. This is not expected before the mid-1980s.

INCREASED EFFICIENCY IN PHOTOVOLTAIC CELLS

ERDA reported that recent tests conducted by NASA's Lewis Research Center confirm an increase in the efficiency of cadmium sulfide (CdS) solar photovoltaic cells from less than 7 to 7.8 percent. The University of Delaware's Institute of Energy Conversion, developers of the cells, achieved the increase by decreasing the series resistance in the cells through better contacts. In the university's next experiment, zinc will be introduced into the CdS to increase open circuit voltages. The university has a goal of 10 percent cell efficiency by 1980.

SOLAR ELECTRIC POWER COMMERCIALIZATION STUDY

FEA, ERDA, and DOI awarded a $500,000 contract to Stone and Webster Engineering and 11 southwestern power companies to do a comprehensive study of the technical, economic, legal, and institutional problems to be overcome to make electric power generation by solar energy succeed in the Southwest. The study, called the Southwest Project, will develop strategies to integrate large-scale solar electric generating equipment into the utility networks of 8 southwestern states. Objectives of the study include determination of the current development status of wind, solar thermal electric, and photovoltaic conversion systems, as well as storage facilities; estimation of the size of the potential market; definition of utility requirements for design and operation of the solar generating equipment; and determination of the role solar energy should play in the plans for expansion of electric generating capacity in the area.

ERDA SOLAR TOTAL ENERGY SYSTEM (STEP)

ERDA announced in January that an experimental STEP will be built and tested. The facility will be designed to provide 200 to 500 kw of electric power plus the energy necessary to heat and cool the facility it serves. The system will supplement energy from conventional resources, operating only during sunlight hours; it will not store energy for overnight operations. Program funding will total $1.2 million for this fiscal year.

Sandia Laboratories was named technical project manager for the program. Sandia will set technical goals and schedules for the nationwide program, provide in-house technical support, and undertake tasks complementary to those performed by industry. Early design and construction of several large-scale experimental systems of 200 to 500 kw are part of the STEP program. These facilities would be followed by construction of demonstration plants of about 2-Mw output, each on a cost-shared basis with industry. A total installed capacity of 30 Mw by the end of 1982 is a specific goal. Long-range plans include a large demonstration facility of about 60 Mw to provide energy for an integrated energy community by 1985.

10 MW-SOLAR POWER PLANT

ERDA announced the selection of a site in the Mojave Desert near Barstow, California, for the first 10-Mw solar thermal power plant. Southern California Edison is heading a team of utilities that will operate the plant when it is completed in 1980 or 1981. The solar power plant will demonstrate the central receiver concept, which involves directing the sun's energy by a field of mirrors to a central receiving boiler at the top of a tower. There, the sun's energy will be absorbed by a working fluid used to drive a steam turbine generator to produce electricity. At peak output, the power plant is expected to meet the electrical needs of a city of 10,000 people. Since the storage system will allow the plant to operate for only a few hours when the sun is not shining, the plant will not be the sole source of electric power.

HYDROGEN PRODUCTION FROM SOLAR ENERGY

A diode capable of generating hydrogen with light in a simple, one-step process has been developed at Allied Chemical's Materials Research Center. Allied calls the device a photochemical diode. Essentially a sandwich of two electrodes, it has two configurations. In one, both electrodes are semiconductors such as titanium dioxide or gallium phosphide; in the other, one electrode is a semiconductor and the other a metal such as platinum. No wires or complex configurations are needed. The simple structure allows easy fabrication with small amounts of materials.

Hydrogen and oxygen are produced by electrolysis on the surface of the diode when it is immersed in a water-acid solution exposed to light. The diodes can be made small enough—even microscopic—to be held in a colloidal suspension, say Allied officials. But, Allied notes, there are practical problems to be resolved before an economically feasible solar-energy system such as this can be realized. The major problem is to develop diode structures and materials with high conversion efficiencies, long-term stabilities, and low costs.

UTILITIES INTEREST IN SOLAR ENERGY

The number of electric utilities sponsoring research into solar energy conversion more than doubled in 1976. Electric Power Research Institute, which conducted a survey, found that 116 utilities are conducting research in the area of solar energy applications, as compared with 53 last year. About 85 percent of the research concerns residential and commercial solar heating and cooling systems. Other research includes solar/thermal electric power, wind energy conversion, photovoltaics, and data collection on solar radiation.

