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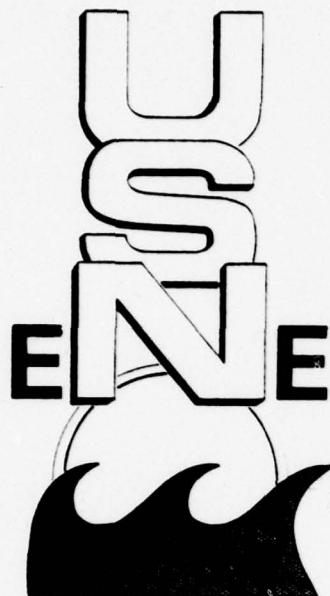
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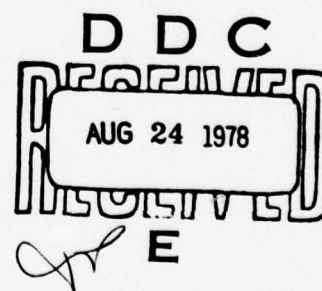
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# ENERGY PLAN AND PROGRAM 1978

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U.S. NAVY ENERGY OFFICE (OPNAV 413)

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DEPARTMENT OF THE NAVY  
OFFICE OF THE CHIEF OF NAVAL OPERATIONS  
WASHINGTON, D.C. 20350

IN REPLY REFER TO  
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27 July 1978

From: Chief of Naval Operations  
To: Distribution List

Subj: U.S. Navy Energy Plan and Program - 1978

Ref: (a) U.S. Navy Energy Plan of 26 January 1977  
(b) OPNAVINST 4100.5A of 9 May 1978

Encl: (1) OPNAV 41P4 U.S. Navy Energy Plan and Program - 1978

1. As our nation's dependence upon foreign sources of petroleum continues to increase, many of the Navy's current and projected military systems will continue to be dependent on petroleum fuels. This source of energy is subject to interdiction and to capricious economic actions by foreign nations. The diminishing sources of petroleum and escalating prices could also seriously affect the Navy's ability to fulfill its primary mission responsibilities. It is essential, therefore, that we maintain the momentum toward greater efficiency in the management and consumption of energy resources in the Navy.

2. The Navy Energy Plan, reference (a), provided you with the basic background, goals, strategies, objectives, and policy to improve energy utilization. The first annual Navy Energy Plan and Program - 1978, forwarded as enclosure (1), provides you with the most up-to-date programs, goals, operating standards, and funding status to assist you in evaluating and implementing an effective energy program. In addition, a summary of program accomplishments is provided to advise you of successfully implemented programs that can be used by your activities.

3. I have tasked the Navy Energy Office (OPNAV-413) with the responsibility of coordinating the total Navy energy program. All hands are responsible for carrying out the objectives and goals outlined in reference (b). The enclosed Navy Energy Plan and Program - 1978 is provided to assist you in that task. Only through your efforts in implementing sound energy policy can we continue to meet our national security obligations.

R. L. J. LONG  
Admiral, U.S. Navy  
Vice Chief of Naval  
Operations

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# U.S. NAVY ENERGY PLAN AND PROGRAM 1978

JUNE 1978

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CHIEF OF NAVAL OPERATIONS

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U.S. NAVY ENERGY OFFICE (OP-413)

DOCUMENT NO. OPNAV 41P4

## **PREFACE**

The 1978 U.S. Navy Energy Plan and Program has been developed by the Navy Energy Office, OP-413, in coordination with the Navy Energy Action Group (EAG). This document is intended to keep the CNO and the EAG apprised of the Navy energy situation and to update Navy energy program goals in light of presidential executive orders and DOD directives. The plan and program include a brief overview of the world, national, and Navy energy situations; a summary of energy objectives and goals; a description of the current Navy energy program; a summary of program accomplishments; a description of the approved FYDP (POM-79) Navy energy program; and a description of an expanded energy program required to meet federally mandated goals.

The Navy Energy Plan and Program also provides OPNAV guidance to assist fleet and shore commanders and program managers at the SYSCOM and laboratory levels in evaluating and implementing various local policies and program activities.



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## **EXECUTIVE SUMMARY**

The 1978 Navy Energy Plan and Program was developed to provide the Chief of Naval Operations and Navy commanders at all echelons with a better appreciation of the effects of energy shortages and escalating energy costs. The plan includes a brief assessment of the current world and national energy situation, as well as the Navy energy situation, and a summary of national, Department of Defense (DOD), and Navy energy objectives and goals. The programs developed by the Navy in response to energy objectives and goals are described, and the many accomplishments made by the Navy in its energy program are summarized. Finally, the Navy energy program plan for FY 1978 through FY 1985 is presented.

### **THE ENERGY SITUATION**

In FY 1977, the Navy consumed about 81 million barrels of oil equivalent (BOE) at a cost of \$1.3 billion—28.9 percent for ship operations, 29.5 percent for aircraft operations, 38.6 percent for operation of shore facilities, and 3.1 percent for vehicle and ground support operations. About 73 percent of the energy consumed was in the form of liquid fuels derived from petroleum.

The Navy's future (to 2000) energy needs are based on the assumption that petroleum will continue to be the primary energy form for operating ships and aircraft. If the Navy does not implement an aggressive energy conservation program, it will require about 99.5 million BOE annually by 2000 at a cost of about \$2.7 billion (in 1977 dollars). This is an increase of 18.5 million BOE and \$1.4 billion from FY 1977.

National defense planning must accommodate expected shortages of petroleum, continued heavy dependence on foreign sources for these petroleum products, and rapidly escalating energy costs. Petroleum shortages will occur by the mid-1980s, when world demand for petroleum is expected to exceed production. The situation will rapidly worsen when world production of crude oil peaks about 1990. The present rate of discovery of new oil reserves is less than today's production of 20 billion barrels per year, and an increase of world production, to an estimated 40 billion barrels per year, will rapidly deplete these reserves. The situation in the United States is even more critical. At present rates of production, economically recoverable U.S. reserves will be depleted by 1995. Furthermore, discovery of significant new reserves would probably delay domestic petroleum exhaustion by only 5 to 10 years. Reducing energy consumption will delay exhaustion further.

Since 1975, the Navy has succeeded in reducing energy consumption by 8.3 percent, an annual energy reduction of 7.4 million BOE and a cost reduction of \$114 million. This reduction has resulted largely from a decrease in ship and aircraft strength. However,

according to on-site energy conservation inspection reports, some shore activities could reduce energy consumption an additional 15 percent by implementing more aggressive energy conservation programs without affecting the Navy's mission or lowering morale.

In view of the potential impact of expected petroleum shortages in the mid-1980s and rapidly escalating energy costs, an energy program is necessary to ensure the Navy's capability to carry out its mission of sea control and projection of power.

## **ENERGY OBJECTIVES AND GOALS**

The Navy has established a set of general objectives and specific energy goals to be achieved by 1985. These objectives and goals (set forth in OPNAVINST 4100.5A dated 9 May 1978) ensure that Navy energy policies and programs are directed toward meeting its future mission requirements in a world of scarce petroleum and natural gas resources. Furthermore, these objectives and goals support Executive Order 12003 and Defense Energy Program Policy Memorandum (DEPPM) No. 78-2. Executive Order 12003, signed by the President on 20 July 1977, establishes specific energy goals for government facilities and requires the development of management plans for all government facilities and federal operations. DEPPM No. 78-2, dated 1 March 1978 and issued by the Assistant Secretary of Defense for Manpower, Reserve Affairs and Logistics, specifies DOD energy goals and objectives. As stated in DEPPM No. 78-2, DOD policy is to reduce dependency on nonrenewable energy resources without impairing the training, readiness, and combat capability of strategic and tactical forces.

The primary objective of Navy resource management is to achieve maximum practical energy conservation for facilities and fleet operations and, when economically practical, substitute alternative or renewable energy sources for petroleum and natural gas. The Navy's success in meeting its objectives and goals, as well as those specified in Executive Order 12003 and DEPPM 78-2, will be measured at the activity level in terms of reduction in the use (or savings) of energy by the end of FY 1985 as compared with the FY 1975 baseline year.

## **NAVY ENERGY PROGRAMS**

Navy energy programs include energy management, energy distribution and allocation, shore operations, ship operations, and aircraft operations. Within these operational areas, the Navy selected five key strategies to provide a balanced approach in achieving its energy objectives and goals. These strategies include energy management planning, energy distribution and allocation, energy conservation, synthetic fuels, and energy self-sufficiency.

The energy management planning strategy involves comprehensive energy management planning for the short, mid, and long terms and provides for continual review of priorities and programs necessary to minimize the adverse effect of energy-related problems. Key programs include training, energy awareness, and energy data collection and analysis.

The energy distribution and allocation strategy supports a worldwide energy distribution system that can efficiently furnish necessary energy supplies to the Navy's forces in the form and quantity required to ensure that there will be no mission degradation caused by domestic or worldwide energy shortages. This program includes a fuel management system that supplies bulk petroleum products to the Navy and Marine Corps, planning and implementation of Prepositioned War Reserve Material Requirements, fuel standardization, modernization of POL storage and distribution facilities, and contingency planning.

The energy conservation strategy involves eliminating wasteful energy use, developing and implementing more efficient propulsion and power generation equipment, and improving basic energy systems so that they will use less energy.

The synthetic fuels strategy involves conducting laboratory and operational tests to ensure that fuels derived from oil shale, tar sands, and coal are compatible with the Navy's equipment. This strategy includes determining the characteristics of military fuels produced from synthetic crude, applying appropriate engineering expertise to ensure the compatibility of synthetic fuels and Navy hardware, and certifying synthetic fuels for military use.

The energy self-sufficiency strategy involves developing local renewable energy resources, such as solar, wind, geothermal, and refuse-derived fuel, at both remote and domestic bases, and where possible, replacing liquid hydrocarbon fuels with more abundant fuels such as coal. The objective of this strategy is to test, evaluate, and implement alternative and advanced energy systems to reduce use of liquid and gaseous hydrocarbons.

Energy research and development (R&D) is also an essential part of the overall Navy energy program. The energy R&D program is structured to achieve specific goals in the three strategies related to energy conservation, synthetic fuels, and energy self-sufficiency.

## **PROGRAM ACCOMPLISHMENTS**

The Navy has made noteworthy accomplishments in its energy program. Energy management accomplishments include publication of the initial Navy Energy Plan in January 1977, the annual Navy Energy R&D Program Plan in October 1977, and OP-NAVINST 4100.5A, "Energy Resource Management," in May 1978.

Shore energy conservation has resulted in the most significant short-term savings. With the completion of over 250 surveys of naval activities, the Naval Facilities Engineering Command (NAVFAC) has identified over 200 major energy conservation projects with a potential annual savings of \$35 million. Estimated annual savings from the Energy Conservation Investment Program (ECIP), implemented in FY 1976, now exceed \$10 million per year and, by FY 1985, should exceed \$52 million (in 1977 dollars) annually. This represents a reduction in Navy expenditures for energy, based on estimated costs without ECIP, of approximately 12 percent.

Boiler tune-up programs were initiated to improve the operating efficiency of the Navy's shore power facilities systems. In plants using over 5 million Btu per hour (some 600



boilers at 126 activities), the program is over 65 percent completed and has achieved annual savings of \$2.5 million. In plants using less than 5 million Btu per hour, 1,500 of 4,000 units have been inspected and calibrated, achieving annual savings of \$0.48 million.

In its energy self-sufficiency efforts, the Navy has focused on testing and evaluating various energy systems being developed by other federal agencies. This effort includes solar heating and hot water systems for family housing, naval hospitals, and the like; development of geothermal resources located at Navy facilities in California, Alaska, and Hawaii; use of refuse-derived fuel at Norfolk, Virginia, and a fluidized-bed boiler at Great Lakes, Illinois.

The Naval Sea Systems Command (NAVSEA) R&D program focuses on reducing ship-board energy consumption through underwater hull cleaning, improved hull coatings, more efficient ship propulsion and auxiliary systems, and improved operating procedures. Underwater hull cleaning includes the evaluation of rotary brush techniques and methods of in-situ cleaning on sonar domes and propellers. In tests on a destroyer based at Pearl Harbor and only 6 months out of dry dock, the Navy recorded fuel savings of 20 percent following in-situ cleaning (an average fuel savings of 10 percent is projected). Work on improved hull coatings includes tests of organometallic polymer (OMP) resins. When formulated in hull coatings, OMP resins should prevent biofouling on ship hulls for the 4 to 5 years between dry dockings for major overhaul.

As a result of research done on synthetic fuels, the Navy has concluded that a significant portion of its mid-term (1985-2000) energy requirements can be supplied by synthetic hydrocarbon fuels produced from domestic resources. In September 1977, an interagency agreement was signed between the Navy and the Department of Energy (DOE) concerning future shale oil production refining and end-use testing. Production of 100,000 barrels of crude shale oil was initiated in FY 1976, and refining of the crude into the full range of military fuels will begin in FY 1979.

Energy conservation in aircraft operations is being achieved through using simulators, computerized flight planning, and advanced technology design changes for Navy aircraft. In FY 1977, aircraft training devices replaced about 145,000 flying hours, thus saving about 75 million gallons of fuel. Computerized flight planning was used on about 10,500 flights in FY 1977, with a fuel savings of about 1.9 million gallons and a cost savings of about \$600,000. The Navy has now extended this system to include Atlantic Fleet and Reserve P-3 aircraft and Reserve and Marine C-9 aircraft.

Mission analysis of F-4, P-3, A-4, A-6, A-7, and F-14 aircraft, which use 75 percent of the Navy's aircraft fuel, began in January 1978. The purpose is to determine the effects of payloads, tactics, mission profiles, mission planning, and training on fuel usage and mission effectiveness, and to identify ways to save fuel.

#### **NAVY ENERGY PLAN, FY 1978—FY 1985**

The Navy Energy Plan includes a wide variety of management, operational, and development projects. Individual descriptions for each project, including the objective,

technical approach, major milestones, and estimated energy savings, are included in the plan for both a Five-Year Development Plan (FYDP) and a required funding level program. The FYDP funding level program attempts to maximize dollar and fuel savings, including substitution of more abundant or renewable fuels. The required funding level program projects the level of effort which, if funded, would achieve the Navy energy objectives and goals. These objectives and goals presently cannot be met by the approved FYDP program. The plan was developed based on the best information available at the time. As new technology evolves and additional energy engineering surveys are conducted, the plan for future years will be modified.

The total Navy energy program funding requirements (in millions of dollars) at both the FYDP and required funding levels for FY 1978 through FY 1985 are:

	<u>FYDP</u>	<u>Required</u>
Shore Operations		
Energy Conservation Investment Program	\$416.9	\$ 416.9
Energy Engineering Program	67.7	312.7
New Buildings Program	0	697.1
Other	17.7	95.7
Total Shore	502.3	1,522.4
Ship Operations		
Improved Hull Maintenance	69.6	69.6
Stack Gas Analyzer/Combustion Optimization	0	14.9
Total Ship	69.6	84.5
Research and Development	355.6	403.9
Total	\$927.5	\$2,010.8

(Aircraft operations energy conservation, which includes improved engine efficiency and aircraft modifications, and synthetic fuels testing are included in the R&D program. Development of aircraft simulators and computerized flight planning are funded outside of the energy program.)

The FYDP funding level total of \$928 million should achieve an average annual energy savings of  $47.5 \times 10^{12}$  Btu, with an average payback of 5.1 years beginning in 1985. The required funding level total of \$2,011 million should achieve an annual energy savings of  $79.6 \times 10^{12}$  Btu with an average payback of 6.2 years.



## THE ENERGY SITUATION

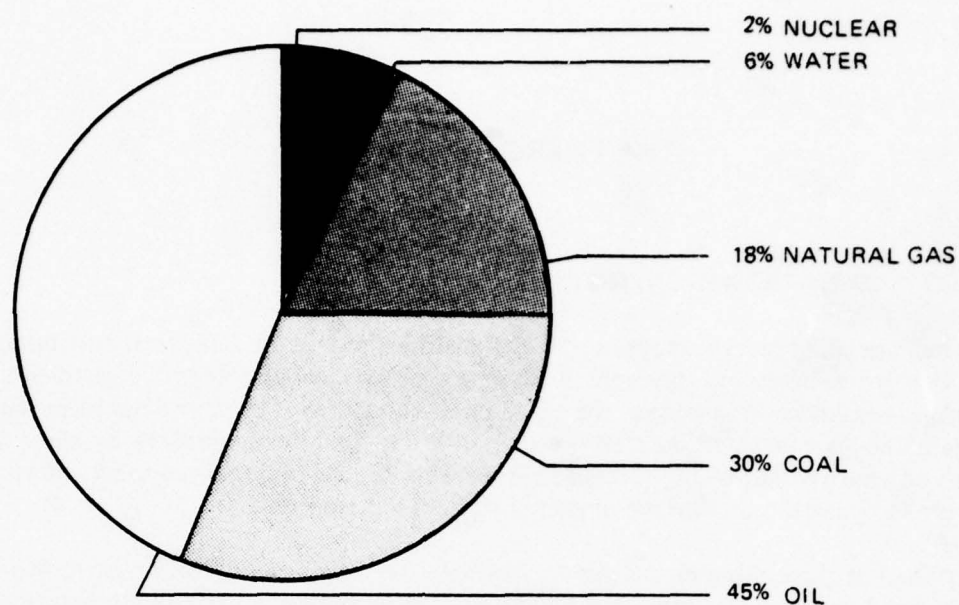
### WORLD AND NATIONAL ENERGY SITUATION

The impending energy crisis is a result of the imbalance in the geological distribution of world energy resources and the rapid depletion of economically recoverable petroleum and natural gas resources. Indicative of the distribution imbalance of energy resources in relation to where they are used is the continued increase in petroleum imports by the United States—now nearly half of the total required to support the national economy. Inevitably, therefore, a transition to alternative energy sources must occur.

In the last three decades, petroleum has been the major energy source of most of the industrialized nations, and present world annual consumption of 21.7 billion barrels constitutes about 45 percent of the world's primary energy consumption. This is nearly as much as natural gas and coal combined (Figure 1). The United States is the leading oil consumer, using 28 percent of world production as shown in Figure 2. The USSR, a distant second, consumes 17 percent. Energy problems for the industrialized nations are basically petroleum problems. This results from the fact that the industrial economies of the world are geared to the use of petroleum products as economically recoverable world petroleum supplies are rapidly becoming exhausted.

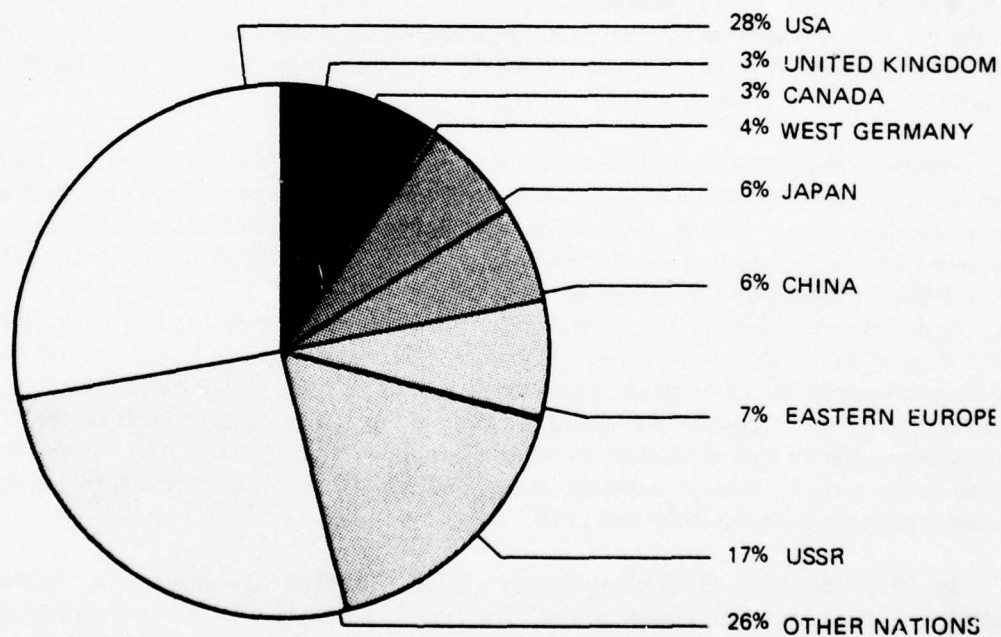
Estimates show that by 1985 world petroleum demand will exceed supply and that current world production, which is approximately 20 billion barrels per year, will peak at about 40 billion barrels per year in 1990. Even now increases in production exceed the rate of discovery of new petroleum reserves, which has averaged less than 20 billion barrels per year since 1950. At the 1966-to-1976 average demand growth rate of 5.7 percent per year, world petroleum resources that can be economically recovered will be exhausted between 2006 and 2010 (Figure 3). At this demand growth rate, to delay exhaustion 13 years would require finding and producing new petroleum resources at the rate of 39 billion barrels per year. Sustaining this demand growth rate would require finding a source equivalent to the United States every year or one equivalent to Saudi Arabia every 3½ years. And, if current demand levels were to remain constant (an unrealistic assumption), petroleum exhaustion would still occur between 2050 and 2070.

In 1975, the U.S. Geological Survey (USGS) lowered its estimate of recoverable petroleum resources in the United States. The USGS estimates, with a 90 percent probability, that the United States initially had between 220 billion and 300 billion barrels (Figure 4). On the basis of projected production estimates, current domestic reserves will be exhausted between 1993 and 2000. New discoveries could conceivably delay exhaustion for an additional 5 to 10 years. However, since U.S. production peaked in 1970 and has been declining since, increased imports will be required to meet any growth in consumption.



NOTE: TOTAL EXCEEDS 100 PERCENT DUE TO ROUNDOFF.

**Figure 1. WORLD ENERGY CONSUMPTION BY ENERGY SOURCE**



SOURCE: BRITISH PETROLEUM STATISTICAL REVIEW OF THE OIL INDUSTRY, 1976.

**Figure 2. WORLD ENERGY CONSUMPTION BY CONSUMING COUNTRY**

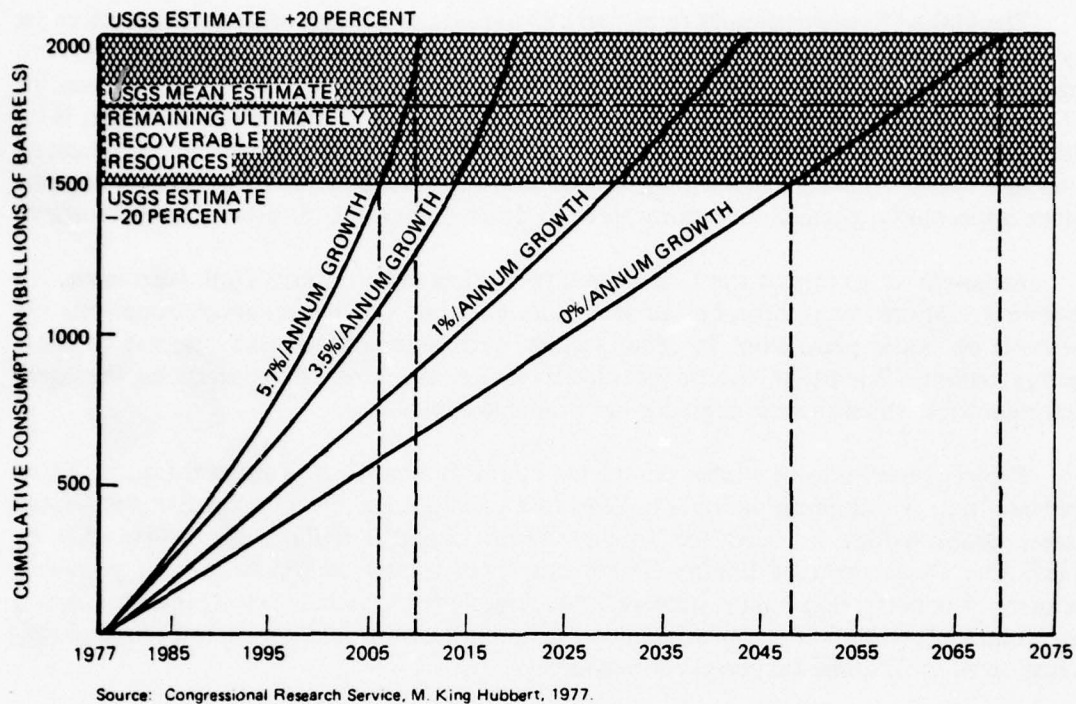


Figure 3. WORLD OIL EXHAUSTION

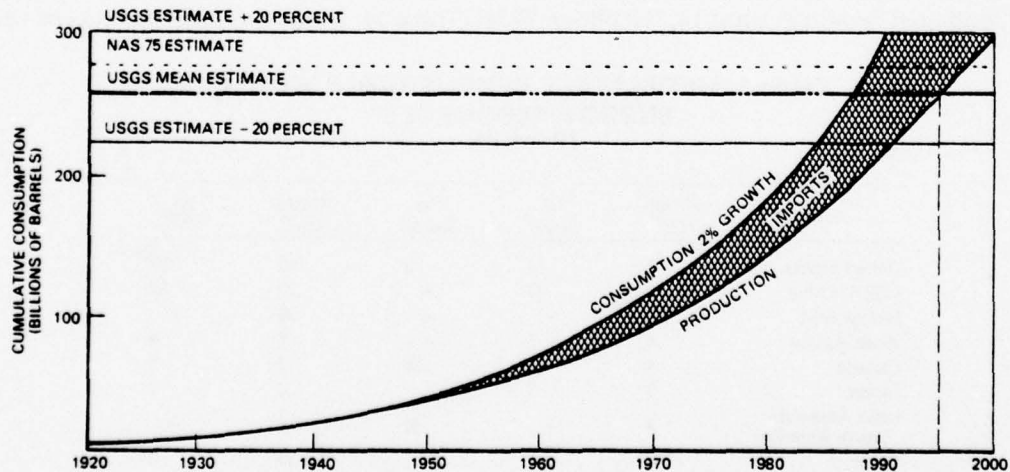


Figure 4. PROJECTED U.S. PETROLEUM EXHAUSTION DATES



The United States continues to increase its imports of foreign oil at the high prices set by the oil-exporting countries because to eliminate, or even to reduce significantly, such imports might disrupt the economy. In 1977, the United States depended on foreign sources for 47 percent of its crude oil supplies. Imports substitute for a domestic production that is insufficient to meet demand and obviate the need for immediate simultaneous development of alternate energy sources, thus helping to maintain the current quality of the environment. More importantly, petroleum imports serve to delay domestic U.S. petroleum exhaustion.

Although all sectors of the U.S. economy rely heavily on energy from petroleum, the mobile operations/transportation sector is unique in that it depends almost completely (98 percent) on liquid petroleum. In other sectors, such as manufacturing, the use of other energy options is important because it could serve to release, for mobile operations, the liquid petroleum for which there is presently no available substitute.

Project Independence studies completed by the Federal Energy Administration (FEA) indicate that, by adopting national policies that promote energy conservation, the United States could reduce its need for foreign oil to about 6 million barrels per day by 1985. The Department of Energy (DOE) has given energy conservation high near-term priority. A conservation policy, however, that is designed to reduce petroleum imports and not domestic production—now at about a maximum rate—would not extend projected exhaustion of U.S. domestic petroleum resources.

Conservation measures alone, even if made much more stringent than those projected, do not provide a solution to our present dependence on liquid hydrocarbon fuel. One alternative, however, is to develop new sources of synthetic liquid fuels from sources such as oil shale, coal, and tar sands.

In the United States, ultimately recoverable oil shale resources total 2,065 billion BOE, and coal resources total 14,310 billion BOE (Table 1). These resources far exceed the

**Table 1. ULTIMATELY RECOVERABLE WORLD  
ENERGY RESOURCES<sup>a</sup>  
(Percent)**

Area	Crude Oil <sup>b</sup>	Oil Shale <sup>c</sup>	Tar Sands <sup>b</sup>	Natural Gas <sup>b</sup>	Coal <sup>c</sup>
United States	7	73	2	10	27
USSR/China	27	12	—	33	62
Middle East	33	—	—	20	—
West Europe	4	1	—	5	4
Canada	4	12	38	5	1
Africa	9	1	—	8	1
Latin America/ South America	7	—	60	8	—
Other	10	1	—	11	5
Total	100	100	100	100	100
Total (in BBOE <sup>d</sup> )	1,785	1,460	1,000	1,345	53,000

<sup>a</sup>Percentages are shown to indicate approximate distribution.

<sup>b</sup>John J. Moody, "Petroleum Resources: How Much and Where?" 1975.

<sup>c</sup>1974 World Energy Conference.

<sup>d</sup>BBOE: Billion barrels of oil equivalent.

**Table 2. TYPICAL DEVELOPMENT TIMES<sup>a</sup>**

Type of Facility	Years
Coal-fired power plant	5-8
Surface coal mine	2-4
Underground coal mine	3-5
Uranium mine (includes exploration)	7-10
Nuclear power plant	9-10
Hydroelectric dam	5-8
Producing oil and gas wells	
From new fields	3-10
From old fields	1-3
Synthetic fuel plant	5
Shale oil plant	6

<sup>a</sup>From go-ahead to production.

estimated remaining domestic petroleum resources. DOD experience indicates that 8 to 13 years are required to develop new energy sources from concept to field use. National Academy of Engineering and Project Independence estimates support this time requirement. Under the Administration's present policy, however, commercial incentives are lacking. Consequently, synthetic liquid fuels for national defense are not projected to be produced in quantity until after 1990. An accelerated program could probably yield between 300,000 and 500,000 barrels of synthetic crude per day by 1990, based on a 10-year development schedule. It might then be possible to produce millions of barrels per day in the mid- to late 1990s. Before an accelerated program could be implemented, however, many constraints involving technical problems, financial incentives, water resources, transportation, environmental regulations, materials priorities, production capacities, and manpower training would have to be resolved.

A second alternative is to mandate a switch from petroleum to other energy sources for fixed installations, wherever possible. While this would free petroleum-derived fuels for transportation and mobile operations, this too would be a relatively long process, even after the policy had been decided and the legislation passed. Moreover, many difficulties and delays are being experienced today in obtaining approval and financing for such developments as nuclear power plants and expansion of coal operations. Projections of typical development times are constantly being increased. Table 2 presents typical development times for energy producing installations.

Our national security objectives can be achieved only if the United States is thoroughly prepared to meet essential industrial and military energy requirements. Attaining these objectives—deterring armed conflict, producing modern weapon systems, and maintaining the readiness of U.S. military forces—depends on all forms of available energy, particularly liquid fuels, to support worldwide commitments on the seas, in the air, and on the ground. In view of both the long lead times required to develop alternative energy sources and the rapidity with which currently used energy sources are being exhausted, the transition must begin immediately.



## NAVY ENERGY SITUATION

DOD is the government's largest consumer of energy, using 252 million BOE, or 1.9 percent of the national requirement. In FY 1977, the Navy consumed about 81 million BOE—28.9 percent for ship operations, 29.5 percent for aircraft operations, 38.6 percent for utilities ground support and cold iron support, and 3.1 percent for vehicle and ground support operations. About 73 percent of this energy consumption was in the form of petroleum products used by operational weapon and mobile support systems (ships, aircraft, and ground vehicles). Energy consumed by the defense industry in supporting the Navy's requirements probably amounts to an additional 100 million BOE annually. A more detailed description of Navy energy usage is contained in Appendix A.

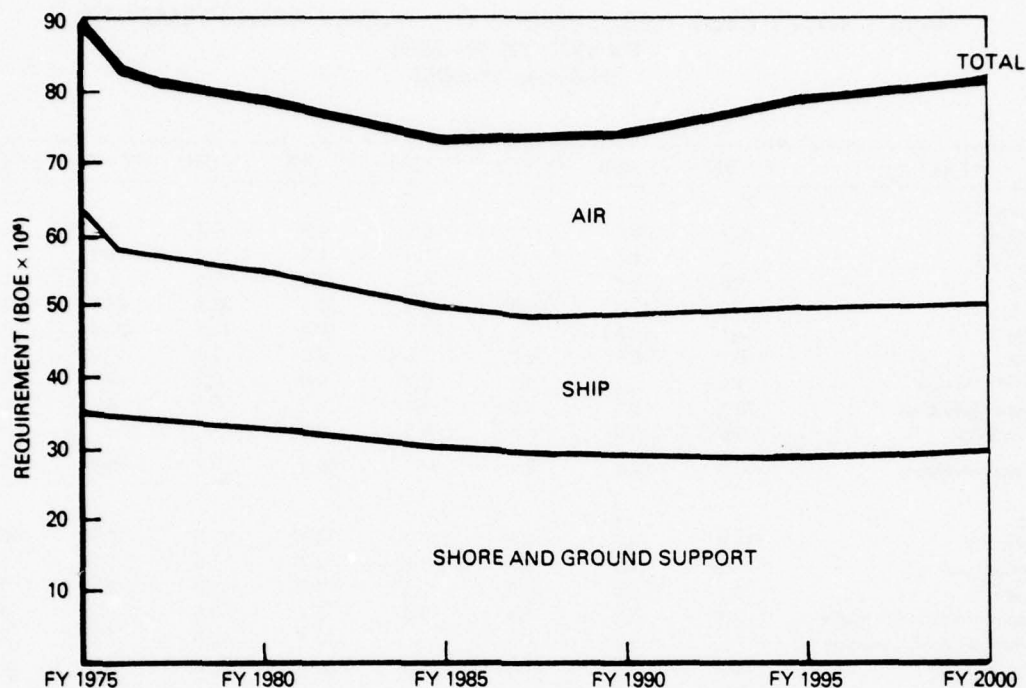
Figure 5 projects the Navy's energy needs to 2000. This energy profile is based on projected force levels, operations tempo (OPTEMPO), unit consumption, and the estimated savings from the Navy energy conservation program. The projections were made using the Navy Energy Usage Profile Analysis System (NEUPAS). The basic data and assumptions used in this analysis are:

- January 1978 Five-Year Development Plan (FYDP) force levels.
- No major changes in operating tempos or deployment/exercise modes.
- Simulator usage of 7 percent of total flying hours in 1977, increasing to 9 percent in 1985.
- Five percent decrease in fuel consumption per flight hour from 1975 usage, spread over the years 1981-1985.
- Ten percent decrease in fuel consumption per steaming hour from 1978 usage, spread over the years 1979-1985 (hull cleaning).
- An additional decrease of 10 percent per steaming hour from 1978 usage, spread over the years 1982-1985 (anti-fouling paints).
- Fifteen percent decrease in vehicle fuel consumption from 1975 usage spread over the years 1978-1985.
- Twenty percent decrease in shore energy consumption from 1975 usage, spread over the years 1978-1985.

The Navy's energy consumption/cost situation relative to the conservation measures adopted in the Navy Energy Plan is:

Fiscal Year	Energy Consumption (Millions of BOE)	Energy Cost (Billions of constant 1977 dollars)
1977	81	1.3
2000 (without conservation)	99.5	2.7
2000 (with conservation)	81	2.2

The Navy's future energy needs are based on the assumption that liquid hydrocarbons will be the primary energy form required by ships and aircraft to 2000. Clearly the Navy



ACTIVITY	REQUIREMENT (BOE × 10 <sup>6</sup> )									
	FY 1975	FY 1976	FY 1977	FY 1978	FY 1979	FY 1980	FY 1985	FY 1990	FY 1995	FY 2000
AIR	24.9	24.7	24.1	24.3	24.5	24.8	23.8	25.5	29.5	30.3
SHIP	29.5	23.7	23.6	22.6	21.6	20.7	19.4	19.7	21.0	21.0
SHORE	32.1	31.6	31.6	31.3	31.0	30.7	26.9	26.1	26.4	27.4
GROUND SUPPORT	2.7	2.7	2.5	2.5	2.5	2.5	2.2	2.2	2.2	2.2
TOTAL	89.2	82.7	81.8	80.7	79.6	78.7	72.3	73.5	79.1	80.9

Figure 5. NAVY ENERGY REQUIREMENTS BY ACTIVITY, FY 1975 TO FY 2000

must have an assured level of liquid fuel to provide the military capability sufficient to fulfill its basic mission. This mission, as assigned in Title X of the U.S. Code, is to conduct prompt and sustained operations at sea and to maintain control of the sea.

In 2000, the Navy will need about 55.7 million barrels of liquid hydrocarbon fuel, which comprise about 69 percent of its total energy requirement. Alternative renewable or more abundant energy sources, such as coal and geothermal or solar energy, are expected to provide about 16 percent of the total by that year.

The Navy expects its energy costs to increase from \$1.3 billion in FY 1977 to \$2.2 billion (in 1977 dollars) in FY 2000 (Table 4). This increase is based on the Navy's best estimate of energy prices through 2000 (Table 5).

**Table 3. NAVY BEST ASSESSMENT OF ENERGY REQUIREMENTS,  
FY 1977 TO FY 2000  
(Millions of BOE)**

Fuel Type	FY 1977	FY 1978	FY 1979	FY 1980	FY 1985	FY 1990	FY 1995	FY 2000
<b>Petroleum</b>								
AVGAS	0.7	0.6	0.6	0.5	0.5	0.4	0.4	0.3
MOGAS	1.2	1.1	1.0	1.0	1.0	1.0	1.0	1.0
JP-4	6.0	4.9	4.5	4.3	3.2	2.6	1.4	1.0
JP-5	18.3	19.3	19.9	20.5	20.6	22.9	28.1	29.4
DFM	16.1	16.5	17.3	17.7	17.4	18.2	20.5	20.6
NDF	6.1	5.0	4.0	3.0	2.0	2.0	1.0	1.0
NSFO/Residual	1.0	0.7	0.6	0.5	0.5	0.3	0.3	0.2
Shore heating oil	10.1	10.0	9.8	9.7	5.1	2.3	2.2	2.2
Undefined	0.8	0.8	0.8	0.5	0.2	—	—	—
<b>Total petroleum</b>	<b>60.3</b>	<b>59.5</b>	<b>58.5</b>	<b>57.7</b>	<b>50.5</b>	<b>49.7</b>	<b>54.9</b>	<b>55.7</b>
<b>Other</b>								
Electricity	16.8	16.5	16.4	16.3	13.5	11.3	10.7	10.3
Natural gas	4.2	4.0	3.7	3.3	2.2	1.8	1.6	1.4
Coal	0.3	0.6	0.9	1.1	4.4	8.4	9.4	10.8
Propane/steam/hot water	0.2	0.2	0.2	0.3	0.3	0.3	0.3	0.3
Renewable (solar/geothermal)	—	—	—	—	1.4	2.0	2.2	2.4
<b>Total other</b>	<b>21.5</b>	<b>21.3</b>	<b>21.2</b>	<b>21.0</b>	<b>21.8</b>	<b>23.8</b>	<b>24.2</b>	<b>25.2</b>
<b>Total</b>	<b>81.8</b>	<b>80.8</b>	<b>79.7</b>	<b>78.7</b>	<b>72.3</b>	<b>73.5</b>	<b>79.1</b>	<b>80.9</b>

**Table 4. NAVY BEST ESTIMATE OF ENERGY COSTS, FY 1977 TO FY 2000  
(Millions of 1977 dollars)**

Fuel Type	FY 1977	FY 1978	FY 1979	FY 1980	FY 1985	FY 1990	FY 1995	FY 2000
<b>Petroleum</b>								
AVGAS	14.0	14.0	14.2	12.0	12.6	11.3	12.5	10.3
MOGAS	15.4	25.7	23.7	24.0	25.3	28.3	31.2	34.2
JP-4	108.4	90.4	84.2	81.6	64.9	60.5	36.7	29.2
JP-5	296.7	355.9	372.1	388.9	417.8	532.7	737.3	859.1
DFM	259.5	308.6	328.2	359.0	404.7	423.3	538.0	602.0
NDF	99.4	92.2	74.8	56.9	37.9	40.6	26.2	29.2
NSFO/Residual	11.7	10.1	8.8	7.8	8.9	5.1	6.9	5.2
Shore heating oil	143.5	143.5	143.0	146.9	90.5	46.8	50.5	56.9
Undefined	12.9	13.5	—	—	—	—	—	—
<b>Total petroleum</b>	<b>961.5</b>	<b>1,053.9</b>	<b>1,049.0</b>	<b>1,077.1</b>	<b>1,062.6</b>	<b>1,148.6</b>	<b>1,439.3</b>	<b>1,626.1</b>
<b>Other</b>								
Electricity	244.6	243.4	254.9	266.2	273.8	273.8	301.6	330.9
Natural gas	43.6	48.0	55.5	62.7	55.3	50.6	49.7	47.6
Coal	2.8	5.9	9.1	11.5	47.0	100.3	124.1	156.3
Propane/steam/hot water	3.5	5.4	5.7	9.1	11.9	15.7	20.6	27.0
Renewable (solar/geothermal)	—	—	—	—	a	a	a	a
<b>Total other</b>	<b>294.5</b>	<b>302.7</b>	<b>325.2</b>	<b>349.5</b>	<b>388.0</b>	<b>440.4</b>	<b>496.0</b>	<b>561.8</b>
<b>Total</b>	<b>1,256.0</b>	<b>1,356.6</b>	<b>1,374.2</b>	<b>1,426.6</b>	<b>1,450.6</b>	<b>1,589.0</b>	<b>1,935.3</b>	<b>2,187.9</b>
Inflated at 5.6 percent per year	1,256.0	1,432.6	1,532.4	1,803.9	2,243.2	3,226.7	5,160.6	7,661.2

<sup>a</sup>Operating and maintenance costs for solar and geothermal systems cannot be estimated at this time.



**Table 5. PROJECTED ENERGY PRICES, FY 1977 TO FY 2000**  
(In 1977 dollars per barrel/BOE<sup>a</sup>)

Fuel Type	FY 1977	FY 1978	FY 1979	FY 1980	FY 1985	FY 1990	FY 1995	FY 2000
Petroleum								
AVGAS	19.19	23.39	23.70	23.97	25.28	28.26	31.24	34.22
Jet fuel	16.17	18.44	18.70	18.97	20.28	23.26	26.24	29.22
Diesel fuel	16.17	18.44	18.70	18.97	20.23	23.26	26.24	29.22
Fuel oil	14.11	14.35	14.59	15.14	17.75	20.36	22.97	25.88
Other (BOE)								
Electricity	14.38	14.75	15.54	16.33	20.28	24.23	28.18	32.13
Natural gas	9.90	12.00	15.00	19.00	25.12	28.09	31.05	34.02
Coal	8.00	9.91	10.16	10.42	10.68	11.94	13.20	14.47
Propane/steam/hot water	25.29	27.00	29.00	31.00	41.00	51.00	61.00	71.00

<sup>a</sup>BOE = 5.8 million Btu.

Source: Appendix C, Navy Energy Plan, January 1977.

The Navy has been successful in cutting energy consumption thus far, largely by reducing its ship and aircraft strength and its general operational activity. However, according to on-site energy conservation inspection reports, some Navy shore activities could achieve as much as an additional 15 percent saving by implementing more aggressive conservation programs without affecting the Navy's mission or lowering morale. Implementing these programs is a question of available man-hours and the degree of command attention that is provided. While aggressive energy conservation investment programs, facilities engineering programs, and energy R&D are under way, payback from these programs will accrue gradually and will not yield significant results until the 1980-1982 period.

The present trend toward more rapid depletion of U.S. petroleum reserves as compared with world petroleum reserves, and continued heavy reliance on imported petroleum will undoubtedly continue. At the present import level, ample fuel stocks will be available to the Navy through 1985, assuming no supply interruptions. Beyond 1985, when world demand will exceed supply, the Navy may face spot shortages of MILSPEC fuels that will affect its operational capability. The Navy must initiate actions now to maintain the required readiness while using less fuel, operating more efficiently, using renewable or alternative energy sources, and being prepared to operate with synthetic petroleum fuels and/or less restrictive MILSPEC fuels. The following sections describe the Navy's energy goals and objectives and its energy program designed to accomplish these actions.

## ENERGY OBJECTIVES AND GOALS

To establish and maintain a well-balanced energy program, the Navy has established a set of general objectives and specific energy goals (see OPNAVINST 4100.5A). The general objectives ensure that Navy energy policies and programs are directed toward meeting the overall energy-related needs of the Navy so that it can meet its future mission requirements in a world of scarce petroleum and natural gas resources. The specific energy goals provide means for measuring progress toward attainment of the Navy energy objectives in the area of energy management, and in shore, ship, and aircraft operations.

Directives that provide energy standards and define energy conservation practices necessary to achieve national goals have been promulgated in the National Energy Plan and Executive Order 12003. These and other DOD directives provide the guidelines and standards within which the Navy's energy plan and programs operate.

### NATIONAL ENERGY PLAN

The National Energy Plan, dated 29 April 1977, established national energy objectives that would enable the United States to reduce dependence on foreign oil, limit supply disruptions, weather a decline in world oil production, and develop renewable energy sources for sustained economic growth. The Plan established the DOE and proposed a national energy conservation program. The Plan also proposed a program to convert industry and utilities that are now using oil and natural gas to coal and other more plentiful or renewable fuels, and encouraged increased development of fossil resources and nuclear power. Other actions set forth in the Plan included establishing a strategic petroleum reserve (SPR), cooperating with the International Energy Agency (IEA) to mitigate supply interruption, supporting a vigorous R&D program to provide renewable energy resources, and initiating an energy management plan for all federal buildings and operations.

The President has further recommended national goals to be achieved by 1985:

- Reduce annual energy demand growth to less than 2 percent.
- Reduce gasoline consumption by 10 percent.
- Reduce oil imports to 6 million barrels per day.
- Establish an SPR of 1 billion barrels.
- Increase coal production to 1 billion tons per year.
- Insulate 90 percent of U.S. homes and all new buildings.
- Use solar energy in more than 2.5 million homes.

## EXECUTIVE ORDER 12003

On 20 July 1977, the President signed Executive Order 12003 establishing specific energy conservation goals for government facilities and requiring the development of management plans for all government facilities and federal operations.

Specific energy management goals are to:

- Reduce by 20 percent, by the end of FY 1985, the average energy used in federally owned existing buildings measured against the 1975 baseline year.
- Reduce by 45 percent, by the end of 1985, the average energy used in federally owned new buildings and buildings constructed specifically for federal lease measured against those in use in the 1975 baseline year.
- Exceed the minimum statutory requirement for fuel economy in the federal passenger automobile fleet by 2 miles per gallon in FY 1978, 3 miles per gallon in FY 1979, and 4 miles per gallon for FY 1980 and beyond.
- Establish energy reduction goals and plans for all other federal operations.

Each executive agency will submit an overall agency energy management plan to the Secretary of Energy containing, when applicable, two major parts: (1) an agency 10-year buildings plan and (2) an agency general operations plan for all agency operations not included in the building plan. These plans will include management objectives, metering, survey and data system descriptions, and cost and estimated savings for planned energy conservation projects.

Major special requirements of Executive Order 12003, which apply primarily to buildings, are:

- Agencies will develop plans to meet established goals.
- Energy reductions are to be measured in comparison to the energy usage level during the 1975 baseline year (1 October 1974 through 30 September 1975).
- Energy saving programs and projects will be specified in the plans.
- The plans will provide estimates of the expected energy and cost savings by fiscal year.
- The plans will estimate the cost of achieving the savings.
- In the development of their plans, all agencies shall use a life-cycle costing method established by the Secretary of Energy with the concurrence of the Director of the Office of Management and Budget (OMB). Each agency is to program proposed energy conservation improvements so as to give highest priority to the most cost-effective projects.
- The Secretary of Energy will evaluate and approve agency 10-year building plans in accordance with the guidelines contained in the Federal Energy Management Plan (FEMP). The draft FEMP guidelines are presently being reviewed and revised by DOE.



## DOD ENERGY OBJECTIVES AND GOALS

The purposes of the DOD energy program are to ensure that energy shortages do not interfere with DOD's capability to defend the nation and accomplish its national security mission, assist U.S. allies in overcoming their energy-related defense problems, and prevent energy-related coercion of the United States or its allies.

Defense energy goals and objectives have been set forth by the Assistant Secretary of Defense (ASD) for Manpower, Reserve Affairs and Logistics (M,RA&L) in Defense Energy Program Policy Memorandum (DEPPM) No. 78-2, dated 1 March 1978. As stated in DEPPM No. 78-2, DOD policy is to reduce dependency on nonrenewable energy resources without impairing the training, readiness, and combat capability of strategic and tactical forces.

The following DOD goals are established to complement and facilitate attainment of the goals mandated by Executive Order 12003:

- Reduce energy use at least 12 percent in existing buildings through the Energy Conservation Investment Program (ECIP).
- Obtain the additional 8 percent reduction in existing buildings through Service-developed programs and initiatives, e.g., improved management, more efficient operation and maintenance, and accomplishment of small-scale conservation projects with operations and maintenance (O&M) funds available to the commands and installations.
- Establish a metering program and conduct energy audits/surveys/engineering analyses as necessary to identify and monitor energy consumption levels in DOD facilities.
- Develop a representative list of energy conservation measures, systems and equipment for DOD buildings.
- Limit the level of energy consumption in the training of tactical and strategic forces in 1985 to that in 1975 by:
  - Improving the efficiency of propulsion systems through design of new equipment and economic retrofit of old equipment.
  - Increasing the efficiency of mobile equipment used in operations and training.
  - Increasing the use of training simulators designed for maximum energy efficiency and energy recovery.
- Obtain at least 10 percent of DOD installation energy from coal, coal gasification, refuse-derived fuel, and biomass by 1985.
- Obtain 1 percent of DOD installation energy by solar and geothermal means by 1985.
- Equip all natural gas heating units and plants with outputs of more than 5 million Btu per hour with the capability to use oil or other fuel by 1982.
- Have on hand at the beginning of each heating season a 30-day fuel supply for all oil, oil-natural gas, and coal heating units with outputs of more than 5 million Btu per hour, and maintain this supply level throughout the three coldest months of the year.

- Assure an adequate fuel supply to meet DOD mobility requirements by devising with DOE a national strategy that will minimize the danger of disruption to DOD liquid hydrocarbon fuel supplies to include:
  - A clear statement of DOD mobility fuel requirements.
  - A secretarial-level DOD-DOE agreement that delineates responsibilities.
  - Procedures for priority allocation of mobility fuels to DOD under the Defense Production Act and other managerial mechanisms.
  - Joint efforts to develop alternative fuel sources (e.g., oil shale) if required to meet DOD mobility requirements.
  - Continued buildup of the SPR to the 1-billion barrel level and provisions for DOD priority use, if required.
  - Performing R&D on propulsion systems capable of using a broad range of conventional and synthetic fuels.
  - Developing adequate fuel specifications and fuel-testing methods for a large slate of mobility fuels.
  - Adjusting the fuel logistics structure in DOD as necessary to match changing fuel supplies.
  - Planning for the transition from petroleum to alternative fuels in the future.

## **NAVY ENERGY OBJECTIVES AND GOALS**

The objectives of Navy energy resource management are to:

- Achieve maximum practical energy conservation for facilities and operations with particular emphasis on conservation of liquid hydrocarbons and natural gas.
- Substitute, when economically practical, alternative, more abundant or renewable energy sources where liquid hydrocarbon and natural gas are now used.
- Consider the effect of energy policy and actions on the health, welfare, and safety of Navy personnel and the environment.

The Navy energy resource management goals support the federal energy program outlined in Executive Order 12003 and related DOD energy programs. Accomplishment of the goals will be measured at the activity level except where noted. Unless otherwise stated, the following goals apply to the reduction in the use (or savings) of energy from the FY 1975 baseline (1 October 1974 through 30 September 1975) by the end of 1985:

- Reduction of 20 percent in existing facilities per gross square foot of building floor area.
- Reduction of 45 percent in new facilities per gross square foot of building floor area, to be achieved through new construction design specifications relative to those for facilities in use during the 1975 baseline. (Approved projects under way on the effective date of the relevant instruction will be accommodated through the retrofit program.)
- Savings of 15 percent in fuel consumption by ground support equipment.
- Reduction of 20 percent in fossil fuel consumption per ship underway steaming hour.

- Reduction of 90 percent in fleet and shore fuel surveys (measured at the overall Navy level).
- Reduction of 5 percent in fuel consumption per flight hour.
- Savings of 9 percent in fuel consumption through simulator substitution.
- Substitution of more abundant or renewable energy forms for 10 percent of the petroleum or natural gas used ashore (measured at the overall Navy level).

On 9 May 1978, the CNO approved OPNAVINST 4100.5A, which includes the above goals (see Appendix F), except the 10 percent substitution goal. The substitution goal was increased from 5 percent as directed by OPNAVINST 4100.5A to 10 percent per ASD (M,RA&L) direction of 1 March 1978.



## **NAVY ENERGY PROGRAMS**

This section summarizes the Navy's major initiatives in the areas of energy conservation and management and utilization of available energy resources. These programs are: Navy energy management, energy distribution and allocation, shore operations, ship operations, and aircraft operations. Within these operational areas five key strategies have been selected to provide a balanced approach in achieving the Navy energy objectives and goals. These strategies include energy management planning, energy distribution and allocation, energy conservation, synthetic fuels, and energy self-sufficiency/alternative energy sources.

The Navy energy R&D program is an essential part of the overall Navy energy program. The Navy Energy and Natural Resources R&D Office (MAT-08T3) publishes a five-year Energy R&D Program Plan in October of each year. This R&D program plan is structured to achieve specific goals in each of the three strategies related to energy conservation, synthetic fuels, and energy self-sufficiency.

The R&D technology needed to accomplish our military objectives in many instances is of significant importance to the non-defense needs of the nation. In this regard, the Navy has joined with DOE and other agencies to share the technical effort as well as fiscal costs of achieving the needed capability. Appendix E summarizes joint Navy/DOE projects and cooperative agreements with DOE and other agencies.

### **STRATEGIES**

#### **Energy Management Planning**

The energy management planning strategy initiates comprehensive energy management planning for the short, middle, and long term. It continually reviews priorities and programs that are necessary to minimize the adverse effect of energy problems.

#### **Energy Distribution and Allocation**

The energy distribution and allocation strategy supports a worldwide energy distribution and allocation system that can efficiently furnish necessary energy supplies to the Navy's forces in the form and quantity required to ensure that there will be no mission degradation caused by domestic or worldwide energy shortages.

#### **Energy Conservation**

The energy conservation strategy involves eliminating wasteful energy use, developing more efficient propulsion and power generation equipment, and improving basic energy

systems so that they will use less energy. This strategy includes the following:

- Test, evaluate, and implement shore-based systems that will use energy more efficiently.
- Develop, test, evaluate, and implement more efficient propulsion and auxiliary systems for the existing and future fleet, and methods for reducing hull drag to achieve greater efficiency and cost-effectiveness in Navy vessels.
- Develop, test, evaluate and implement modifications in operational concepts, tactics, and equipments that will reduce aircraft fuel usage and develop more energy-efficient aircraft propulsion and other systems (for both current inventory aircraft and advanced designs).

Energy conservation is the only significant near-term solution to the decreasing availability of energy sources and increasing costs, and is, therefore, a major part of the Navy's R&D program. The Navy's conservation effort primarily involves using more energy-efficient operating techniques and improving system designs to reduce energy consumption. The Navy Energy and Natural Resources R&D Office is concentrating on conserving energy on ships and at shore installations. The Navy is also defining its requirements and conducting programs that address energy usage aspects peculiar to Navy aircraft operations, although the Air Force is the lead Service responsible for military aircraft energy conservation.

### **Synthetic Fuels**

The synthetic fuels effort involves conducting laboratory and test and evaluation projects to ensure that fuels derived from domestic fossil reserves such as oil shale, tar sands, and coal are compatible with the Navy's equipment. This strategy includes the following:

- Determine the characteristics of military fuels produced from synthetic crude.
- Test, evaluate, and apply appropriate engineering expertise to ensure that synthetic fuels and Navy hardware are compatible.
- Certify synthetic fuels for military use and issue specifications and fleet implementation guidelines.
- Certify for Navy use conventional petroleum-based fuels that have broadened specifications.

Synthetic liquid hydrocarbon fuels can be made from oil shale, coal, and tar sands, all of which are sufficiently plentiful in the United States to last well into the next century. There are extensive plans for synthetic fuels R&D, with DOE providing the primary impetus in the development of a synthetic fuels industry. Within DOD, the Navy is the lead Service responsible for synthetic fuels R&D. The Navy's goal in synthetic fuels R&D is to ensure that the fuels resulting from various government- and industry-sponsored synthetic fuels programs will be suitable for Navy needs. The Navy and DOE have joint programs to acquire, refine, test, and evaluate synthetic fuels. As the fuels become available in sufficient quantities, the Navy will ensure compatibility between the synthetic fuels and Navy equipment through testing programs. While it will certify all synthetic fuels—whether derived from coal, tar sands, or oil shale—the Navy is now concentrating primarily on certifying

fuels derived from oil shale. The Navy is also assessing the feasibility and possible cost advantages of operating on fuels having broader specifications than those currently used by the military. This effort will require determining relationships between fuel chemistry and physical properties of equipment as well as the effects of fuel properties on equipment performance. The results of this work will be directly applicable to synthetic fuels R&D.

### **Energy Self-Sufficiency/Alternative Energy Sources**

The energy self-sufficiency strategy involves developing local renewable energy resources such as solar, wind, geothermal, and refuse-derived fuel at both remote and domestic bases; and, where possible, replacing liquid hydrocarbon fuels with more abundant fuels such as coal. The objective of this strategy is to test and evaluate alternative and advanced energy systems to reduce the use of liquid and gaseous hydrocarbons.

Development and application of technology to increase energy self-sufficiency within the Navy will decrease its dependence on petroleum supplies—especially at remote locations, which are in more danger of supply-line interruption and which involve higher transportation costs. In addition, such an R&D program allows the Navy to be well informed on national efforts to develop energy technologies (solar conversion systems, for example) that soon may be applied in both civilian and military systems. In its self-sufficiency activities, the Navy is applying systems and developing resources, using conventional and advanced systems in the best possible mix that is economically, environmentally, and strategically sound.

### **NAVY ENERGY MANAGEMENT**

Navy energy management focuses on providing innovative management of energy programs and reducing organizational shortcomings. It also provides planning for the short, middle, and long term, and for improving coordination of energy matters within DOD, DOE and other federal agencies. New programs that are necessary to minimize the adverse effect of the present and future energy situation are established and continually reviewed.

Because of the universal nature and magnitude of the current energy situation, Navy energy management and planning are influenced by national and DOD energy-related activities. Federal legislation, executive orders, and national objectives also directly affect the resources available to the Navy. Figure 6 illustrates the manner in which the Navy program supports the national program.

In looking ahead, long-range planning and lead time are two of the most critical elements that will affect the Navy's future energy status. Generally, the Navy's procedures, organizational structures, and planning processes operate within the established Planning, Programming and Budgeting System (PPBS) and annual budgets as included in the FYDP. However, planning and managing energy-related activities must span decades if optimum results are to be achieved. For example, major shore-station conversion from natural gas to coal is a long-term objective. Federal legislation calls for 10-year conservation plans to be submitted by federal agencies, and the Navy's ship-design policy extends into the 1990s. The



NAVY PROGRAMS	NATIONAL GOALS							
	REDUCE ANNUAL ENERGY DEMAND GROWTH RATE TO LESS THAN 2 PERCENT	REDUCE GASOLINE CONSUMPTION BY 10 PERCENT	CUT OIL IMPORTS TO ONE HALF OF 1985 PROJECTION	INCREASE COAL PRODUCTION TO 1 BILLION TONS PER YEAR	INSULATE 90 PERCENT OF U.S. HOMES AND ALL NEW BUILDINGS	USE SOLAR ENERGY IN MORE THAN 25 MILLION HOUSES	ACHIEVE 45% ENERGY REDUCTION FOR NEW CONSTRUCTION	
IMPROVE FUEL MANAGEMENT								
DEVELOP BETTER TRAINING AND OPERATING PROCEDURES								
IMPROVE THERMAL EFFICIENCY OF EXISTING BUILDINGS								
DESIGN MORE ENERGY - EFFICIENT BUILDINGS FOR NEW CONSTRUCTION								
ESTABLISH ENERGY MONITORING AND CONTROL SYSTEMS								
IMPLEMENT COGENERATION SYSTEMS								
REDUCE SHIP DRAG								
DEVELOP MORE EFFICIENT SHIP PROPULSION AND AUXILIARY SYSTEMS								
USE COMPUTERIZED FLIGHT PLANNING								
USE FLIGHT SIMULATION TRAINING METHODS								
DEVELOP MORE EFFICIENT AIRCRAFT SYSTEMS								
USE WASTE OIL AND REFUSE DERIVED FUELS								
CHARACTERIZE MILITARY FUELS FROM SYNCRUDES								
ENSURE COMPATIBILITY BETWEEN SYN-FUELS AND SYSTEMS								
QUALIFY NONSPECIFICATION FUELS FOR NAVY USE								
DEVELOP SYSTEMS LESS DEPENDENT ON OIL OR NATURAL GAS								
USE RENEWABLE ENERGY SOURCES: WIND, GEO THERMAL, SOLAR, TRASH, OTHER								

DIRECT SUPPORT

RELATED SUPPORT

DOES NOT APPLY

DIRECT SUPPORT 
 RELATED SUPPORT 
 DOES NOT APPLY 

**Figure 6. NAVY ENERGY PROGRAM SUPPORT TO NATIONAL ENERGY GOALS**

Navy will also have to deal with institutional and life-style changes caused by limitations imposed by available energy resources and environmental standards. These needs demand a planning process that fully considers the long lead times involved. The Navy energy program considers these long lead times in its planning process.

Energy management activities consist of: energy management organization, training and energy awareness programs, and energy information systems.

### **Energy Management Organization**

Navy energy management responsibilities are primarily vested in the Deputy Chief of Naval Operations for Logistics (OP-04) who provides policy coordination and guidance related to energy matters. The Director, Material Division (OP-41) provides the principal staff support for energy matters and serves as chairman of the Chief of Naval Operations (CNO) Energy Action Group. The Navy Energy Office (OP-413) acts as a central point of contact and provides policy guidance on all matters pertaining to energy and energy conservation, except those pertaining to nuclear energy. OP-413 is responsible to OP-41 for planning and monitoring efficient use of energy throughout the Navy.

The Director, Research, Development, Test and Evaluation (OP-098) is the development coordinator for all Navy energy R&D programs and is responsible at the OPNAV level for accomplishing all approved research, development, test and evaluation (RDT&E) program actions. All energy matters in the Department of the Navy are also closely coordinated with the Navy Special Assistant for Energy.

The Director, Navy Energy and Natural Resources R&D Office (MAT-08T3), is responsible for the planning, execution, and appraisal of the Navy's energy and natural resources R&D programs. Management of the R&D program at the Navy Systems Command (SYSCOM) level is carried out by assigned offices. A complete analysis of the Navy energy organization, as well as that in DOD and DOE, is provided in Appendix B.

### **Training and Energy Awareness Programs**

Training and energy awareness programs are a key part of Navy energy management. These programs include energy management training, Navy Energy Awareness Week, Navy energy awards program, and a Navy incentives award program.

#### **Energy Management Training**

The Civil Engineering Corps Officers' School (CECOS) conducts a one-week energy management course that provides training for operational and survey personnel. It is conducted three times per year—alternating on each Coast—and utilizes the instructional staff of the CECOS from Port Hueneme, California, supplemented with lecturers from the Naval Facilities Engineering Command (NAVFAC) and private industry. The Engineering Field Divisions (EFDs) of NAVFAC also conduct regional seminars periodically for public works personnel from the various activities. These seminars provide for interchange of management techniques and updating on Navy energy management policy. A NAVFAC cor-

respondence course for utility system operators was published in 1976 to assist in energy conservation, especially in the area of boiler plant operations. Finally, NAVFAC technical and design manuals are now undergoing updating and revision.

Energy awareness and energy conservation instruction is included in the curricula at both the Naval Academy, Annapolis, Maryland, and the Navy Post Graduate School at Monterey, California. This instruction includes a review of the present and future energy situation as it affects the Navy and provides indoctrination in the need for energy conservation and the use of alternative energy sources.

A document which has been of some use in preparation of local training sessions is DOE publication DOE/CS-003411, *Practical Materials for Teaching Energy Management, A Resource File*, Edition I, November 1977. Copies of this publication are available from the U.S. Department of Energy, Assistant Secretary for Conservation and Solar Applications, Washington, D.C.

#### **Navy Department Energy Awareness Week**

A special week is to be observed Navy-wide to make all Navy and Marine Corps personnel aware of the importance of energy conservation and their respective energy programs. Wide publicity and participation at all Navy and Marine Corps installations will be included. The first observance of Navy Department Energy Awareness Week will be 23-27 October 1978.

#### **Navy Energy Awards Program**

The Navy awards program (see Secretary of the Navy Instruction 4100.8 of 7 April 1978) is a special program to grant "Energy Conservation" awards to various ships, aircraft squadrons, and Navy and Marine Corps shore activities. This program is intended to take place in conjunction with Navy Energy Awareness Week. The first observance will be in the fall of 1978.

#### **Navy Incentives Award Program**

The federal government employees incentive awards program was established to improve government operations and acknowledge the achievements of employees. The Secretary of the Navy has delegated responsibility for the overall administration of the program to the Director of Civilian Manpower Management, who establishes policy, issues standards, grants exceptions, disseminates contributions to DOD and other federal agencies, and consolidates required reports. Also, the Navy's Incentive Awards Board has been created to assist in attaining program objectives. The present incentives award program will include special recognition for improved energy resources management.

#### **Energy Information Systems**

Information related to fuel and energy consumption is obtained through the Defense Energy Information System, NEUPAS, MINI-GAP energy reports, a Utilities Cost Analysis Report, and special reports as required.



## Defense Energy Information System (DEIS)

During the Arab oil embargo of 1973-74, DOD determined that timely and accurate energy inventories and consumption information were restricted entirely to bulk fuel terminal operations. The exigencies of the situation required definitive information from all levels regarding individual base/unit/activity energy inventories and consumption. In response to this energy information requirement, the DEIS was developed.

The Defense Fuel Supply Center (DFSC) maintains and updates DEIS-I for shipboard, aircraft, and ground support energy consumption, and DEIS-II for military installations and shore facilities.

The Navy Petroleum Office (NAVPETOFF) monitors the final DEIS-I report to ensure that the Navy's data are accurate and complete and also supplies special summary reports for CNO. All major claimants must fill out and submit DEIS-I report forms monthly. DFSC receives these reports and puts them into the DEIS-I automated data bank. The computerized system then generates monthly compilations of the use of the various standard fuel types by each of the services. The program categorizes data according to several breakdowns and summarizes overall fuel use.

NAVFAC is the program coordinator for DEIS-II. It provides quality control, activity guidelines, and analysis of the data to CNO. DEIS-II also provides a monthly report of facility energy consumption to major claimants, enabling facility managers to be aware of energy costs on a timely basis.

Revised DEIS guidelines were published 25 April 1978 as DOD Directive 5126.46.

## Navy Energy Usage Profile and Analysis System (NEUPAS)

The designated program manager for NEUPAS is the Navy Energy and Natural Resources R&D Office (MAT-08T3). MAT-08T3 is assisted by the NAVFAC Energy and Utilities Division (FAC-102) and the David W. Taylor Naval Ship Research and Development Center (DTNSRDC). The mission resource and program sponsor is the Deputy Chief of Naval Operations for Logistics, OP-04.

NEUPAS was designed to provide the historical patterns of energy usage included in Appendix A. In addition, NEUPAS uses the historical energy usage data to predict general and specific future Navy energy requirements. This system is a compilation of the end-user fuel and utility energy consumption reports, operational hours reports, and current force-level data. The data are supplemented with projected force levels, unit energy usage characteristics, and energy cost information to support the predictive analysis.

The historical Energy Usage Profile Analysis Program produces energy usage profiles, interyear comparisons, and historical energy usage trends.

The FY 2000 Energy Usage Projection Program forecasts total Navy energy usage and cost yearly through FY 2000, based on projected force levels, energy cost, and unit con-

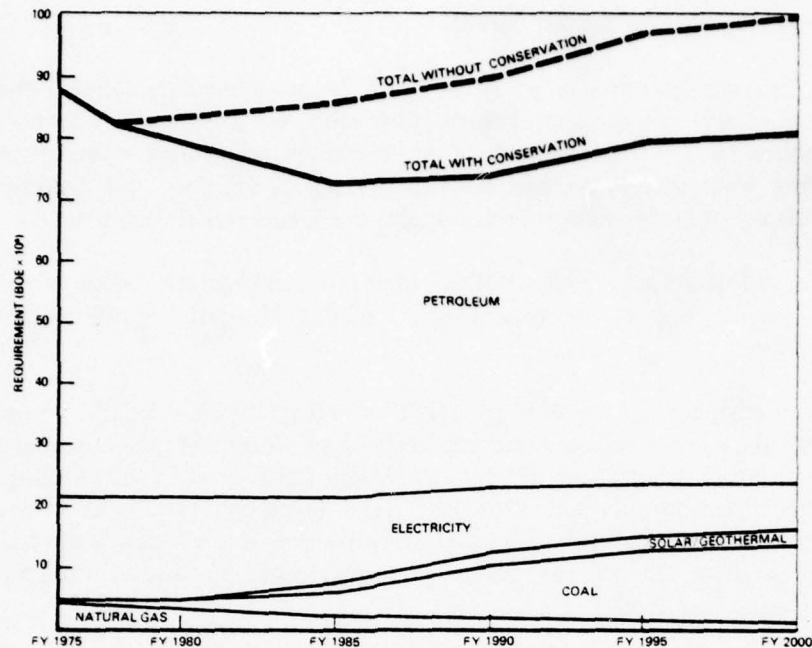


Figure 7. NAVAL ENERGY REQUIREMENTS TO 2000

sumption. Shore energy usage projections for this plan are not produced by NEUPAS, although that capability exists. NAVFAC (FAC-102) generates its best assessment of Navy shore energy requirements. Figure 7 shows the Navy's best assessment of total energy usage, with conservation, by fuel type through FY 2000.

The Scenario Energy Usage Projection Program is essentially a special case of the FY 2000 projection. The program projects the energy needs of specifically defined, task force-size naval units, based on appropriate sections of the total FY 2000 projection. Parameters which may be varied, at the option of the analyst, are task force units (both ship and aircraft types and numbers), the OPTEMPO, and the operational duration.

#### MINI-GAP Energy Reports

The MINI-GAP program displays public works centers (PWCs) and naval shipyards energy consumption trends, energy production and utilization efficiencies, and cost by energy type. The program can display these data by individual activity and/or provide comparative analyses among activities. The program also displays past and present data. The Utility Cost Analyses Report and DEIS are the sources of data for this report. The data base and program are maintained by the Office of the Comptroller of the Navy (NAVCOMPT).

#### Utilities Cost Analysis Report (UCAR)

The energy cost report entitled "Utilities Cost Analysis Report" permits each activity to compute the unit cost of energy produced and distributed. This is essential for the ac-

curate billing of tenant activities, and is the basic source data for management reports such as the PWC/shipyard indices reports (MINI-GAP).

#### **Special Report**

The Civil Engineering Laboratory (CEL) at Port Hueneme, California, has established a CEL "Hot Line" to respond to questions on energy projects. All questions should be directed to Fred Herrman, Code L03C, CEL, NCBC, Port Hueneme, California 93043. The telephone number is Autovon 360-5562 or commercial (805)982-5562.

### **ENERGY DISTRIBUTION AND ALLOCATION**

The energy distribution and allocation program is designed to ensure that the appropriate mix of energy supplies is available where needed in sufficient quantities to support the required tempo of operation. This program area includes POL training, fuel management systems, Prepositioned War Reserve Material Requirements (PWRMR), Navy POL Modernization Program, fuel standardization, and contingency planning.

#### **POL Training**

The Navy uses about 60 million barrels of fuel per year. This includes POL for almost 500 ships, over 5,000 aircraft, and all the Navy's shore facilities. These products are stored, transferred, and used at practically every naval facility, both ashore and afloat. The volume and diversity of petroleum products require Navy personnel to be trained in procurement, quality assurance, and operational procedures and techniques for handling ship propulsion and aviation fuels.

Fuel distribution training for the Navy is currently conducted at the U.S. Army Quartermaster School, Fort Lee, Virginia. Additionally, a bulk fuel system course, more tailored toward naval shore facilities requirements, has been developed by the CINCPACFLT. Information regarding this course may be obtained from the Naval Petroleum Training Unit, U.S. Pacific Fleet, Treasure Island, San Francisco, California 94130. The first regular course convened in June 1978.

#### **Fuel Management Systems**

The systems that supply bulk petroleum products to the Navy and Marine Corps include:

- Underway replenishment system, which supplies bulk fuels to the fleet.
- DOD terminal system, which supplies wartime stocks to satisfy PWRMR and peacetime operating stocks.
- At-sea transportation system, which transfers POL from commercial production facilities to designated storage sites.
- Shore transportation system, which supplies CONUS terminals and bases.
- Fuel management system, which procures bulk petroleum products and manages the above components.



The worldwide DOD fuel management system, including procurement, has been assigned to the DFSC of the Defense Logistics Agency (DLA). The Military Sealift Command (MSC) furnishes the TAOs, which are under fleet command, in the same manner as the USN AOs. The MSC also acts as the waterborne fuel transportation agent.

Basic petroleum management policies are contained in DOD Directive 5105.22, DLA and DOD Directive 4140.25, and DOD Manual 4140.25-M, "Procedures for the Management of Petroleum Products," dated August 1974. These documents, which provide detailed guidelines, are presently being updated and revised.

Policy guidance is also provided in OPNAVINST 4020.25, dated 10 February 1978 which outlines requirements for developing local procedures for managing and controlling ground fuel products at the station and unit level of each naval establishment. This instruction was prepared in response to a General Accounting Office (GAO) audit which revealed serious procedural weaknesses and inadequate control over ground fuel products. Minimum basic requirements include validation of the quality and quantity of fuel on receipt of an order; the supplier's invoice by sampling, gauging and/or metering; and deliveries and disbursement. Physical inventories of stocks on hand are conducted at least weekly.

#### **Prepositioned War Reserve Material Requirements (PWRMR)**

PWRMR are part of the mobilization reserve material needs that are positioned before hostilities begin, either at or near the point of planned use, or issued to the user. This is to ensure timely support of a specific project or designated forces during the initial phase of war until normal resupply is established. One of the most important components of PWRMR is bulk petroleum products to be used by the active Navy, Naval Reserve Forces (NRF), MSC, Coast Guard, and U.S. Marine Corps. The PWRMR program determines POL requirements for ships, aircraft, CNO special projects, and overseas shore bases. The ASD (M,RA&L), DFSC, CNO, and fleet commanders share responsibility for specifying requirements, designating the location and level of terminals to store PWRM stocks, provisioning PWRM stocks to designated terminals, and managing the system.

Navy PWRM requirements, levels, and location of stocks are developed through a computer model under the responsibility of CNO (OP-413). The model uses the Ship Management Information System (SMIS), the Aircraft Program Data File (APDF), consumption rate information taken from NWIP 11-20 and NAVMAT P-4000-2, and day-of-supply (DOS) information recommended by the Joint Chiefs of Staff (JCS SM-64-74 of 6 February 1974). The program is updated to include the latest "Defense Policy and Planning Guidance (DPPG)" and "Planning and Programming Guidance Memorandum (PPGM)." PWRMR methodology is provided as an enclosure to OPNAVINST S4020.15H of 31 January 1975.

#### **Navy POL Facility Modernization Program**

In April 1975, the ASD (M,RA&L) released a memorandum emphasizing the need for the military services and DOD components to schedule the repair and maintenance of bulk petroleum storage facilities needed to assure worldwide military readiness. Specifically, ASD

(M,RA&L) directed that a review of deficiencies and operating support requirements be initiated, and that corrective action programs be submitted through the Program Objectives Memorandum (POM) process. NAVPETOFF developed a POM package for all Navy storage pursuant to this objective, and initiated a POM 78 Issue Paper concerning the needs of Navy Supply Systems Command (NAVSUP) activities. The NAVPETOFF paper listed all known deficiencies and itemized NAVSUP activities by project, location, and type of funding required. Detailed requirements of facilities under the cognizance of fleet, force, and area commanders are under their respective purviews. This comprehensive paper cites deficiencies in pollution abatement and control facilities at bulk POL terminals.

The modernization program will increase the military readiness of POL distribution facilities to include increased operational efficiency and reduced likelihood of major oil spills. A growing emphasis on POL facilities has been expressed at the Office of the Secretary of Defense (OSD) level because of the national energy crisis and the need for energy independence. Lack of funds for major maintenance of the terminals has restricted the full capability to perform at a time when energy needs are critical.

NAVSUP is responsible for constructing, maintaining, and operating the Navy's bulk petroleum terminal facilities in CONUS and Hawaii. CINCPACFLT, CINCLANTFLT, and CINCUSNAVEUR are responsible for facilities in their respective areas. NAVPETOFF supplies technical assistance to NAVSUP and the CINCs with regard to facility construction, maintenance, and operation. It also furnishes technical advice and assistance concerning fuel and lubricant quality control, and coordinates worldwide Navy POL consumption requirements and reserve stock levels assigned to CONUS bulk terminals.

The Navy stores about 46 million barrels of bulk fuel at deepwater terminals around the world. Of this total, NAVSUP is responsible for operating and maintaining nine major terminals with a capacity of 21 million barrels. The NAVSUP portion of the worldwide terminal system costs \$10 million to operate annually and has a maintenance backlog of \$38 million. The modernization and pollution abatement project backlog stands at \$77 million. About 50 percent of the total capacity is located on U.S. soil. The major emphasis is on modernizing U.S. bulk terminals.

Military construction (MILCON) funding for FY 1978 includes \$22.0 million for rehabilitating the Red Hill POL terminal in Hawaii and \$5.1 million for replacing the Manchester fuel pier in Puget Sound. These two locations are the most critical rehabilitation projects in FY 1978.

### **Fuel Standardization**

The ASD (M,RA&L) established the present DOD fuel standardization policy through DOD Directive 4140.43, of 5 December 1975. This directive prescribes greater flexibility in procuring and using fuels by the U.S. military. Also, the directive calls for a reduction in the number of different fuel types in the military logistics system.

In order to optimize the standardization and use of fossil fuels within the military, NATO and civilian section, a Joint Technical Coordinating Group on Fossil Fuels Standard-

ization and Utilization was chartered by the Joint Logistics Commanders shortly after issuance of the DOD directive.

Since that time the group has: (a) developed a policy on DOD liquid hydrocarbon fuels for equipment design, operation and logistics support which was published as DOD Directive 4140.43 (this directive and the 9 September 1976 DOD report on aircraft turbine fuels resulted in UK and NATO standardization on JP-8 in Europe starting in June 1978; the Navy will retain JP-5 for carrier operations because of the low flash point of JP-8); (b) published a report on aviation gasoline recommending that the Services convert from 115/145 to 100/130 aviation gasoline; (c) published a report on marine, ground diesel and burner fuels that resulted in a single multipurpose fuel for surface ship propulsion being approved as Diesel Fuel, Marine, NATO F-76 (the U.S. Armed Forces have also standardized on the NATO guide specification for diesel fuel, NATO F-54, for ground operations in Europe); (d) published a report recommending the Services approve the use of unleaded motor gasoline in CONUS and approve the use and total standardization of NATO F-46 motor gasoline overseas; and (e) published a report recommending the establishment of a national policy for the production of synthetic liquid fuels derived from oil shale, coal and tar sands. The last major action of the group was the preparation of a technical report on reclamation and re-refining of lubricating oils and other petroleum products. After completion of all assigned tasks, the group was disestablished on 22 March 1978.

### **Contingency Planning**

The potential for periodic domestic energy curtailments and disruption of mission accomplishment of Navy shore and fleet activities, government-owned contractor-operated (GOCO) plants, and Navy contractors and suppliers is increasing. Disruptions have occurred as a result of the 1973 oil embargo, the 1976-77 natural gas shortages and the 1977-78 coal-induced electric power shortages.

A DLA Plan for "Bulk POL Support during an Arab Oil Embargo" (short title: DLA OPLAN 1-77), was approved in May 1977. This plan provides for continuing bulk POL support to the military services in the event of an embargo of crude oil and/or refined products by Arab oil-producing nations. The plan envisions the need to reduce reaction times to changes in POL source requirements to a minimum prior to depletion of peacetime operating stocks, which would require the use of reserves. Primary reliance will be on prepared standby orders which will be placed with industry. Based on the circumstances at the time of any embargo, DFSC will evaluate immediate-type actions, cargo diversions, alternate lifts, accelerated deliveries and redistribution of assets as approved by the JCS and the CINCs.

Local contingency plans and knowledge of available policy and procedures are necessary to minimize the impact of future energy supply disruption. Local contingency plans are also receiving renewed emphasis as part of the ongoing energy conservation surveys. Most Navy activities, dependent for fuel from the same commercial suppliers as private industry, may have natural gas deliveries curtailed, are subject to power distribution outages, and receive lower voltages during brownouts. Preparation for such contingencies requires estimates of quantities of fuel and electricity that are consumed by each building at



an activity, so that reduction actions can be quantitatively determined prior to last-minute interruption.

OPNAVINST 4100.6, dated 27 July 1976, entitled "Energy Source Selection and Criteria for Shore Facilities," and DOD Instruction 4140.25, entitled "Management of Bulk Petroleum Products, Facilities and Services" direct that a 30-day oil storage capability, based on the coldest 30 days requirement, be maintained at all oil-fired plants or plants with oil standby, and that all natural gas-fired plants of a capacity of 5 million Btu per hour and greater be modified to have a capability to burn fuel oil.

The Navy is in the process of identifying, constructing, and/or modifying facilities to comply with the storage and alternate fuel requirements within available MILCON funds.

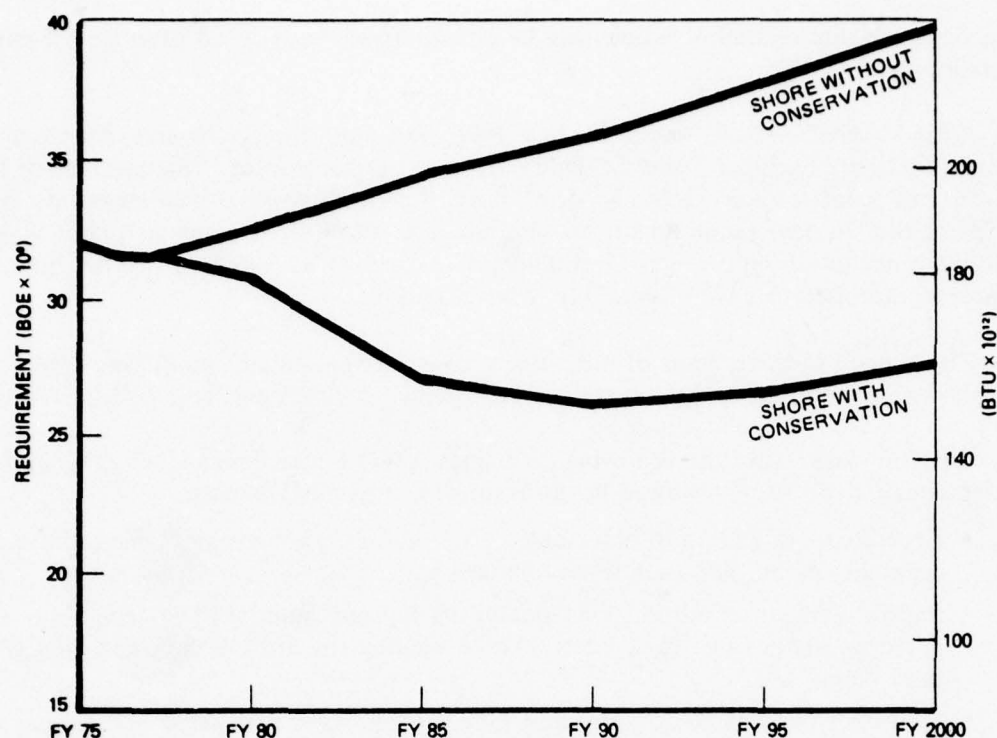
The Navy has issued the following guidelines (CNO Letter Serial 413C/221782, dated 20 September 1977) to be followed in the event of energy curtailments:

- Expedite modification of Navy and GOCO natural gas burning plants to have dual capability of burning fuel oil and natural gas.
- Expedite construction and load out of 30-day minimum storage capability, computed on the basis of the coldest 30-day requirement, for all Navy and GOCO oil-fired plants.
- Identify all major contractors and GOCOs who have projected natural gas curtailments and overall energy shortages during the 1977-1978 heating season.
- Advise GOCOs and Navy contractors of action to be taken with respect to projected, or in the event of actual natural gas shortages, to secure additional supplies. Actions, in order of priority, include:
  - Obtaining an alternative energy source.
  - Appealing to local natural gas distributor and to state regulatory body for relief.
  - Purchasing intrastate natural gas directly from producer under provisions of Federal Power Commission (FPC) Order No. 533.
  - Appealing to FPC for "Extraordinary Relief" under provisions of FPC Order No. 467-C.
  - Invoking the Defense Production Act (DPA) of 1950.