APPLICATION OF SOLAR EQUIPMENT TO NAVY HOUSING

In response to the Solar Heating and Cooling Act of 1974, the Navy is involved in a program to apply state-of-the-art solar equipment to Navy family housing. Flat-plate solar collectors, water-to-air heat pump transfer, and a buried water storage back-up system—the most economical equipment available—will be used. The solar-assisted optimized heat pump (SAOHP) system provides low-cost energy, and the amount of supplementary energy required is minimal. The plan includes the application of solar power for both new construction and retrofits, and the SAOHP is equally applicable to houses, office buildings, barracks, and any other structures where significant benefits are feasible. Thus far in the program, 16 Navy houses at bases in San Diego, Charleston, New Orleans, Twenty-nine Palms, and New London have been selected for the installation of the SAOHP system.

SOLCHEM

Solchem is a novel concept for converting solar energy to heat, which is used to produce electrical energy. The research is being performed at the E. O. Hulburt Center

for Space Research, Naval Research Laboratory. The Solchem power plant, designed to provide 24-hour demand-responsive electrical energy, has three main components: solar energy collection field, energy storage tanks, and electricity generating facility.

The collection field consists of many small solar furnaces distributed over the plant site. The furnaces are composed of a parabolic concentrating collector and a small chemical reactor suspended at the focus point of the collector. A gaseous working fluid such as sulfur trioxide (SO_3) is catalytically decomposed in a heat-absorbing reaction. The reactor receives SO_3 gas from the storage system at about 90° C. The gas, entering the heat exchanger, spirals into the center region and is heated to about 700° C. The heated gas flows downward into the reaction chamber where it is heated to about 800° C. With the absorption of solar heat, and as the gas passes over a catalyst, the SO_3 dissociates into sulfur dioxide (SO_2) and oxygen (O_2). The dissociated gases pass outward through passages in a stock of spiral plates in the reactor, are cooled to about 100° C, and piped to the energy storage boiler tanks. Preliminary analysis shows that a central power station providing a continuous 24-hour electrical output of 100 Mw, and energy storage for 72 hours in the absence of sunlight, would require 35,500 solar furnace collectors, each 7 meters in diameter.

The dissociated gases enter the bottom of the storage tank in catalytic conversion pipes where the SO_2 and O_2 are recombined to form SO_3. The recombination reaction is exothermic, liberating energy. The liberated energy is stored at the latent heat of fusion at 385° C in the form of a molten-solid salt eutectic.

The energy is transferred from the catalytic conversion pipes at the bottom of the tank to the outside surface of the salt eutectic cans (for storage) and to water/steam generator lines entering at the top of the tank. Electricity is generated using this steam in a high-pressure steam generator. The SO_3 gas is recirculated to the collector reactor thus completing the system loop.

Thus far, Solchem is largely experimental, but work has started on the energy-storage boiler tank with material compatibility tests currently under way. This work should lead to a demonstration of a 10-foot energy-storage boiler tank by the end of 1977.

The critical element in the Solchem process is the reactor heat exchanger. There is still need for design study and trial fabrication work before experimental tests are started. Initial experimental studies could possibly be started late in 1977. Initial tests will be done in White Sands, New Mexico, using the solar furnace belonging to the Army's White Sands Thermal Effects Facility.

FIRST ERDA WINDMILL

The municipal utility in Clayton, New Mexico, announced in December that it planned construction of the nation's first commercial electrical generating windmill, under a cooperative arrangement with ERDA. The $1 million windmill will be mounted on a

steel truss tower 100 feet high. Its two-bladed propeller, with a span of 125 feet, will turn a horizontal shaft that transmits motion through a gear box to an 1,800 rpm generator. The windmill will operate automatically in winds from 8 to 40 mph. The windmill will generate 200 kw of electricity for the small town located in northeastern New Mexico where the winds average 15 mph. The facility, to be operated by the local utility, should provide 5 to 15 percent of the town's electricity needs that are now being supplied entirely by oil and natural gas. Clayton's windmill generator is the first in a series of four similar projects, two of 200 kw and the second two of 1.5 Mw. Although NASA built the prototype for the Clayton mill, ERDA has contracted General Electric and United Technologies to design and build the larger model.

ERDA WIND ENERGY PROJECTS

In January, ERDA awarded a total of $300,000 to two contractors to investigate some unconventional concepts for producing energy from wind.

Grumman Aerospace Corporation was awarded a $200,000 contract to study and develop a vortex tower wind energy system. This system, which works on the same principle as a tornado, has a tall, cylindrical tower. In the tower, a low-pressure central core is produced by wind entering the tower tangentially through vanes open on the windward side of the tower. Near the base of the tower, in a narrow neck, is a vertical-axis wind turbine with air inlets below it. The pressure differential between the ambient air beneath the turbine and the low-pressure core of the vortex above it causes a strong upward flow of air driving the turbine to generate electricity.

South Dakota School of Mines and Technology was awarded a $100,000 contract to explore the possibility of harnessing the energy released when water vapor is turned back into water. One possibility is a large structure, similar to a cooling tower, in which warm moist air would rise to an altitude where the outside temperature would be low enough to cause condensation. A heat engine placed between the humid air in the tower and the cooler air outside would extract the energy released during condensation. South Dakota scientists believe that the process may be practical even if it extracts only 5 percent of the energy stored in the humid air because the "fuel" (humid air) is readily available in most parts of the country.

ERDA/NASA 2-MW WINDMILL

Under the direction of ERDA, NASA chose the Kaman Aerospace Corporation for negotiation of a contract to fabricate a 150-foot rotor blade for an electricity-generating windmill. The purpose of the contract is to determine whether rotor blades of this size can be built and handled. ERDA officials say that two blades of this size would be needed for a 2-Mw wind-turbine generator at a site where winds average 14 mph. Methods used to build helicopter blades will be adapted to build the blade of glass fiber at Kaman's Connecticut plant. (The largest helicopter blade now in use is about 55 feet long.)

Detailed design studies of the wind turbine are to begin later this year and should generate enough data by the time the large blade has been built and tested to allow the two agencies to decide on the future of the program.

GEYSERS GEOTHERMAL POWER PLANT

Pacific Gas and Electric Company (PG&E) announced in October that its Geysers power plant will deliver 773,000 kw by 1979. This level will be made possible by the construction of two additional units of 110,000 kw and 55,000 kw at the power plant site 90 miles northeast of San Francisco. The facility is already the largest geothermal power plant in the world.

At this time, PG&E is waiting for an authorization from the California Public Utilities Commission to construct an additional 135,000-kw unit. This unit is expected to be in commercial operation in 1979, and will be the largest turbine generator at the power plant facility. When all three of the new units are in operation, it is expected the plant will deliver 908,000 kw, which will reduce PG&E's oil consumption by about 9 million barrels per year.

Two million pounds of geothermal steam is required to generate 100,000 kw of electricity at the Geysers power plant. The steam is delivered by 14 wells at the plant site at a temperature of 350° F and a pressure of 100 pounds per square inch. One hundred thousand kwh is roughly equivalent to 200 barrels of petroleum.

GEOTHERMAL SCALE CONTROL

ERDA's Lawrence Livermore Laboratory (LLL) reported encouraging results from tests using hydrochloric acid to reduce scale formation caused by geothermal brine. Scale in pipes and nozzles is a major limiting factor in the use of high salinity geothermal brines in southern California. In recent tests near Niland, California, researchers succeeded in preventing the scaling of a nozzle through which high salinity brine flowed during a 24-hour test by the addition of a small amount of hydrochloric acid to the brine. A control nozzle subjected to the same test without the acid was nearly one-third closed at the end of 24 hours. A stationary simulated turbine blade subjected to the acidified brine flow exhibited no scaling, corrosion, or erosion. LLL spokesmen estimate this method of scale control would add less than 1 mill per kwh to the operating cost of a geothermal power plant. LLL plans to continue field experiments with brine flow rates and mixtures, nozzle configurations, and acidifiers.

COSO GEOTHERMAL PROGRAM

The Coso Thermal Area, (CTA) is located in the Southern Coso Mountains adjacent to Rose Valley in Inyo County, California. The CTA has been identified as a vast hydrothermal system, with great development potential as a geothermal energy resource. The system is thought to lie mostly within the boundaries of the China Lake Naval Weapons Center.

Obvious surface manifestations and preliminary investigations, including geologic mapping, heat flow studies, and limited exploratory drilling, have indicated potential sites for development. A program plan for full exploitation of the CTA is currently being formulated by the Navy, DOI, and ERDA. ERDA is considering contracting for drilling of a production well in the near future.

Controlled exploration of the essentially virgin geothermal deposit will provide an excellent opportunity to develop the techniques required to model geothermal deposits. As the geothermal field is developed, effects of new drilling, fluid extraction, fluid reinjection, and experimentation can be predicted by the model, and the results compared with measured data.