The Emergency Petroleum Allocation Act (EPAA) authorizes DOE to allocate petroleum products such as butane, propane, commercial jet fuel, and motor gasoline. All other petroleum products have been decontrolled and cannot be obtained under the EPAA. For energy resources other than natural gas and petroleum, regulatory responsibility is generally diffused and indefinite for peacetime domestic emergencies.

## SHORE OPERATIONS

The basic objective of the shore operations program is to provide naval shore activities and others with the technical expertise and assistance needed to achieve the energy conservation and alternative fuels goals promulgated in OPNAVINST 4100.5A. Shore operations, which include Navy and Marine Corps facilities (active and reserve), GOCO plants, and use



**Figure 8. NAVAL SHORE ENERGY REQUIREMENTS**

of ground support equipment such as transportation vehicles represents one of the Navy's primary energy consumption areas. Shore energy consumption is expected to increase from  $186.2 \times 10^{12}$  Btu in 1975 to  $230.8 \times 10^{12}$  Btu in 2000 without conservation as shown in Figure 8. This area had a total energy cost of over \$400 million in FY 1977. It is projected that, with conservation, energy usage in FY 2000 will be  $158.9 \times 10^{12}$  Btu and that utilities expenditures will be more than \$700 million in 1977 dollars. The projected increase in consumption of 1 percent per year in Figure 8 is due to increased reliance of ships in port on shore power (cold iron), increased simulator usage, and more energy-intensive operations. The high costs projected accentuate the need for, and importance of, an effective shore conservation program that will ensure mission support with minimum energy use and waste.

The shore operations program is recognized at all levels as a top priority effort. NAVFAC acts as the shore facilities energy conservation program manager, coordinating all shore establishment energy conservation actions, providing technical sponsorship, and serving as the Navy central point of contact for those actions assigned by the Navy Energy Office (OP-413). NAVFAC Engineering Field Division (EFD) personnel act as principal technical experts in providing guidance and assistance in the achievement of Navy energy goals. NAVFAC acts as the vehicle operations energy conservation program manager. The GOCO program is now just evolving and will be managed at the Naval Material Command level. An OSD program, Energy Conservation and Management (ECAM) is under development for GOCO energy projects which will be similar to the Energy Conservation Investment Program, described later.

The challenge of meeting energy conservation goals in the Navy's shore operations is directly related to the various conditions under which shore facilities and ground vehicles operate. When extremes of climate, available energy sources, essential fuel costs, diverse mission responsibilities, and the existing condition of facilities and utility systems are balanced against providing a safe, comfortable, and efficient personnel and operational environment, it is easy to see that this program is extremely site specific. This challenge is being met by a comprehensive program structured to satisfy mission requirements, while systematically applying economic criteria, such as payback and cost/benefit analyses, to identify and select new technology and energy alternatives.

### Energy Conservation

The energy conservation program for shore operations involves eliminating wasteful energy use and improving the energy efficiency of existing or planned buildings and ground support equipment. Energy conservation includes: energy conservation surveys of existing buildings; Energy Conservation Investment Program (ECIP); Energy Engineering Program (EEP); boiler tune-up program; Navy housing; Navy housing utility metering program; planning, engineering and designing new facilities; vehicle conservation; and research and development.

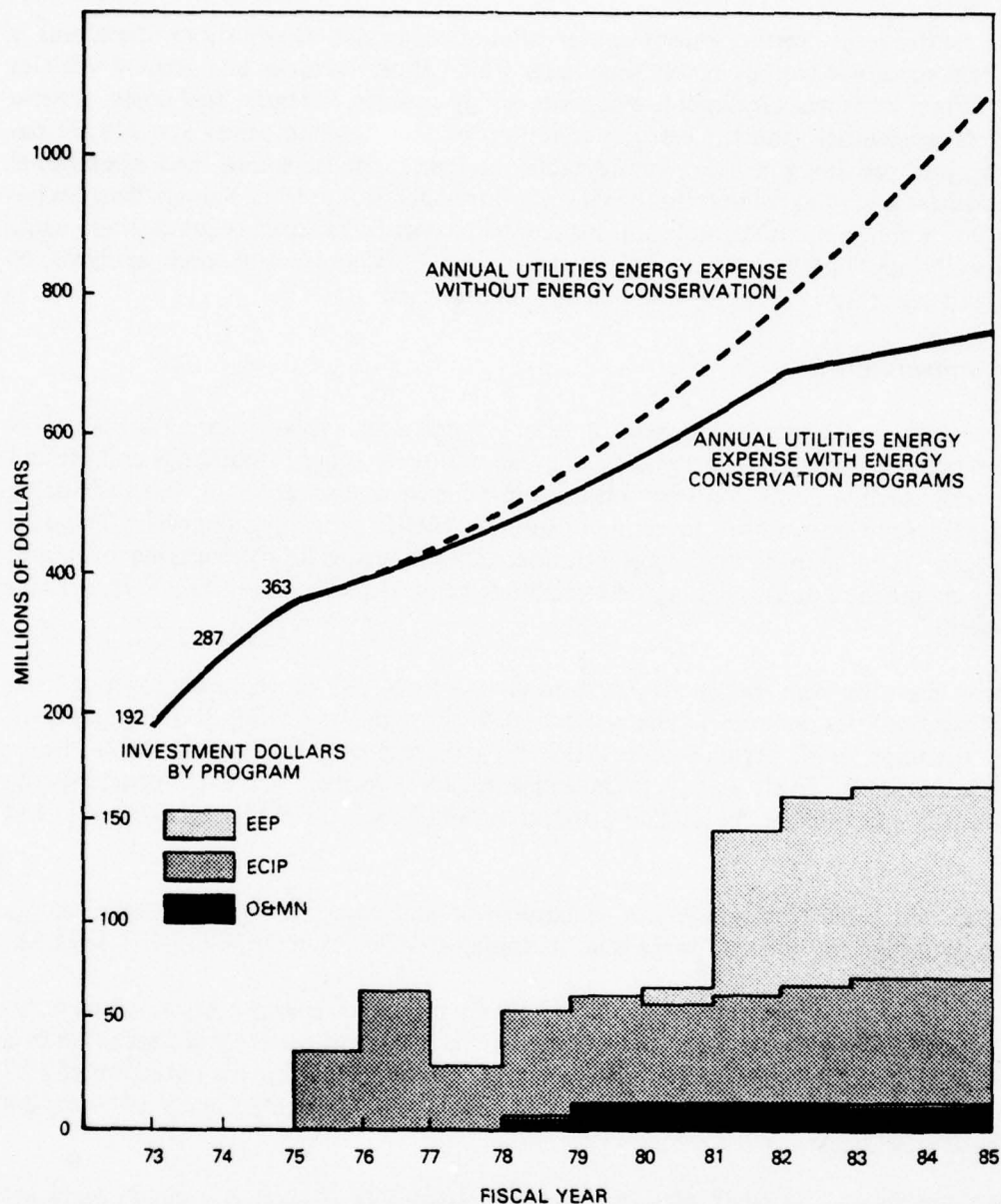
Projects evolve from energy conservation surveys by NAVFAC representatives or from the local base utilities personnel. The projects flow through the regular Shore Installation Facilities Planning and Program System (SIFPPS) and are given priority by NAVFAC headquarters according to Btu's saved per thousand dollars invested. NAVFAC structures the priority listing and sponsors individual projects to NAVMAT, OPNAV (OP-04), OSD and OMB.

Policy and procedural guidelines to implement and continue the Navy-wide energy management program for shore operations, including GOCOs, is in OPNAVINST 4100.5A.

Although shore energy usage is being effectively managed, energy costs continue to increase, particularly for natural gas and electricity. Petroleum prices are still rising, but at a rate lower than the severe 1974-1975 OPEC increase. Notwithstanding the reduction of 13.7 percent in energy usage over FY 1973, the Navy's energy bill for utilities in FY 1977 was 2.4 times the FY 1973 cost.

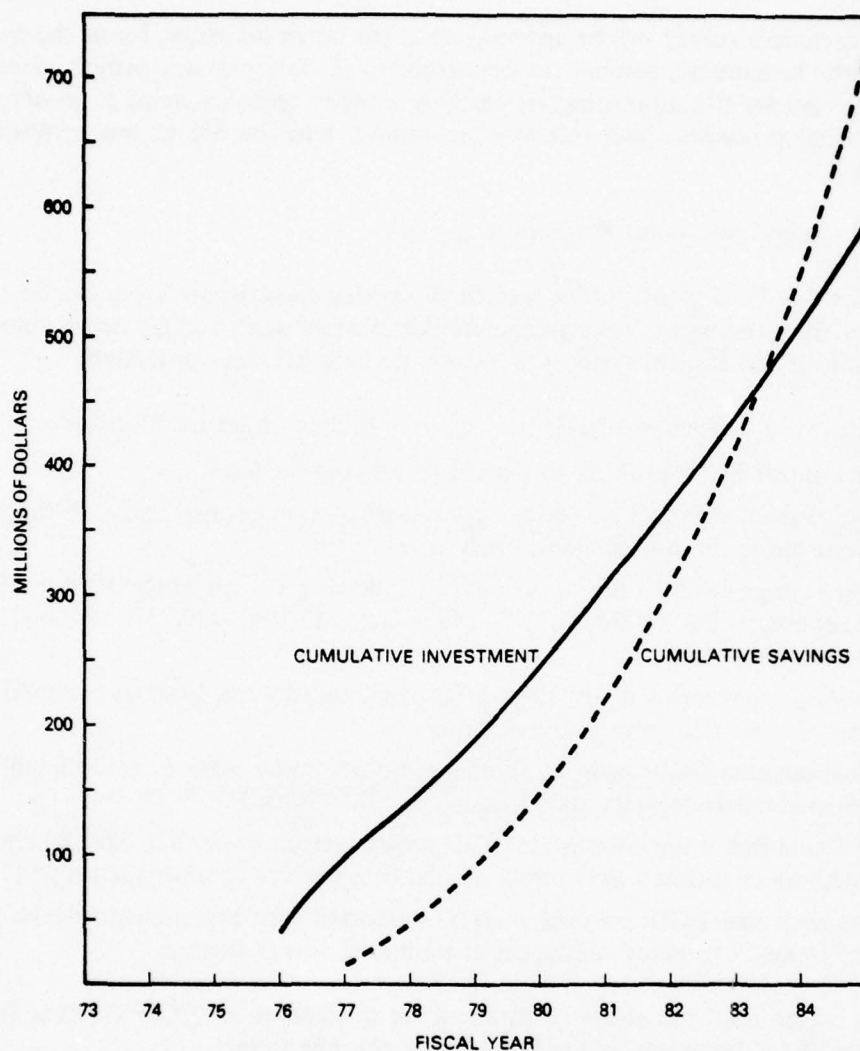
Figure 9 shows total utilities expense and total expected savings in the Navy's currently funded energy engineering and energy conservation investment programs that are described in the following paragraphs. The curves at the bottom of Figure 9 depict the yearly investment levels of O&M, MILCON, and other funding that will support the NAVFAC proposed facilities energy program through 1985. The two curves at the top of Figure 9 show annual utilities expense with and without the proposed energy conservation programs. The curve plotted without energy conservation assumes that the mix of energy used after 1977 will not change from the 1977 mix (i.e., no increased use of coal, no decreased use of POL, no use of renewable energy, etc.) Based on these assumptions, in 1985 utilities expense without a conservation program would increase to \$1,100 million or \$365 million above the projected cost with a conservation program. Beyond 1985 utilities savings should continue at a level of several hundred million dollars per year.





**Figure 9. NAVY AND MARINE CORPS ENERGY CONSERVATION PROGRAM SAVINGS FOR SHORE FACILITIES**

Figure 10, which is derived from Figure 9, shows the potential cumulative energy savings in dollars plotted against the cumulative investment in the energy engineering and conservation investment programs. This figure indicates that savings escalate as energy costs increase. Early in 1983 a break-even point occurs at the estimated time when the total dollars invested in energy conservation will be repaid by energy dollars saved. By 1985 it is expected that cumulative savings will be \$730 million, which exceeds cumulative investment in shore conservation programs by \$140 million.



**Figure 10. NAVY AND MARINE CORPS ENERGY CONSERVATION INVESTMENT U.S. SAVINGS**

#### Energy Conservation Surveys of Existing Buildings

Shortly after the 1973 oil embargo to utilities division of the EFDs of NAVFAC embarked upon an energy conservation survey program of all naval activities. During the completed Phase I effort, survey teams were sent out to identify wasteful practices and to help activities develop individual energy conservation and contingency plans. Equally important, the terms also developed or helped the activities to develop self-amortizing repair and retrofit projects (for accomplishment within the activity commander's budget, the major claimant's project budget limits, and the Navy's ECIP MILCON budget). Phase II, now under way, is a series of revisits, primarily to seek out and develop capital investment projects of a more complex and technically sophisticated nature.

A third or fourth survey will be appropriate at the larger activities, for as the price of energy continues to increase, so does the opportunity for early payback project identification. These surveys are also addressing increasingly complex technical areas of conservation such as industrial processes, heat recovery techniques, and the use of less conventional energy sources.

#### Energy Conservation Investment Program (ECIP)

The MILCON ECIP provides for retrofit of existing facilities to: (1) minimize energy loss; (2) utilize the latest energy savings, materials and equipment; and (3) install automatic energy monitoring and control systems to ensure the most efficient operation.

Criteria used to determine eligible projects for funding under ECIP include:

- Restriction of ECIP projects to retrofit of existing facilities.
- Cost-effectiveness of all projects, i.e., a savings-to-investment ratio (SIR) greater than one based on life-cycle cost analysis.
- Energy savings-to-cost ratio of at least the following million Btu's saved per \$1,000 of investment: FY 1979—23, FY 1980—22, FY 1981—20, FY 1982—19, FY 1983—19, FY 1984—18.
- A provision that, prior to FY 1981, all projects outside the 50 states must derive 20 percent of their fuel from U.S. sources.
- A provision that ECIP projects should combine similar work in various buildings. (Major individual projects may include dissimilar work.)
- A provision that when a basewide ECIP project affects more than one claimant, the lead activity or public works center should prepare and sponsor the project.
- A provision that ECIP projects shall be supported with engineering calculations in sufficient detail to allow validation of estimated energy savings.

Projects which meet the above criteria and are candidates for ECIP funding are forwarded to NAVFAC by means of the SIFPPS for consideration.

In the ECIP program, several different types of modifications and repairs are being implemented:

- Steam and Condensate System Modifications—Install condensate return lines, cross-connect lines, and looped systems to permit plant shutdown and sectionalized line shutdown during low-load summer months. Existing lines will be rehabilitated, including improved insulation and steam flow metering and controls.
- Boiler Plant Modifications—Modify boiler controls and boiler water treatment facilities and install facilities to burn refuse-derived fuel.
- Lighting Conversion—Replace incandescent fixtures with sources such as sodium vapor, which has approximately 10 times the light output per watt as the comparable incandescent fixture. Other innovations will include skylights, selective controls, timers, and photoelectric cells.



- **Electrical Energy Conservation**—Provide scheduling controls for electrical systems, combined loads on generators, capacitors for power factor correction, and other methods for reducing the consumption of electrical energy.
- **Heating, Ventilation, and Air Conditioning (HVAC)**—Install more efficient HVAC systems to provide necessary environmental control while greatly reducing energy requirements. Some examples are: replacing inefficient and wasteful controls, adding controls where there are none, and replacing entire systems.
- **Energy Monitoring and Control**—Incorporate automatic temperature setback devices, electrical load shedding and peak shaving systems, lighting system timers, remote sensors on outlying plants, and other equipment to avoid waste and increase system efficiency through more timely maintenance and operations response. These devices also have potential savings in use of maintenance and watch personnel.
- **Heat Recovery**—Recover and reuse heat or primary energy from boiler stacks, motors, and incinerators that would otherwise be lost from industrial processes.
- **Insulation and Storm Windows**—Install storm windows and insulation in existing buildings.
- **Building Alterations**—Install heating/cooling controls, weather stripping, ventilators, and high-intensity lighting; reduce glass area; add solar screens and reflective roof coatings to reduce overall energy consumption.

The projects selected for each fiscal year's ECIP are those giving the greatest energy saved per thousand dollars invested.

#### Energy Engineering Program (EEP)

The EEP, managed by NAVFAC, is a new program to develop permanent technical measures to conserve energy Navy-wide through identification and development of high technology projects. This program will complement the ECIP to ensure that all possible practical energy conservation actions are initiated. EEP is a program funded by O&M,N that will pay for itself within 5 years and will result in an estimated cost avoidance of over \$6 million annually by 1985.

The program also will contribute toward accomplishment of the goals of Executive Order 12003 and assure reliable energy engineering support for naval shore activities. A parallel effort in this program is engineering assistance provided to the shore activities that are converting from natural gas and fuel oil to coal and nonfossil energy sources such as solar energy, refuse-derived fuel, and geothermal energy.

Industrial activities consume more than 22 percent of shore energy. Naval shipyards, Naval Air Rework Facilities (NARFs), and GOCO facilities dominate the list of major utility users in the Navy. Energy resource management efforts in the private industrial sector indicate that utility savings of 20 to 50 percent may be realized through such practices as improved work scheduling; basic conservation efforts; modifications to HVAC systems; and improved industrial processes.

The following elements make up the new initiatives in the EEP:

- Cogeneration/Total Energy Analysis—Implement a program and conduct total/selective energy studies for 11 plants to produce heat and electric energy in accordance with load profiles.
- Industrial Energy Surveys—Identify opportunities to reduce significantly energy consumption at Navy industrial activities.
- Energy Monitoring and Control Systems (EMCS)—Develop and apply methodology to determine and acquire optimum EMCS for each shore activity.
- Industrial/Boiler Water Treatment—Improved control procedures to minimize thermal loss from 3,500 Navy boilers and improve life expectancy for 200 central air conditioning plants.
- Air Conditioning Tune-up—Develop and implement an air conditioning tune-up program (ACT-UP) to improve the operation and maintenance of 175 major air conditioning plants with capacities over 75 tons. These plants are among the largest users of electrical energy at Navy facilities. This effort will include hands-on inspection, project development and operator training.
- Heating and Cooling Operator and Mechanic Training—Provide system-specific training for all operators and mechanics. Programs will be developed to train all new personnel as well as retraining existing personnel in the latest techniques. RDT&E support to determine type, location, and extent of training is required to implement this program.
- Energy Efficiency Indices—Improve and extend energy efficiency indices currently under development by public works centers and shipyards to other facilities. The management capability to monitor effectively and control indices, and direct energy conservation actions will be provided as required.
- Energy Distribution System Improvements—Provide the required mechanical utility distribution system expertise to survey and provide a complete picture of utility distribution systems throughout the Navy. Selected systems will be upgraded by installing controls and engineering condensate return systems where feasible.
- Alternative Energy Sources—Apply developing techniques and methodology to existing and new facilities to conserve and utilize energy resources in the most efficient manner. Such nonfossil applications as solar, wind, geothermal, refuse-derived fuels, waste heat reclamation, etc., are included.
- Combustion Efficiency—Develop and implement a program to improve the thermal efficiency of Navy central steam and/or electric plants by upgrading equipment and controls, correcting operational and maintenance deficiencies, and providing enhanced personnel training.
- Energy Technology Application Programs—Initiate a centrally-managed program funded by O&M,N for identifying, validating and funding rapid payback energy conservation projects.

### Boiler Tune-Up Program

The Navy initiated the boiler tune-up program to improve the operation of 4,600 shore boiler plants, assure compliance with air-emission regulatory standards, and increase combustion and thermal efficiency to the greatest degree possible. This program includes all stationary shore boilers with capacities of over 5 million Btu per hour. Over \$7 million worth of boiler deficiencies have been identified which, if corrected, could save an estimated 10 million gallons of No. 2 fuel oil.

The tune-up program for correcting plant deficiencies includes two distinct phases. The first phase is to establish and attain a level of boiler performance that is consistent with clean, efficient operation. To establish this baseline, NAVFAC EFDs will conduct a series of inspections and tests on each unit. This work will culminate in the calibration of automatic combustion controls to maintain combustion at the most efficient air-to-fuel ratios over the entire load range. The appropriate EFD has the additional responsibility of summarizing for the activity the necessary maintenance deficiencies and resource requirements so that funds can be made available for repair or improvement projects resulting from the inspections. The second phase of work involves source emissions testing (stack gas analysis), the results of which will be used in determining requirements for pollution abatement equipment.

An additional benefit of these boiler improvements is the on-the-job training and experience that the facilities plant personnel will receive as they work on a day-to-day basis with manufacturers' representatives, architects and engineering contractors, and field division engineers and technicians. This will improve substantially the reliability of utility systems and should ensure that the conservation benefits obtained at the time of equipment adjustment are maintained.

### Navy Housing

Navy family housing uses about 10 percent of all utilities consumed by the entire Navy's shore facilities. However, these utilities' costs account for about 35 percent of the total family housing O&M,N budget.

	Total Cost (millions) <u>FY 1977</u>	Cost/Unit Year <u>FY 1977</u>	Number of Units <u>FY 1977</u>
Navy	\$50.9	\$693	73,449
Marine	12.4	601	20,570
Total	\$63.3	\$673	94,019

FY 1977 utility costs for the Navy's housing were about 20 percent higher than FY 1975 costs.



The Navy's housing utility costs (in millions of dollars) for FY 1975-1977 were:

	<u>FY 1975</u>	<u>FY 1976</u>	<u>FY 1977</u>
Electricity	66.1	67.4	65.4
Gas	13.7	14.2	15.7
Fuel oil	9.9	7.4	7.8
Other	10.3	11.0	11.1

FY 1977 data indicate an increase in utility costs for natural gas and other (steam, propane, and the like) with electricity showing a decrease. The increases are due to a higher rate of cost increase for natural gas and other category energy sources relative to electricity. Natural gas consumption during this period decreased nearly 18 percent.

The Navy goal for housing conservation, in accordance with Executive Order 12003, is to achieve a minimum 20-percent reduction in utilities consumption by FY 1985 when compared to the 1975 baseline year. However, the Navy will not impose on its housing occupants more stringent or restrictive energy conservation measures than those imposed by the private community. It is NAVFAC's responsibility to implement and monitor the housing energy conservation programs.

Navy housing conservation programs are divided into three general categories: personnel, technical, and management.

Personnel programs are public affairs and education programs that encourage housing occupants to participate in conservation programs. Some of these programs are:

- Publication of the Navy's "Family Housing Energy Conservation Handbook" by NAVFAC in March 1974. This handbook identifies the role of the Commanding Officer, Public Works Officer, Energy/Utilities Conservation Officer, Housing Manager, and occupant in the energy conservation program and includes a pamphlet, given to tenants, that contains energy-saving information and reminders.
- Distribution of the FEA pamphlet, "Tips for Energy Savers," to all housing occupants.
- Implementation of an annual Navy Energy Awareness Week in FY 1978.
- Stress on energy conservation in all NAVFAC activity and housing publications.

The technical programs focus on:

- Installing storm windows, storm doors, solar screens, and temperature setback thermostats, and replacing incandescent lighting with fluorescent fixtures.
- Installing water and energy-saving shower heads. NAVFAC anticipates a 65-percent reduction in water, energy and sewerage costs that is expected to result in payback of procurement and installation costs in 3 to 4 months.
- Demonstrating solar energy use in family housing hot water, heating, and cooling systems.

The management program uses utility conservation teams to make comprehensive energy conservation surveys of activities. These teams look for routine repairs and other items that contribute to energy conservation. The recommendations may include repairing steam and other leaks, adjusting boilers, closing off unused areas, and installing thermostatically controlled dampers in individual rooms.

#### Navy Housing Utility Metering Program

As a result of a General Accounting Office (GAO) report, which estimated energy consumption in military housing at 30 to 50 percent higher than civilian housing, Congress, in the 1978 MILCON Authorization Act, authorized \$70 million to install meters in existing units in FY 1978 and beyond. Following a test program, the Secretary of Defense is directed to establish reasonable energy norms for energy consumption in military housing and to assess the occupant for excess usage. This applies to all units in the 50 states, D.C., Puerto Rico and Guam.

Congress specified five guidelines for the test as follows:

1. Cost for purchasing the meters and conducting a test is limited to \$8.5 million.
2. At least 10,000 units that provide a cross section of the various climatic zones must be sampled.
3. The test should include some units with and without storm windows, insulation, and other energy-saving devices.
4. Occupants should receive a bill for excess consumption (which they do not have to pay) during the test.
5. Congress must be kept informed with scheduled progress reports.

The objectives of the test program are limited to testing the feasibility of installing meters, developing valid energy norms and creating an automated system to issue bills for energy consumed above the norm.

The 10 activities selected by OSD for test are shown below:

<u>Zone</u>	<u>Location</u>	<u>Units</u>	<u>Service</u>
Cold	Great Lakes, Illinois	2,076	Navy
Moderate (without air conditioning)	Port Hueneme, California	215	Navy
	Point Mugu, California	883	Navy
Moderate (with air con- ditioning)	Quantico, Virginia	1,167	Marine Corps
	Fort Eustis, Virginia	1,325	Army
Hot Humid	Fort Gordon, Georgia	883	Army
	Beaufort, South Carolina	1,276	Marine Corps
	Little Rock, Arkansas	1,535	Air Force
Hot Dry	Cannon, New Mexico	1,012	Air Force
	Yuma, Arizona	290	Army
Total Units		10,662	

OSD has established the following milestones for the metering program. Not later than 30 June 1978, meters for electricity, gas, oil, propane, steam, and hot-water heat should be installed in each military-owned housing unit. Norms must be established and a data collection phase will begin on 1 October 1978 and will continue for one year. There will be three months to analyze the test data and the results must be submitted to Congress by January 1980.

The Navy's initial tasking included development of an automated system which would produce bills and then provide the system specifications to the other Services so that they could write the program to fit their hardware. The Navy's responsibility has now increased into developing and installing a Service-wide integrated billing system.

#### Planning, Engineering and Designing New Facilities

The objective of this program is to integrate energy policy, standards, and goals into the master planning, engineering, and design activities of NAVFAC and its EFDs. The plans and specifications for military construction for Navy, Marine Corps, OSD, Air Force, and other agencies are prepared according to NAVFAC's standards and criteria. All energy features of each major project are thoroughly analyzed, including a computer simulation of various system alternatives. Design engineers incorporate energy-saving features in major new construction and rehabilitation projects. The total construction effort is between \$600 million and \$800 million annually, depending on congressional authorization and appropriation.

Energy conservation has been included as a requirement in NAVFAC's master planning function. All new plans, and revisions of existing master plans, must contain a separate analysis of energy planning considerations.

As a basis for evaluating and weighing life-cycle cost analyses of all facilities projects, planning factors that consider projected energy costs are continually assessed. An ongoing effort will determine and validate near-term and long-term energy and energy-related costs. The most recent study of this subject was completed early in 1976. Energy and commercial utility situations will be further assessed as they develop.

Specific and representative energy-related criteria in facilities planning design and engineering which have been issued include:

- "Technical Guidelines for Energy Conservation."
- "Selection, Application, and Cost Analysis of Control Building Automation Systems."
- "Criteria for More Economic and Better Insulated Underground Heat Distribution Systems."
- "Energy Conservation in New and Rehabilitated Buildings by Computer Simulation of Building Energy Consuming Systems."
- "Energy Conservation Lighting Criteria."
- "Mechanical Guide Specifications and Referenced Equipment Specifications for Better Energy Utilization."



- "Boiler Construction Criteria—Improved Design and Efficiency."
- Modernization of specifications for control steam heating plants.
- New specifications for convertible (coal-oil-gas) packaged boilers.
- Revised shore activity master plans to incorporate energy features, utilities planning, and total energy concepts.
- Revised guidelines for economic analyses of facilities projects.

In concert with these tasks, the AXCESS computer program was developed to perform energy analyses on architectural features and HVAC systems of buildings to aid in designing the most energy-efficient building at the lowest cost.

NAVFAC revised NAVFACINST 4100.5A, in accordance with OPNAVINST 5100.5A, on 10 November 1977. This instruction provides an updated and consolidated list of energy conservation measures to be considered in designing new buildings to achieve a 45 percent reduction in energy use by 1985 as compared to similar buildings designed or constructed before 1975, as specified in Executive Order 12003.

The instruction includes criteria for the following:

- Architectural—Siting, building orientation and building envelope.
- Mechanical—HVAC system design, HVAC equipment selection, controls, and plumbing.
- Electrical—Transformers, power factor, lighting, and distribution.

#### Vehicle Conservation

Navy goals regarding vehicle fuel consumption require the acquisition of more fuel-efficient vehicles and reduction of fuel consumption from 1975 levels. A program that follows NAVFAC guidelines for conservation of vehicle motor fuels has been promulgated by NAVFAC letter 1032 A/JVS of 17 April 1978. The program calls for:

- Acquisition of more energy-efficient vehicles.
- Reduction of vehicle usage to a minimum.
- Maintenance of vehicles for optimum performance.
- Operation of vehicles in a fuel-efficient manner.

Procurement of new vehicles commencing in FY 1978 will be governed by the EPA average miles-per-gallon standards included in Appendix D. In order to meet these standards the existing mix of vehicles will have to be further modified such that by FY 1981 the vehicle fleet mix will consist of 345 compact, 2,070 intermediate and 138 standard for a total of only 2,553 vehicles. This reduction in size and number of vehicles should permit the Navy to meet the required mileage standards.

#### Research and Development

The objective of the shore facilities energy conservation R&D program is to reduce the consumption and total energy cost of shore activities by evaluating and implementing new

technologies, or applying new operational practices that will reduce energy consumption. This will be achieved by eliminating energy losses and utilizing new auxiliary power generating, heating, and cooling equipment that is more efficient.

NAVFAC is responsible for energy conservation R&D at naval shore facilities. The Energy Program Office at CEL is the lead laboratory for this effort.

The Navy is building a technology base, tailored to its needs, by assimilating advances made in the national energy program and by evaluating more efficient energy utilization and generating systems. NAVFAC then applies the technology, where appropriate, to shore-based facilities. Methods for eliminating wasteful usage in Navy facilities such as the installation of storm windows and doors, insulation, and other simple retrofit modifications, are also being identified and developed.

More sophisticated methods of conserving energy at shore-based facilities are being studied. These include improved construction materials, methods, and designs; improved or advanced HVAC systems; improved lighting systems and single building control systems; energy loss detection and measurement; energy applications analyses; data compilation and assembled by CEL for on-site measurement of energy consumption is also being utilized in or advanced power cycles or energy utilization systems.

A specially constructed home called the Advanced Energy Utilization Test Bed (AEUTB), constructed at CEL, is being used to test new energy conservation and alternative energy source technologies. Studies on the detection and measurement of energy losses from buildings and pipelines by infrared and sulfur hexafluoride ( $\text{SF}_6$ ) tracer gas techniques are being conducted; instrumentation packages to detect energy losses are being procured and assembled for field survey use. CEL is continuing the application of engineering studies to provide technology transfer from CEL to NAVFAC and the EFDs. A mobile laboratory assembled by CEL for on-site measurement of energy consumption is also being utilized in the field.

To increase building thermal efficiencies, testing and evaluation are being conducted on a low-energy structure (LES) concept for new construction and retrofit applications. An LES test cell, which demonstrates the louvered atrium concept, is being constructed.

EMCS work, including effectiveness validation, study of expansion capabilities, determination of necessary evaluation criteria, study of advanced EMCS and analysis of system economics, is being pursued.

### **Synthetic Fuels**

Navy synthetic fuel strategy is directed toward ensuring the continued availability of hydrocarbon fuels. Immediate emphasis is being placed on synthetic fuels that are now becoming available as a result of national R&D programs. The Navy's approach is to ensure that the Navy is an informed customer and that the products of the national synthetic fuel program will be suitable for meeting naval requirements.

The synthetic fuel program is designed to develop a capability to utilize shale-derived fuels in existing Navy hardware by the mid-1980s. Major hardware changes are assumed to be impractical before this time period.

It is highly unlikely that any single portion of a synthetic fuels industry, once commercially developed, would be solely dedicated to the supply of a single end-use customer. Like the petroleum industry of today, the synthetic fuel industry will probably supply fuels across a broad spectrum of the consumer marketplace. It is within this marketplace that the Navy will probably obtain, as it has in the past, the fuels required to carry out its military missions.

As in the past, the Navy will adapt fuel technologies to specific military requirements in a manner which is supportive of, and which receives maximum benefit from, the national energy program. Detailed discussions have been held between the Navy and DOE officials on the planning and execution of synthetic crude acquisition, refining, and fuel-testing programs. In September 1977, an interagency agreement was signed between the Navy and DOE concerning future shale oil production, refining and end-use testing. Joint agency plans are being prepared and supporting funds have been requested. DOE will benefit from DOD testing of synthetic fuels in support of their various national demonstration programs. DOD will benefit from the experience gained in assessing the suitability of synthetic fuels for military use and will therefore be prepared to use these fuels at the time they become commercially available.

In FY 1976, production of 100,000 barrels of crude shale oil was begun. Production is expected to be complete in late FY 1978. Refining of the crude into the full slate of military fuels will begin early in FY 1979 and the fuels will be distributed to various DOD, federal, and industry groups for testing. This joint DOD, DOE, NASA 100,000 barrel program, coordinated by the Navy, is intended to extend the data base acquired by the previous joint 10,000 barrel shale oil project that was conducted in FY 1974 and FY 1975. Additionally, testing of the fuels from the current 100,000 barrel program will enable establishment of further refining and test requirements. Increments of 100,000 barrels of synthetic crude from other sources are expected to be acquired in future years. Fuels produced from these sources also will undergo characterization, performance, and compatibility testing, based upon experience gained from the current 100,000 barrel program. Under current plans, only limited full-scale testing will be done because of the limited amounts of fuel available.

The planned synthetic fuels testing program for facilities during the period FY 1978 through FY 1985 will include:

- Fuel properties analyses—Verification of chemical and physical properties and comparison with existing specifications; evaluation of effects of fuel property changes on equipment behavior.
- Safety—Evaluation of safety aspects compared with fuels in current use.
- Component development—Provides for possible minor equipment modification and redesign to ensure operability of in-service systems with synthetic fuels.
- Fuels co-mingling and additive development—Provides for evaluation of co-mingled fuels and investigation of additives to solve problems uncovered during boiler testing.



- Small-scale boiler tests—Small-scale tests to determine burner performance.
- Fuel systems component testing—Testing of compatibility and operability of fuel handling auxiliaries.
- Full-scale operational boiler tests, including pollution effects and their control.

### **Energy Self-Sufficiency/Alternative Energy Sources**

Achieving the maximum measure of energy self-sufficiency for shore installations will be accomplished by using renewable energy sources and converting to more abundant fuels, such as coal. CEL, the principal activity performing R&D in energy self-sufficiency, and the Naval Weapons Center (NWC) are responsible for developing geothermal, solar and wind energy conversion systems, waste-recovery techniques for producing energy, coal utilization technology, applications and data analysis studies and demonstrations, and a Navy energy self-sufficiency plan and demonstration. The current Navy goal is to achieve a 5 percent substitution of shore petroleum and natural gas usage with power derived from alternative energy sources by 1985. (This goal will soon be changed officially to 10 percent to conform with the DOD goal established by DEPPM No. 78-2, dated 1 March 1978.)

#### **Coal Conversion/Reconversion**

One of the obvious methods to reduce consumption of petroleum and natural gas is to burn coal in plants in which the equipment is capable of reconversion. Two major factors limiting reconversion are (1) the need to install new grates and coal handling equipment and to locate coal supplies, and (2) the necessity to meet current pollution abatement requirements. Also, most installations need extensive feasibility studies, similar to one recently completed at the Public Works Center, Great Lakes, to determine the economics of the relatively high-cost conversions and subsequent O&M costs.

#### **Geothermal Energy**

Utilization of geothermal energy potential, located at a number of Navy sites, is being investigated for space heating and power generation. For example, it is estimated that, at NWC China Lake, as much as 4,000 megawatts of electric power could be generated using geothermal steam. This would satisfy the power requirements of all Navy activities in southern California. Other sites with geothermal energy potential are located at Adak, Alaska; Oahu, Hawaii; and Keflavik, Iceland. The Navy intends to encourage development of these sites by outside contractors to provide low-cost energy.

#### **Refuse-Derived Fuel**

The Navy is also interested in implementation of new methods of using refuse-derived fuel. One promising method has been demonstrated by this country's first waterwall trash-to-steam plant located at the Norfolk Naval Base. Since 1967 this plant has been producing steam from the pier area of the Base. Surveys are now evaluating various other naval locations for either conversion to, or new construction of, refuse-derived fuel plants.

## Solar Energy Initiatives

The Navy has many thousands of family housing units now heated by natural gas, and solar heating is one method being explored for possible use in these units in the next decade or two. Valuable cost-effectiveness data are being obtained through limited solar demonstration units being constructed with DOE funding. Forty-eight housing units at three Navy locations are now ready for contract award where 60 percent of the space heating and 90 percent of the domestic hot water will be from solar energy. A project to install solar-heated hot water systems for 385 family housing units at the Naval Station, Roosevelt Roads, Puerto Rico, is now being studied.

In the nonhousing areas, solar projects are under design and evaluation for heating, cooling, and hot water for new facilities such as BEQs, dispensaries, hospitals, and dining facilities. Four separate projects have been identified for ECIP funding with payback less than 10 years. A summary of in-place and planned solar heating and cooling projects is provided in Table 6. In addition, a plan for Navy photovoltaic projects, prepared for DOE, will be completed in late 1978.

## Navy Energy Self-Sufficiency Plan/Demonstration

The Navy, with DOE support, funded an energy optimization study of the Sewell's Point naval complex located at Norfolk, Virginia. This study, conducted by Battelle Laboratories, included a detailed investigation of the total energy usage at Sewell's Point as a basis for developing a master plan. The master plan will reduce reliance on natural gas and petroleum fuels as well as identifying methods of both reducing energy consumption and utilizing renewable energy resources.

## Research and Development

In its energy self-sufficiency R&D effort, which began in FY 1973, the Navy is developing the capability to use local, renewable energy sources at both remote and domestic bases. The Navy is also developing the capability to replace liquid hydrocarbon fuels at domestic bases with more abundant fuels, such as coal. The present R&D program includes:

- A three-phase study to determine the best way to convert from oil and natural gas to coal for electric power and steam generation systems at Navy bases.
- Study of the utilization of waste materials, primarily focusing in three areas: evaluation of packaged heat-recovery incinerators, handling and burning tests of refuse-derived fuel, and, in conjunction with the Environmental Protection Agency, conversion of solid waste to gasoline.
- Siting and management support for a DOE-funded fluidized-bed boiler demonstration at Great Lakes, with construction starting early in FY 1978.
- Testing and evaluation of various solar collectors by CEL.
- Conceptual designs for a solar-electric turbine generator that appears to have economic potential. (This work is being done in conjunction with the Electric Power Research Institute and DOE.)

Table 6. NAVY SOLAR HEATING AND COOLING PROJECTS

<u>Year Initiated</u>	<u>Station</u>	<u>Type Facility</u>	<u>Application</u>
1976	Naval Station Hawthorne, NV	Single family	H-W
1976	Naval Training Station Orlando, FL	Single family	W
1977	Civil Engineering Laboratory Port Hueneme, CA	Advanced Energy Utilization Test Bed	H-C-W
1977	Naval Complex Newport, RI	Multiple family	H-W
1977	Naval Academy Annapolis, MD	Multiple family	W
1978	Naval Station San Diego, CA	Office/classroom	H-W
1978	Naval Air Station Cecil Field, FL	Office/classroom	W
1979	Naval Observatory Flagstaff, AZ	Office/classroom	H-W
1979	Naval Station Roosevelt Roads, Puerto Rico	Single/multiple	W
1979	Marine Base Pendleton, CA	Training/swimming pools	H
1979	Naval Weapons Center China Lake, CA	Office/classroom	H-C-W
1979	Naval Air Station North Island, CA	Office/classroom	H-W
1979	Naval Station San Diego, CA	Recreation/facilities	W
1979	Marine Base Camp Lejeune, NC	Barracks	W
1979	Marine Base Camp Lejeune, NC	Office/classroom	W
1979	Naval Air Station Bermuda	Barracks	W
1979	Naval Regional Medical Center Jacksonville, FL	Office/classroom	W
1979	Naval Regional Medical Center Orlando, FL	Office/classroom	C-W
1979	Naval Hospital Quantico, VA	Office/classroom	W
1979	Maintenance Activity Pearl Harbor, HI	Office/classroom	W
1980	Marine Base Camp Lejeune, NC	Barracks	W
1980	Naval Station Mayport, FL	Office/classroom	H-C-W
1980	Naval Training Station Orlando, FL	Single family	W
1981	Marine Base Lejeune, NC	Office/classroom	W

H = heating  
C = cooling  
W = hot water



- Studies on the conversion of wind energy to electricity and its potential use at various Navy installations.
- Studies to assess the potential of geothermal resources at Navy bases.

## SHIP OPERATIONS

Ship operations energy programs provide the methodology and improved technology necessary to maintain the required level of mission responsiveness and readiness levels in the face of decreasing energy supplies and rapidly increasing energy costs. In addition to enhancing energy conservation, ship programs are directed toward the use of synthetic fuels or modified fuel specifications to achieve greater fuel flexibility in fleet operations.

Since 1973 ship fuel consumption has decreased by 46 percent, primarily due to decreased OPTEMPO, while the cost of fuel for ship operation has increased by 140 percent, from \$158 million in 1973 to \$379 million in 1977.

Projected ship fuel consumption is shown in Figure 11. Without energy conservation, annual energy consumption in 1985 is projected to be 23.6 million barrels in 1985 and 25.6 million barrels in 2000. However, with conservation, it is expected that the fleet can achieve fuel savings of 4.2 million barrels in 1985 at a cost savings of \$67 million in 1977 dollars. The savings in 2000 would be even greater: 4.6 million barrels and \$73 million in 1977 dollars.