Environmental management studies will be performed involving fluid disposal techniques, underground facilities, submerged pipelines, well-head equipment, and air pollution control. Uses for geothermal resources not requiring power conversion, such as geothermal space heating and chemical processing, will also be studied.

Several other supporting studies will be required for full development. For example, legal and institutional considerations require careful analysis and resolution before on-line power production. The legal and institutional areas of concern are being addressed concurrently with the development of the CTA.

COAL CLASSIFICATION REPORT

In October, the Department of the Interior (DOI) and the Environmental Protection Agency (EPA) published a report entitled *Sulfur Reduction Potential of the Coals of the United States.* The report revealed that less than 15 percent of raw coal samples meet federal environmental standards, but that with sacrifices in heating value, an additional 18 percent of the samples could be washed to remove the pyritic sulfur by gravity separation to meet EPA standards.

However, 30 to 70 percent of the sulfur in U.S. coals is organic (bound chemically to the coal) and cannot be removed by conventional cleaning. Therefore, coal with high organic sulfur content cannot meet sulfur dioxide standards for new power plants even after washing. DOI is evaluating chemical washing techniques that remove organic sulfur by treating the pulverized coal with oxidizers such as sodium hydroxide or chlorine. DOI also plans to introduce the citrate scrubbing process to remove sulfur dioxide from power lant stack gases. Currently, EPA limits the sulfur dioxide content of smokestack emissions to 1.2 pounds per million Btu for coal burned in new power plants (those beginning operation after July 1, 1975).

FLUIDIZED-BED PLANT DESIGN

In February, ERDA awarded Stone and Webster Engineering Corporation a 1-year, $1.35 million contract to develop conceptual designs for a 500- to 600-Mw atmospheric fluidized-bed power plant. Stone and Webster will request fluidized-bed boiler designs

from several large boiler manufacturers; the best features of each design will be incorporated into the overall conceptual plant design. Design completion is scheduled for January 1978, when Stone and Webster will recommend the size for the ERDA demonstration plant that must be built to test the fluidized-bed concept. The demonstration plant is expected to be in the 200-Mw range. A 30-Mw pilot plant using an atmospheric fluidized-bed boiler is now being tested by ERDA in Rivesville, West Virginia.

GAS FROM MANURE

The possibility of converting cow manure to methane is being studied by Hamilton Standard Company under a $50,000 contract with Pacific Gas and Electric Company (PG&E) and Southern California Gas Company. Hamilton Standard will conduct a 6-month study of the required facilities, environmental feasibility, and economics involved in the conversion. PG&E said its resources group had indicated there is probably enough waste generated in feedlots in Imperial, Fresno, and Kern Counties alone to produce 30 million cubic feet of methane daily. One conversion process being considered is anaerobic digestion by bacteria. This method is being used by Calorific Recovery Anaerobic Process, Inc., in Oklahoma to produce gas for Chicago.

BIOCONVERSION PLANT

Construction was started on an experimental gasification plant that will convert solid wastes and sewage sludge into methane gas. The $2.8 million plant is being built for ERDA by Waste Management, Inc., in Pompano Beach, Florida, to demonstrate the feasibility of larger plants supplying gas for urban areas. Waste Management estimates that a gasification plant processing 1,000 tons of refuse a day could produce enough methane to serve 10,000 homes, while reducing waste-disposal volume by 70 percent. The experimental plant will process about 100 tons of waste a day, and is scheduled to go on stream late this year.

APPENDIX C

LEGISLATION

APPENDIX C

LEGISLATION

When the 95th Congress convened on January 4, 1977, much of the energy legislation that had failed to become law by the close of the 94th Congress was reintroduced. This legislation includes:

Energy Research and Development Administration's FY 1978 Budget Request. The FY 1978 budget submitted by President Ford in January was revised by President Carter to reflect new priorities in energy research and development. Funding requests for conservation, fossil energy, solar heating and cooling, and environmental and biomedical research were increased, and those for solar electric, fusion power, and nuclear fuel cycles were decreased. (See Appendix D.)

Natural Gas Price Control. The 95th Congress responded to the recent natural gas crisis by enacting legislation giving the President temporary authority to control natural gas prices and allocation systems. In anticipation of the August 1, 1977, expiration of the President's authority, bills have been introduced by forces both for and against deregulation. Proposals range from total deregulation of natural gas prices to federal regulation of both inter- and intrastate natural gas.

Amendments to the Outer Continental Shelf (OCS) Lands Act. Legislation has been introduced to reform the management procedures used by the Department of Interior to grant OCS oil and gas leases and to increase the states' role in OCS development. The legislation has received support from both the new Administration and representatives of the coastal states. Advocates of the legislation are confident that they have the votes necessary for passage this session. The measure was defeated by a four-vote margin in the House last year.

Surface Mining and Land Reclamation. Legislation to establish the first national regulations for surface mining and reclamation will be a controversial issue this session. A similar bill was vetoed by President Ford during the 94th Congress, but the new Administration has publicly endorsed the measure. President Carter's strong support for such federal action, however, is no guarantee of passage, since opponents are now emphasizing that many states are enacting their own standards, thereby reducing the need for federal intervention.

Coal-Slurry Pipeline. Legislation to grant eminent domain to companies constructing coal-slurry pipelines has been introduced, but action on the measure will most likely be delayed until the Office of Technology Assessment completes a study on the subject.

Clean Air Act Amendments. Provisions requiring minimal deterioration of areas where the air is relatively clean have been strongly opposed by energy groups

and industry. This and other issues, such as auto emission standards, will be considered by the 95th Congress.

Electricity Rate Reform. Although Congressional action on electricity rates will most likely be delayed until the Federal Energy Administration completes its proposals for improved electric rate design (as required by the Energy Conservation and Production Act), several reform measures have been introduced. The reforms focus on establishing rates that reflect the cost of providing service to each class of consumer and on adjusting rates that now encourage increased consumption. Other issues, such as mandatory "lifeline" rates for residential users, limits on passing through advertising expenditures, and state regulations, are also addressed in various bills introduced.

Nuclear Proliferation Control. The issue of controlling nuclear proliferation has become more complex as more nations develop nuclear capabilities. The proliferation of nuclear materials involves not only energy development, but also defense and international relations. President Carter's strong public support of limited exportation of nuclear materials to maintain international stability is certain to influence Congressional actions.

Nuclear Fuel Assistance. The question of nuclear fuel assistance facing Congress is whether or not the government should allow and, in some situations, support the construction of private uranium plants. The more moderate proposals introduced call for a moratorium on development until the subject can be studied further.

Divestiture. Proposals for both horizontal and vertical divestiture have been introduced in the 95th Congress. Support for such measures has increased because of publicity generated by the 1976 Senate divestiture hearings. The outcome of Congressional deliberation on this issue is uncertain, especially since the Carter Administration has yet to adopt a clear-cut policy.

Tax Incentives for Conservation. Legislation has been introduced to amend the IRS Code to allow for a wide range of tax credits for conservation measures. Credits for investments in solar and geothermal equipment, insulation, heat pumps, and various other energy-efficient devices, as well as automobiles meeting certain mileage efficiency standards, are being considered.

Synthetic Fuels. The Energy Research and Development Administration is seeking Congressional approval of individual synthetic fuel projects, rather than approval of a single bill to provide for an overall synthetic fuels program as was proposed in the 94th Congress. Bills for several high-Btu coal gasification and oil-shale projects have already been introduced.

The approach and priorities of the 95th Congress are much different than those of the 94th Congress. As the result of November's election a unique situation exists in that not only is there a new President of the majority party, but there is also new leadership in both houses. The defeat and retirement of several key members will also have an effect on the attitude Congress takes toward energy issues. In addition, the recently completed Senate committee reorganization, which results in the creation of a Committee on Energy

and Natural Resources, and the proposed consolidation of energy jurisdiction in the House is directed toward improving Congress' responsiveness to energy issues. Whether or not these changes will result in policy shifts remains to be seen.

APPENDIX D

NATIONAL ENERGY POLICY AFFECTING THE NAVY

APPENDIX D
NATIONAL ENERGY POLICY AFFECTING THE NAVY

The new Administration is developing a comprehensive national energy policy. This development process has involved a review of various policies affecting the nation's overall energy needs. Until the effects of long-term decontrol could be analyzed, for example, President Carter rescinded his predecessor's proposal to end price controls on gasoline and signed into law the Emergency Natural Gas Act (Public Law 95-2), which provides for temporary price increases and allocation powers.

Much of President Carter's energy philosophy is revealed in the Energy Research and Development Administration's FY 1978 budget. While the budget total differs very little from the original Ford budget, the distribution of funds between the various programs is significant, as shown in the following table.