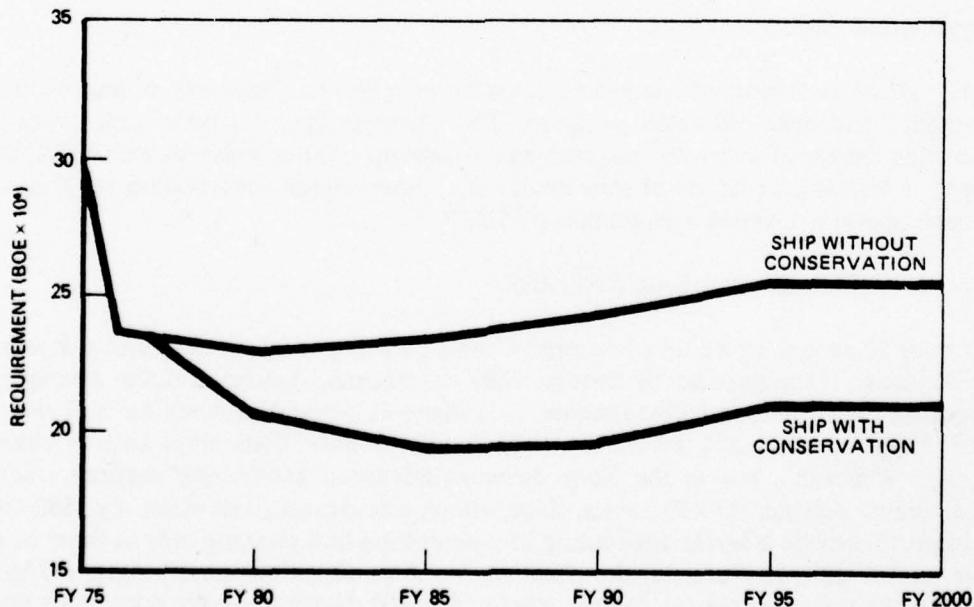


Figure 11. NAVAL SHIP ENERGY REQUIREMENTS

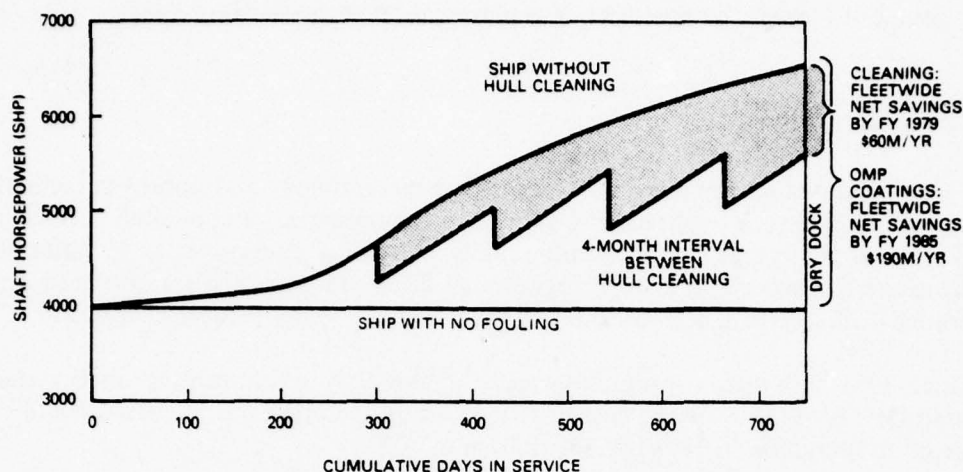


Figure 12. FUEL SAVINGS DUE TO HULL CLEANING/OMP COATINGS

### Energy Conservation

As part of its shipboard energy conservation program the Navy has an improved hull maintenance and drag reduction program. This program includes both underwater hull cleaning and the use of improved hull coatings. In addition, faced with reduced OPTEMPO, the Navy is intensifying its use of ship simulators. Other energy conservation programs are shipboard operator training and supporting R&D.

#### Improved Hull Maintenance/Drag Reduction

About 10 percent of a ship's fuel can be conserved by periodic hull cleaning to remove marine fouling. If the ship can be cleaned while waterborne, significant dollar savings over dry-docking costs result and fleet readiness is enhanced. Annual payback for hull cleaning alone is expected to be \$31 million by 1980 in 1977 dollars. Fleet ships require cleaning every 3 to 9 months, but as the Navy develops advanced antifouling coatings, such as organometallic polymer (OMP) paints, ships will require cleaning less often. By 1982 OMP paints should provide a 5-year antifouling life, permitting hull cleaning only at times of major overhaul. Figure 12 illustrates the effectiveness of a hull maintenance program. The top line shows the typical curve for fouling where after 300 days out of dry dock shaft horsepower requirements have increased by 20 percent from 4,000 to 4,800. Cyclical hull cleaning, the interim solution, results in the sawtooth curve with the related savings. The ultimate solution of no fouling would be indicated by a horizontal line.

The Navy is accelerating the underwater hull cleaning program to take advantage of the significant fuel savings expected to accrue from such action. Accordingly, the following actions have been assigned to the fleet commanders:

- Beginning in FY 1979, funding has been programmed and, if approved, will be provided in the fleet budgets for underwater hull cleaning.
- A quarterly schedule, showing the ships to be cleaned and the dates for the respective cleanings, is to be provided to NAVSEA 15 days prior to each quarter.
- Sufficient funds will be provided to NAVSEA to clean all ships scheduled for cleaning in the upcoming quarter.
- Necessary base clearances and base support will be provided to the contractor as required and contractor performance will be monitored as necessary to ensure compliance with contract specifications.

The Chief of Naval Material (CNM) has been directed to issue a master hull cleaning contract and sufficient FY 1978 funds have been identified by the fleets to allow issuance of a level-of-effort type contract. The CNM will:

- Provide, on a random basis, technical monitoring and checking of the contractual effort and effect prompt improvements to the program, as required to ensure maximum effectiveness.
- Provide instruction on hull cleaning for fleet guidance.
- Provide a draft of a proposed OPNAVINST which will specify the Naval Sea Systems Command (NAVSEA) and fleet responsibilities for the hull cleaning effort.
- Receive existing documentation and data from the fleets and contractor-generated documentation for analysis and publication of consolidated reports on accomplishments and problems.

#### Ship Simulator Program

Ship simulators have been used long before the present energy situation. They range from large cumbersome analog systems to sophisticated modern digital computer-based systems. They are designed for specific purposes such as shipboard antisubmarine warfare (ASW) and antiair warfare (AAW) training, pilot and navigation training, ASW tactical training and war gaming. Representative systems include: NEWS-WARS at Naval War College, Newport, Rhode Island; 20A61 at the Education and Training Center, Newport, Rhode Island; 14A2 ASW ship simulators at various locations; 14A6 ASW tactical trainers at Norfolk, Virginia, and San Diego, California; and TACDEW AAW trainers at Dam Neck, Virginia, and Point Loma, California.

#### Shipboard Operator Training

Conservation through operator training can be accomplished by encouraging responsible operators to avoid energy-wasting practices. To promote awareness of the impact of individual energy conservation on ship fuel consumption, a pocket manual, "Conservation of Energy Aboard Ship," was prepared, published, and distributed to the entire fleet. This



manual, which includes factual information on energy usage patterns within the fleet and stresses the importance of responsible operator action in effecting energy conservation measures, will be updated periodically.

#### Research and Development

NAVSEA has primary responsibility for shipboard energy conservation and synthetic fuels testing. A NAVSEA 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. DTNSRDC/A (Annapolis) is the primary Navy laboratory conducting the shipboard energy conservation R&D program.

#### *Exploratory Development (Future Fleet Conservation)*

This effort, directed at the future nonnuclear fleet, was initiated in FY 1975 with the analysis of machinery system options for gas turbine-powered destroyers and hydrofoil platforms representative of the future fleet. These analyses will be the basis for projections of the energy conservation potential of the available options, and will be used to extrapolate requirements for future ships and naval vessels. RDT&E efforts are being conducted for each major energy-consuming class of ships in the following areas:

- Hull/hull appendages designed to minimize energy consumption over the total operational profile.
- Propulsors for both existing and new designs of ships that may reduce power loss and increase propulsive efficiency.
- Internal propulsion systems to minimize the fuel consumption of the main propulsion system over the full range of the ship's operational profile.
- Ship's service to electric power systems to identify and develop less energy-intensive systems for the near, mid, and far terms.
- Auxiliary machinery to reduce the energy consumption of HVAC systems as well as that of shipboard pumping and lighting equipment.
- Total energy systems whereby the interaction between propulsion, electrical, and auxiliary plants are considered on a total ship basis in an effort to minimize overall fuel consumption.

#### *Underwater Hull Cleaning*

Underwater hull cleaning activities involved the evaluation of rotary-brush techniques and methods for in-situ cleaning of sonar domes and propellers. An interim fleet instruction on how to perform underwater hull cleaning has been issued, and a 2-year test program involving at-sea trials to determine the required frequency and the cost-effectiveness of underwater cleaning techniques has been initiated.

### *Improved Hull Coatings*

This project has involved synthesis of OMP paints, which were applied for a patch-panel static immersion test and shipboard evaluation. Of the 150 OMP resins that were synthesized, four have shown antifouling characteristics through 5 years of patch-panel immersion tests.

Antifouling OMP hull coatings are undergoing tests for compliance with current military specifications. Small-batch formulations are being procured for patch-panel static immersion tests and shipboard application evaluation. First-test applications on ship hulls will take place in August/September 1978.

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 for compliance with current military paint specifications and will also be evaluated for antifouling effectiveness through patch-panel static immersion tests. If acceptable, sufficient paint quantities will then be procured to conduct shipboard evaluations. As these paints are introduced to the fleet the need for the underwater hull cleaning program will be reduced.

### *Machinery Optimization*

The objective of the machinery optimization program is to reduce the fuel consumption of existing steam-powered ships by improving the operating procedures and machinery systems. Realistic energy utilization profiles will be determined for various missions, total steaming hours, the effects of degraded machinery conditions, and individual operator preferences. Based on these analyses, preliminary recommendations supported by cost information will be formulated for procedures and equipment modifications to effect energy savings. A significant result of the machinery optimization program is the conclusion that ship performance under different machinery and operational variables must be monitored continually.

### *Improved Hull and Appendage Design*

The objective of this project is to identify existing and/or verify new designs of ship appendages, hulls and propulsors that may reduce power loss or increase propulsive efficiencies. Candidate designs for naval ship hulls, appendages and propulsors are being evaluated in laboratory model tests to identify those most likely to improve efficiency. A DD-963 class model was built with the stern section modified to fit novel stern appendages. Perry-class frigates were also evaluated to define improvements that might lead to new reduced-drag levels.

### *Fuel Oil Stripping*

A new program has been initiated to determine how much usable fuel is lost because of shipboard fuel tank stripping and to recommend solutions to reclaim the fuel for shipboard use.

### *Stack Gas Analyzer/Combustion System Improvements*

Two separate initiatives involving shipboard combustion systems are included in shipboard R&D. The first is a stack gas analyzer which automatically controls boiler combustion air at peak efficiency. Competing systems have been analyzed, and laboratory investigations and shipboard trials of laboratory systems completed. Additional shipboard combustion system improvements are being designed to improve the efficiency of a ship's propulsion system by reducing the excess boiler air requirements from 15 percent to 5 percent.

### *Water Resource Management*

Water resource management studies and experiments are being conducted to improve the efficiency of freshwater production and utilization aboard ship. Techniques to reduce water consumption in galley, photo lab, laundry, and shower areas are being tested and evaluated. These tests and evaluations include laboratory and shipboard tests.

### *Performance Monitoring*

The objective of performance monitoring is to provide ship engineering officers with diagnostic information on hull and power plant condition, thereby enabling immediate rectification of the effects of system malfunction/degradation and elimination of increased fuel consumption. NAVSEA will define the causes (such as design deficiencies, operator error, necessary maintenance, or system/component degradation) of nonoptimum operations aboard ship. From these determinations, performance monitoring is expected to provide an indication of deviation from optimum system heat balance, provide a quantitative basis for timely correction, promote a means for comparing different operating modes, and determine the effects of remedial actions.

### *2000-Kilowatt Quiet Diesel Generator*

The objective is to procure, test and evaluate a quiet diesel generator suitable for installation aboard ASW combatants. Diesel engines used to drive electrical generators offer advantages in energy efficiency but noise isolation techniques are of concern. This program includes a comprehensive analysis to define in detail the various noise isolation options and their trade-offs.

### *Synthetic Fuels*

The synthetic fuels program for ship operations is designed to develop a capability to utilize fuels derived from oil shale in existing Navy ships by the mid-1980s. Major hardware changes are assumed to be impractical before this time. The background and program description are provided in the synthetic fuels section of shore operations.



The planned synthetic fuels testing program for ships for FY 1978 through FY 1985 will include:

- Fuel property analyses—Verification of chemical and physical properties, comparison with existing specifications, and evaluation of the effects of various fuel properties on equipment performance.
- Toxicology—Evaluation of the health effects of using synthetic fuels aboard ship as compared with the petroleum-derived fuels in current use.
- Engine and component development—Provides for possible minor equipment modification and re-design to ensure operability of in-service systems with synthetic fuels.
- Fuels co-mingling and additive development—Provides for evaluation of co-mingled fuels and investigation of additives to solve problems uncovered during engine testing.
- Small-scale combustor tests—Involves six different boiler burner types, four or five different diesel combustor types and three different gas turbine combustor types.
- Fuel systems component tests—Testing of compatibility and operability of fuel handling auxiliaries.
- Full-scale land-based engine tests—Involves three different systems each for boilers, diesels and gas turbines.
- Sea trials—Evaluation of synthetic fuels under at-sea conditions to determine performance handling and safety aspects of using synthetic fuels.

## **AIRCRAFT OPERATIONS**

Energy savings in aircraft operations are being achieved by decreasing flying hours, using flight simulators, improving flight planning, and improving aircraft performance and efficiency. Since 1973, aircraft fuel consumption has decreased by 17 percent, primarily due to decreased OPTEMPO, while the cost (in current dollars) of aircraft fuels has increased by 156 percent from \$158 million to \$404 million.

Projected aircraft fuel consumption is shown in Figure 13. Without energy conservation, annual energy consumption is projected to be 25.0 million barrels in FY 1985 and 31.5 million barrels in FY 2000. However, with conservation the Navy is expected to save 1.2 million barrels of fuel in 1985 at a cost savings of \$19 million in 1977 dollars, with similar savings in 2000.

### **Energy Conservation**

Lead responsibility for aircraft energy conservation and improved fuel economy has been assigned to the Department of the Air Force under DOD RDT&E guidelines. However, NAVMAT and NAVAIR have a program to use flight simulators, computerize flight planning, and undertake R&D to optimize component modifications for Navy aircraft.

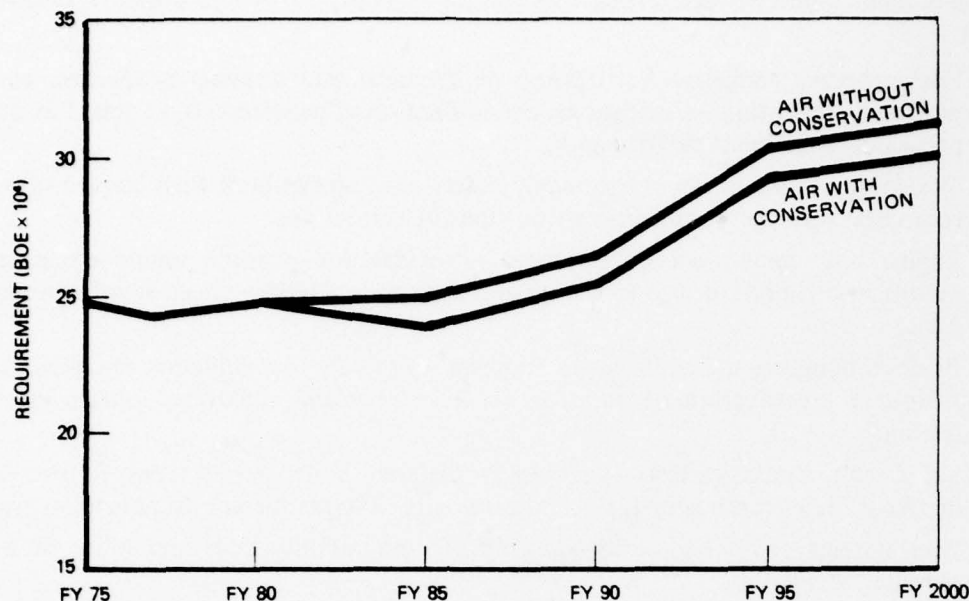


Figure 13. NAVAL AIR ENERGY REQUIREMENTS

#### Flight Simulation Program

Since 1975, the Navy has increased emphasis on training in a simulated environment in conjunction with training in operational equipment. The intent is to improve training effectiveness and maintain combat readiness while holding training costs to reasonable levels and coping with current and future problems of fuel availability. The Navy flight simulator training is DOD-directed. This program includes funding for new devices and spare parts as well as for modifications of existing equipment to keep abreast of changes in aircraft systems.

DOD program efforts to achieve a 25-percent reduction in flying hours and a concomitant savings of energy resources, with increased use of simulators by 1981, has been consistently supported by Congress and the Navy. However, presently funded simulator programs will not achieve the goal because of acquisition and support funding deficiencies, training effectiveness considerations, and manpower constraints. The Navy goal is to achieve a 9-percent substitution rate by 1985.

The Deputy Chief of Naval Operations (Air Warfare) and the Director of the Manpower and Training Division, in coordination with Marine Corps Headquarters, are responsible for all matters pertaining to the Navy's and Marine Corps' flight training devices. The Aviation Training Device Requirements Branch manages all simulator and other training

programs. That office establishes requirements for flight training equipment, approves training device plans and programs, and prepares the simulator equipment budget that is considered by Congress.

The Navy uses several types of training devices, some of which simulate a wartime environment that could otherwise be produced only through the highly expensive deployment of carriers and aircraft. These devices include weapons system trainers, night carrier landing trainers, flight instrument trainers, air-combat maneuvering simulators, and initial F-18 training devices.

The anticipated fuel savings from the Flight Simulation Program for the next 5 years are:

<u>Fiscal Year</u>	<u>POL Gallons Saved</u>
1978	75,300,000
1979	78,000,000
1980	92,500,000
1981	95,000,000
1982	96,000,000

Other benefits attributable to the use of simulators include an improved and increased training capability, a reduction in the number of aircraft accidents, extended airframe life, less use of airspace and airfields, and fewer missiles and less ammunition needed for training.

#### Computerized Flight Planning

The Navy is using a computerized flight planning service to optimize routing, altitude, airspeed, cruise management, fuel load, and payload trade-offs for point-to-point flights using current and forecast weather. Lockheed's computer flight planning and fuel management system (JetPlan) is currently being used, but a similar system will be developed within the Navy.

#### Research and Development

Aircraft energy conservation R&D is the responsibility of the Naval Air Systems Command (NAVAIR). The program activities include tasks to improve the efficiency of aircraft propulsive systems and components, and studies/analyses to investigate and identify ways to conserve fuel usage of current inventory USN/USMC aircraft. The goal of this latter program is to identify new (advanced) technology applications and/or mission operational alternatives which could save energy.

An additional task, to be initiated when funding is available, is to conduct fuel usage analyses of "advanced weapon systems concepts" and aid in the design of energy-efficient air systems as a function of both efficient aircraft design and new naval air operational concepts.



## **Synthetic Fuels**

The synthetic fuel program for aircraft operations is designed to develop a capability to utilize shale-derived fuels in existing Navy aircraft by the mid-1980s. Major aircraft hardware changes, as in the case of other Navy hardware, are assumed to be impractical before that time period. Background data and a description of the Navy synthetic fuels program are discussed in the section on shore operations.

The planned synthetic fuels testing program for aircraft from FY 1978 through FY 1985 will include:

- Fuel property analyses—Verification of chemical and physical properties, comparison with existing specifications and evaluation of effects of fuel property changes on equipment reliability.
- Engine and component development—Provides for possible minor equipment modification and re-design to ensure operability of in-service systems with synthetic fuels.
- Co-mingling of fuels and additive development—Provides for evaluation of co-mingled fuels and investigation of additives to solve problems uncovered during engine testing.
- Small-scale combustor tests—Involves three different gas turbine combustor types.
- Fuel system component tests—Testing of compatibility and operability of fuel handling auxiliaries.
- Full-scale land-based engine tests—Full-scale engine tests will be conducted on TF-34 and TF-30 engines.
- Sea trials—Evaluation of synthetic fuels in Navy aircraft under at-sea conditions, and handling and safety aspects of using synthetic fuels at sea.

## NAVY ENERGY PROGRAM ACCOMPLISHMENTS

The Navy has made substantial accomplishments in its energy program thus far. In FY 1977, the Navy realized an energy reduction of  $43 \times 10^{12}$  Btu compared with the 1975 baseline year. As shown in Figure 14, this reduction was equivalent to 7.4 million BOE, or a cost reduction of \$114 million in 1977 dollars, as shown in Figure 15. As in FY 1976, energy consumption was reduced mainly by restraining demand. Ship steaming hours in FY 1977 were 18.2 percent lower and aircraft flying hours were 6.9 percent lower than in FY 1975, resulting in energy reductions of 5.4 million BOE and 0.8 million BOE, respectively. Energy conservation efforts resulted in 16 percent of the total reduction, or 1.2 million BOE. A complete analysis of recent energy usage data and energy conservation is provided in Appendix A.

The following sections include a summary of program accomplishments in energy management, shore operations, ship operations, and aircraft operations. These accomplishments are discussed in terms of three strategies: energy conservation, synthetic fuels, and energy self-sufficiency/alternative energy sources.

### ENERGY MANAGEMENT

The Navy made significant progress in FY 1977 in Navy energy resource management. Well-defined energy program and energy R&D plans were prepared and the supporting studies and instructions completed. Documents and planning efforts included:

- Publication of U.S. Navy Energy Plan, January 1977.
- Publication of U.S. Navy Energy R&D Program Plan, FY 1978-FY 1983, October 1977.
- Distribution of the Navy Expanded Defense Energy Action Plan (approved by the Assistant Secretary of the Navy on 16 November 1977).
- Preparation of an Energy Resource Management Instruction (OPNAVINST 4100.5A).
- Preparation of a Ground Fuel Management Instruction (OPNAVINST 4020.25).
- Preparation of a Waste Oil Instruction.
- Planning for Secretary of the Navy Energy Awards.
- Planning for an annual Navy Energy Awareness Week (scheduled for October 1978).
- Preparation of a Navy Decision Coordinating Paper (NDCP) for Energy Conservation.
- Preparation of an NDCP for Synthetic Fuels.
- Preparation of an NDCP for Energy Self-Sufficiency.

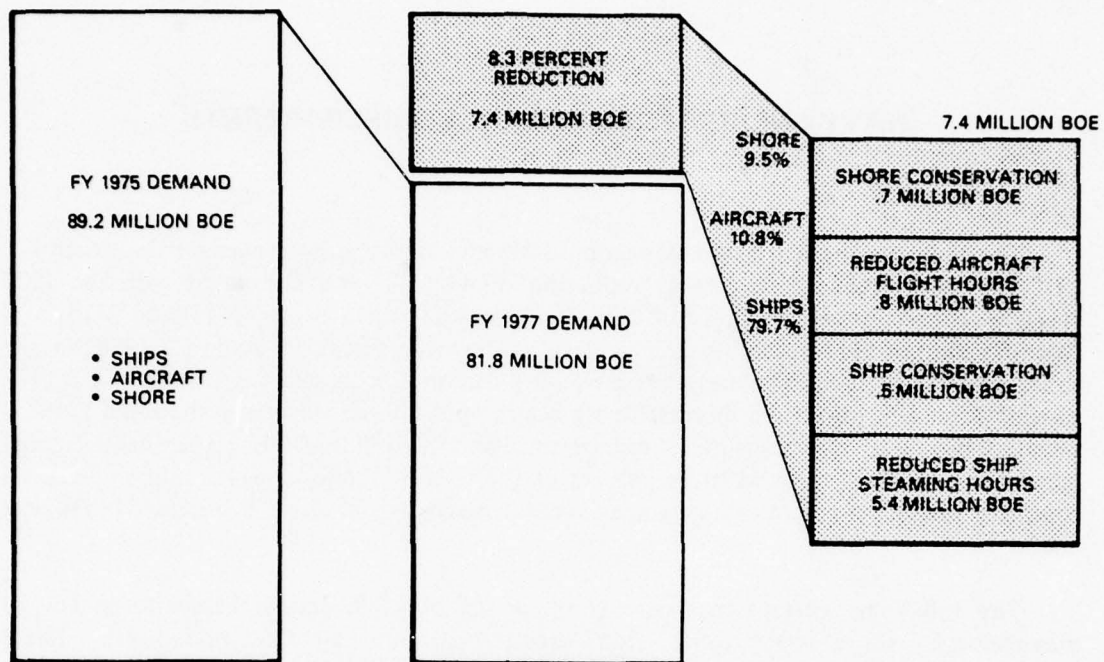


Figure 14. NAVY DIRECT CONSERVATION PROFILE, FY 1977 (BARRELS OF OIL EQUIVALENT)

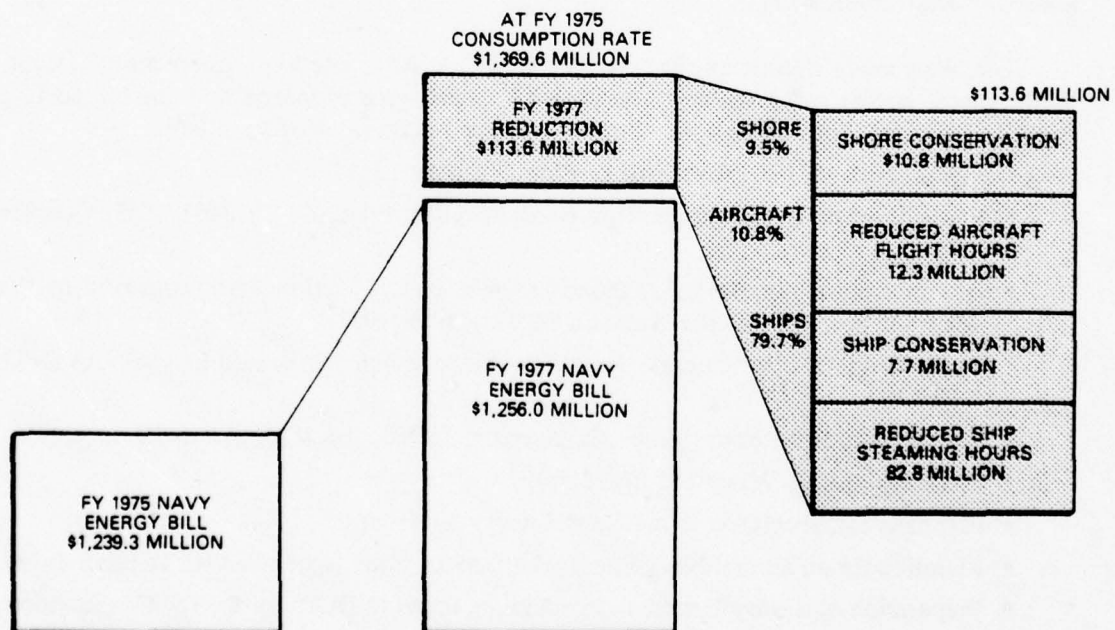


Figure 15. NAVY DIRECT ENERGY CONSERVATION PROFILE, FY 1977 (CURRENT DOLLARS)



## **Navy Energy Plan**

The Navy Energy Plan, approved by CNO on 26 January 1977, was developed by the Navy Energy Office, OP-413, in coordination with the Navy Energy Action Group (EAG). This plan set forth EAG's and OPNAV's best assessment of the implications to the Navy of the national energy problem in the short, mid, and long terms; provided the CNO with a centralized, coordinated, and explicit approach for assessing the energy situation; evaluated energy matters that affect the Navy's many interests; and provided overall Navy direction in the energy field. The plan set forth integrated energy goals, strategies, and objectives to assist program managers and fleet and shore commanders in evaluating and implementing local policies and program activities.

Nuclear energy was excluded from the plan because DOE has this responsibility, although nuclear energy is closely monitored by appropriate Navy offices.

## **Navy Energy R&D Program Plan**

The Navy published an Energy R&D Program Plan, developed by the Navy Energy and Natural Resources R&D Office, in October 1977. Volume 1 of the plan presents the overall philosophy of the energy R&D program and the status of its development, together with a summary of the individual work units. Volume 2 contains the details of the ongoing R&D program for use primarily by those who monitor the program.

The Navy Energy R&D Program Plan is the principal management tool of the Director, Navy Energy and Natural Resources R&D Office (MAT-08T3). The plan provides a well-integrated energy R&D program that has been developed with the objective of finding technological solutions to the energy and energy-related problems confronting the Navy. MAT-08T3 has undertaken energy R&D fully cognizant of DOD energy programs as well as those conducted by other government agencies.

Energy R&D strategies were developed and refined to guide the projects and tasks being performed by the SYSCOMs, laboratories, and related R&D facilities. The Navy energy R&D budget structure was revised in accordance with these strategies for more effective staff review and improved coordination.

## **Energy Information Systems**

Energy conservation and consumption is reported via DEIS-II. Each Navy activity forwards to DLA a monthly summary report that includes the amount and cost of each kind of energy consumed that month. Each activity reports the cost of electricity, fuel oil, natural gas, and coal. The information is processed by a computer, and a report distributed to the CNO and all major claimants.

PWCs and naval shipyards are now reporting energy consumption trends via the newly developed mechanized indexes (MINI-GAP) report which provides local management and major claimants with energy data in a format that compares present demand with past energy consumption.

The UCAR permits each activity to compute the unit cost of energy produced and distributed. This is essential for the accurate billing of tenant activities, and is the basic source data for management reports such as the PWC/shipyard indexes reports.

### **Energy Optimization Study**

An energy optimization study of the Sewell's Point Naval Complex at Norfolk was performed with DOE funding support. The study was conducted by Battelle Laboratories, Columbus, Ohio, under a contract administered by the Navy. The conclusions of this study, applicable to many shore installations, are:

- In the near term, conversion of the existing central plant to low-sulfur coal, as currently planned, is the most effective way to reduce residual oil consumption and cost.
- In the long term, the most cost-effective concept involves the addition of a gas-turbine, combined-cycle power plant with a back-pressure steam-turbine generator fired with low-energy gas from an on-site coal and waste wood gasification facility.
- At present and projected costs of natural gas, the lowest cost option for space heating is to continue the use of gas furnaces. (However, if the use of natural gas is continued, even for another heating season, conservation practices should be established in family housing to reduce heating loads.)
- For combined heating and cooling, heat pumps are the most energy- and cost-effective alternatives for family housing, and allow the use of coal- or residual oil-derived electric power.
- The present salvage fuel boiler plant should be upgraded to its full capacity of 100,000 pounds of steam per hour. Liquid wastes (sewage or oily wastes) should not be used because of insufficient supply.
- A public education program is vital to the success of energy conservation in both private and military transportation systems.

### **Energy Education Program**

In September 1977, a special training session on energy education was conducted by the Consortium on Environmental and Educational Sciences (CEES) at the naval facility, Rota, Spain. During a 3-day session, CEES trained 107 elementary and secondary teachers and administrators on principles of energy conservation and the use of alternative energy sources. This is the initial effort in an educational program designed to inform and motivate dependents of Navy personnel to conserve depletable natural resources.

### **SHORE OPERATIONS**

Of the three strategies in the Navy's shore operations energy program—energy conservation, use of synthetic fuels, and energy self-sufficiency/alternative energy sources—energy conservation has resulted in the most significant short-term savings. (The development of new energy sources will occur in the mid to long term.) Considerable progress has been made in all three areas, however.

## **Energy Conservation**

The energy conservation program for Navy shore facilities, under way since early 1974, has been extremely effective in that it has resulted in an energy savings of 5.1 million BOE and a cost savings of \$61.8 million. General activity surveys made by the NAVFAC EFDs have provided shore facilities personnel with guidance for immediate energy management action such as reduced thermostat settings and lowered lighting levels. More recent surveys have identified cost-effective building retrofit projects for inclusion in the ECIP, focusing on those programs with the quickest payback in energy savings and cost avoidance.

### **Energy Conservation Surveys**

Most of the MILCON energy projects so far have resulted from over 250 surveys of naval activities conducted by about 60 energy conservation engineers from the regional EFD offices in Philadelphia, Washington, Norfolk, Charleston, San Francisco, and Honolulu. The engineers, primarily of the mechanical, electrical, and industrial disciplines, are augmented by architects and other skilled personnel as necessary.

In these energy conservation surveys, the Navy has identified over 200 major energy conservation projects, with potential annual savings of \$35 million. Dividing \$35 million by the engineering manpower cost of \$1.5 million shows that, for each dollar spent for surveys, \$23 of potential annual savings were identified. The identified projects provided the basis for the Energy Conservation Investment Program.

### **Energy Conservation Investment Program**

NAVFAC responded to a 1974 energy conservation directive by CNO with a survey program to identify projects with an average time payback on investment of 4 years. These projects were implemented when Congress, in the FY 1976 military construction bill, authorized \$29.9 million for the Navy ECIP program. Congress approved \$52.5 million for additional projects in FY 1977, and an additional \$26 million for FY 1978. Annual savings presently exceed \$10 million, and by 1985 should reach \$50 million. These figures represent a cost avoidance in Navy expenditures for energy, based on estimated costs without ECIP, of about 12 percent.

Completed projects include improvements to HVAC, energy monitoring and control, electrical, and lighting systems. Building alterations, such as installation of solar screens, space consolidation, reduction of glass area, and application of white roof coatings, have also resulted in cost savings. Other ECIP projects that have resulted in significant energy savings consisted of cross connecting steam plants and providing condensate return lines; replacing outmoded controls on boilers; and recovering waste heat from boiler stacks, motors, and incinerators.

### **Boiler Tune-up Program**

The boiler tune-up program was undertaken to improve the operating efficiency of the Navy's shore power facility system, which uses energy-intensive equipment. The boiler tune-



up program has been implemented in about 65 percent of Navy plants using over 5 million Btu (some 600 boilers at 126 activities), and has resulted in an annual savings of \$2.5 million. In plants using less than 5 million Btu, 1,500 of a total of 4,000 units have been inspected and calibrated, achieving annual savings of \$480,000. This effort involves testing and tuning boilers to design standards by a combination of local, EFD, and contract personnel.

#### Organic Rankine Cycle Bottoming Systems

A joint DOE-Navy program was undertaken to conduct a 3-year demonstration of the new organic Rankine cycle bottoming technology. The prime site for this program is Naval Air Station (NAS), Bermuda.

Large diesel engines (those used by utilities to generate electrical power) have efficiencies of approximately 35 percent. Consequently, 65 percent of the energy value of diesel fuel is presently wasted in the cooling system and exhaust gases. Bottoming cycles utilize this waste heat to provide additional power and increase economy. Studies at CEL indicate that the use of a bottoming system at a large diesel-electric power facility could reduce plant fuel consumption by 10 to 15 percent. At current fuel prices, payback time on the system is about 5 years.

DOE has determined that a 500-kilowatt bottoming system is best for commercial use. One system under construction uses toluene as the working fluid and a single-stage supersonic impulse turbine as the expander. The second approach features trifluoroethanol with 3 percent water and a six-stage impulse and reaction turbine. The third design is a binary system (two radial inflow turbines and two working fluids) with a steam topper and Freon II bottomer. As the Navy's agent in the project, CEL is coordinating the selection of one of the three systems for demonstration and installation at Bermuda. The demonstration system is expected to operate for 3 years.

#### Energy Loss Detection

Instrumentation packages, developed by CEL for detecting and measuring energy losses, were delivered to the North, South, and West EFDs in March 1978. These instrumentation packages include infrared scanning systems, R-factor meters, surface and air temperature thermometers, wind meters, and SF<sub>6</sub> leak detection equipment for compressed air and steam lines. (South Division will share the instrumentation with Lant Division, and North Division will share its package with Ches Division.) A two-man CEL team spent a week at each EFD training energy conservation survey teams in the proper field use of the sophisticated equipment. NAVFAC will evaluate these systems before procuring additional units. The instrumentation package offers the potential for reduction of energy losses by detection of leaks, reduction of man-hours needed for inspection, and verification of contractor performance.

#### Vehicle Procurement

To conserve fuel and reduce operating costs, the Navy initiated a program in FY 1975 to increase the number of compact and intermediate sedans and administrative vehicles. This

has resulted in a decrease in the number of standard vehicles as well as the total number of vehicles:

	<u>Compact</u>	<u>Intermediate</u>	<u>Standard</u>	<u>Total</u>
FY 1975	110	562	3,164	3,836
FY 1976	500	506	2,846	3,852
FY 1977	459	406	2,256	3,121

Beginning in FY 1978, procurement of new vehicles will be governed by the EPA average miles-per-gallon standards.

#### Research and Development

The Navy's energy conservation R&D program has resulted in significant achievements:

- Improved construction materials, methods, and designs.
- Improved or advanced heating systems.
- Improved HVAC systems.
- Improved lighting systems and single-building control systems.
- Qualification of energy loss detection and measurement equipment.
- Energy monitoring and control systems.
- Improved or advanced power cycles or energy utilization systems.
- Determination of the effect of insulation anomalies.
- Initiation of the selection process for an organic Rankine bottoming cycle system.
- Development of a lighting maintenance program.
- Procurement of a microprocessor time clock for use in environmental control systems.
- Use of the AEUTB in experimental tests.

To increase building thermal efficiencies, the Navy has continued its work on construction materials and methods with tests of wall panels to determine thermal, structural, safety, and related characteristics. One of the significant findings of this study was that small voids in ceiling or wall insulation greatly add to heat losses. Testing and evaluation also continued on the LES concept for new construction and retrofit applications. Construction of an LES test cell to demonstrate the louvered atrium concept was started.

Potential cogeneration sites were surveyed; more than 20 CONUS Navy bases were considered applicable. On the basis of the analysis, the Jacksonville, Florida, NAS/NARF was selected as the site for a cogeneration exemplar study.

EMCS work included effectiveness validation, study of expansion capabilities, determination of necessary evaluation criteria, study of advanced EMCS, and analysis of system economics.

Studies of HVAC systems continued in several different areas and included:

- Identification of options for reducing HVAC energy consumption, including the technical feasibility, potential savings, and potential markets for alternative HVAC systems.
- Survey of 10 potential Navy sites for sea/lakewater cooling, resulting in the selection of four sites for further evaluation.
- Measurements of seawater temperature, surveys of onshore and offshore areas, and studies of biofouling in preparation for the design and installation of a prototype seawater cooling system at the Naval Security Group Activity (NSGA), Winter Harbor, Maine.

CEL continued application engineering studies to provide technology transfer from CEL to NAVFAC and the EFDs. The dissemination of energy technology information in bulk occurs in a wide variety of ways, including overview brochures, the CEL Energy Newsletter, technical data sheets, progress reports to NAVFAC, detailed handbooks, and formal CEL technical memoranda, notes, and reports.

### **Synthetic Fuels**

CEL is evaluating the physical and chemical characteristics of synthetic residuals and fuel oils and comparing their characteristics with those of conventional fuels to determine if these synthetic fuels can be used in land-based heating and power generating systems. CEL has also evaluated the technical and economic feasibility of central coal gasification plants.

#### **Synthetic Fuels Laboratory Test Program**

Synthetic heavy fuel oil has been tested in a 30-horsepower fire tube boiler as well as in open-air burners with acoustic and steam atomization nozzles. Analysis of radiation heat-flux measurements in the latter test indicates that, at a particular firing rate, the heat flux was 43 percent greater using the synthetic heavy fuel oil than it was using conventional No. 5 burner oil.

Waste jet/fresh oil blends of up to 60 percent jet fuel have been successfully fired. Blends of up to 30 percent waste ship fuel, however, were less successful, burner problems possibly being caused by bilge accumulations in the waste oil.

#### **Small-Scale Tests with Synthetic Fuels**

A 300-horsepower (20,000 pounds per hour) PWC utility boiler at the Naval Construction Battalion Center (NCBC) was fired using 15,000 gallons of synthetic heavy fuel oil refined from shale oil. The emission of nitrogen oxides was about three times higher than federal standards allow. However, 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.

Instruments for measuring stack-gas emissions were installed on a 200-horsepower boiler; multiple fuel storage, metering, and transfer systems were completed; and boiler



shakedown tests were conducted. The facility is now fully operational with approximately 10,000 gallons of residual shale oil on hand for testing.

#### **Central Coal-Gasification Plant**

A preliminary design, cost estimate, and site selection feasibility study for a central gasification plant was awarded to Bechtel Corporation, San Francisco, California. This study was completed and a final report is being prepared.

#### **Energy Self-Sufficiency/Alternative Energy Sources**

In its energy self-sufficiency effort, which began in FY 1973, the Navy is developing the capability to use local, renewable energy sources at both remote and domestic bases. The use of alternative energy sources is focused on tests and evaluation of various energy systems being developed by other federal agencies or by the Navy in conjunction with other agencies, such as DOE, EPA, and the Electric Power Research Institute (EPRI). Systems using solar, wind, waste conversion, and geothermal energy are being considered. The Navy is also developing the capability to replace liquid hydrocarbon fuels at domestic bases with more abundant fuels such as coal.

#### **Solar Energy**

The Navy's first experiment in the use of solar energy began in 1976 when three commercially available solar domestic hot water systems were installed in McCoy family housing units in Orlando, Florida. These systems have been operational since early in 1976 and are providing nearly 70 percent of the domestic hot water requirements. NAVFAC now has under construction six projects into which solar heating and cooling systems are being incorporated. These include medical and dental clinics at the Naval Air Station, Cecil Field, Florida; the naval hospital, Orlando, Florida; bachelor enlisted quarters at Camp Lejeune, North Carolina; and swimming pools used for training at Camp Pendleton, California, and the naval amphibious base, Coronado, California.

Bids have been received for the installation of solar domestic hot water systems on 385 family housing units at Roosevelt Roads, Puerto Rico, and bids have been solicited for three projects: the naval observatory, Flagstaff Arizona; the Naval Weapons Center, China Lake, California; and the Naval Air Station, North Island, California. Solar system applications now being designed include some 30 installations (excluding family housing units), which are scheduled for construction award during the next 15 months.

NAVFAC has completed the design of a 20-unit solar heating and domestic hot water project at Newport, Rhode Island. The project at Newport features a 7,000 square-foot, ground-mounted central collector array, which will provide all units with domestic hot water. It will also provide hot water for those units with existing hot water space heating systems. The solar system is designed to satisfy the annual requirements for 60 percent of the normal heating season and 100 percent of the domestic hot water requirements throughout the year. Also in the design stage at the present time are solar domestic hot water systems for 16 family units at Annapolis, Maryland, and for 12 family units in New Orleans, Louisiana.

These projects have been funded and contracts will be awarded during this fiscal year.

Other solar initiatives include completion of a study that defined the potential of solar air conditioning and completion of a design for a solar electric turbine generator.

Total costs for the Navy's current solar systems construction program (less family housing) are projected to be \$12 million. The Navy anticipates increasing emphasis on the development of solar systems and significant expansion of its application in future military construction programs.

#### Geothermal Energy

Development of geothermal resources on Navy bases has been a major part of the self-sufficiency R&D effort. NWC, China Lake, is the primary geothermal research activity. At the Coso thermal area at NWC, a production-size well has been successfully drilled to 1,478 meters, where temperatures up to 196° C have been recorded. Further temperature logging and flow tests are being conducted, and environmental issues and other factors of development are being studied as well as the technical feasibility of using geothermal fluids to generate electricity for West Coast DOD activities.

At Adak, Alaska, completion of geophysical studies resulted in the selection of several drill sites. One hole was drilled to only 322 meters because of hole squeeze problems. In a second hole, which was drilled to 628 meters, the bottom-hole temperature was 66° C, which is hot enough to provide a source for hot water heating. A contractor is studying the engineering and economics of piping geothermal heating fluids at Adak, with prospects appearing favorable.

Preliminary environmental assessments of drill sites proposed at the Naval Ammunition Depot (NAD), Lualualei, Hawaii, were completed.

A final report was issued examining the legal and institutional problems of exploring and developing geothermal resources adjacent to Navy property. Reports on the effect of geothermal development on Navy missions have also been written.

#### Refuse-Derived Fuel

In addition to the RDF plant located at Norfolk, the Navy is considering contractual arrangements with private contractors or municipalities at Philadelphia and Portsmouth. The Navy would sell its solid waste and purchase the produced steam. Construction of a \$1.3 million project will be completed in the summer of 1978 at Norfolk to test and evaluate the segregation and processing of an RDF that can be burned with coal to produce low-cost steam. Also, 50 ton-per-day refuse-to-energy plants are under construction at NS, Mayport and NAS, Jacksonville and will be completed during 1979.

#### Fluidized-Bed Boiler Demonstration

The Navy is providing siting and management support for a DOE-funded fluidized boiler demonstration at Great Lakes, with construction starting early in FY 1978.

## Research and Development

### *Solar Energy*

In its solar R&D program, the Navy is monitoring the nationwide effort in solar technology and preparing for use of commercial solar energy conversion hardware at Navy facilities. Three solar collectors were tested on CEL's test stand (with a flat-plate collector) according to the National Bureau of Standards (NBS) format. Efficiencies of 40 to 75 percent were achieved. An advanced solar system to be installed on the test stand was designed and analyzed by computer.

A preliminary plan for Navy photovoltaic projects, prepared for DOE, identifies specific sites, kilowatts required and break-even dollars versus investment. The plan will be completed in late 1978 and will be updated annually thereafter.

Solar desalination plants are operating at several naval facilities around the world. At some locations, the insolation level is high enough to permit efficient use of solar desalination systems. The Navy has been conducting technical and economic studies of such systems. An economic analysis of various solar desalination systems for supplying water at Navy bases was completed, and bench experiments with a solar still were started.

### *Advanced HVAC Systems*

Studies of heat pumps and advanced HVAC systems using local renewable resources continued. Both hardware and computer simulations were designed for analysis of solar augmented heat pumps. A report was issued on life-cycle cost analysis of solar absorption air conditioning; results indicate that these systems will be economically competitive by 1985. Contract work on thermodynamic analysis of two-stage ammonia-sodium thiocyanate absorption refrigeration systems was started.

### *Wind Energy Conversion*

The Navy identified some bases at which the wind resource is sufficient to produce electrical power at a cost that is competitive with that of conventional resources. Wind velocity and power duration curves are being developed for several other promising Navy sites. Small commercially available wind generators are being tested and modified as necessary. A 5-kilowatt system tested at Laguna Peak will be tested further at San Nicolas Island, where the plant should generate about 11,500 kilowatt-hours per year. Also, a  $\frac{2}{3}$ -kilowatt wind generator is operating well at the AEUTB site.

## SHIP OPERATIONS

NAVSEA has primary responsibility for shipboard energy conservation and synthetic fuels testing. A NAVSEA 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. NSRDC/A is the primary Navy laboratory conducting the shipboard energy conservation R&D program.



## **Energy Conservation**

### **Energy Effectiveness Analysis**

An "Energy Conservation Aboard Ship" project involved studies of baseline performance efficiency and life-cycle cost analysis of propulsion, ships' services, electrical, and major auxiliary subsystems for future ships and craft. Fully automated analysis routines for total energy systems and life-cycle cost and effectiveness studies have been developed. Trade-off studies for alternative major auxiliary systems have been conducted, and characteristics of the future fleet have been determined.

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 destroyers and hydrofoils were determined during FY 1975. During FY 1976, 90 propulsion systems and 48 ships' service electrical system alternatives were screened according to their fuel consumption characteristics over typical mission profiles. Performance, life-cycle cost, effectiveness, and developmental risk assessment of those concepts exhibiting superior fuel consumption characteristics were analyzed in detail. Based on NAVSEA's recommendation, development of a computer program to conduct life-cycle cost analyses over a realistic procurement schedule was initiated; the program will consider logistics cost impact.

Also in FY 1976, the major energy users (exclusive of propulsion and electrical generation) were identified for two baseline platforms, and a program plan to analyze the energy intensiveness of major auxiliary system options was formulated.

Destroyer lighting systems were studied, and several hardware areas for shipboard suitability studies and cost analyses were recommended. Analyses of destroyer platform hydronic pumping systems were also initiated in FY 1977, as were preliminary investigations of ship heating, cooling, and ventilating systems.

### **Shipboard Total Energy Model (STEM)**

A STEM program was written that will allow integrated energy studies of all shipboard systems and identification of optimum energy-conservation arrangements. The program was installed on DTNSRDC's CDC 6700 computer, and validating tests were conducted. A library of component data was developed as reference data for the STEM. Energy storage systems potentially compatible with shipboard requirements were studied; the results were integrated into the STEM component library.

As an outgrowth of surveys and assessment studies, several tasks were started in FY 1976 and FY 1977. The use of free-turbine engines for ships' service power applications was analyzed, for example. During FY 1977, a life-cycle cost computer model was completed and is being used to conduct detailed studies of energy-conservation electrical and propulsion options. Concepts meeting certain payback criteria and cumulative life-cycle savings have been recommended for further development.

### Underwater Hull Cleaning

Underwater hull cleaning activities involved the evaluation of rotary brush techniques and methods for in-situ cleaning of sonar domes and propellers. In tests conducted aboard a Pearl Harbor-based destroyer only 6 months out of dry dock, fuel savings of about 20 percent were recorded. This R&D program is now utilizing two East Coast-based and two West Coast-based test ships to determine the most cost-effective cleaning cycle.

### Improved Hull Coatings

To date, 150 OMP resins have been tested. After 4 years of exposure, the totally foul-free condition of one of the coatings compared with the heavily fouled adjacent areas has demonstrated that marine life not in direct contact with the OMP coating is not affected. Four of the more promising OMP resins are being formulated into paint systems for subsequent laboratory and shipboard testing in an effort to prevent biofouling of ship hulls during the period (4 to 5 years) between dry dockings for major overhaul.

Antifouling OMP hull coatings are being tested for compliance with current military specifications. Small-batch formulations are being procured for patch-panel static immersion tests and shipboard application evaluation.

Special application coatings designed for use on propellers and sonar domes are being developed by altering chemically 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 for compliance with current military paint specifications and will also be evaluated for antifouling effectiveness through patch-panel static immersion tests.

### Improved Operating Efficiency

The future fleet has been described in terms of ship type and power requirements. This provides a mechanism for scaling current baseline data to project future ship types and forms a basis for prioritization of R&D efforts.

To reduce fuel consumption by the existing fleet, improved machinery alignment and operating procedures were tested at sea on the USS Holt (FF 1074). Results indicated the fuel consumption rate could be lowered 10 to 20 percent by using the improved procedures. The test methodology and procedures are being extended to other ship classes.

### Water Resource Management

Water resource management studies and experiments were conducted to improve the efficiency of freshwater production and utilization aboard ship. Techniques to reduce water consumption in galley, photo lab, laundry, and shower areas are being tested and evaluated.

## Energy Conservation Manual

A pocket manual, "Conservation of Energy Aboard Ship," has been prepared and distributed to the fleet.

### Synthetic Fuels

As a result of the research done to date, the Navy has concluded that a significant portion of its mid-term (1985-2000) energy needs for ship operations can be supplied by synthetic hydrocarbon fuels produced from domestic resources.

#### Coal Liquids

The Navy began investigating synthetic fuels in FY 1974. The Energy Research and Development Administration (ERDA) provided the Navy with 1,238 barrels of synthetic crude from FMC's Char-Oil Energy Development (COED) pilot plant for test and evaluation under the SEACOAL project. Successful completion of preliminary tests on the distilled crude culminated in a sea-trial demonstration in the USS Johnston. Test results indicated that the characteristics of the fuel produced using the COED process are similar to those of conventional, petroleum-based fuels used in Navy boilers.

#### Oil Shale

In 1974, the Army, Navy, Air Force, Maritime Administration (MARAD), Coast Guard, NASA, and ERDA established a joint project to evaluate shale oil products. An extensive testing program culminated in the successful cruise of the steamer, Edward B. Green, sponsored by the Navy, MARAD, and the Coast Guard. Tests demonstrated the feasibility of using crude shale oil as a feedstock for marine fuels.

System compatibility and special logistics and handling needs of synthetic fuels aboard ship are being analyzed. The effectiveness of present fire-fighting agents and techniques in extinguishing synthetic fuel fires is being investigated.

Diesel fuel, marine (DFM) derived from 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 shale oil were awarded to Detroit Diesel; Allison, Pratt and Whitney; and General Electric. Results were reported in "Compilation of Oil Shale Test Results."

### Synthetic Fuels Toxicology

In synthetic fuels toxicology projects, a 12-point sampling system for monitoring the concentration of fuel vapors in shipboard compartments was developed. A semi-empirical technique, based on shipboard and laboratory measurement, is being developed to predict shipboard exposure levels of potentially toxic compounds resulting from using synthetic fuels. Evaluations of a thermal desorption unit, a portable gas chromatograph, and sorbent media for hydrocarbon vapors were initiated.



Atmospheric surveys aboard USS Hewes (FF-1078), USS Talbot (FFG-4), USS Saratoga (CV-60), and USS Elliot (DD-967) were completed, and total hydrocarbons from conventional and synthetic DFM were measured. Shipboard compartments were surveyed for suspended particulate matter, sulfur dioxide, nitrogen dioxide, and carbon monoxide. Atmospheric contaminants were within threshold values set by the Bureau of Medicine and Surgery.

## **AIRCRAFT OPERATIONS**

The Naval Air Development Center (NADC) is investigating and identifying ways to conserve energy during the operation of current inventory Navy aircraft. The goal is to identify potential technology applications, operational alternatives, or both, which could save energy. NADC and NRL are evaluating the chemical and physical suitability of synthetic and conventional fuels having broadened specifications for use in aircraft propulsion systems.

### **Energy Conservation**

Energy conservation in aircraft operations is achieved through use of simulators, computerized flight planning, and advanced technology design changes.

#### **Aircraft Simulators**

Simulators of Navy air operations include weapons systems trainers, night carrier landing trainers, flight instrument trainers, air combat maneuvering simulators, and initial F-18 training devices. In FY 1977, training devices replaced about 145,000 flying hours, thus saving about 75 million gallons of fuel and about \$29 million. From FY 1975 to FY 1985, the Navy will save about 22 million barrels of fuel and over \$400 million (in 1977 dollars).

#### **Computerized Flight Planning**

Computerized flight planning (JetPlan) was used on about 7,500 flights in FY 1976 with a fuel savings of about 33,000 barrels and a cost savings of about \$450,000. In FY 1977, the program was used for 10,500 flights with a fuel savings of about 46,000 barrels and a cost savings of about \$600,000. The Navy expanded JetPlan to include Atlantic Fleet and Reserve P-3 aircraft and Reserve and Marine C-9 aircraft. JetPlan is also being incorporated for S-3A aircraft used for antisubmarine warfare missions in which there is a potential for additional fuel savings.

## **Advanced Aircraft Technology**

Selected Navy aircraft are being studied to analyze the effects on fuel usage of potential "advanced technology" design changes in aerodynamics, airframe, propulsion, etc. These studies will be followed by an investigation of the effect of applying these proposed energy-saving modifications on selected aircraft.

Six Navy and Marine aircraft types (F-4, P-3, A-4, A-6, A-7, and F-14) that used 75 percent of the Navy's aircraft fuel during 1976 were identified. Conservation efforts will concentrate on these aircraft types. Mission/function analyses of the six aircraft types began during January 1978. The purpose is to determine the effects of payloads, tactics, mission profiles, mission planning, and training procedures on fuel usage and mission effectiveness, and identify promising fuel saving techniques and their impact on fuel usage, system costs, schedules, performance, and system effectiveness.

## **Synthetic Fuels**

The physical and chemical characteristics of synthetic and nonspecification aviation fuels are being evaluated to determine possible safety, handling, compatibility, and performance problems associated with their use.

### **Coal Liquids**

The characteristics of coal-derived fuels were found to deviate from those required in current specifications. These differences, however, did not significantly affect performance of the coal-derived fuel in a small engine test. Most of the off-specification properties could be corrected by more costly refining procedures that are not normally used when refining conventional crude into JP-5.

### **Tar Sands**

A Canadian (Athabasca) tar sands JP-5, produced from Unifined kerosene supplied by Sun Oil Company, was found to meet all the specification requirements, and its performance in small-engine and fuel-handling tests was equivalent to that of petroleum JP-5.

### **Oil Shale**

The thermal stability of a shale oil-derived JP-5 was found to be unacceptable because of the organic nitrogen compounds in the fuel. The effects of accelerated storage tests on this fuel demonstrated the need for oxidation inhibitors. However, despite the gross contamination and instability of this particular synthetic JP-5, engine performance was satisfactory. These problems can likely be corrected by more sophisticated refining techniques. High levels of nitrogen oxides were also found in the exhaust because of fuel-bound nitrogen. Most of the fuel deficiencies, such as thermal instability and the presence of gums, were corrected by postrefining techniques performed in the laboratory.

A T63 engine exhaust emission test with blends of petroleum and oil shale JP-5 fuels and a TF30 fuel system test with JP-5 refined from oil shale were completed. Test results showed that the performance of the oil shale fuel was equivalent to that of a petroleum JP-5. A post-test tear down inspection of the TF30 test equipment showed corrosion in some of the critical areas of the fuel control system. This corrosion is believed to be caused by the fuel-bound nitrogen compounds.



## NAVY ENERGY PLAN FY 1978-1985

As the energy problem becomes more acute it affects all types of naval operations. Therefore, the Navy energy plan includes a variety of resource management, operations and maintenance, research and development and construction projects. Within this section, the many energy-related activities in which the Navy is engaged are organized by functional area and strategy as shown below:

- Energy Management
- Shore Operations
  - Energy Conservation
  - Synthetic Fuels
  - Energy Self-Sufficiency
- Ship Operations
  - Energy Conservation
  - Synthetic Fuels
- Aircraft Operations
  - Energy Conservation
  - Synthetic Fuels.

Individual descriptions for each project within these functional areas and strategies include a project description, milestones, FYDP and required funding, responsible activities and estimated energy savings at both the FYDP and required funding levels. The FYDP funding level program attempts to maximize dollar and fuel savings, including substitution of more abundant or renewable fuels, within the approved POM funding level. The required funding level program projects the level of effort that, if funded, would achieve the Navy energy objectives and goals, which presently cannot be met by the approved FYDP program.

The plan has been developed based on the best information available at the time. As new technology evolves and additional engineering surveys are conducted, the plan for future years will be modified.

Tables 7 and 8 summarize the Navy energy program funding requirements at both the FYDP and required funding levels. For planning purposes requirements for FY 1985 have been estimated based on FY 1984 funding levels. The FYDP funding level of \$928 million for the period FY 1978-FY 1985 should achieve an average annual energy savings of  $47.46 \times 10^{12}$  Btu with an average payback of 5.1 years. The required funding level of \$2,011 million should achieve an annual energy savings of  $79.55 \times 10^{12}$  Btu with an average payback of 6.2 years.

Table 7. NAVY ENERGY PROGRAM — FYDP FUNDING LEVEL

Appropriation/Project	Funding Requirement (\$M)							Savings/Year, 1985 and Beyond		MBtu/\$K	Average Payback (Years)
	FY 1978	FY 1979	FY 1980	FY 1981	FY 1982	FY 1983	FY 1984	FY 1985	Total	Btu (10 <sup>12</sup> )	\$M (1977)
<b>MILCON</b>											
New buildings — 45 percent reduction	26.1	43.1	47.0	53.0	55.0	59.7	66.5	66.5	416.9	19.78	52.4
Energy conservation investment program	—	—	—	—	—	—	—	—	—	—	—
Energy engineering program	2.0	—	—	—	—	—	—	—	2.0	0.30	0.8
Temperature setback device	0.2	—	—	—	—	—	—	—	0.2	0.10	0.3
Boiler tune-up program	2.5	1.7	0.6	0.5	0.5	0.5	0.5	0.5	7.3	0.73	1.9
Navy family housing	—	—	—	—	—	—	—	—	—	—	—
Reserve facilities	1.1	0.6	0.5	0.5	0.5	0.5	0.5	0.5	4.7	0.24	0.6
Self-sufficiency/alternative energy	—	—	—	—	—	—	—	—	—	—	—
<b>OGM,N</b>											
Energy engineering program	—	7.7	10.0	10.0	10.0	10.0	10.0	10.0	67.7	2.30	6.1
Boiler tune-up program	0.8	—	—	—	—	—	—	—	0.8	0.30	0.8
Temperature setback device	2.7	—	—	—	—	—	—	—	2.7	0.40	1.1
Hull maintenance	—	11.8	12.4	13.1	9.9	7.1	7.1	3.5	64.9	9.79	25.9
Stack gas analyzer	—	—	—	—	—	—	—	—	—	—	—
<b>OPN</b>											
Hull maintenance	—	—	—	1.2	2.4	1.1	—	—	4.7	0.71	1.9
Stack gas analyzer	—	—	—	—	—	—	—	—	—	—	—
<b>RDT&amp;E</b>											
Exploratory development (62765)	5.2	5.9	6.4	6.5	6.7	6.7	6.7	6.7	50.8	a	—
Advanced development (63724)	—	—	—	—	—	—	—	—	—	—	—
Conservation (Z0623)	—	—	—	—	—	—	—	—	—	—	—
Shore	(1.0)	(1.1)	(2.2)	(2.6)	(2.6)	(2.6)	(2.6)	(2.6)	(17.3)	(0.59)	(1.5)
Ship	(1.1)	(0.9)	(2.0)	(3.2)	(3.8)	(3.5)	(3.5)	(3.5)	(21.5)	(3.54)	(9.4)
Air	—	(0.3)	(0.6)	(1.0)	(1.5)	(2.0)	(2.0)	(2.0)	(9.4)	—	—
Total	2.1	2.3	4.8	6.8	7.9	8.1	8.1	8.1	48.2	4.13	10.9
Synthetic fuels (Z0638)	3.9	4.1	8.6	15.0	16.9	16.9	16.9	16.9	99.2	b	2.9
Self-sufficiency (Z0640)	1.5	2.0	4.0	7.4	9.0	9.1	9.1	9.1	51.2	c	6.2
Engineering Development (64710)	—	—	—	—	—	—	—	—	—	—	—
Conservation (Z0371)	—	—	—	—	—	—	—	—	—	—	—
Shore	(1.4)	(2.0)	(3.0)	(3.2)	(3.5)	(3.2)	(3.2)	(3.2)	(22.7)	(0.77)	(2.0)
Ship	(1.6)	(2.0)	(3.2)	(4.9)	(5.2)	(5.1)	(5.1)	(5.1)	(32.2)	(5.16)	(13.7)
Air	—	—	—	—	—	—	—	—	—	—	—
Total	3.0	4.0	6.5	9.7	11.2	11.3	11.3	11.3	68.3	5.93	15.7
Synthetic fuels (Z0347)	—	—	1.4	2.0	2.8	3.9	3.9	3.9	17.9	b	2.9
Self-sufficiency (Z0350)	—	—	0.6	1.4	2.0	2.2	2.2	2.2	10.6	0.40	1.1
Laboratory and facilities management support (65861)	1.0	1.2	1.2	1.2	1.2	1.2	1.2	1.2	9.4	c	—
<b>Total: MILCON</b>	31.9	45.4	48.1	54.0	56.0	60.7	67.5	67.5	431.1	21.15	56.0
<b>OGM,N</b>	3.5	19.5	22.4	23.1	19.9	17.1	17.1	13.5	136.1	12.79	33.9
<b>CPN</b>	—	—	—	1.2	2.4	1.1	—	—	4.7	0.71	1.9
<b>RDT&amp;E</b>	16.7	19.5	33.5	50.0	57.7	59.4	59.4	59.4	355.9	12.81	33.9
<b>Total</b>	52.1	84.4	104.0	128.3	136.0	138.3	144.0	140.4	927.5	47.46	125.7

<sup>a</sup>Energy savings are not identifiable at the exploratory development stage.

<sup>b</sup>Substitution of synthetic fuels will not be achieved until about 1980. Also, no savings are associated with the project to identify applicability of non-MILSPEC fuels in military hardware.

<sup>c</sup>Funding is required to support management, planning and data analysis of energy programs and is not identifiable to specific energy savings.

Table 8. NAVY ENERGY PROGRAM -- REQUIRED FUNDING LEVEL

Appropriation/Project	Funding Requirement (\$M)							Savings/Year 1985 and Beyond		MBtu/\$K	Average Payback (Years)
	FY 1978	FY 1979	FY 1980	FY 1981	FY 1982	FY 1983	FY 1984	FY 1985	Total	Btu (10 <sup>11</sup> )	\$M (1977)
<b>MILCON</b>											
New buildings -- 45 percent reduction	26.1	43.1	105.0	98.5	97.9	131.9	131.9	131.9	697.1	6.29	16.7
Energy conserving investment program	—	—	47.0	53.0	55.0	59.7	66.5	66.5	416.9	19.78	52.4
Energy engineering program	2.0	—	—	10.0	54.0	69.0	64.0	48.0	245.0	9.08	24.1
Temperature setback device	0.2	—	—	—	—	—	—	—	2.0	0.30	0.8
Boiler tune-up program	2.5	1.7	0.6	0.5	0.5	—	0.5	0.5	7.3	0.10	0.3
Navy family housing	1.1	0.6	0.5	0.5	0.5	—	0.5	0.5	4.7	0.73	1.9
Reserve facilities	—	—	28.0	—	10.0	10.0	15.0	15.0	78.0	0.24	0.6
Self-sufficiency/alternative energy	—	—	—	—	—	—	—	—	—	5.51	14.8
<b>OBM,N</b>											
Energy engineering program	0.8	7.7	10.0	10.0	10.0	10.0	10.0	19.0	67.7	2.50	6.6
Boiler tune-up program	2.7	—	—	—	—	—	—	—	0.8	0.30	0.8
Temperature setback device	—	—	—	—	—	—	—	—	2.7	0.40	1.1
Hull maintenance	—	11.8	12.4	13.1	9.9	7.1	7.1	3.5	64.9	9.79	25.9
Stack gas analyzer	—	—	1.2	1.2	1.2	1.2	1.2	1.2	7.2	2.44	6.5
<b>OPN</b>											
Hull maintenance	—	—	—	1.2	2.4	1.1	—	—	4.7	0.71	1.9
Stack gas analyzer	—	1.1	1.1	1.1	1.1	1.1	1.1	1.1	7.7	2.61	6.9
<b>RDTE</b>											
Exploratory development (62785)	5.2	6.2	6.4	6.5	6.7	6.7	6.7	6.7	51.1	a	—
Advanced development (63724)	—	—	—	—	—	—	—	—	—	—	—
Conservation (Z0829)	—	—	—	—	—	—	—	—	—	—	—
Shore	(1.0)	(1.1)	(2.3)	(2.8)	(2.8)	(3.0)	(3.0)	(3.0)	(19.0)	(0.70)	(1.9)
Ship	(1.1)	(0.9)	(2.2)	(3.5)	(3.9)	(4.2)	(4.2)	(4.2)	(24.2)	(4.78)	(12.7)
Air	—	—	(0.8)	(1.3)	(2.3)	(2.6)	(2.6)	(2.6)	(12.5)	—	—
Total	2.1	2.3	5.3	7.6	9.0	9.8	9.8	9.8	56.7	5.48	14.6
Synthetic fuels (Z0838)	3.9	4.1	9.1	15.0	16.9	17.4	17.4	17.4	101.2	b	—
Self-sufficiency (Z0840)	1.5	2.0	5.5	7.4	9.0	11.1	11.1	11.1	58.7	4.15	11.0
Engineering Development (64710)	—	—	—	—	—	—	—	—	—	—	—
Conservation (Z0371)	—	—	—	—	—	—	—	—	—	—	—
Shore	(1.4)	(2.0)	(3.0)	(3.2)	(5.0)	(4.4)	(4.4)	(4.4)	(27.8)	(1.03)	(2.7)
Ship	(1.6)	(2.0)	(3.2)	(4.9)	(6.5)	(6.6)	(6.6)	(6.6)	(38.0)	(6.97)	(18.5)
Air	—	—	(0.3)	(1.6)	(5.8)	(3.9)	(3.9)	(3.9)	(19.4)	—	—
Total	3.0	4.0	6.5	9.7	17.3	14.9	14.9	14.9	85.2	8.00	21.2
Synthetic fuels (Z0347)	—	—	2.1	2.7	4.7	5.7	5.7	5.7	26.6	b	—
Self-sufficiency (Z0350)	—	—	2.7	2.5	3.0	2.6	2.6	2.6	16.0	1.14	3.0
Laboratory and facilities management support (65981)	1.0	1.2	1.2	1.2	1.2	1.2	1.2	1.2	9.4	c	—
<b>Total: MILCON</b>	31.9	45.4	181.1	162.5	217.9	271.6	278.4	262.4	1,451.2	42.03	111.4
<b>OBM,N</b>	3.5	19.5	23.6	24.3	21.1	18.3	18.3	14.7	143.3	15.43	40.9
<b>OPN</b>	—	1.1	1.1	2.3	2.2	1.1	1.1	1.1	12.4	3.32	8.8
<b>RDTE</b>	16.7	19.8	38.8	52.6	67.8	69.4	69.4	69.4	403.9	18.77	49.7
<b>Total</b>	52.1	85.8	244.6	241.7	310.3	361.5	367.2	347.6	2,010.8	79.55	210.8

\*Energy savings are not identifiable at the exploratory development stage.  
 bSubstitution of synthetic fuels will not be achieved until about 1990. Also, no savings are associated with the project to identify applicability of non-MILSPEC fuels in military hardware.  
 cFunding is required to support management, planning and data analysis of energy programs and is not identifiable to specific energy savings.



## ENERGY MANAGEMENT

Under the direction of the Navy Energy Office, the Navy will continue to develop program plans and documentation in accordance with the defense Planning, Programming and Budgeting System (PPBS). The events listed below are scheduled to be completed in FY 1978 and FY 1979.

<u>Event</u>	<u>Action</u>	<u>Planned Completion Date</u>
Publish Energy Resource Management Instruction OPNAVINST 4100.5A	OP-413	5/78
Conduct Energy Program Reviews		
Facilities	CEL	1/78
Aircraft	NAVAIR	2/78
Ships	NAVSEA	5/78
Develop Navy Decision Coordinating Papers (NDCPs)	MAT-08T3/OP-413	5/78
Revise MINI-GAP (energy production, consumption, and financial data base)	NAVCOMPT	6/78
Prepare FY 1977 Navy Energy Usage Analysis	OP-413	5/78
Publish Shore Fuel Management Instruction	NAVPETOFF/OP-413	2/78
Develop POM-80	OP-413	3/78
Publish Navy Energy Program and Plan—1978	OP-413	6/78
Update Navy Energy Briefing	OP-413	5/78
Publish Waste Oil Instruction	FAC-102	6/78
Produce Navy Energy Film	CNINFO/OP-413	8/78
Implement Navy Energy Awards Program	OP-413	9/78
Revise DOD Acquisition Instructions 5000.1 and 5000.2	MAT-08T3/OP-413/Services	9/78
Revise Navy Energy Usage Profile and Analysis System (NEUPAS) Program	DTNSRDC	9/78
Implement Navy Energy Awareness Week	OP-413	10/78
Publish Navy Energy Program and Plan—1979	OP-413	2/79

## **Management Studies and Technical Support**

### **Responsible Activity**

O&M,N: OPNAV (OP-413)  
RDT&E: NAVMAT (MAT-08T3)

### **Description**

#### **FYDP Funding Level**

Various energy studies provide support to the energy management program to develop profiles of the energy characteristics of individual Navy bases, and CEL contracts for support to obtain, analyze, and structure details of Navy shore installation climatic environments, energy uses, and consumption. Data related to the application of new power systems and conservation measures at Navy shore installations are being assembled, analyzed, and indexed.

An additional study is being conducted to review Navy policy governing central steam and electric power generation in view of current fuel costs and projected escalation. The economics of central steam and power generation will be compared with dispersed steam generation and purchased electric power.

Other energy management contract support provided to the Navy Energy and Natural Resources R&D Office includes:

- Studies and analyses in support of technical decisions; technological forecasts for long-range planning and policies; determinations of technological and operational impact of legislative and executive actions; and determination of acceleration of, or changes in, industrial technology.
- Preparation of a time-phased, integrated Navy Energy Research and Development Program Plan, incorporating consideration of technological advances already achieved, and annual Progress Reports.
- Update of the Navy Energy Fact Book.
- Preparation of monthly energy situation reports which report on accomplishments of the Navy energy R&D program.

The Navy Energy Office uses contractual support to:

- Edit and publish an annual update to the Navy Energy Plan and Program.
- Prepare guidance materials for use in conducting an annual Navy Energy Awareness Week.
- Prepare technical engineering energy conservation guideline manuals for use by energy specialists throughout the Navy.

#### **Required Funding Level**

No additional effort above that identified at the FYDP funding level.

## SHORE OPERATIONS

In response to the need to conserve energy in the operation of its shore facilities and in accordance with DOD and national guidelines the Navy has developed a comprehensive energy plan and program for shore operations. This program includes the following:

- Energy Conservation
  - Exploratory Development
  - Energy Conservation Investment Program (ECIP)
  - Navy Housing
  - Naval Reserve Facilities
  - Energy Engineering Program (EEP)
    - Cogeneration/Total Energy System
    - Industrial Energy Surveys
    - Energy Monitoring and Control System (EMCS)
    - Industrial/Boiler Water Treatment
    - Air Conditioning Tune-up
    - Heating and Cooling Operator and Mechanic Training
    - Energy Efficiency Indices
    - Energy Distribution System Improvements
    - Alternative Energy Sources
    - Combustion Efficiency
    - Energy Technology Applications Program (ETAP)
  - New Facilities
  - Boiler Tune-up Program
  - Temperature Setback Devices
  - Advanced/Engineering Development
- Synthetic Fuels
  - Synthetic Fuels for Facilities
- Energy Self-Sufficiency
  - Exploratory Development
  - Coal Conversion/Reconversion
  - Solar Energy Systems
  - Geothermal Resource Development
  - Refuse-Derived Fuel Systems
  - Energy Self-Sufficiency Plan/Demonstration



## **Energy Conservation Exploratory Development**

### **Responsible Activity**

RDT&E: NAVMAT (MAT-08T3)

### **Description**

#### **FYDP Funding Level**

A significant portion of the NAVFAC energy conservation program deals with evaluating and using more efficient energy generation and distribution systems. Exploratory development work at the Civil Engineering Laboratory supports many of the ECIP and EEP projects of this program. For example, CEL efforts to assess the technical and economic feasibility of low temperature heat recovery systems for improved fuel economy for Navy applications relates directly to energy recovery systems tasks of the ECIP.

As part of its support to the EEP, CEL plans to determine the feasibility of and survey applicable Navy sites for cogeneration facilities. Other EEP-related exploratory development efforts focus on: investigating and evaluating new coal technologies to provide recommendations on their applicability for Navy facilities; examining existing EMCS for parameters affecting future procurement and system development; evaluating and testing instrumentation and techniques for detecting leaks in various types of pipelines; and investigating electrical control, distribution, and power transmission equipment for its conservation potential and applicability for use with alternative energy sources. CEL also has developed a lighting application handbook for Navy applications and plans to evaluate instrumentation and procedures for measuring losses in electrical distribution systems.

In projects on building thermal design CEL is determining thermal, structural, safety, and related characteristics of new construction methods and materials; developing a Loads and Systems Simulation (LASS) model to provide an accurate method of evaluating building heating and cooling loads; evaluating and testing instrumentation and techniques to locate and measure energy losses from buildings; and examining characteristics and potential benefits of insulated expansive concrete sandwich construction.

#### **Required Funding Level**

No additional effort above that identified at the FYDP funding level.

## Energy Conservation Investment Program (ECIP)

### Responsible Activity

MILCON: NAVFAC (FAC-102)

### Description

#### FYDP Funding Level

ECIP provides for improvements, alterations, upgrading and repair of existing structures and utility systems to reduce unnecessary energy consumption. The program includes the following for FY 1979 and FY 1980.

Projects	FY 1979		FY 1980	
	Number of Projects	Cost (\$M)	Number of Projects	Cost (\$M)
Steam and condensate system	2	1.4	10	20.8
Boiler plant modification	4	3.6	—	—
Lighting system	7	3.2	8	1.6
HVAC systems	8	4.6	8	3.9
Energy monitoring and control systems	15	19.8	5	5.8
Insulation and storm windows	7	2.6	8	9.7
Building alterations	9	6.0	3	5.2
Energy recovery systems	2	1.9	—	—
	54	43.1	42	47.0

Projects for FY 1981 through FY 1985 will be similar in nature and proposed work to be performed is now being evaluated.

The two steam and condensate system projects for FY 1979 are to install condensate return lines and modernize and rehabilitate deteriorating lines with improved insulation and steam flow metering and controls. Additionally, cross-connect lines and looped systems will be installed to permit plant shutdown and sectionalized shutdown during low-load summer months.

The four boiler plant modification projects funded for FY 1979 will focus on improving boiler plant equipment. Some of these modifications include installing new boilers and controls, replacing silencers and exhaust systems, installing an improved boiler water treatment facility, and installing economizers to use waste heat to heat boiler feedwater.

Less efficient incandescent fixtures in many buildings will be replaced with light sources such as sodium vapor, which has about ten times the light output per watt as the comparable incandescent fixture. Use of other innovations to conserve electrical energy will include equipment such as selective controls, timers, and photoelectric cells.

Many existing heating, ventilating and air conditioning (HVAC) systems in buildings at Navy facilities were installed without the controls necessary for meeting current efficiency standards. The objective of eight projects authorized for FY 1979 is to install heating and air

conditioning systems that are more efficient and will provide the necessary environmental control with greatly reduced input energy requirements.

By installing central energy monitoring and control systems (EMCS) on mechanical and electrical systems, poor efficiency and unnecessary waste of energy can be detected readily and corrected. Work on 15 projects authorized for FY 1979 includes installing automatic temperature setback devices, electrical load shedding and peak shaving systems, lighting system timers, remote sensors on outlying plants, and equipment to avoid waste and increase system efficiency through more timely maintenance and operations response.

Seven projects were funded for FY 1979 to install storm windows and insulation to reduce heat losses that have been identified in various buildings.

To reduce overall energy consumption in specific Navy facilities, the Navy not only is practicing energy conservation but also is altering and rehabilitating buildings when necessary. Work on nine projects funded for FY 1979 will focus on installing building equipment and materials such as heating/cooling controls, weather stripping, ventilators, high-intensity lighting, and roof coatings. Efforts also will be directed toward consolidating space, reducing glass area, and installing solar screens.

Work on energy recovery systems will emphasize recovering heat or primary energy from industrial processes for reuse to satisfy additional energy requirements. Such applications will result in essentially "free" energy which otherwise would be lost. One of the two projects authorized for FY 1979 provides for installation of waste heat recovery equipment to use exhaust gases from diesel-engine, electric generating units to produce steam at Adak, Alaska; the other calls for modification of three boilers at Long Beach, California, to reclaim waste heat from flue gases.

Research and development efforts in support of the ECIP will focus on conservation in machinery, buildings and energy systems.

#### Required Funding Level

No additional effort above that identified at the FYDP funding level.

#### Annual Energy Savings (Beginning in FY 1985)

##### FYDP Funding Level

Btu $\times 10^{12}$	19.78
Barrels $\times 10^3$	3,410.00
\$ Millions (1977 dollars)	52.40
Payback (years)	5.42



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## Navy Housing

### Responsible Activity

MILCON: NAVFAC (FAC-08)

### Description

#### FYDP Funding Level

MILCON projects which are planned for Navy housing include typical ECIP projects as previously described under the ECIP program. Housing projects are evaluated and approved using the same criteria as for all other ECIP projects.

#### Required Funding Level

No additional effort above that identified at the FYDP funding level.

### Annual Energy Savings (Beginning in FY 1985)

#### FYDP Funding Level

Btu $\times 10^{12}$	.73
Barrels $\times 10^3$	125.80
\$ Millions (1977 dollars)	1.93
Payback (years)	3.76

## Naval Reserve Facilities

### Responsible Activity

MILCON: Chief of Naval Reserve

### Description

#### FYDP Funding Level

Projects which are funded for Naval Reserve Facilities include typical ECIP projects as described under the ECIP program. The projects are evaluated and approved using the same criteria as for all other ECIP projects.

#### Required Funding Level

No additional effort above that identified at the FYDP funding level.

### Annual Energy Savings (Beginning in FY 1985)

#### FYDP Funding Level

Btu $\times 10^{12}$	.24
Barrels $\times 10^3$	41.40
\$ Millions (1977 dollars)	.64
Payback (years)	5.78



## Cogeneration/Total Energy Systems

### Responsible Activity

MILCON: NAVFAC (FAC-102)  
O&M,N: NAVFAC (FAC-102)

RDT&E: NAVMAT (MAT-08T3)

### Description

#### FYDP Funding Level

The Navy will develop and apply methodology to conduct base-wide and area-wide analyses for applying cogeneration and the total energy concept. Specific R&D advanced development objectives for FY 1978 are to: identify the most probable high payback site for a feasibility study; perform a comprehensive feasibility study, up to the 30 percent design stage, that addresses all constraining variables; and develop a generic feasibility method and planning guide that considers all variables found to be critical during the pilot study.

Beginning in FY 1979 R&D will continue to support this EEP element to ensure incorporation of state-of-the-art equipment and technology. If the feasibility study and supporting R&D analysis is successful, three O&M,N supported studies will be conducted annually to determine the best applications, site selection and design studies beginning in FY 1980.

#### Required Funding Level

MILCON funding is required beginning in FY 1982 to begin construction at those sites where cogeneration systems are deemed cost-effective at a rate of two sites per year. The sites are selected through O&M,N supported studies conducted under the basic program. Additional R&D effort above the basic level in the FY 1980-85 period will investigate state-of-the-art cogeneration equipment and technology for transition to Navy systems.

### Annual Energy Savings (Beginning in FY 1985)

#### FYDP Funding Level

There are no savings at this funding level.

#### Required Funding Level

Btu $\times 10^{12}$	2.00
Barrels $\times 10^3$	344.80
\$ Millions (1977 dollars)	5.30
Payback (years)	7.15

## Industrial Energy Surveys

### Responsible Activity

MILCON: NAVFAC (FAC-102)  
O&M,N: NAVFAC (FAC-102)

OPN: NAVAIR, NAVSEA  
RDT&E: NAVMAT (MAT-08T3)

### Description

#### FYDP Funding Level

As part of the EEP, the Navy plans to reduce significantly energy consumption at Navy industrial activities. The Navy will identify opportunities for energy conservation, initiate specific high payback energy conservation projects, and develop a methodology to guide follow-on surveys. During FY 1978 comprehensive R&D funded energy conservation pilot surveys will be conducted by NAVFAC at the Philadelphia Naval Shipyard, the Norfolk Naval Air Rework Facility, and at two government-owned contractor-operated facilities (Calverton NWRP and NIROP Minneapolis) to determine industrial energy losses. If these surveys are successful and cost-effective, an additional four surveys per year at similar facilities will begin in FY 1979. Immediate quick payback modifications will be implemented as surveys are completed.

Under R&D advanced development, CEL also will conduct field tests of selected portable infrared imaging systems, heat flux meters, leak detectors, surface temperature thermometers, and ancillary items needed for field surveys. Another R&D objective is to support the operational survey activities at specific Navy sites by providing analysis of the latest states of technology for various industrial equipments.

#### Required Funding Level

Major retrofits of industrial sites as a result of these surveys would begin in FY 1981 using MILCON or procurement funds.

### Annual Energy Savings (Beginning in FY 1985)

#### FYDP Funding Level

Btu $\times 10^{12}$	.45
Barrels $\times 10^3$	77.60
\$ Millions (1977 dollars)	1.19
Payback (years)	2.94

#### Required Funding Level

Btu $\times 10^{12}$	4.28
Barrels $\times 10^3$	737.90
\$ Millions (1977 dollars)	11.34
Payback (years)	4.28

## **Energy Monitoring and Control Systems (EMCS)**

### **Responsible Activity**

MILCON: NAVFAC (FAC-102)  
O&M,N: NAVFAC (FAC-102)

RDT&E: NAVMAT (MAT-08T3)

### **Description**

#### **FYDP Funding Level**

The Navy is developing procedures for determining and applying the optimum EMCS for each Navy shore activity. Specific FY 1978 objectives are to develop guidance and retrofit existing EMCS with modern micro-processor techniques and hardware at two hospitals (R&D initiative). In FY 1978 EMCS for housing control and remote metering will also be investigated and demonstrated. Beginning in FY 1979 a PWC EMCS and metering demonstration will be conducted. Follow-on EMCS studies at hospitals, housing and PWC's will begin in FY 1979. Installation of improved EMCS systems at surveyed sites will begin in FY 1982 (funded by ECIP). In FY 1978 a technical notice on recommended use and potential economic benefits of conventional use and potential economic benefits of conventional monitoring and control systems technology will be prepared. RDT&E efforts, in addition to the above demonstration projects, focus on evaluating and demonstrating a micro-processor timeclock, determining the capabilities of a modularized approach to EMCS expansion, and determining the economic and operational potential for high-technology modifications of installed EMCS. CEL also is deriving methods for evaluating the economics of proposed EMCS.

#### **Required Funding Level**

*No additional effort above that identified at the FYDP funding level.*

#### **Annual Energy Savings (Beginning in FY 1985)**

#### **FYDP Funding Level**

Energy savings resulting from the EMCS program are reported under ECIP.