ENERGY RESEARCH AND DEVELOPMENT ADMINISTRATION
FY 1977 AND FY 1978 BUDGET
(Millions of dollars)

Program	FY 1977		Original FY 1978		Revised FY 1978[a]	
	Authority	Outlay	Authority	Outlay	Authority	Outlay
ENERGY RD&D						
Conservation	161	125	160	140	318	244
Fossil energy	483	445	598	500	640	519
Solar heating and cooling	86	61	45	61	90	86
Solar electric and other	204	122	260	173	215	164
Geothermal energy	55	49	88	68	88	68
Fusion power development	416	322	513	431	433	392
Liquid metal fast breeder reactor	686	595	855	736	656	651
Nuclear fuel cycle and safeguard	406	336	636	503	611	486
Other fission	146	122	148	137	148	137
Special foreign currency funds	0	2	2	3	2	3
Subtotal	2,643	2,179	3,305	2,752	3,201	2,750
SUPPORTING RESEARCH						
Environmental and biomedical research	181	175	210	198	215	200
Basic energy sciences	156	137	175	162	175	162
Subtotal	337	312	385	[illegible]0	390	362
FINANCIAL INCENTIVES						
Geothermal resources development fund	30	4	30	7	30	7
Alternate fuels demonstration program	0	0	295	3	300	3
Subtotal	30	4	325	10	330	10
Total	3,010	2,495	4,015	3,122	3,921	3,122

[a]Revised by the Carter Administration.

Conservation was increased the most over the original FY 1978 budget–$158 million more in authority and $104 million more in outlays. This and other funding changes reflect an emphasis on near-term energy goals and a slowdown in nuclear RD&D.

President Carter retained a program (proposed in the original FY 1978 budget) of financial incentives for an alternative fuels demonstration program. Federal incentives such as loan guarantees, cost sharing, grants, or price supports would be reviewed by Congress on a project-by-project basis. This approach is expected to be better received than previous so-called "commercialization" proposals.

Other program goals, as highlighted by the Office of Management and Budget, include:

- Conservation
  - Improve efficiency of heat engines for transportation.
  - Implement Electric and Hybrid Vehicle Demonstration Act.
  - Establish energy extension service program.
  - Develop energy conversion efficiency.
  - Improve technologies for electric energy, energy storage, and conversion.
  - Increase energy conservation in buildings, industry, and transportation.
- Fossil Energy
  - Substitute coal and coal-derived fuels for oil and gas.
  - Improve techniques for recovery of oil and oil shale.
- Solar Energy
  - Implement solar heating and cooling demonstration program.
  - Develop technologies for using agriculture and industrial process heat and biomass conversion.
  - Encourage solar electric R&D.
- Geothermal Energy
  - Initiate a 50-Mw demonstration facility.
  - Intensify resource exploration, assessment, and utilization.

APPENDIX E

SHALE OIL PROGRAM

APPENDIX E

SHALE OIL PROGRAM

Consistent with DOD's desire to support the development of a domestic commercial synthetic fuel industry, the Navy, acting as lead agency for DOD, is pursuing the assessment and qualification of oil-shale-derived fuels for military use. The Navy is now serving as the contracting agency and project director for a joint DOD/ERDA program for acquiring, refining, and testing fuels derived from 100,000 barrels of shale oil. The shale oil is being produced by the Paraho process from oil shale on the Naval Oil Shale Reserves near Rifle, Colorado. This program is a follow-on to the previously conducted 10,000-barrel shale oil refining and testing program.

To date, the Navy has let approximately $2.1 million in contracts to Development Engineering, Inc. for 1) refurbishing the production facility, now completed; 2) producing the first increment of crude shale oil (15,000 barrels scheduled to have been produced by the end of April 1977); and 3) constructing storage for an additional 60,000 barrels of crude oil at the production site (scheduled for completion by 1 May 1977). Negotiations are now being conducted for the production of additional increments of crude shale oil.

The refining phase of this project was initiated with the issuance of a Request for Proposal on 11 March 1977; a preproposal conference was held on 12 April 1977; and proposals are due 15 June 1977. The Request for Proposal addresses the first phase of the two-phase shale oil refining program and requires the demonstration of a method for producing military-specification fuels from crude shale oil in a pilot plant. The actual refining will be done during the second phase. When the refining is completed, the fuel products will be distributed to various government and contractor facilities for test and evaluation.