## Industrial/Boiler Water Treatment

### Responsible Activity

O&M,N: NAVFAC (FAC-102)

### Description

#### FYDP Funding Level

The program will provide improved control procedures to minimize thermal losses of 3,500 Navy boilers and to improve life expectancy for 200 central air conditioning plants. Implementing teams will visit approximately 20 percent of the Navy boilers and central air conditioning plants annually to recommend procedural changes and maintenance actions.

#### Required Funding Level

No additional effort above that identified at the FYDP funding level.

### Annual Energy Savings (Beginning in FY 1985)

#### FYDP Funding Level

Btu $\times 10^{12}$	.44
Barrels $\times 10^3$	75.80
\$ Millions (1977 dollars)	1.17
Payback (years)	1.28

## Air Conditioning Tune-up

### Responsible Activity

MILCON: NAVFAC (FAC-102)  
O&M,N: NAVFAC (FAC-102)

RDT&E: NAVMAT (MAT-08T3)

### Description

#### FYDP Funding Level

The Navy will develop and implement an Air Conditioning Tune-up Program (ACT-UP) to improve the operation and maintenance of 175 major air conditioning plants that have a capacity greater than 75 tons. Possible actions will be to replace inefficient and wasteful controls, add controls where there are none, and replace entire systems that may be inefficient. In FY 1978, the Navy will demonstrate (RDT&E engineering development) prototype tune up under the ACT-UP program at NAS Jacksonville, Florida, to detect, locate, and correct problems in Navy air conditioning systems. EFD ACT-UP teams will be formed in FY 1979 to conduct annual visits and tune up major air conditioning plants. In FY 1982, FY 1983, and FY 1984 MILCON (ECIP) will be required to provide new and more efficient air conditioning equipment to replace defective equipment identified by the ACT-UP teams.

#### Required Funding Level

No additional effort above that identified at the FYDP funding level.

### Annual Energy Savings (Beginning in FY 1985)

#### FYDP Funding Level

Btu $\times 10^{12}$	.26
Barrels $\times 10^3$	44.80
\$ Millions (1977 dollars)	.69
Payback (years)	4.78

## **Heating and Cooling Operator and Mechanic Training**

### **Responsible Activity**

O&M,N: NAVFAC (FAC-102)

### **Description**

#### **FYDP Funding Level**

To provide utilities operators and maintenance personnel with effective and efficient operations and maintenance procedures and technology, the Navy is reviewing, updating, and initiating training courses. Other efforts will include developing comprehensive support for career advancement of utilities personnel; conducting regional seminars periodically to interchange O&M techniques and update field division personnel on Navy energy management policy; providing a correspondence course for utility system operators to assist in energy conservation, especially as related to boiler plant operations; and updating and revising technical design manuals. Course development is expected to be completed in FY 1979. Full implementation of the resulting training program will be completed by FY 1983.

#### **Required Funding Level**

No additional effort above that identified at the FYDP funding level.

### **Annual Energy Savings (Beginning in FY 1985)**

#### **FYDP Funding Level**

Btu $\times 10^{12}$	.16
Barrels $\times 10^3$	27.60
\$ Millions (1977 dollars)	.42
Payback (years)	1.67



## Energy Efficiency Indices

### Responsible Activity

O&M,N: NAVFAC (FAC-102)

### Description

#### FYDP Funding Level

The Navy is identifying and developing utilities technical management indices to assist shipyards, public works centers, and other major Navy activities in improving their energy systems management. Management capability will be provided to effectively monitor indices to identify potential energy conservation actions as required.

#### Required Funding Level

No additional effort above that identified at the FYDP funding level.

### Annual Energy Savings (Beginning in FY 1985)

#### FYDP Funding Level

Btu $\times 10^{12}$	.35
Barrels $\times 10^3$	60.00
\$ Millions (1977 dollars)	.93
Payback (years)	1.61

## Energy Distribution System Improvements

### Responsible Activity

MILCON: NAVFAC (FAC-102)  
RDT&E: NAVMAT (MAT-08T3)

### Description

#### FYDP Funding Level

To improve energy and electrical power distribution both R&D and O&M,N projects are planned. Expertise will be provided to evaluate energy conservation potential, with surveys beginning in FY 1979. Utilities energy distribution systems for shore facilities will be identified in the surveys. Beyond FY 1979, R&D will continue support to the EEP to ensure continued improvements in equipment and technology.

#### Required Funding Level

The MILCON money necessary to modernize and retrofit the energy distribution systems identified by the surveys is included at this funding level.

### Annual Energy Savings (Beginning in FY 1985)

#### FYDP Funding Level

There are no savings at this funding level.

#### Required Funding Level

Btu $\times 10^{12}$	2.09
Barrels $\times 10^3$	360.00
\$ Millions (1977 dollars)	5.54
Payback (years)	6.88

## **Alternative Energy Sources**

### **Responsible Activity**

O&M,N: NAVFAC (FAC-102)

### **Description**

#### **FYDP Funding Level**

The Navy will evaluate developing technology and methodology to identify possible renewable and non-fossil energy applications to conserve Navy nonrenewable energy resources. These applications will include non-fossil resources such as solar, wind, and geothermal energy, and refuse-derived fuels. The program is more completely defined under self-sufficiency projects (coal conversion, solar, geothermal and refuse-derived fuels).

#### **Required Funding Level**

See self-sufficiency projects.



## Combustion Efficiency

### Responsible Activity

MILCON: NAVFAC (FAC-102)  
O&M,N: NAVFAC (FAC-102)

RDT&E: NAVMAT (MAT-08T3)

### Description

#### FYDP Funding Level

The Navy will develop and implement a program to improve plant efficiency at Navy central steam and/or electric plants by upgrading burner equipment air mixture controls and correcting operational and maintenance deficiencies, and training personnel. Technical knowledge will be obtained for studies to be conducted at about ten bases annually. Major retrofit actions will begin in FY 1982. R&D activities will be centered on providing assessments of available technology for specific site installations.

#### Required Funding Level

MILCON will be required beginning in FY 1982 to modernize burner and air mixture controls.

### Annual Energy Savings (Beginning in FY 1985)

#### FYDP Funding Level

Btu $\times 10^{12}$	.38
Barrels $\times 10^3$	65.50
\$ Millions (1977 dollars)	1.01
Payback (years)	5.00

#### Required Funding Level

Btu $\times 10^{12}$	2.12
Barrels $\times 10^3$	365.50
\$ Millions (1977 dollars)	5.62
Payback (years)	4.81

## Energy Technology Applications Program (ETAP)

### Responsible Activity

O&M,N: NAVFAC (FAC-102)

### Description

#### FYDP Funding Level

NAVFAC will provide a centrally managed operations and maintenance program to identify, validate, and fund rapid payback facilities retrofit projects that cannot be funded under current military construction funding limits. This program will be similar to the highly successful pollution abatement program.

#### Required Funding Level

No additional effort above that identified at the FYDP funding level.

### Annual Energy Savings (Beginning in FY 1985)

#### FYDP Funding Level

Btu $\times 10^{12}$	1.62
Barrels $\times 10^3$	280.00
\$ Millions (1977 dollars)	4.29
Payback (years)	4.83

## **New Facilities**

### **Responsible Activity**

MILCON: NAVFAC (FAC-04)  
RDT&E: NAVMAT (MAT-08T3)

### **Description**

#### **FYDP Funding Level**

No effort is presently planned under the approved FYDP funding level.

#### **Required Funding Level**

This program, designed to achieve the 45 percent reduction goal of Executive Order 12003, is requiring more energy efficient design criteria/specifications beginning in the FY 1980 MILCON program. Orientation, design, construction materials, siting, environment and other such factors will now be considered.

Design aids (computer programs) will be evaluated and used in the design process. Currently, ACCESS is used by NAVFAC for design evaluation. However, efforts will continue to support the federal effort to improve and use the Building Loads and System Thermodynamics (BLAST) simulator, employing HVAC feedback on thermal loads, improved climate situations and reference-day models for specific Navy locales, and MILCON life-cycle cost analyses.

In advanced development, CEL is determining suitable instrumentation and formulating a user's guide for conducting field surveys of energy losses. Field tests will be conducted on selected portable infrared imaging systems, heat flux meters, leak detectors, surface temperature thermometers, and ancillary items needed for field surveys. CEL will identify new requirements and develop survey methodology during joint field tests with Engineering Field Division survey teams. Other work focuses on determining optimum polyurethane roofing systems and maintenance procedures for new applications on Navy facilities.

The objective of an engineering development project at CEL is to conduct air leakage measurements in 24 instrumented Navy housing units for calculating energy cost savings obtained by three levels of insulation. Measurements will be made by the sulfur hexafluoride tracer gas dilution technique. The Naval Weapons Center (NWC) is developing low-energy structure concepts for new and retrofit construction on existing buildings to satisfy the need for reduced energy consumption and plans to demonstrate these concepts.

#### **Major milestones include:**

- September 1978—Demonstrate low-energy structure concepts for louvers and atriums.



- December 1978—Monitor contract for air flux measurements.
- August 1980—Develop methods for eliminating thermal degradation due to moisture penetration in built-up insulated roofing design.
- September 1980—Demonstrate component retrofit low-energy structure concepts.
- February 1981—Investigate commercial, industrial, and residential energy-saving shell construction concepts and recommend Navy application of such concepts as appropriate.
- Continuing—Support federal effort to improve and use the BLAST simulation, employing HVAC.

#### **Annual Energy Savings (Beginning in FY 1985)**

##### **FYDP Funding Level**

There are no savings shown at this time. However, preliminary results from ongoing computer analysis indicate that some savings will be realized without additional investment.

##### **Required Funding Level**

Btu $\times 10^{12}$	6.29
Barrels $\times 10^3$	1,080.00
\$ Millions (1977 dollars)	16.67
Payback (years)	26.16

## **Boiler Tune-up Program**

### **Responsible Activity**

MILCON: NAVFAC (FAC-102)

O&M,N: NAVFAC (FAC-102)

### **Description**

#### **FYDP Funding Level**

The objective of the Boiler Tune-up Program is to assure compliance with air emission regulatory standards and to achieve the optimum combustion and thermal efficiency. This program will be completed in late FY 1978.

#### **Annual Energy Savings (Beginning in FY 1985)**

#### **FYDP Funding Level**

Btu $\times 10^{12}$	.40
Barrels $\times 10^3$	70.00
\$ Millions (1977 dollars)	1.06
Payback (years)	.94

## Temperature Setback Devices

### Responsible Activity

MILCON: NAVFAC (FAC-102)

O&M,N: NAVFAC (FAC-102)

### Description

#### FYDP Funding Level

The objective of the Temperature Setback Devices Program is to assure the installation of an automatic control system on all natural gas heating systems. This program will be completed in late FY 1978.

#### Required Funding Level

No additional effort above that identified at the FYDP funding level.

### Annual Energy Savings (Beginning in FY 1985)

#### FYDP Funding Level

Btu $\times 10^{12}$	.70
Barrels $\times 10^3$	120.00
\$ Millions (1977 dollars)	1.86
Payback (years)	2.53



## **Synthetic Fuels for Facilities**

### **Responsible Activity**

RDT&E: NAVMAT (MAT-08T3)

### **Description**

#### **FYDP Funding Level**

Synthetic fuels are being tested in small-scale components to determine their acceptability for use in Navy shore facility boiler plants. Performance tests with small-scale components will include pollution emission measurements. Preliminary systems tests will be conducted 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 synthetic fuels fail.

Instruments for measuring stack-gas emissions were installed on a 200-horsepower boiler, and multiple fuel and boiler shakedown tests conducted. The facility is now fully operational and awaiting delivery of synthetic fuels from the 100,000 barrel program which is scheduled for early FY 1979.

Operational data will be available to allow use of broadened specification petroleum based fuels by 1984 and synthetic hydrocarbon fuels by 1990.

#### **Required Funding Level**

The fuel flexibility effort for facilities will be accelerated to provide operational data on broadened specification petroleum fuels one year earlier by 1983.

## **Energy Self-Sufficiency Exploratory Development**

### **Responsible Activity**

RDT&E: NAVMAT (MAT-08T3)

### **Description**

#### **FYDP Funding Level**

Exploratory development efforts provide support to advanced and engineering development projects. The Naval Weapons Center (NWC) has identified equipment suitable for use with geothermal power at Navy bases and surveyed Navy sites to select and prioritize for geothermal development. Work also has been directed toward evaluating the results of U.S. Geological Survey (USGS) and DOE geological/geophysical studies at the Navy's Coso Thermal Site, identifying legal/institutional problems and providing guidelines to the Navy for management of geothermal resources, characterizing geothermal operations to determine their effect on basic Navy missions, and exploring the causes and nature of corrosion at specific Navy sites.

Ongoing CEL wind energy projects deal with evaluating 5- to 10-kW capacity wind generators for supplying power for buildings and determining the feasibility of small-scale vertical-axis wind machines for converting wind energy for space heating. Other wind-related exploratory development projects focus on preparing a handbook for application of wind power generators at Navy facilities and selecting sites for installing and testing 100- to 1,500-kW wind generators.

To support solar-related advanced and engineering development projects, CEL is performing economic evaluations and comparisons of solar air conditioning systems; testing solar collector and storage methods integrated with HVAC systems; providing technical guidance for site selection and evaluation of solar systems; conducting solar-augmented heat pump studies; and conducting a seawater cooling survey. CEL also is making a preliminary assessment of the applicability of photovoltaic systems at Navy advanced bases; determining the feasibility, cost-effectiveness, and performance of solar desalination methods applied at Navy sites, and defining Navy requirements for energy storage systems integrated with use of local energy sources such as solar and wind energy.

In other exploratory development projects CEL is determining the parameters desirable in a densified RDF for direct thermal conversion to energy in small packaged units; verifying the ability to burn high concentrations of waste oils with fresh oil rather than dispose of the waste; and providing preliminary data and analysis of combined liquid and solid waste processes. NWC is developing and demonstrating technology to produce gasoline from trash and quantify yields and energy efficiencies. This project has been funded by EPA.

#### **Required Funding Level**

No additional effort above that identified at the FYDP funding level.

## **Coal Conversion/Reconversion**

### **Responsible Activity**

MILCON: NAVFAC (FAC-102)

RDT&E: NAVMAT (MAT-08T3)

### **Description**

#### **FYDP Funding Level**

Major steam and power plants that now burn natural gas or oil are to be converted to coal to provide these plants with a reliable future fuel source. Work has begun on preliminary engineering and planning for converting 15 of these oil- or natural-gas-fired facilities, which formerly were coal-fired, to coal. At most installations, extensive reliability studies, similar to the one recently completed at the Great Lakes Naval Training Center, are needed to determine the economics of the relatively high-cost conversions and subsequent O&M costs.

Major candidates for conversion are located at:

- MCB, Camp LeJeune (completed).
- NSY Charleston (completed).
- PWC, Norfolk (under construction).
- MCAS, Cherry Point (under construction).

Reliability studies will begin in FY 1979 for the additional projects.

A related DOE study is under way to build a 50,000-pound-per-hour fluidized-bed boiler at a Great Lakes Naval Training Center site to demonstrate a process for burning high-sulfur coal without using stack scrubbing equipment.

#### **Required Funding Level**

Additional RDT&E funds will identify more conversion projects. As these projects are identified, MILCON funds will be requested.

#### **Estimated Savings (Substitution)**

MCB, Camp LeJeune and NSY Charleston provide  $2.1 \times 10^{12}$  Btu per year. PWC, Norfolk and MCAS, Cherry Point will provide  $2.6 \times 10^{12}$  Btu per year.



## Solar Energy Systems

### Responsible Activity

RDT&E: NAVMAT (MAT-08T3)

### Description

#### FYDP Funding Level

NAVFAC is pursuing the preliminary design and demonstration of several advanced solar energy applications. These include demonstration of solar collectors for Navy housing, determination of the applicability of photovoltaics and solar desalination tests of a solar augmented heat pump, design of a solar air-turbine generator, and evaluation of solar related energy storage techniques.

#### *Solar Collectors for Navy Housing*

As part of a joint DOE-DOD solar retrofit project, the Navy is installing commercially available solar collectors in buildings at several bases. The collectors will be used for space heating and hot water systems in both domestic housing and services buildings such as commissaries and post exchanges. In each building, the collectors are expected to supply at least 90 percent of the energy demand for hot water, and about 60 percent of the demand for space heating with systems supplying both space heating and hot water.

Flat-plate, all-liquid type collectors are being purchased, and in some cases additional or replacement hot water storage systems will be installed. The collectors will be installed in:

- 20 units, Naval Education Training Center, Newport, Rhode Island (space heating and hot water).
- 16 units, U.S. Naval Academy, Annapolis, Maryland (hot water).
- 12 units, Naval Support Activity, New Orleans, Louisiana (hot water).
- 385 units, Naval Station, Roosevelt Roads, Puerto Rico (hot water).
- 3 units, McCoy Naval Annex, Orlando, Florida (hot water).

#### *Photovoltaics*

Projects to demonstrate the applicability of photovoltaic systems will begin in FY 1979 and FY 1981, respectively. Major milestones include the design, fabrication, and demonstration of full-scale equipment for advanced bases by July 1982. An annual plan will be prepared for this effort.

#### *Heat of Solution Air Conditioning*

CEL is conducting an engineering study and will provide a working model of a solar-powered endothermic refrigeration system for naval use.

After a complete thermodynamic analysis of such a system CEL will design and fabricate a bench model. Laboratory experiments will be performed using this model.

Review of the final report for a solar-powered endothermic refrigeration system was completed in 1977.

#### *Solar Desalination*

RDT&E projects focus on preparing a preliminary design for a full-scale solar desalination plant and testing and evaluating such a system at a Navy site. The planned program includes the following:

- June 1978—Perform laboratory experiments on bench models for solar desalination.
- February 1979—Prepare contract schedule to implement design of a full-scale desalination system.
- September 1979—Prepare preliminary design for a full-scale desalination plant.
- June 1981—Fabricate and install desalination system.
- September 1982—Test and evaluate desalination system.

Other efforts will provide analytical information and experimental data on multiple-effect solar stills for remote Navy activities.

#### *Solar Augmented Heat Pump (SAHP)*

The solar augmented heat pump project involves investigation and development of a concept that consists of a heat pump assisted by collected solar energy for heating and nighttime radiation for cooling. The object of this effort will be to determine the best arrangement and size of components in the system. Once this information has been determined, an experimental system will be built and tested to verify the results. A demonstration will follow to transfer the knowledge gained to the field activities. The planned program includes the following:

- March 1978—Design and install the experimental SAHP system in the Advanced Energy Utilization Test Bed (AEUTB) at CEL.
- September 1978—Prepare contract documentation for the demonstration of the design principles of efficient operation of air conditioning equipment at part load in new and existing applications.
- September 1979—Test possible configurations and operating modes of concepts for retrofit SAHP systems in the AEUTB. Prepare technical memorandum for distribution on FY 1978 results.

#### *Solar Air-Turbine Generator*

In advanced development, CEL plans to design, construct, and test a solar air-turbine generator for application at advanced Navy bases. This project, which will begin in FY 1978, includes the following milestones:

- September 1979—Complete acceptance and check-out tests on prototype solar-electric turbine generator unit.
- March 1981—Conduct performance tests on units at selected sites.
- September 1984—Prepare specifications for production of Navy solar-electric turbine generator systems.

### *Energy Storage Techniques*

CEL plans to demonstrate energy storage techniques and integrate storage systems with local energy sources such as solar and wind energy. Based on evaluations resulting from exploratory development work, storage systems will be selected for fabrication and installation at Navy sites where exploitation of solar and wind energy is planned. CEL is monitoring a contract for a chemical storage study and will publish the contractor's report by September 1978.

### *Wind Energy Conversion*

In advanced development, commercial wind generators (5 to 20 kW) will be tested at four Navy sites, and field demonstrations of various wind generator power conditioning systems will be conducted, e.g., a synchronous inverter for grid integration, solid state inverter for stand alone operation, and a CEL load-matching system for load sharing. These tests will provide extensive O&M cost data.

In engineering development, a 100-kW generator will be field tested for three years by integrating it with the base grid fed by a diesel generator. It is expected that tests of the 100-kW generator will provide data and experience sufficient to plan for procurement of a 1,500-kW generator based on a DOE design.

Major milestones include:

- January 1978 to September 1980—Perform field tests on  $\frac{2}{3}$ -kW and 6-kW plants at the AEUTB site.
- April 1979—Procure and install 10- and 15-kW wind generators at three sites for a 4-year evaluation.
- December 1979—Procure and install a 100- to 200-kW wind generator at San Nichols Island for a 3-year evaluation period by a contractor.

### *Required Funding Level*

DOE funding is expected to be provided for additional permanent installations in the solar heating and cooling, photovoltaic, wind energy and other areas. Funding for these additional installations is expected to start in FY 1981.

### *Annual Energy Savings (Beginning in FY 1985)*

#### *FYDP Funding Level*

Btu $\times 10^{12}$	.87
Barrels $\times 10^3$	150.00
\$ Millions (1977 dollars)	2.30
Payback (years)	21.80

#### *Required Funding Level*

Btu $\times 10^{12}$	4.00
Barrels $\times 10^3$	690.00
\$ Millions (1977 dollars)	10.60
Payback (years)	10.82



## **Geothermal Resource Development**

### **Responsible Activity**

MILCON: NAVFAC (FAC-PC-3)

RDT&E: NAVMAT (MAT-08T3)

### **Description**

#### **FYDP Funding Level**

The potential for using geothermal energy to supply electrical power and space heating to Navy facilities will be assessed at the Coso range at NWC, China Lake, California; Adak Island, Alaska; Oahu Island, Hawaii; and other promising sites selected during exploratory studies.

Geological, geophysical, and geochemical analyses will provide preliminary information on the location and size of the geothermal resources and on the potential of developing the resource for Navy purposes. Concurrent with resource analysis, economic feasibility of developing the resource will be determined. If recommended, exploratory drilling will begin, supported by environmental studies appropriate for each site. Energy conversion devices being developed in other Navy alternative energy programs are being evaluated for use with geothermal fluids. Major milestones include:

- January 1978—Evaluated results of slim hole drilling with respect to geothermal potential at Coso, China Lake.
- January 1978—Completed Adak engineering, drilling, environmental studies.
- March 1978—Monitored temperature gradients and formulated drilling plans for Adak.
- April 1978—Completed final report on the impact of geothermal development on naval missions of shore facilities.
- June 1978—Prepare an updated geothermal economic impact report for Adak.
- September 1978—Monitor and analyze corrosion processes.
- September 1978—Conduct Phase I geological and economic utilization studies at Navy geothermal site (NGS) No. 1 (Lualualei, Hawaii).
- September 1979—Conduct exploratory drilling at NGS No. 1 and conduct Phase I geological and economic utilization studies at NGS No. 2 (Lualualei, Hawaii).
- September 1980—Conduct exploratory drilling at NGS No. 2.
- Continuing—Analyze results of exploratory/production drilling at Coso, China Lake with respect to reservoir potential and Navy use.

#### **Required Funding Level**

In FY 1980 construction will begin to convert Naval Station, Keflavik to geothermal, provided agreements with Icelandic government are reached and funding obtained. If tests

are successful at Adak or Oahu construction of a geothermal plant will begin in FY 1982. Commercial development of the Coso resource at China Lake is planned in FY 1983.

**Annual Energy Savings (Beginning in FY 1985)**

**FYDP Funding Level**

There are no savings at this funding level.

**Required Funding Level**

Btu $\times 10^{12}$	3.23
Barrels $\times 10^3$	556.90
\$ Millions (1977 dollars)	8.56
Payback (years)	10.99

## **Refused-Derived Fuel (RDF) Systems**

### **Responsible Activity**

MILCON: NAVFAC (FAC-102)  
RDT&E: NAVMAT (MAT-08T3)

### **Description**

#### **FYDP Funding Level**

NAVFAC plans to demonstrate the applicability of packaged incinerator systems for Navy bases. It has operated a 360-ton-per-day water-wall trash-to-steam incinerator at the Navy base in Norfolk, Virginia, since 1967. A 160-ton-per-day steam-producing incinerator is nearing completion at the Naval Shipyard, Portsmouth, Virginia. The Navy is evaluating various other Navy locations to determine the feasibility of constructing new solid waste-fueled plants or converting existing fossil-fueled plants. Construction is planned to begin in FY 1982 on an RDF plant at NSY Philadelphia which will be contractor funded and operated.

The Navy will test and evaluate the segregation and processing of solid waste to manufacture an RDF that can be burned with coal to produce low-cost steam. In advanced development, CEL plans to verify theoretical data during FY 1979-81 by obtaining data on a 100-ton-per-day RDF system operating with a variable waste stream and producing various RDFs. This effort will be designed to ascertain the costs of producing RDF; determining the reliability of existing equipment; and gaining knowledge handling and mixing RDF with other fuels. If successful, construction of an RDF plant is scheduled for FY 1982.

The following major milestones are to be completed by the dates indicated:

- September 1978—Procure and install components of a basic demonstration prototype.
- March 1979—Perform initial tests to determine parameters for full automation.
- August 1979—Design and install components for storage and automatic loading of RDF.
- September 1980—Test and demonstrate packaged incinerator systems for comparative evaluation of various operating modes, including different RDFs.

#### **Required Funding Level**

If analysis determines the feasibility of 100-ton-per-day RDF plants for Navy facilities, and if funding is made available, construction will begin in FY 1982.



### Annual Energy Savings (Beginning in FY 1985)

#### FYDP Funding Level

Btu $\times 10^{12}$	2.75
Barrels $\times 10^3$	474.10
\$ Millions (1977 dollars)	7.29
Payback (years)	11.40

#### Required Funding Level

Btu $\times 10^{12}$	3.57
Barrels $\times 10^3$	615.50
\$ Millions (1977 dollars)	9.57
Payback (years)	10.38

## **Energy Self-Sufficiency Plan/Demonstration**

### **Responsible Activity**

RDT&E: NAVMAT (MAT-08T3)

### **Description**

#### **FYDP Funding Level**

A plan for the identification, selection, and integration of alternative energy sources and demonstration of energy self-sufficiency will be accomplished at NWC China Lake, California, in three phases. In Phase I, energy needs of the NWC will be analyzed and preliminary designs developed for the more promising options. Phase I will conclude with the preparation of a data package including costs, risks, technical difficulties, system impact and a proposed plan for development. During Phase II, an A&E contract effort will provide detailed cost data and a better evaluation of potential risks and impacts. R&D efforts will continue in those areas where technical difficulties exist. Phase III will consist of a detailed system design, procurement of hardware and construction of the required system.

Major milestones include the completion of the basic program plan and initiation of Phase II during January 1978.

#### **Required Funding Level**

Phase III efforts will be accelerated in FY 1980 and FY 1981 to develop a detailed system design, procure hardware and begin construction of a prototype system. MILCON funding will be identified as the project develops.

## SHIP OPERATIONS

As part of its ship operations energy program, the Navy is pursuing improved hull maintenance/drag reduction, shipboard machinery optimization, advanced ship components performance monitoring, water resource management and testing of light refined synthetic fuels for ships. These activities which have, in the past, been primarily funded as exploratory and advanced development R&D programs are now being implemented for fleet operations. In particular, underwater hull cleaning will be initiated on a semi-annual basis in FY 1979 and by FY 1982 a program of applying new improved hull coatings will be initiated. This program includes the following:

- Energy Conservation
  - Exploratory Development
  - Improved Hull Maintenance
  - Stack Gas Analyzer
  - Advanced Ship Components
  - Shipboard Machinery Optimization
  - Performance Monitoring
  - Water Resource Management
- Synthetic Fuels
  - Synthetic Fuels for Ships.



## **Ship Exploratory Development**

### **Responsible Activity**

RDT&E: NAVMAT (MAT-08T3)

### **Description**

#### **FYDP Funding Level**

The NAVSEA exploratory development program emphasizes the reduction of fuel consumption by the future fleet through the use of alternative propulsion and auxiliary subsystems. The David W. Taylor Naval Ship Research and Development Center (DTNSRDC) is the primary Navy laboratory for conducting the shipboard energy conservation program.

This effort consists of characterizing the future nonnuclear fleet in terms of power requirements, mission capabilities and anticipated dates of fleet implementation. Propulsion and auxiliary system alternatives will be synthesized to identify energy-related design parameters. Development problems and risks will also be identified. Where the necessary technology base is not sufficient, exploratory development programs are to be directed toward demonstrating the feasibility of pursuing hardware demonstrations. Upon realization of competing concepts, either project termination (where no advantage can be demonstrated) or graduation into advanced development is to be recommended. Where analysis results in positive recommendations for implementation of systems currently in the development cycle, the existing program is to be updated to ensure a reasonable probability of component availability relative to a projected ship's construction schedule.

Computer modeling efforts in the exploratory development program include the Shipboard Total Energy Model (STEM) which allows integrated energy studies on shipboard systems to identify optimum energy conservation arrangements. A cost analysis program is being used also which identifies payback and life-cycle savings.

#### **Required Funding Level**

No additional effort above that identified at the FYDP funding level.

## Improved Hull Maintenance

### Responsible Activity

RDT&E: DTNSRDC/A

### Description

#### FYDP Funding Level

Full application of hull cleaning techniques on a semi-annual basis to 400 ships will begin in FY 1979. In FY 1982 the use of new antifouling hull coatings will be initiated and over a 5-year period the need for semi-annual cleaning will be reduced and finally eliminated except on an exception basis. The advanced development work being performed by DTNSRDC will continue to develop improved underwater hull cleaning techniques and determination of optimum cleaning periods. This effort will also include: more advanced biofouling protection systems; improved hull sonar dome and propeller coatings; and associated laboratory analyses. The specific objective of the engineering development work is to provide for at-sea testing of improved hull maintenance technologies. Major milestones include:

- December 1977—Complete rotary brush development.
- June 1978—Complete evaluation of propeller-cleaning brush.
- July 1978—Shipboard application and evaluation of antifouling paints.
- December 1978—Instruct fleet on how to clean ships' hulls; conduct sea trials on cleaning Atlantic and Pacific Fleet ships.
- September 1979—Complete ship evaluation of antifouling paints.
- December 1979—Prepare large-batch formulations of hull coatings for testing by June 1980.
- September 1982—Begin fleet implementation of antifouling paints.

#### Required Funding Level

No additional effort above that identified at the FYDP funding level.

### Annual Energy Savings (Beginning in FY 1985)

#### FYDP Funding Level

Btu $\times 10^{12}$	18.60
Barrels $\times 10^3$	3,210.00
\$ Millions (1977 dollars)	49.29
Payback (years)	1.28

## Stack Gas Analyzer

### Responsible Activity

RDT&E: DTNSRDC/A

### Description

#### FYDP Funding Level

In engineering development, DTNSRDC is developing a fully automatic combustion control system based on the oxygen analysis principle that will maintain boiler combustion air at peak efficiency during all conditions of command. This new technique will result in approximately a 6 percent reduction in fuel consumption on major ship classes. A specification to procure two analyzer systems for use on 1,200-psi plants will be prepared—one based on in-situ analyzers, the other on extraction techniques. Major milestones include:

- June 1978—Receive combustion control system.
- November 1978—Install system on board ships.
- February 1979—Complete operations evaluation of combustion control system.
- April 1979—Complete final report, recommending the preferred system and completion of training requirements.

#### Required Funding Level

Installation of units on 36 ships (23 4-boiler and 13 2-boiler) will begin in FY 1981, provided that O&M,N and OPN funding is available.

### Annual Energy Savings (Beginning in FY 1985)

#### FYDP Funding Level

There are no savings at this funding level.

#### Required Funding Level

Btu $\times 10^{12}$	5.05
Barrels $\times 10^3$	870.00
\$ Millions (1977 dollars)	13.38
Payback (years)	.90



## **Advanced Ship Components**

### **Responsible Activity**

RDT&E: NAVMAT (MAT-08T3)

### **Description**

#### **FYDP Funding Level**

Advanced development work at DTNSRDC will provide for model tests and hardware demonstrations of machinery systems and components that have the potential to reduce fuel consumption through improved efficiency, without reducing the effectiveness and mission capability, of future nonnuclear ships and craft. The feasibility of combining the technologies developed during the exploratory development phase into technological building blocks will be demonstrated experimentally. The goal is to provide proof of the advantage to be gained through the application of new technology, as well as to define additional development necessary before proceeding to the engineering development program. Specific tasks currently under way or planned for initiation in FY 1978 deal with: propulsion-derived ship service power, reverse osmosis desalination, improved hull design, diesel noise analysis, heat-powered air conditioning, and advanced pumping systems.

Engineering development work will focus on qualifying full-scale propulsion, electrical, and auxiliary systems for present and future fleets. Major milestones include:

- January 1978—Initiate noise analysis and conceptual design of auxiliary diesel generators.
- March 1978—Initiate improved pump system development; improve ultrafiltration technique for reverse osmosis desalination; and complete alternative system assessment of heat-powered air conditioning.
- May 1978—Initiate hardware development for heat-powered air conditioning.
- September 1978—Complete improved hull design analysis; improve membranes and automatic start-up/shutdown for reverse osmosis desalination.
- December 1978—Test hull appendage model.
- September 1979—Complete propulsion test; complete high pressure brine pumps.
- December 1979—Complete system design for reverse osmosis desalination.
- August 1980—Complete technical evaluation of auxiliary diesel generators.
- May 1982—Issue recommendations for fleet implementation of auxiliary diesel generators.

#### **Required Funding Level**

Efforts will be accelerated so that all milestones will occur 6 months to 1 year earlier.

## Shipboard Machinery Optimization

### Responsible Activity

RDT&E: DTNSRDC/A  
OPN: NAVSEA

### Description

#### FYDP Funding Level

In engineering development, fuel consumption of existing steam-powered ships is to be reduced by at least 10 percent through the identification of energy-intensive machinery systems and operational procedures and the recommendation of modifications to effect major energy savings. The numerous variables associated with ship machinery, such as mission, steaming hours, and individual equipment settings and operations, will be monitored in detail under strictly controlled conditions. After detailed analysis of such variables, work will be done to improve the operating procedures of the various machinery and thus reduce fuel consumption. Also, diagnostic information on hull and power plant condition will be provided to ship operators to enable immediate rectification of the effects of system malfunction/degradation and elimination of increased fuel consumption. Major milestones include:

- December 1977—Complete sensitivity analysis and make FF 1074 recommendations.
- December 1978—Complete analysis of major auxiliaries.
- June 1979—Complete system development for shipboard machinery performance monitoring.
- December 1979—Complete analysis of major amphibious ships.
- January 1980—Make recommendations for implementing shipboard machinery performance monitoring.

#### Required Funding Level

Additional funding will support acceleration of analysis and promulgation of resulting recommendations.

#### Annual Energy Savings (Beginning in FY 1985)

##### FYDP Funding Level

Btu $\times 10^{12}$	.60
Barrels $\times 10^3$	103.00
\$ Millions (1977 dollars)	1.59
Payback (years)	2.14

##### Required Funding Level

Btu $\times 10^{12}$	2.90
Barrels $\times 10^3$	500.00
\$ Millions (1977 dollars)	7.69
Payback (years)	.49

## **Performance Monitoring**

### **Responsible Activity**

RDT&E: DTNSRDC/A

### **Description**

#### **FYDP Funding Level**

The objective of this program is to provide diagnostic information to ship engineering officers concerning hull and power plant condition, thereby enabling immediate rectification of the effects of system malfunctions/degradation and elimination of increased fuel consumption.

As a result of findings during the Machinery Optimization program, NAVSEA has identified areas of potential energy savings through continual performance monitoring.

Initially, NAVSEA will define the causes of nonoptimum operations aboard ship. These include areas such as design deficiencies, operator error, necessary maintenance, or system/component degradation.

From these determinations performance monitoring is expected to:

- Provide an indication of deviation from optimum system heat balance.
- Provide a quantitative basis for timely correction.
- Promote a means for comparing different operating modes.
- Quantify before and after effects of remedial actions.

#### **Required Funding Level**

No additional effort above that identified at the FYDP funding level.



## Water Resource Management

### Responsible Activity

RDT&E: DTNSRDC/A

### Description

#### FYDP Funding Level

In engineering development work, the DTNSRDC is identifying freshwater flow patterns aboard ship and formulating water resource management techniques to improve the efficiency of freshwater production and utilization aboard ship. Existing processes, operations, and activities consuming fresh water will be analyzed on an FF 1052 class frigate and an aircraft carrier to identify potential payoff areas. Major milestones include:

- Complete laundry rinse water reuse laboratory evaluation.
- Install water storage control system.
- Prepare draft of fleetwide water management plan.
- Instrument USS Saratoga and USS McCandless to obtain long-term usage patterns.
- Install laundry water reuse system on USS Saratoga.

#### Required Funding Level

Implementation of water resource management techniques will begin in FY 1983 if funding is made available.

### Annual Energy Savings (Beginning in FY 1985)

#### FYDP Funding Level

There are no savings at this funding level.

#### Required Funding Level

Btu $\times 10^{12}$	.75
Barrels $\times 10^3$	130.00
\$ Millions (1977 dollars)	1.99
Payback (years)	.96

## **Synthetic Fuels for Ships**

### **Responsible Activity**

RDT&E: NAVMAT (MAT-08T3)

### **Description**

#### **FYDP Funding Level**

Advanced development work includes performance of computer-sponsored studies of synthetic fuel impact in terms of system compatibility, logistics and handling problems, fire and safety hazards, and toxicological effects. To allow greater flexibility, broader fuel specifications will be considered for petroleum-based fuels.

For synthetic fuels, initial boiler evaluation will be based on tests conducted with a single-burner test rig, and diesel engine evaluations will be based on tests conducted with small-scale (one- and three-cylinder) diesel test engines. Gas-turbine engine evaluations will be based on tests conducted with both single-can combustor and annular combustor test rigs. If, on the basis of the small-scale engine and laboratory test results, a particular synthetic fuel remains a viable candidate for fleet operational use, it will be recommended for full-scale engine test and evaluation. The tests will use generic engines, representative of the major populations of boilers, diesels, and gas turbines currently used or proposed for use in the fleet.

In the area of shipboard fuels flexibility, the feasibility of adopting a multifuel capability will be assessed. Should this assessment indicate that there are measurable cost and availability advantages to be realized by permitting the use of fuels that cannot be procured under current military specifications a determination will be made as to the degree and nature of the fuel flexibility that could be permitted without compromising fleet operational performance.

As part of the engineering development program, DTNSRDC will perform final sea-trial qualifications of synthetic and broadened specification petroleum-based diesel fuel (marine) for fleetwide use including identification of handling and personnel training requirements and evaluation of long-term effects on the operational environment.

Operational data will be available to allow use of broadened specification petroleum-based fuel by 1984 and synthetic hydrocarbon fuels by 1990.

#### **Required Funding Level**

The fuel flexibility effort for ships will be accelerated to provide operational data on broadened petroleum fuels one year earlier by 1983.

## **AIRCRAFT OPERATIONS**

As part of its aircraft investigations program NAVAIR is managing and implementing Navy activities in the DOD flight simulator program and is developing a computer flight planning and fuel management system. NAVAIR is also identifying those categories of Navy aircraft that are major fuel users and that are amenable to fuel conservation modifications, and the use of synthetic JP-5 is being tested using T63 and TF34 engines. This program includes the following:

- Energy Conservation
  - Exploratory Development
  - Aircraft Investigations
  - Advanced Aircraft Component Optimization
- Synthetic Fuels
  - Synthetic Fuels for Aircraft.



## **Aircraft Exploratory Development**

### **Responsible Activity**

RDT&E: NAVMAT (MAT-08T3)

### **Description**

#### **FYDP Funding Level**

The Air Force is the lead DOD agency for aviation-related energy conservation programs. Therefore, NAVAIR has primarily a supporting role. NAVAIR will be starting a new task in FY 1978. An analysis will be made of the fuel used by current USN/USMC aircraft by aircraft type and mission. Using these data and the rework schedules for current inventory aircraft, possible design changes/modifications and/or mission operational changes will be evaluated to reduce fuel usage. Analyses of the projected fuel use of "advanced" systems concepts will also be undertaken.

NAVAIR also has an exploratory development effort oriented toward the test and evaluation of synthetic jet fuels from alternative sources. The NAVAIR effort is coordinated periodically in sponsored group meetings with the Army Aviation System Command, NASA, and the Air Force Systems Command. The overall program involves testing synthetic jet fuels derived from oil shale, tar sands, and coal. The physical and chemical characteristics of synthetic-derived and nonspecification aviation fuels will be determined and compared with those of military specification fuels. Distinctive characteristics of these fuels along with possible safety, handling, compatibility, and performance problems will be determined.

#### **Required Funding Level**

No additional effort above that identified at the FYDP funding level.

## **Aircraft Investigations**

### **Responsible Activity**

RDT&E: NAVAIR

### **Description**

#### **FYDP Funding Level**

The Navy plans to expand its use of flight simulators and develop energy conservation procedures for aircraft engine development and testing. Other work will focus on examining the use of winglets and other potential airframe, propulsion or aerodynamic modifications, and aircraft operating procedures that will require only minor modification to improve energy conservation.

#### **Required Funding Level**

Additional engineering development funds, if provided, will accelerate implementation of changes in operating procedures and aircraft modifications.

### **Energy Savings**

Due to the early nature of these investigations (other than flight simulators) savings cannot be estimated at this time. However, savings are expected to reach a level of 3 to  $5 \times 10^{12}$  Btu per year by 1985.

## **Advanced Aircraft Component Optimization**

### **Responsible Activity**

RDT&E: NAVAIR

### **Description**

#### **FYDP Funding Level**

The Navy plans to identify those categories of Navy aircraft that are major fuel users and are amenable to modification for conservation purposes. Those aircraft will be examined in detail to determine which components can be modified profitably. Modifications will be made using existing technology, if possible.

#### **Required Funding Level**

Additional funds will expand this activity to include more aircraft type.



## **Synthetic Fuels for Aircraft**

### **Responsible Activity**

RDT&E: NAVMAT (MAT-08T3)

### **Description**

#### **FYDP Funding Level**

The Navy will conduct critical experiments to establish the technical, military, and economic feasibility of using, as soon as they are available, commercially produced synthetic military fuels made from domestic reserves of oil shale, tar sands, and coal. These synthetic fuels will be direct substitutes for today's military fuels from dwindling reserves of natural crude oil. Fuel flexibility work will include studies and tests to assess the impact (on availability, cost, performance, reliability, safety, etc.) of using broadened specification or nonmilitary-specification fuels from conventional sources to avoid compromising fleet readiness when military specification fuels are unavailable or in short supply.

Advanced development work focuses on determining actual engine performance and emissions characteristics using T63 and TF34 engines. Engineering development sea-going flight tests are planned for final qualification of aircraft fuels verifying compliance with maximum performance requirements under conditions of actual carrier-dependent aircraft operations. Handling and safety expertise are also to be developed.

Operational data will be available to allow use of broadened specification petroleum-derived fuels by 1984 and synthetic hydrocarbon fuels by 1990.

#### **Required Funding Level**

The fuel flexibility effort for aircraft will be accelerated to provide operational data for broadened specification petroleum-based fuels one year earlier by 1983.

## GLOSSARY

AEUTB	Advanced Energy Utilization Test Bed
APDA	Aircraft Program Data File
ASD (M,RA&L)	Assistant Secretary of Defense (Manpower, Reserve Affairs, and Logistics)
ASW	Antisubmarine warfare
BOE	Barrels of oil equivalent
BOM	Bureau of Mines
Btu	British thermal unit
BUMED	Bureau of Medicine
CEC	Civil Engineer Corps
CEL	Civil Engineering Laboratory
CECOS	Civil Engineer Corps Officer's School
CHINFO	Chief of Naval Information Office
CINCLANTFLT	Commander in Chief, Atlantic Fleet
CINCPACFLT	Commander in Chief, Pacific Fleet
CINCUSNAVEUR	Commander in Chief, U.S. Naval Forces in Europe
CNM	Chief of Navy Material
CNO	Chief of Naval Operations
CONUS	Continental United States
DASD(EE&S)	Deputy Assistant Secretary of Defense (Energy, Environment and Safety)
DEDAP	Defense Energy Data and Analysis Panel
DEIS	Defense Energy Information System
DEPC	Defense Energy Policy Council
DEPPM	Defense Energy Program Policy Memorandum
DFM	Diesel fuel marine
DFSC	Defense Fuel Supply Center
DLA	Defense Logistics Agency
DOD	Department of Defense
DOE	Department of Energy
DOI	Department of Interior
DPPG	Defense Policy and Planning Guidance
DTNSRDC	David Taylor Naval Ship Research and Development Center
DTNSRDC/A	David Taylor Naval Ship Research and Development Center/Annapolis
EAG	Energy Action Group
ECAM	Energy Conservation and Management
ECIP	Energy Conservation Investment Program
EEP	Energy Engineering Program
EFD	Engineering Field Division
EMCS	Energy Monitoring and Control System
EPA	Environmental Protection Agency
EPRI	Electric Power Research Institute
ERDA	Energy Research and Development Administration
ETAP	Energy Technology Applications Program
FEA	Federal Energy Administration
FEMP	Federal Energy Management Plan
FY	Fiscal Year
FYDP	Five Year Development Plan
GAO	General Accounting Office
GSA	General Services Administration
GOCO	Government-owned, contractor-operated

HVAC	Heating, ventilating, and air conditioning
IEA	International Energy Agency
LANTDIV	Atlantic Division
LASS	Loads and system simulation
LES	Low energy structure
MARAD	Maritime Administration
MILCON	Military Construction
MILSPEC	Military Specification
MIS	Management Information System
MSC	Military Sealift Command
NAD	Naval Ammunition Depot
NADC	Naval Air Development Center
NAE	National Academy of Engineering
NAPC	Naval Air Propulsion Center
NARF	Naval Air Rework Facility
NAS	Naval Air Station
NASA	National Aeronautics and Space Administration
NAVAIR	Naval Air Systems Command
NAVFAC	Naval Facilities Engineering Command
NAVMAT	Naval Material Command
NAVPETOFF	Navy Petroleum Office
NAVSEA	Naval Sea Systems Command
NAVSUP	Navy Supply Systems Command
NBS	National Bureau of Standards
NCBC	Naval Construction Battalion Center
NDCP	Navy Decision Coordinating Paper
NEUPAS	Navy Energy Usage Profile Analysis System
NRL	Naval Research Laboratory
NRMC	Naval Regional Medical Center
NSGA	Naval Security Group Activity
NSRDC	Naval Ship Research and Development Center
NTC	Naval Training Center
NWC	Naval Weapons Center
OASD (M,RA&L)	Office of Assistant Secretary of Defense (Manpower, Reserve Affairs and Logistics)
OCS	Outer Continental Shelf
OMB	Office of Management and Budget
O&M	Operations and Maintenance
O&M,N	Operations and Maintenance, Navy
OMP	Organometallic polymer
OPEC	Organization of Petroleum Exporting Countries
OPN	Operations
OPTEMPO	Operating Tempo
OSD	Office of the Secretary of Defense
PPBS	Planning, Programming and Budgeting System
PPGM	Planning and Programming Guidance Memorandum
POL	Petroleum, Oil and Lubricants
POM	Program Objectives Memorandum
PWC	Public Works Center
PWRMR	Prepositioned War Reserve Material Requirements



R&D	Research and development
RD&D	Research, development, and demonstration
RDF	Refuse-derived fuel
RD&E	Research, development, test, and evaluation
RFP	Request for proposals
SIFPPS	Shore Installation Facilities Planning and Program System
SMIS	Ship Management Information System
SPR	Strategic Petroleum Reserve
STEM	Shipboard Total Energy Model
SYSCOM	Systems Command
UCAR	Utilities Cost Analysis Report
USGS	U.S. Geological Survey

**APPENDIX A**

**PATTERNS OF ENERGY USAGE IN THE U.S. NAVY**

## APPENDIX A

### PATTERNS OF ENERGY USAGE IN THE U.S. NAVY

The Navy Energy Usage Profile and Analysis System (NEUPAS) is the Navy-wide system to collect, verify, and present energy usage data. Data for FY 1975 and FY 1976 are for the adjusted baseline year, 1 October through 30 September. In cases where quarterly data were available, actual usage data are provided. In those cases where no quarterly data were available, a percentage contribution by quarter was used based upon FY 1977 quarterly data. Errors introduced by this method are less than 1 percent. FY 1977 data are for actual usage.

Fuel usage data for petroleum fuels were obtained from DTNSRDC/A's NEUPAS computer printout. Shore utility data were obtained from NAVFAC. Both sets of data were checked against each other and against DEIS I and II. Fuel survey data were provided by NAVPETOFF POL survey reports. Aircraft simulator substitution savings were estimated for FY 1975 and FY 1976 and provided by OP-59C for FY 1977.

Navy energy costs were determined by two different methods. Mobility petroleum fuel costs were obtained from DFSC price bulletins and multiplied by actual fuel usage. In those cases where prices changed in mid-fiscal year, fuel usage was assumed to be constant throughout the year for ease of calculation. A percentage contribution to the yearly average price was calculated and that yearly average multiplied by actual fuel usage. Shore utility costs, including shore heating oil, were provided by NAVFAC 102.

Table A-1 shows the conversion factors used in the energy profile system. Because the heating or thermal value of a fuel is related to its API gravity, an average value for each fuel type was used. This average value is being revised based upon procurement distribution patterns of the Defense Fuel Supply Center. Table A-2 shows the average cost to the Navy of each energy form for FY 1975 through FY 1978.

As shown in Figure A-1, the Navy realized a total energy reduction of 7.3 percent in FY 1976 and 8.3 percent in FY 1977, compared with the baseline year of FY 1975. The greatest reduction was achieved by ships, which used 20.0 percent less energy in FY 1977 than in FY 1975. Most of this saving was not due to real conservation improvements, however. Ships experienced an 18.2 percent reduction in underway steaming hours and 8.8 percent reduction in the nonnuclear fleet strength. Effectively, then, ship conservation contributed only about 1.8 percent of the energy saving. This real conservation percentage will increase markedly as hull cleaning and hull coating technology and other conservation efforts developed by NAVSEA begin to be applied fleetwide.



**Table A-1. ENERGY CONVERSION FACTORS**

Energy Form	Quantity Unit	Btu <sup>a</sup> per Quantity Unit
Automotive gasoline	bbl <sup>b</sup>	5.25x10 <sup>6</sup>
Aviation gasoline	bbl	5.25x10 <sup>6</sup>
Jet fuel, JP-4	bbl	5.34x10 <sup>6</sup>
Jet fuel, JP-5	bbl	5.67x10 <sup>6</sup>
Kerosene	bbl	5.67x10 <sup>6</sup>
Diesel fuel	bbl	5.83x10 <sup>6</sup>
Distillate fuel oil, No. 2	bbl	5.83x10 <sup>6</sup>
Navy distillate fuel oil (ND)	bbl	5.95x10 <sup>6</sup>
Navy special fuel oil (NSFO)	bbl	6.22x10 <sup>6</sup>
Residual fuel oil, Bunker C	bbl	6.29x10 <sup>6</sup>
Propane	gal	95,500
Natural gas	SCF <sup>c</sup>	1,031
Coal, bituminous	short ton	24.58x10 <sup>6</sup>
Steam	lb	1,000
Electricity	kWh	11,600 <sup>d</sup>
Barrel of oil equivalent (BOE) <sup>e</sup>	bbl	5.8x10 <sup>6</sup>

<sup>a</sup>British thermal unit (Btu).

<sup>b</sup>1 barrel (bbl) = 42 U.S. gallons.

<sup>c</sup>Standard cubic foot (SCF).

<sup>d</sup>NAVFAC value—includes energy production and transmission losses. (U.S. National Bureau of Standards value is 3,412 Btu/kWh and does not include production and transmission losses.)

<sup>e</sup>1 million BOE = 10<sup>6</sup> BOE.

**Table A-2. AVERAGE NAVY ENERGY COSTS BY ENERGY FORM**

Energy Form	FY 1975 <sup>a</sup>	FY 1976 <sup>a</sup>	FY 1977	FY 1978 <sup>b</sup>
Petroleum fuels (\$/bbl)				
AVGAS	18.666	18.596	19.194	23.394
MOGAS	16.440	16.601	13.222	22.806
JP-4	16.125	16.034	18.186	17.640
JP-5	15.414	15.467	16.170	18.522
DFM	14.802	14.774	16.170	18.522
NDF	14.879	14.774	16.170	18.522
NSFO	13.813	13.665	13.146	17.388
Residual	13.813	13.665	13.146	17.388
Shore heating oil	13.147	13.340	14.109	18.522
Average petroleum cost <sup>c</sup>	14.873	14.863	15.889	18.200
Electricity (\$/MWh)	24.480	26.210	28.750	—
Natural gas (\$/million Btu)	0.990	1.240	1.760	—
Propane (\$/million Btu)	3.540	4.080	4.410	—
Coal (\$/ton)	39.510	35.149	33.920	—
Steam and hot water (\$/million Btu)	2.720	3.570	4.360	—

<sup>a</sup>Modified to cover period 1 October through 30 September.

<sup>b</sup>Preliminary.

<sup>c</sup>Computed on basis of total barrels of each fuel used.

Aircraft achieved a 3.2 percent overall reduction but only through a 6.9 percent reduction in flight hours. The average usage rate per flight hour for naval aircraft actually increased 3.4 percent between FY 1975 and FY 1977. Notable exceptions to this increase were A-4, A-6, AV-8, C-9, EA-6, F-4, F-14, KC-130, and RA-5 aircraft. The largest increase in fuel usage rate was the T-2.

Shore and ground support energy usage both decreased, but it is difficult at this time to ascertain how much of the saving is due to decreased activity and how much to real conservation.

Figure A-2 shows Navy energy costs. Although energy usage was reduced by about 7.4 million barrels of oil equivalent (BOE) between FY 1975 and FY 1977, the Navy's energy bill showed a \$16.7 million increase. (An upward trend of prices for the various energy forms in Table A-2 explains how this occurred.)

Figure A-3 illustrates the changing pattern of energy usage in the Navy. Generally, less petroleum is being used, and more emphasis is being placed on the use of electricity by facilities instead of gas. The disadvantage is that electricity is much more expensive at the user outlet because of the inherent inefficiencies of generation and transmission. Coal usage has declined markedly, but is expected to increase in future years.

Petroleum fuel usage by fuel type is illustrated in Figure A-4. This figure shows the trend toward the middle distillates, particularly DFM and JP-5. However, after several years of declining usage, JP-4 took a large jump in FY 1977, which appears to be an anomaly. In succeeding years, other fuels will be introduced as a result of NAVSEA and NAVAIR fuel flexibility studies.

Petroleum costs are detailed in Figure A-5. After an initial drop in cost due to the government ordered price rollback in fuels in FY 1976, prices began to rise again, resulting in increases in the Navy fuel bill.

As shown in Figure A-6, the major ship classes all decreased their energy usage. The "other" category showed an increase in FY 1977 mainly because of the increased usage by smaller vessels. A comparison of ship energy usage in Figure A-7 with the steaming hours in Figure A-8 shows that decreases in ship energy usage were significantly influenced by reductions in steaming hours. Figure A-7 shows the petroleum usage for ships by fuel type. DFM is quickly becoming the dominant fuel for Navy ships, showing a 25 percent increase between FY 1975 and FY 1977. DFM's contribution has increased from 42 percent in FY 1975 to 65.7 percent in FY 1977. Usage of all other fuels has decreased. Figure A-8 gives the breakdown in underway and not underway steaming hours. Between FY 1975 and FY 1977, every class of ship showed a decrease in the number of underway steaming hours. The same is true for not underway steaming hours with the exception of destroyers and frigates.

Figure A-9 illustrates the calculated fuel usage rate per underway steaming hour, which indicates the conservation performance of the various general ship classes. Within each class, individual ships may have performed better or worse than the norm for their class. The overall performance of ships was a decrease of 9.6 percent in fuel usage rate per underway

steaming hour between FY 1975 and FY 1976, but a 0.9 percent increase between FY 1975 and FY 1977. The goal for ships is a 20 percent reduction in fuel usage per underway steaming hour by 1985.

Figure A-10 shows the results of fleet fuel surveys. The goal is a 90 percent reduction in surveys from the FY 1975 baseline. An excellent start has been made; the Navy achieved a 50 percent reduction in fuel surveys between FY 1975 and FY 1977.

Energy usage by aircraft type is shown in Figure A-11. Only those aircraft types that used 250,000 barrels of fuel or more in FY 1976 are listed individually. All others were added to the "other" category. Energy usage decreased for most aircraft with the exception of C-9, EA-6, F-14, KA-6, S-3, and T-2 aircraft. The increase in energy usage by C-9, F-14, and S-3 aircraft is generally attributed to the introduction of greater numbers of these aircraft into the fleet. Aircraft fuel usage declined 0.8 percent between FY 1975 and FY 1976, and 3.2 percent between FY 1976 and FY 1977. However, over these same periods, flight hours declined 3.8 percent and 6.9 percent respectively.

Figure A-12 is a breakdown of petroleum fuel usage for aircraft by fuel type. As has been the case historically, most naval aircraft fuel is JP-5. The large drop in JP-5 usage between FY 1975 and FY 1977 was offset to a degree by a significant increase in JP-4 usage. AVGAS usage continued to decline. By FY 1977, JP-5 provided 72.2 percent of naval aircraft fuel requirements; JP-4, 24.9 percent; and AVGAS, 2.9 percent. In FY 1975, the contributions were 83.5 percent, 11.7 percent, and 4.8 percent, respectively.

Figure A-13 illustrates the total flight hours by aircraft type. The detailed breakdown is the same as Figure A-11. The overall totals decreased 3.8 percent between FY 1975 and FY 1976 and 6.9 percent between FY 1975 and FY 1977. There were major increases for C-9, EA-6, F-14, and S-3 aircraft, but not enough to balance declines. Most aircraft showed a decrease from FY 1975 levels in FY 1976, but by FY 1977 the aircraft types showing decreases were about the same number as those showing increases.

The major indicator of aircraft conservation efforts is Figure A-14. Most aircraft types achieved a decrease in energy usage per flight hour between FY 1975 and FY 1977 after holding even or increasing between FY 1975 and FY 1976. The energy usage rate was significantly reduced by A-4 (15 percent), AV-8 (16.6 percent), C-9 (13.6 percent), and F-4 and F-14 (each 4.5 percent) aircraft. Two aircraft types reported increases from FY 1975 to FY 1977. They were the KA-6 (up 5.6 percent) and T-2 (up 28.2 percent). In addition, energy usage rates for the remainder of aircraft combined in the "other" category more than doubled (up 116.7 percent) between FY 1975 and FY 1977. This was enough to offset all the other decreases, leaving a net gain of 3.4 percent in energy usage rate. The goal for aircraft is a 5 percent reduction in energy usage per flight hour by 1985.

Figure A-15 shows the savings resulting from substituting simulators for actual aircraft operations. The savings amounted to the equivalent of 5.7 percent of fuel used by aircraft in FY 1975, 6.7 percent in FY 1976, and 7.3 percent in FY 1977, or to an equivalent of 1.4 million barrels of oil in FY 1975, 1.7 million barrels in FY 1976, and 1.8 million barrels in FY 1977. The Navy's goal is a 9 percent savings by 1985 from simulator substitution.



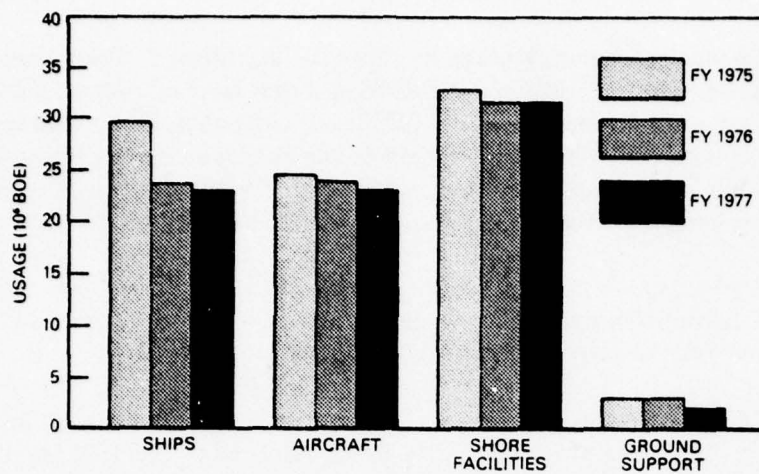
Figure A-16 illustrates energy usage by shore facility utilities. There was a decrease of 0.5 million BOE between FY 1975 and FY 1976 and that level of usage held steady for FY 1977. This amount is 1.6 percent below FY 1975 levels. Although the total usage for FY 1976 and FY 1977 was the same, the mix of energy forms changed. Electricity continued its upward trend and fuel oil rebounded after a drop in FY 1976. Natural gas has been decreasing steadily. Propane usage has remained relatively steady, but coal usage has decreased.

Energy usage per square foot of building floor is shown in Figure A-17, again reflecting a 1.6 percent reduction from FY 1975 levels for both FY 1976 and FY 1977. The Navy's goal is a 20 percent reduction in energy usage per square foot by 1985.

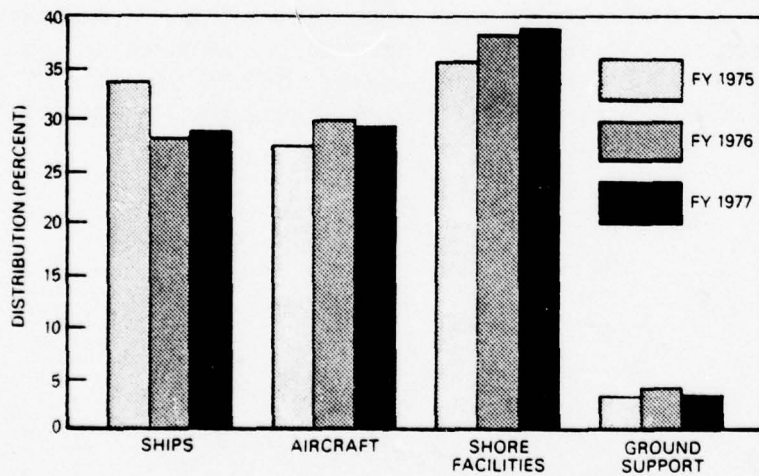
Figure A-18 shows ground vehicle energy usage by fuel type. There was an 11.8 percent increase between FY 1975 and FY 1976, but usage returned to FY 1975 levels in FY 1977. The mix of fuels, however, changed between those years. A slight shift from motor gasoline to diesel fuel was seen. A reduction of 15 percent by 1985 is the goal.

Figure A-19 shows that alternative fuels were substituted for 0.6 percent of the total shore facilities liquid hydrocarbon/natural gas usage in FY 1977. The goal is at least a 5 percent substitution by 1985.

In summary, although there has been a decrease in the overall energy usage by the Navy between FY 1975 and FY 1977, most energy reductions were achieved by reducing operations. In fact, average energy usage rates for ships and aircraft have increased. Shore energy usage decreased from FY 1975 to FY 1976, but remained at FY 1976 levels in FY 1977. Ground vehicles, after increasing usage in FY 1976, have dropped back to FY 1975 levels.



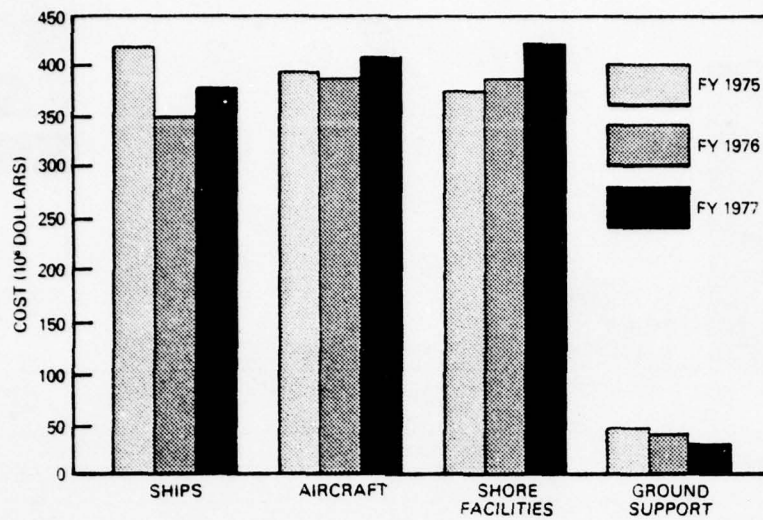
ACTIVITY	ENERGY USAGE (10 <sup>6</sup> BOE)			CHANGE (PERCENT)	
	FY 1975 <sup>a</sup>	FY 1976 <sup>a</sup>	FY 1977	FY 1975-76	FY 1975-77
SHIPS	29.5	23.7	23.6	-19.7	-20.0
AIRCRAFT	24.9	24.7	24.1	-0.8	-3.2
SHORE FACILITIES	32.1	31.6	31.6	-1.6	-1.6
GROUND SUPPORT	2.7	2.7	2.5	0	-7.4
<b>TOTAL</b>	<b>89.2</b>	<b>82.7</b>	<b>81.8</b>	<b>-7.3</b>	<b>-8.3</b>



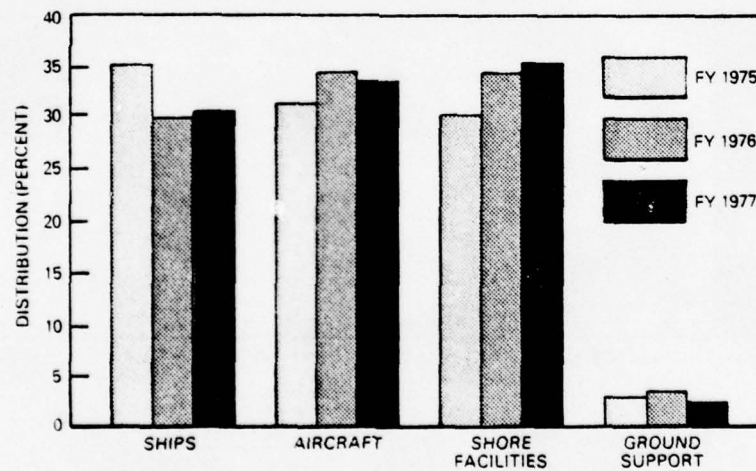
ACTIVITY	ENERGY USAGE DISTRIBUTION (PERCENT)		
	FY 1975 <sup>a</sup>	FY 1976 <sup>a</sup>	FY 1977
SHIPS	33.1	28.7	28.9
AIRCRAFT	27.9	29.9	29.5
SHORE FACILITIES	36.0	38.2	38.6
GROUND SUPPORT	3.0	3.3	3.1

<sup>a</sup>Modified to cover 1 October through 30 September.  
Sources: NEUPAS and NAVFAC 102.

**Figure A-1. ENERGY USAGE BY ACTIVITY**



ACTIVITY	ENERGY COST (10 <sup>6</sup> DOLLARS)			CHANGE (PERCENT)	
	FY 1975 <sup>a</sup>	FY 1976 <sup>a</sup>	FY 1977	FY 1975-76	FY 1975-77
SHIPS	435.7	348.5	378.8	-20.0	-13.1
AIRCRAFT	390.2	387.1	403.7	-0.8	+3.5
SHORE FACILITIES	370.6	388.0	436.7	+5.2	+17.8
GROUND SUPPORT	42.8	41.7	36.8	-2.6	+14.0
TOTAL	1,239.3	1,165.3	1,256.0	-5.8	+1.3

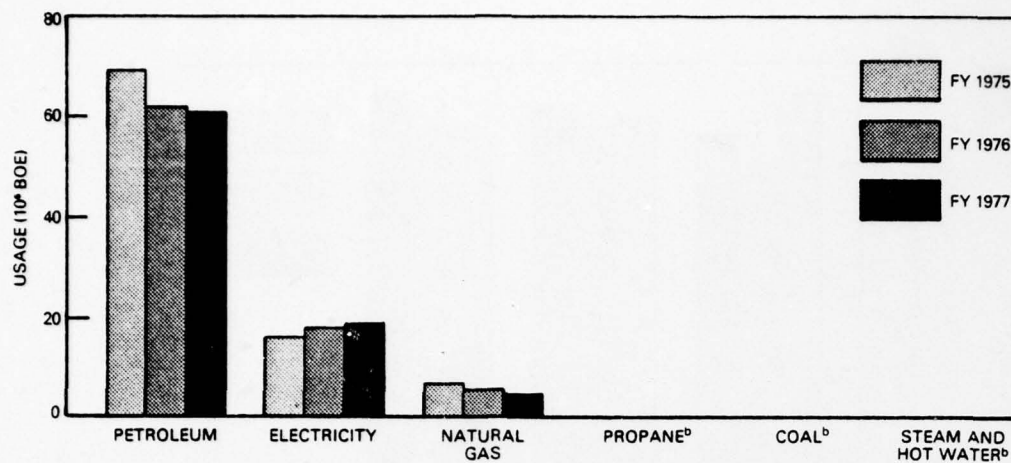


ACTIVITY	ENERGY COST DISTRIBUTION (PERCENT)		
	FY 1975 <sup>a</sup>	FY 1976 <sup>a</sup>	FY 1977
SHIPS	35.2	29.9	30.2
AIRCRAFT	31.5	33.2	32.1
SHORE FACILITIES	29.9	33.4	34.8
GROUND SUPPORT	3.5	3.6	2.9

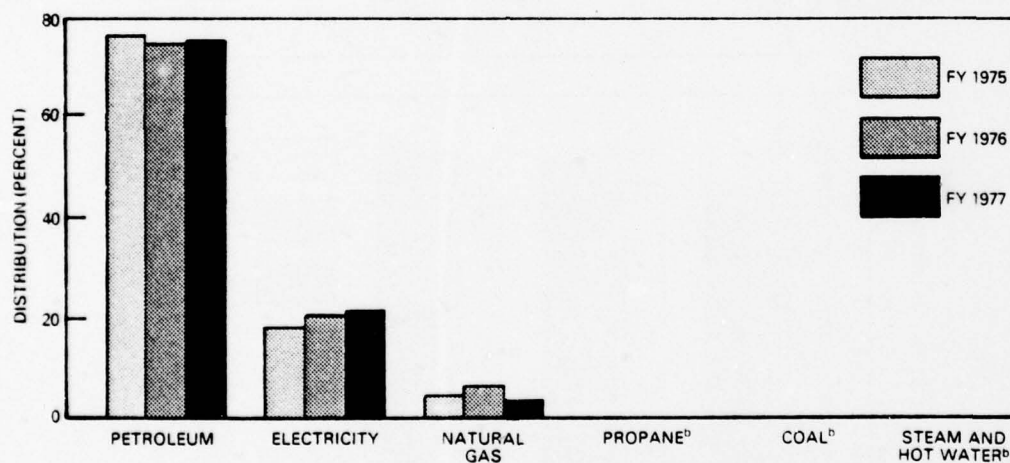
<sup>a</sup>Modified to cover 1 October through 30 September.  
Sources: OP-413 and NAVFAC 102.

**Figure A-2. ENERGY COST BY ACTIVITY**





ENERGY FORM	ENERGY USAGE (10 <sup>6</sup> BOE)			CHANGE (PERCENT)	
	FY 1975 <sup>a</sup>	FY 1976 <sup>a</sup>	FY 1977	FY 1975-76	FY 1975-77
PETROLEUM	67.7	60.6	60.3	-10.5	-10.9
ELECTRICITY	15.7	16.5	16.8	+5.1	+7.0
NATURAL GAS	5.1	4.9	4.2	-3.9	-17.6
PROPANE	0.1	0.1	0.1	0	0
COAL	0.5	0.4	0.3	-20.0	-40.0
STEAM AND HOT WATER	0.2	0.2	0.1	0	-50.0
<b>TOTAL</b>	<b>89.2</b>	<b>82.7</b>	<b>81.8</b>	<b>-7.3</b>	<b>-8.3</b>



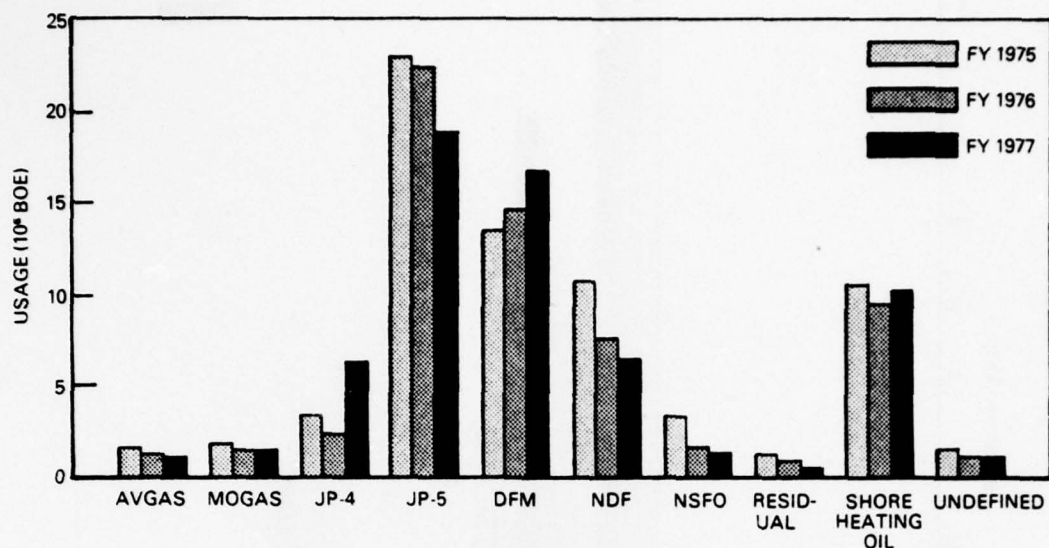
ENERGY FORM	ENERGY USAGE DISTRIBUTION (PERCENT)		
	FY 1975 <sup>a</sup>	FY 1976 <sup>a</sup>	FY 1977
PETROLEUM	75.9	73.3	73.7
ELECTRICITY	17.6	20.0	20.5
NATURAL GAS	5.7	5.9	5.1
PROPANE	0.1	0.1	0.1
COAL	0.6	0.5	0.4
STEAM AND HOT WATER	0.2	0.2	0.1

<sup>a</sup>Modified to cover 1 October through 30 September.

<sup>b</sup>Numbers too small for graphic representation.

Sources: NEUPAS and NAVFAC 102.

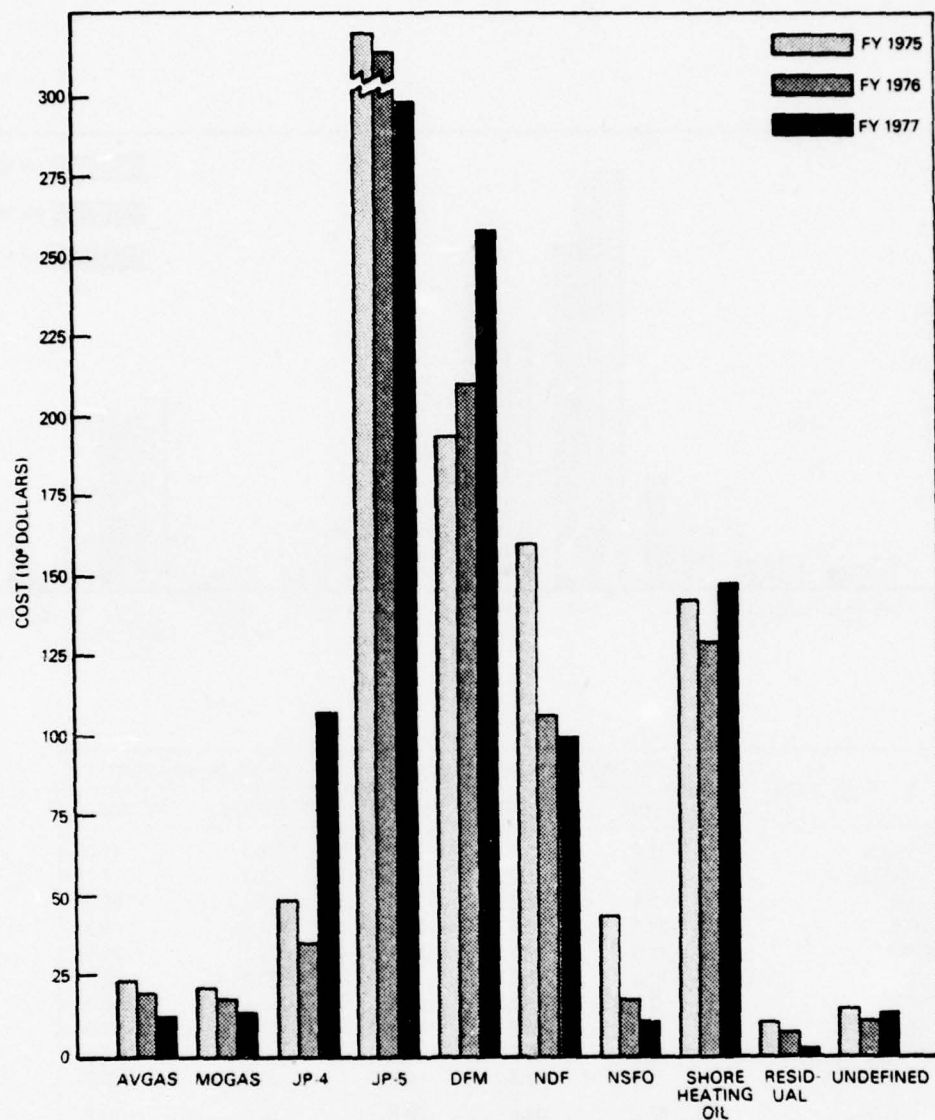
**Figure A-3. ENERGY USAGE BY ENERGY FORM**



FUEL TYPE	ENERGY USAGE (10 <sup>6</sup> BOE)			CHANGE (PERCENT)	
	FY 1975 <sup>a</sup>	FY 1976 <sup>a</sup>	FY 1977	FY 1975-76	FY 1975-77
AVGAS	1.2	1.1	0.7	-8.3	-41.7
MOGAS	1.3	1.2	1.2	-7.7	-7.7
JP-4	2.9	2.2	6.0	-24.1	+106.9
JP-5	23.3	22.7	18.3	-2.6	-21.5
DFM	12.9	14.2	16.1	+10.1	+24.8
NDF	10.8	7.2	6.1	-33.3	-43.5
NSFO	2.9	1.2	0.9	-58.6	-69.0
RESIDUAL	0.8	0.5	0.1	-37.5	-87.5
SHORE HEATING OIL	10.6	9.5	10.1	-10.4	-4.7
UNDEFINED	1.0	0.8	0.8	-20.0	-20.0
TOTAL	67.7	60.6	60.3	-10.5	-10.9

<sup>a</sup>Modified to cover 1 October through 30 September.  
Source: NEUPAS.

Figure A-4. ENERGY USAGE BY FUEL TYPE

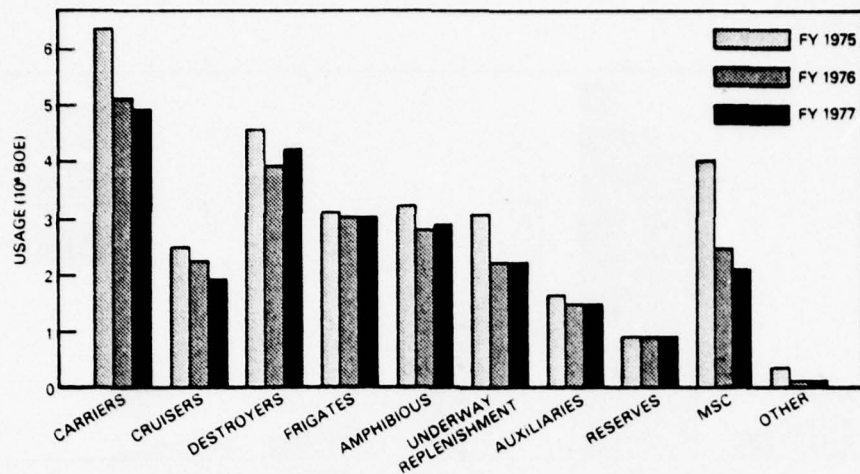


FUEL TYPE	ENERGY COST (10 <sup>6</sup> DOLLARS)		
	FY 1975 <sup>a</sup>	FY 1976 <sup>a</sup>	FY 1977
AVGAS	23.2	20.6	14.2
MOGAS	21.2	19.2	15.4
JP 4	47.5	35.1	108.4
JP 5	359.8	350.7	296.7
DFM	190.2	210.4	259.5
NDF	160.7	106.0	99.4
NSFO	39.7	16.5	11.7
RESIDUAL	11.1	6.4	1.1
SHORE HEATING OIL	139.2	126.7	142.2
UNDEFINED	15.3	12.5	12.9
TOTAL	1,007.9	904.1	961.5

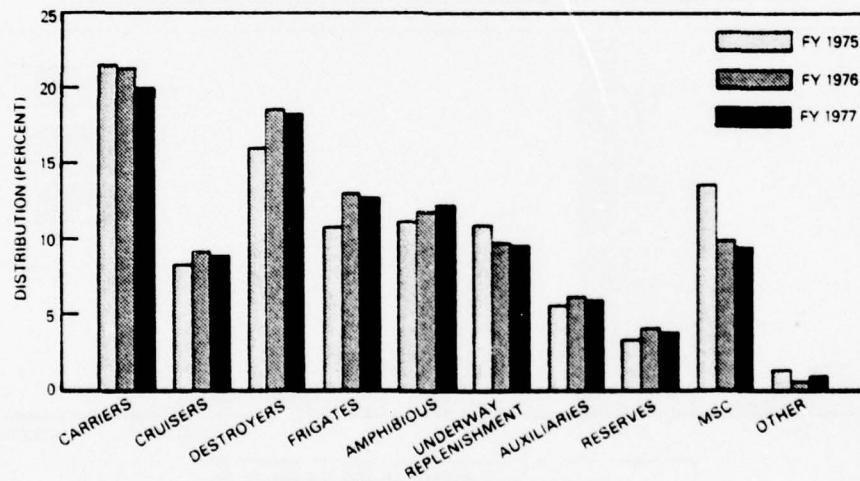
<sup>a</sup>Modified to cover 1 October through 30 September.  
 Source: OP 413.

**Figure A-5. ENERGY COST BY FUEL TYPE**





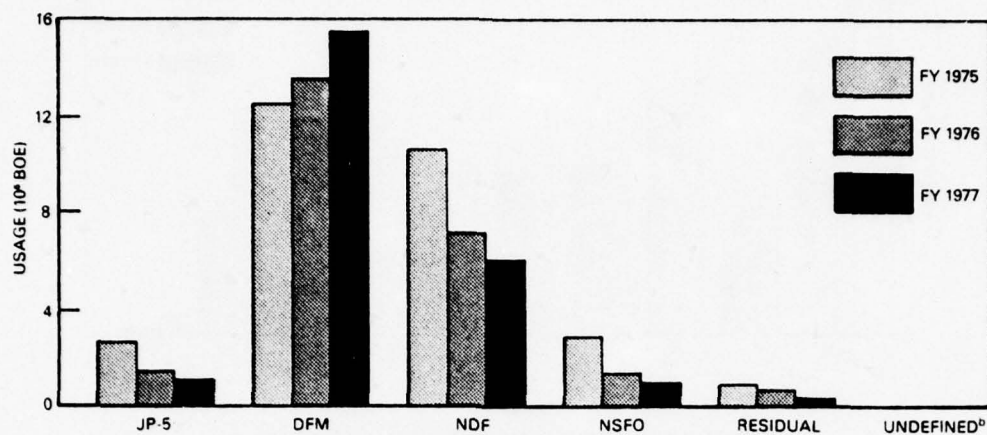
SHIP CLASS	ENERGY USAGE (10 <sup>6</sup> BOE)			CHANGE (PERCENT)	
	FY 1975*	FY 1976*	FY 1977	FY 1975-76	FY 1975-77
CARRIERS	6.4	5.1	4.9	-20.3	-23.4
CRUISERS	2.4	2.0	1.9	-13.7	-20.8
DESTROYERS	4.6	3.9	4.3	-15.2	-6.5
FRIGATES	3.1	3.0	3.0	-3.2	-3.2
AMPHIBIOUS	3.2	2.7	2.8	-15.6	-12.5
UNDERWAY REPLENISHMENT	3.1	2.3	2.3	-25.8	-25.8
AUXILIARIES	1.8	1.4	1.4	-12.5	-12.5
RESERVES	0.8	0.8	0.8	0	0
MSC	4.0	2.4	2.1	-40.0	-47.5
OTHER	0.3	0.1	0.1	-66.7	-66.7
<b>TOTAL</b>	<b>29.5</b>	<b>23.7</b>	<b>23.6</b>	<b>-19.7</b>	<b>-20.0</b>



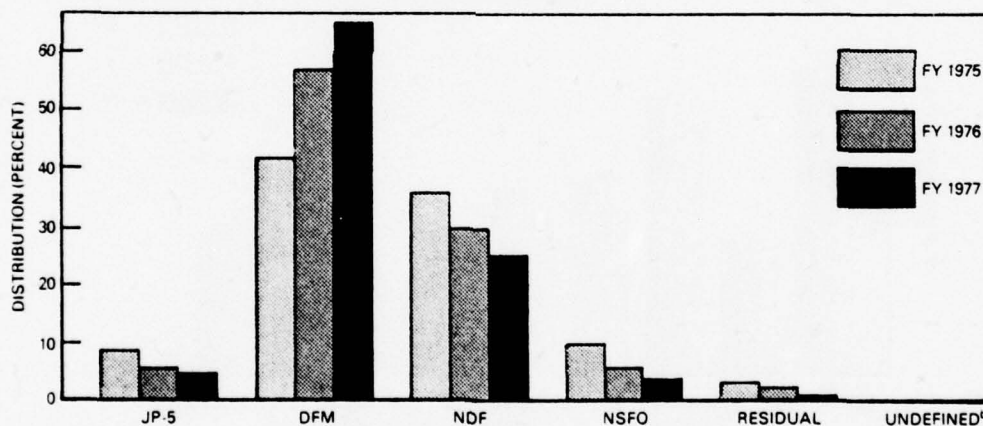
SHIP CLASS	ENERGY USAGE DISTRIBUTION (PERCENT)		
	FY 1975*	FY 1976*	FY 1977
CARRIERS	21.7	21.5	20.9
CRUISERS	8.1	8.4	8.3
DESTROYERS	15.6	16.5	18.2
FRIGATES	10.5	12.7	12.6
AMPHIBIOUS	10.8	11.4	12.0
UNDERWAY REPLENISHMENT	10.5	9.7	9.6
AUXILIARIES	5.4	5.9	5.8
RESERVES	2.7	3.4	3.3
MSC	13.6	10.1	8.7
OTHER	1.0	0.4	0.6

\*Modified to cover 1 October through 30 September.  
Source: NEUPAS

Figure A-6. ENERGY USAGE BY SHIP CLASS (EXCEPT NUCLEAR)



FUEL TYPE	ENERGY USAGE (10 <sup>6</sup> BOE)			CHANGE (PERCENT)	
	FY 1975 <sup>a</sup>	FY 1976 <sup>a</sup>	FY 1977	FY 1975-76	FY 1975-77
JP-5	2.6	1.2	1.0	-53.8	-61.5
DFM	12.4	13.6	15.5	+9.7	+25.0
NDF	10.8	7.2	6.1	-33.3	-43.5
NSFO	2.9	1.2	0.9	-58.6	-69.0
RESIDUAL	0.8	0.5	0.1	-37.5	-87.5
UNDEFINED	<0.1	<0.1	<0.1	0	0
<b>TOTAL</b>	<b>29.5</b>	<b>23.7</b>	<b>23.6</b>	<b>-19.7</b>	<b>-20.0</b>



FUEL TYPE	ENERGY USAGE DISTRIBUTION (PERCENT)		
	FY 1975 <sup>a</sup>	FY 1976 <sup>a</sup>	FY 1977
JP-5	8.8	5.1	4.2
DFM	42.0	57.4	65.7
NDF	36.6	30.4	25.8
NSFO	9.8	5.1	3.8
RESIDUAL	2.7	2.1	0.4
UNDEFINED	0.1	<0.1	<0.1

<sup>a</sup>Modified to cover 1 October through 30 September.

<sup>b</sup>Numbers too small for graphic representation.

Source: NEUPAS.

**Figure A-7. SHIP ENERGY USAGE BY FUEL TYPE**

SHIP TYPE	STEAMING HOURS UNDERWAY (10 <sup>3</sup> )			CHANGE (PERCENT)		STEAMING HOURS NOT UNDERWAY (10 <sup>3</sup> )			CHANGE (PERCENT)	
	FY 1975 <sup>a</sup>	FY 1976 <sup>a</sup>	FY 1977	FY 1975-76	FY 1975-77	FY 1975 <sup>a</sup>	FY 1976 <sup>a</sup>	FY 1977	FY 1975-76	FY 1975-77
CARRIERS	44.2	39.6	34.5	-10.4	-21.9	29.7	23.9	24.8	-19.5	-16.5
CRUISERS	58.6	54.2	46.0	-7.5	-21.5	47.6	37.1	39.6	-22.1	-16.8
DESTROYERS	157.6	137.8	135.3	-12.6	-14.1	106.3	96.2	114.0	-9.5	+7.2
FRIGATES	145.5	153.3	135.5	-5.4	-6.9	64.8	63.8	76.1	-1.5	+17.4
AMPHIBIOUS	131.8	117.1	113.9	-11.2	-13.6	128.8	90.9	107.0	-29.4	-16.9
UNDERWAY REPLENISHMENT	119.1	91.5	78.7	-23.2	-33.9	112.5	84.6	80.0	-24.8	-28.9
AUXILIARIES	124.0	105.8	104.3	-14.7	-15.9	182.3	137.9	157.3	-24.4	-13.7
RESERVES	56.1	54.5	49.7	-2.9	-11.0	69.7	51.6	63.5	-26.0	-8.9
MSC	-	-	-	-	-	-	-	-	-	-
OTHER	63.6	44.5	38.8	-30.0	-39.0	83.4	46.9	31.0	-43.8	-62.8
TOTAL	900.5	798.3	736.8	-11.3	-18.2	825.1	632.9	693.3	-23.3	-16.0

<sup>a</sup>Modified to cover 1 October through 30 September.  
Source: NEUPAS.

**Figure A-8. SHIP ACTIVITY AS MEASURED BY STEAMING HOURS BY SHIP TYPE (EXCLUDING NUCLEAR)**

SHIP TYPE	NUMBER OF SHIPS (END OF FISCAL YEAR)			FUEL CONSUMPTION PER UNDERWAY STEAMING HOUR (BBL)			CHANGE (PERCENT)	
	FY 1975 <sup>a</sup>	FY 1976 <sup>a</sup>	FY 1977	FY 1975 <sup>a</sup>	FY 1976 <sup>a</sup>	FY 1977	FY 1975-76	FY 1975-77
CARRIERS	13	11	10	130.3	106.3	121.0	-18.4	-7.1
CRUISERS	22	21	20	33.3	29.7	33.5	-10.8	+0.6
DESTROYERS	70	69	64	23.9	21.9	25.5	-8.4	+6.7
FRIGATES	64	64	64	17.9	16.1	18.8	-10.1	+5.0
AMPHIBIOUS	64	62	62	18.4	17.0	18.5	-7.6	+0.5
UNDERWAY REPLENISHMENT	43	40	39	21.3	20.4	22.7	-4.2	+6.6
AUXILIARIES	78	74	67	5.7	5.3	6.5	-7.0	+14.0
RESERVES	63	60	59	11.5	10.8	12.3	-6.1	+7.0
SUBMARINES	10	10	10	2.5	3.9	2.7	+56.0	+8.0
PATROL COMBATANT AND MINE WARFARE	17	11	10	2.0	1.8	2.1	-10.0	+5.0
TOTAL	444	422	405	22.8	20.6	23.0	-9.6	+0.9

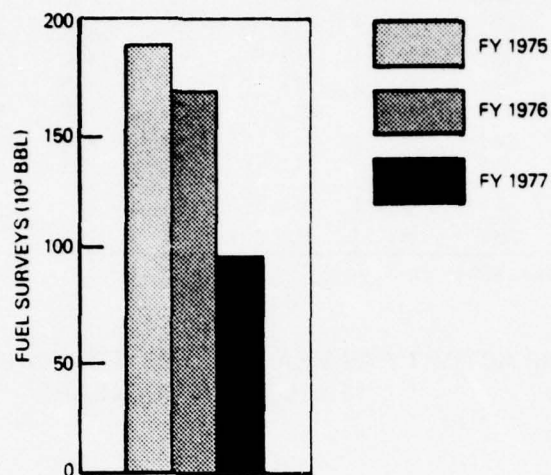
<sup>a</sup>Modified to cover 1 October through 30 September.

Note: The Navy's goal is to reduce fossil fuel energy consumption per underway steaming hour 20 percent by 1985.

Sources: NEUPAS and "Active Fleet Historical Force Levels," 3/9/78, OPNAV 902K.

**Figure A-9. FUEL CONSUMPTION PER STEAMING HOUR BY SHIP TYPE (EXCLUDING NUCLEAR AND MSC)**





FUEL SURVEYS (10³ BBL)			CHANGE (PERCENT)	
FY 1975 <sup>a</sup>	FY 1976 <sup>a</sup>	FY 1977	FY 1975-76	FY 1975-77
193	171.5	96.5	- 11.1	- 50.0

<sup>a</sup>Modified to cover 1 October through 30 September.

Note: The Navy's goal is to achieve a 90 percent reduction in fleet surveys by 1985.

Sources: NAVPETOFF Fuel Survey Reports.

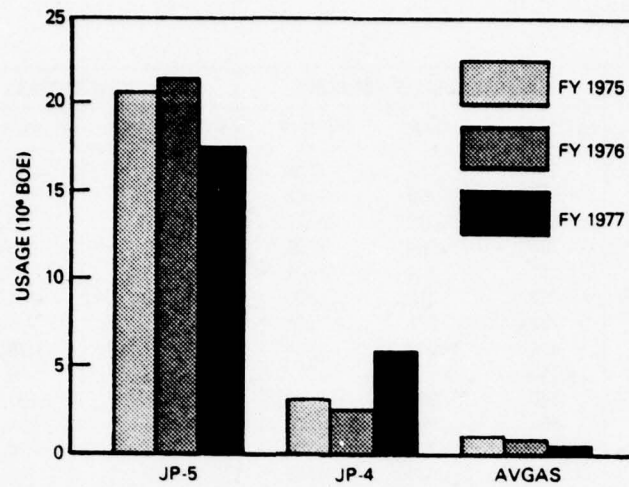
**Figure A-10. FUEL SURVEYS**

AIRCRAFT TYPE	ENERGY USAGE (10 <sup>3</sup> BOE)			CHANGE (PERCENT)	
	FY 1975 <sup>a</sup>	FY 1976 <sup>a</sup>	FY 1977	FY 1975-76	FY 1975-77
A-4	1,334	1,134	774	- 15.0	- 42.0
A-6	1,679	1,759	1,643	+ 4.8	- 2.1
A-7	2,576	2,545	2,520	- 1.2	- 2.2
AV-8	220	264	190	+ 20.0	- 13.6
C-9	352	414	401	+ 17.6	+ 13.9
C-118	292	274	220	- 6.2	- 24.7
CH-46	293	271	274	- 7.5	- 6.5
EA-6	414	504	531	+ 21.7	+ 28.3
F-4	4,710	4,411	4,251	- 6.3	- 9.7
F-8	546	265	0	- 52.4	- 100.0
F-14	554	906	1,300	+ 83.5	+ 134.7
KA-6	318	320	395	+ 0.6	+ 24.2
KC-130	456	430	458	- 5.7	+ 0.4
P-3	3,965	3,955	4,181	- 0.3	+ 5.4
RA-5	297	254	262	- 14.5	- 11.8
S-3	123	331	503	+ 169.1	+ 308.9
SH-3	261	255	253	- 2.3	- 3.1
T-2	677	847	839	+ 25.9	+ 23.9
TA-4	1,964	1,850	1,728	- 5.9	- 12.1
OTHER	1,921	3,733	3,362	+ 94.3	+ 75.0
TOTAL	24,918	24,722	24,085	- 0.8	- 3.2

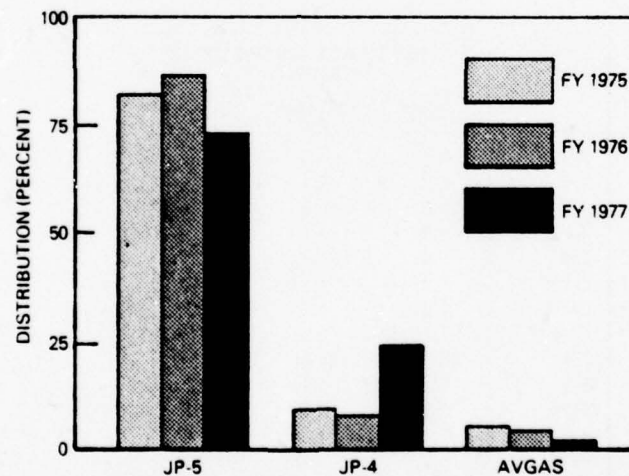
AIRCRAFT TYPE	ENERGY USAGE DISTRIBUTION (PERCENT)		
	FY 1975 <sup>a</sup>	FY 1976 <sup>a</sup>	FY 1977
A-4	5.4	4.6	3.2
A-6	6.7	7.1	6.8
A-7	10.3	10.3	10.5
AV-8	0.9	1.1	0.8
C-9	1.4	1.7	1.7
C-118	1.2	1.1	0.9
CH-46	1.2	1.1	1.1
EA-6	1.7	2.0	2.2
F-4	18.9	17.8	17.6
F-8	2.2	1.1	0
F-14	2.2	3.7	5.4
KA-6	1.3	1.3	1.6
KC-130	1.8	1.7	1.9
P-3	15.9	16.0	17.4
RA-5	1.2	1.0	1.1
S-3	0.5	1.3	2.1
SH-3	1.0	1.0	1.1
T-2	2.7	3.4	3.5
TA-4	7.9	7.5	7.2
OTHER	7.7	15.1	14.0

<sup>a</sup>Modified to cover 1 October through 30 September.  
Source: NEUPAS.

**Figure A-11. ENERGY USAGE BY AIRCRAFT TYPE**



FUEL TYPE	ENERGY USAGE (10 <sup>6</sup> BOE)			CHANGE (PERCENT)	
	FY 1975 <sup>a</sup>	FY 1976 <sup>a</sup>	FY 1977	FY 1975-76	FY 1975-77
JP-5	20.8	21.4	17.4	+ 5.9	- 13.9
JP-4	2.9	2.2	6.0	- 24.1	+ 106.9
AVGAS	1.2	1.1	0.7	- 8.3	- 41.7
TOTAL	24.9	24.7	24.1	- 0.8	- 3.2



FUEL TYPE	ENERGY USAGE DISTRIBUTION (PERCENT)		
	FY 1975 <sup>a</sup>	FY 1976 <sup>a</sup>	FY 1977
JP-5	83.5	86.6	72.2
JP-4	11.7	8.9	24.9
AVGAS	4.8	4.5	2.9

<sup>a</sup>Modified to cover 1 October through 30 September.  
Source: NEUPAS.

**Figure A-12. AIRCRAFT ENERGY USAGE BY FUEL TYPE**



AIRCRAFT TYPE	FLIGHT HOURS (10 <sup>3</sup> )			CHANGE (PERCENT)	
	FY 1975 <sup>a</sup>	FY 1976 <sup>a</sup>	FY 1977	FY 1975-76	FY 1975-77
A-4	95.0	78.1	65.0	-17.8	-31.6
A-6	70.2	73.4	73.9	+4.6	+5.3
A-7	187.6	182.6	185.7	-2.7	-1.0
AV-8	13.0	15.5	13.5	+19.2	+3.8
C-9	16.0	17.5	21.0	+9.4	+31.3
C-118	29.5	27.7	22.4	-6.1	-24.1
CH-46	75.7	69.8	78.7	-7.5	+4.2
EA-6	17.3	21.0	23.6	+21.4	+36.4
F-4	133.9	125.7	126.5	-6.1	-5.5
F-8	27.3	13.2	0	-51.6	-100.0
F-14	19.4	32.4	47.6	+67.0	+145.4
KA-6	13.3	13.3	15.7	0	+18.0
KC-130	24.6	22.6	26.8	-8.1	+8.9
P-3	225.5	223.9	238.7	-0.7	+5.9
RA-5	8.7	7.5	8.2	-13.8	-5.7
S-3	13.0	35.4	57.9	+172.3	+345.4
SH-3	70.1	69.3	74.2	-1.1	+5.8
T-2	95.6	99.7	92.1	+4.3	-3.7
TA-4	166.0	154.8	148.1	-6.7	-10.8
OTHER	814.4	751.8	650.8	-7.7	-20.1
TOTAL	2,116.1	2,035.2	1,970.4	-3.8	-6.9

<sup>a</sup>Modified to cover 1 October through 30 September.  
Source: NEUPAS.

**Figure A-13. AIRCRAFT ACTIVITY AS MEASURED BY FLIGHT HOURS BY AIRCRAFT TYPE**

AIRCRAFT TYPE	NUMBER OF AIRCRAFT			CHANGE (PERCENT)		ENERGY USAGE RATE (BBL/HR)			CHANGE (PERCENT)	
	FY 1975 <sup>a</sup>	FY 1976 <sup>a</sup>	FY 1977	FY 1975-76	FY 1975-77	FY 1975 <sup>a</sup>	FY 1976 <sup>a</sup>	FY 1977	FY 1975-76	FY 1975-77
A-4	284	259	249	-8.8	-12.3	14.0	14.5	11.9	+3.6	-15.0
A-6	218	212	248	-2.8	+13.8	23.9	24.0	22.2	+0.4	-7.1
A-7	442	450	488	+1.8	+10.4	13.7	13.9	13.6	+1.5	-0.7
AV-8	61	63	67	+3.3	+9.8	16.9	17.0	14.1	+0.6	-16.6
C-9	8	11	14	+37.5	+75.0	22.0	23.7	19.0	+7.7	-13.6
C-118	39	37	42	-5.1	+7.7	9.9	9.9	9.8	0	-1.0
CH-46	225	243	277	+8.0	+23.1	3.9	3.9	3.5	0	-10.3
EA-6	52	54	61	+3.8	+17.3	24.0	24.0	22.5	0	-6.3
F-4	410	390	486	-4.9	+18.5	35.2	35.1	33.6	-0.3	-4.5
F-8	103	47	0	-54.4	-100.0	20.0	20.1	-	+0.5	-
F-14	66	128	189	+95.5	+186.4	28.6	28.0	27.3	-2.1	-4.5
KA-6	44	36	55	-18.2	+25.0	24.0	24.0	25.2	0	+5.0
KC-130	31	31	47	0	+51.6	18.6	19.0	17.1	+2.2	-8.1
P-3	308	325	368	+5.5	+19.5	17.6	17.7	17.5	+0.6	-0.6
RA-5	26	22	25	-15.4	-3.8	34.0	34.1	31.9	+0.3	-6.2
S-3	37	78	146	+110.8	+294.6	9.5	9.4	8.7	-1.1	-8.4
SH-3	172	165	180	-4.1	+4.7	3.7	3.7	3.4	0	-8.1
T-2	232	226	201	-2.6	-13.4	7.1	8.5	9.1	+19.7	+28.2
TA-4	349	348	356	-0.3	+2.0	11.8	12.0	11.7	+1.7	-0.8
OTHER	1,907	1,778	1,614	-6.8	+15.0	2.4	5.0	5.2	+108.3	+116.7
TOTAL	5,014	4,904	5,113	-2.2	+2.0	11.8	12.1	12.2	+2.5	+3.4

<sup>a</sup>Modified to cover 1 October through 30 September.  
Note: The Navy's goal is to reduce fossil fuel energy usage per flight hour 5 percent by 1985.  
Source: OP-413.

**Figure A-14. ENERGY USAGE PER FLIGHT HOUR BY AIRCRAFT**

AIRCRAFT TYPE	ENERGY SAVINGS (10 <sup>3</sup> BBL)			CHANGE (PERCENT)		PERCENT OF AIRCRAFT ENERGY USAGE			CHANGE (PERCENT)	
	FY 1975 <sup>a</sup>	FY 1976 <sup>a</sup>	FY 1977	FY 1975-76	FY 1975-77	FY 1975 <sup>a</sup>	FY 1976 <sup>a</sup>	FY 1977	FY 1975-76	FY 1975-77
A-4			21.9					2.8		
A-6			NR					-		
A-7			170.4					6.8		
AV-8			6.5					3.4		
C-9			NR					-		
C-118			NR					-		
CH-46			2.9					1.1		
EA-6			39.8					7.5		
F-4			182.6					4.3		
F-8			-					-		
F-14			377.4					29.0		
KA-6			NR					-		
KC-130			30.3					6.6		
P-3			317.7					7.6		
RA-5			NR					-		
S-3			55.3					11.0		
SH-3			11.6					4.6		
T-2			137.0					16.3		
TA-4			347.7					20.1		
OTHER			68.9					2.0		
TOTAL	1,430	1,650	1,770	+ 15.4	+ 23.7	5.7	6.7	7.3	+ 1.0	+ 1.6

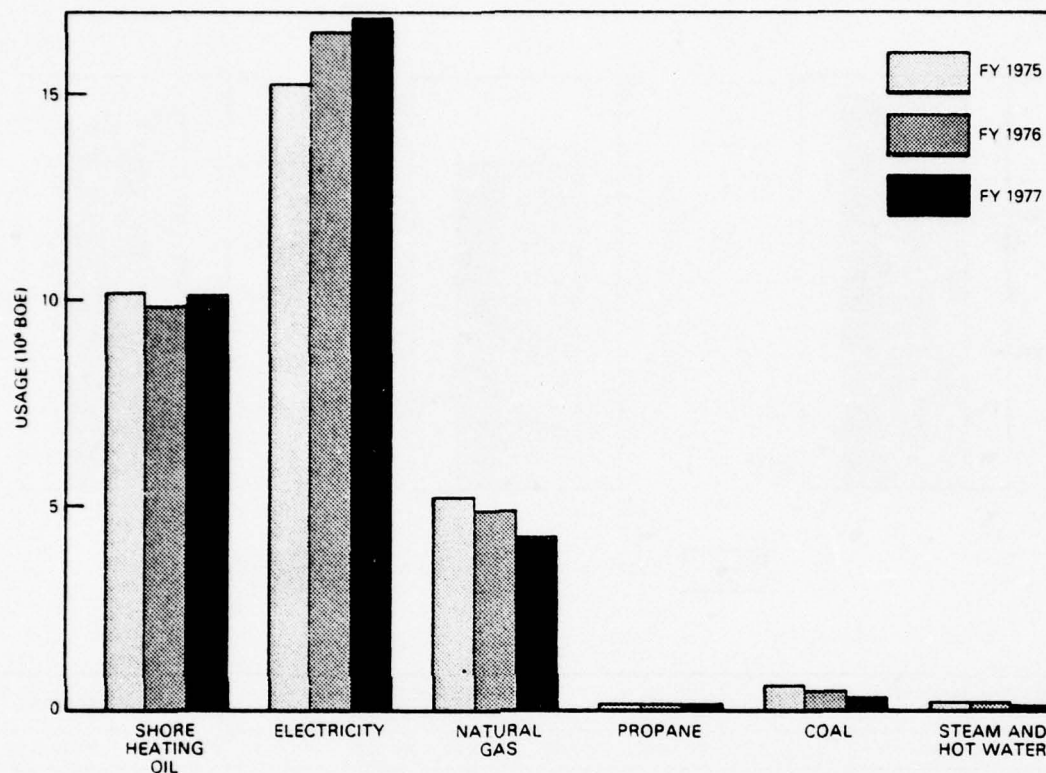
NR = Not reported.

<sup>a</sup>Modified to cover 1 October through 30 September.

Note: The Navy's goal is 9 percent energy savings per year by 1985.

Sources: FY 1975 and FY 1976 estimated; FY 1977 data are from OP-59C.

**Figure A-15. ENERGY SAVED BY AIRCRAFT SIMULATOR SUBSTITUTION**

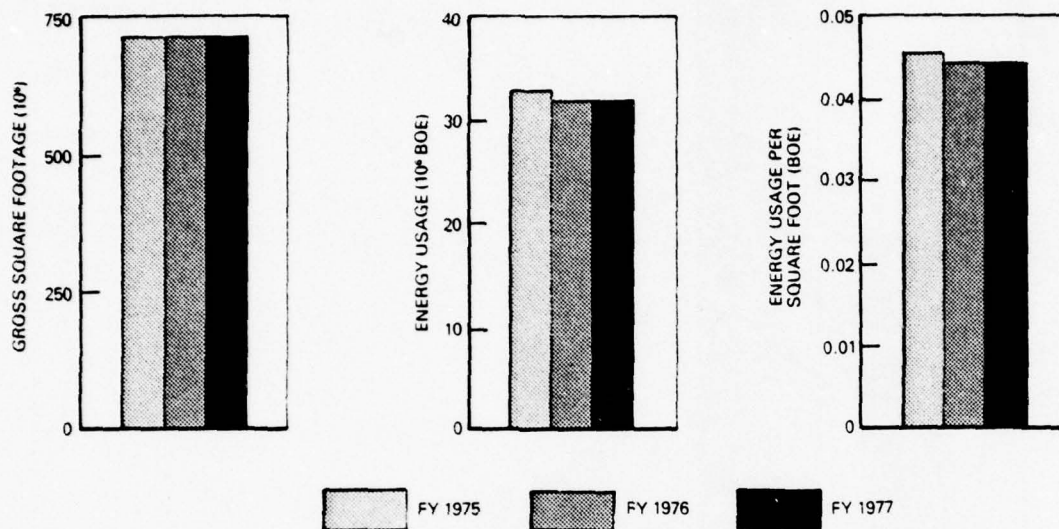


ENERGY FORM	ENERGY USAGE (10 <sup>6</sup> BOE)			CHANGE (PERCENT)	
	FY 1975 <sup>a</sup>	FY 1976 <sup>a</sup>	FY 1977	FY 1975-76	FY 1975-77
SHORE HEATING OIL	10.5	9.5	10.1	-9.5	-3.8
ELECTRICITY	15.7	16.5	16.8	+5.1	+7.0
NATURAL GAS	5.1	4.9	4.2	-3.9	-17.6
PROPANE	0.1	0.1	0.1	0	0
COAL	0.5	0.4	0.3	-20.0	-40.0
STEAM AND HOT WATER	0.2	0.2	0.1	0	-50.0
<b>TOTAL</b>	<b>32.1</b>	<b>31.6</b>	<b>31.6</b>	<b>-1.6</b>	<b>-1.6</b>

<sup>a</sup>Modified to cover 1 October through 30 September.  
Source: NAVFAC 102.

**Figure A-16. SHORE FACILITY ENERGY USAGE BY ENERGY FORM**





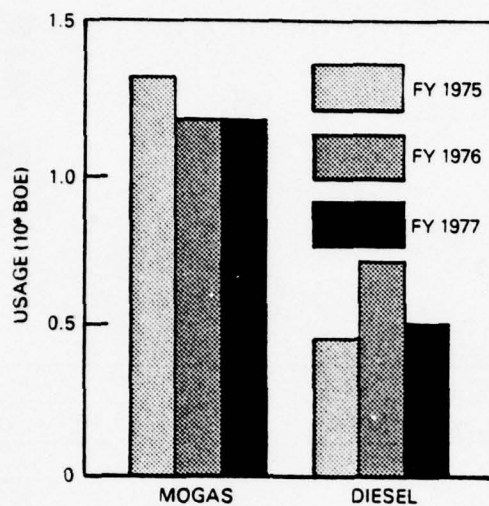
GROSS SQUARE FOOTAGE (10 <sup>6</sup> )			ENERGY USAGE (10 <sup>6</sup> BOE)			ENERGY USAGE PER SQUARE FOOT (BOE)			CHANGE (PERCENT)	
FY 1975 <sup>a</sup>	FY 1976 <sup>a</sup>	FY 1977	FY 1975 <sup>a</sup>	FY 1976 <sup>a</sup>	FY 1977	FY 1975	FY 1976	FY 1977	FY 1975-76	FY 1975-77
710	710	710	32.1	31.6	31.6	0.0452	0.0445	0.0445	- 1.6	- 1.6

<sup>a</sup>Modified to cover 1 October through 30 September.

Note: The Navy's goal is to reduce energy use per square foot of building floor area 20 percent by 1985.

Source: NAVFAC 102.

**Figure A-17. ENERGY USAGE FOR EXISTING FACILITIES**



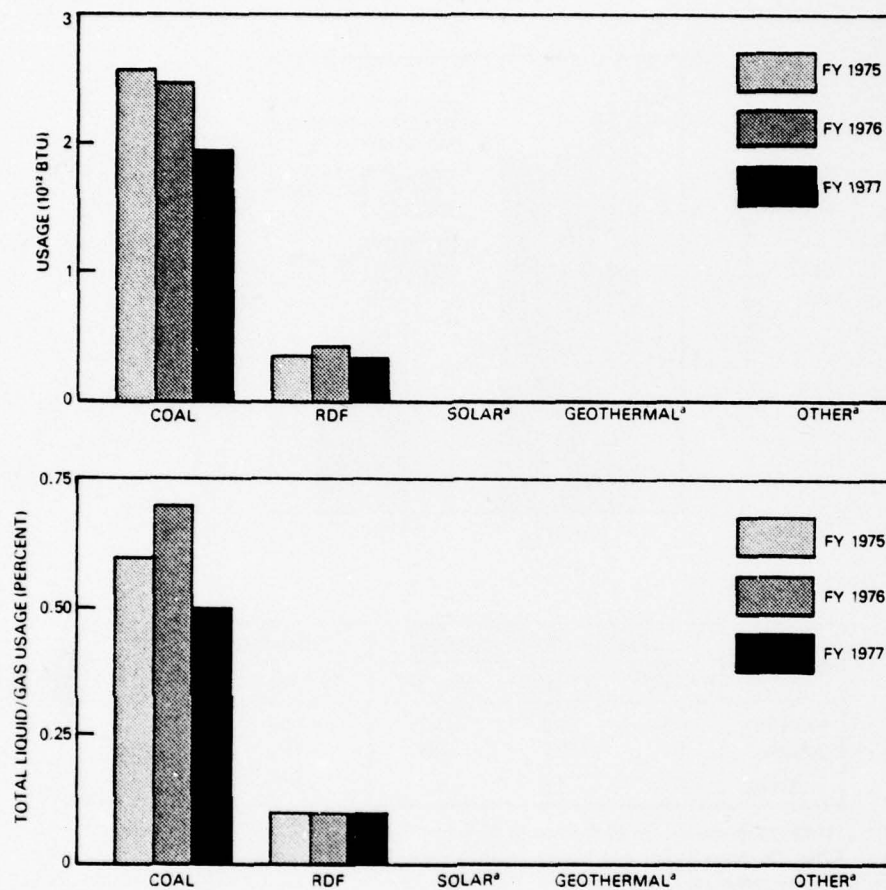
FUEL TYPE	ENERGY USAGE (10 <sup>6</sup> BOE)			CHANGE (PERCENT)	
	FY 1975 <sup>a</sup>	FY 1976 <sup>a</sup>	FY 1977	FY 1975-76	FY 1975-77
MOGAS	1.3	1.2	1.2	-7.7	-7.7
DIESEL	0.4	0.7	0.5	+75.0	+25.0
TOTAL	1.7	1.9	1.7	+11.8	0

<sup>a</sup>Modified to cover 1 October through 30 September.

Note: The Navy's goal is to reduce energy usage 15 percent by 1985.

Source: NEUPAS.

**Figure A-18. VEHICLE ENERGY USAGE BY FUEL TYPE**



ENERGY FORM	USAGE (10 <sup>12</sup> BTU)			CHANGE (PERCENT)		TOTAL SHORE FACILITIES LIQUID HYDROCARBON AND NATURAL GAS USAGE (PERCENT)			CHANGE (PERCENT)	
	FY 1975	FY 1976	FY 1977	FY 1975-76	FY 1975-77	FY 1975	FY 1976	FY 1977	FY 1975-76	FY 1975-77
COAL	2.6	2.4	1.9	-5	-28	0.6	0.7	0.5	+17	-17
RDF	0.3	0.4	0.3	+17	+5	0.1	0.1	0.1	-	-
SOLAR	-	-	-	-	-	-	-	-	-	-
GEOTHERMAL	-	-	-	-	-	-	-	-	-	-
OTHER	-	-	-	-	-	-	-	-	-	-
TOTAL	2.9	2.8	2.2	-2.5	-24.5	0.7	0.8	0.6	+14	-14

\*Numbers too small for graphic representation.

Note: The Navy's goal is to substitute 5 percent of the petroleum or natural gas used ashore with more abundant or renewable energy forms.

Source: NAVFAC 102.

**Figure A-19. ENERGY USAGE BY ALTERNATIVE FORM**



**APPENDIX B**  
**FEDERAL ENERGY ORGANIZATION AND PROGRAMS**

## **APPENDIX B**

### **FEDERAL ENERGY ORGANIZATION AND PROGRAMS**

As the Navy institutes more programs to meet its changing energy requirements, it becomes increasingly important that these efforts are integrated with the Department of Defense (DOD) energy resource management program and the national energy program being administered by the Department of Energy (DOE). This exchange can be accomplished through transfer of information, cooperative use of facilities, and coordination of related programs. These mutual efforts will serve to expedite new energy developments that will benefit both the military and civilian sectors. Appendix B contains information on the Navy and DOD organizations for developing and implementing energy policy, as well as information on DOE and other federal agencies with energy programs.

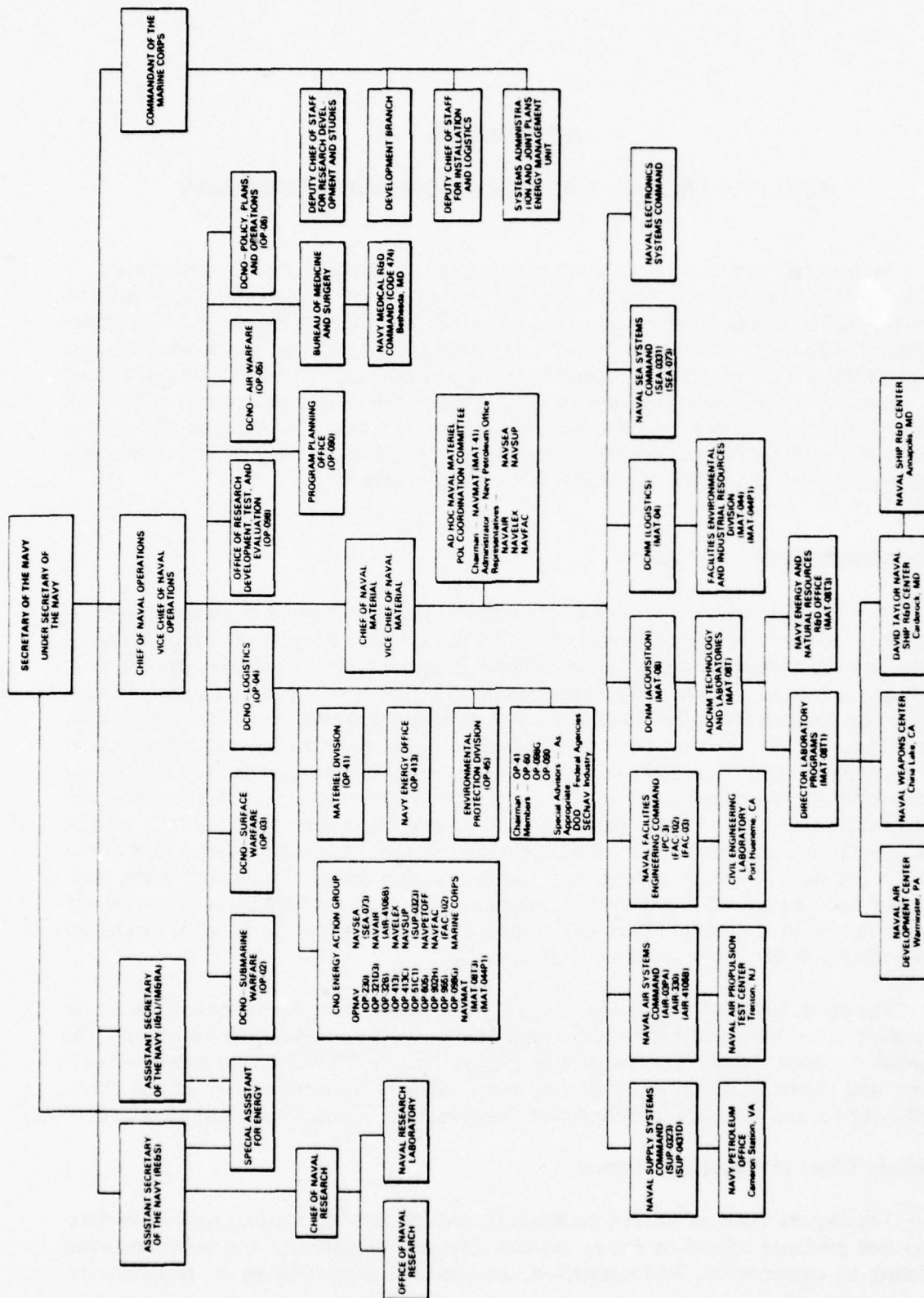
#### **DEPARTMENT OF THE NAVY**

On 3 August 1972, a year before the embargo, the Assistant Secretary of the Navy (ASN) for Research and Development—now Research, Engineering and Systems (RE&S)—initiated an assessment of the impact and definition of the appropriate Navy response to an anticipated crisis in the availability of petroleum fuels. The resulting study group concluded that an energy crisis would eventually occur and recommended actions to offset such a crisis. Since then, the Navy has developed a well-balanced energy program. The general objectives of the program ensure that Navy energy policies and programs are directed toward meeting the overall energy-related needs of the Navy so that it can meet its future mission requirements in a world of scarce petroleum and natural gas resources. The Navy's specific energy goals provide means for measuring progress toward attainment of its energy objectives in the areas of energy management; fuel distribution and allocation; and shore, ship, and aircraft operations. The Navy's organization for energy program planning and implementation, as shown in Figure B-1, supports energy projects from the research and development (R&D) phase to actual application.

The development of overall Navy energy policy comes under the purview of the Under Secretary of the Navy and ASN(RE&S), supported by the Special Assistant for Energy. The Special Assistant reviews and coordinates energy planning activities from a policy standpoint and serves as scientific adviser on energy matters to the Secretary of the Navy, ASN(RE&S), and the ASN for Manpower, Reserve Affairs, and Logistics (M,RA&L).

#### **Deputy Chief of Naval Operations**

The Deputy Chief of Naval Operations (Logistics), OP-04, provides policy coordination and guidance related to energy matters. Systems development and implementation relating to conservation, standardization, analysis and determination of requirements,





facilities, and operations are coordinated by OP-04. The Director, Material Division (OP-41) provides the principal staff support for energy matters and serves as chairman of the CNO Energy Action Group.

#### **Navy Energy Office**

The Navy Energy Office (OP-413) is responsible to OP-41 for planning and monitoring efficient use of energy throughout the Navy. The Navy Energy Office also provides policy guidance on all matters pertaining to energy and energy conservation, except those relating to nuclear energy; ensures that the Navy can provide the required energy resources to the operating forces and shore establishment; coordinates with the Office of the CNO and acts as a central point of contact for Navy energy and energy conservation matters (other than nuclear energy); and participates in functions of interdepartmental interest pertaining to energy matters.

#### **Directorate, Research, Development, Test and Evaluation**

The Director, Research Development, Test and Evaluation (RDT&E), OP-098, carries out the CNO's RDT&E responsibilities and assists ASN(RE&S) with the coordination, integration, and direction of the Navy RDT&E program. The Director, RDT&E, supervises and coordinates the POM submission and the RDT&E budget authorization request and FYDP update submission. The Director, RDT&E, is the principal supporting witness for the ASN(RE&S) before congressional committees. In addition, he makes presentations and provides descriptive summaries and other requested material to Navy staff elements to further explain and support specific R&D programs.

The Development Coordinator for all Navy energy R&D programs, OP-098G, is responsible for accomplishing all RDT&E actions at the OPNAV level associated with the approved program. The main function of the Development Coordinator is to review energy-related R&D documents for accuracy, completeness, and applicability to total Navy R&D requirements. In addition, the Development Coordinator ensures that required R&D documents are submitted on time and that funding profiles reflect energy requirements that are attainable, given the total R&D budget.

#### **Chief of Naval Material**

The Deputy Chief of Naval Material for Acquisition (MAT-08) is the senior staff official of NAVMAT, reporting to the Chief of Naval Material on all matters associated with the Navy material acquisition process, including energy resource management. His responsibilities encompass all matters associated with conceptual and exploratory development, production, test and evaluation, acceptance, Navy laboratory management, and security assistance programs.

#### **Navy Energy and Natural Resources Office**

The Director, Navy Energy and Natural Resources R&D Office (MAT-08T3) supervises the planning, execution, and appraisal of NAVMAT's energy and natural resources ex-

ploratory, advanced, and engineering development programs. To fulfill its responsibilities, the Navy Energy and Natural Resources R&D Office staff must review all Navy programs involving energy technology evolution or applications to assess the feasibility of achieving program goals, the validity of the technical approach, the adequacy of management and funding to accomplish these goals, the feasibility of proposed schedules, and the progress and future prospects of the programs.

The Energy and Natural Resources R&D Office sponsors experiments and demonstrations in the application of the technological advancements resulting from energy R&D efforts sponsored by the Navy, other military departments, other federal agencies, and private industry. Through these efforts, such technological developments can be applied within the Navy as quickly as possible.

### **Navy Systems Commands**

Each SYSCOM commander provides for and meets those material support needs of the Department of the Navy that are within the assigned "material support" responsibility of his command. This includes specific responsibility for the research, design, development, logistics planning, testing, technical evaluation, acquisition, procurement, contracting, production, construction, manufacture, inspection, outfitting, supply, maintenance, alteration, conversion, repair, overhaul, modification, and advance base outfitting of naval material for which the command is assigned responsibility.

NAVFAC sponsors the ECIP, EEP, and shore facilities R&D program. Under the sponsorship of NAVFAC, CEL has responsibility for the shore establishment RDT&E portion of the program. NAVSEA (NSRDC/A) has primary responsibility for ship energy programs and NAVAIR (NADC and NAPC) has primary responsibility for the aircraft energy program.

## **DEPARTMENT OF DEFENSE**

Immediately following the 1973-1974 oil embargo, DOD implemented a number of energy-related organizational measures, including the establishment of a Defense Energy Policy Council in the Office of the Secretary of Defense, an Energy Office, a Defense Energy Action Group, and a Defense Energy R&D Coordination Committee. These organizations, with the assistance of the Defense Logistics Agency (DLA), are responsible for planning and implementing DOD energy policy. DOD's organization for energy management is shown in Figure B-2.

### **Defense Energy Policy Council**

DOD's energy policy guidelines are developed by the Defense Energy Policy Council. Chaired by the Assistant Secretary of Defense (ASD), M,RA&L, the Council comprises representatives of ASD, International Security Affairs; ASD, Planning and Evaluation; ASD, Public Affairs; Under Secretary of Defense for Research and Engineering; Joint Chiefs of Staff; Department of the Air Force; Department of the Army; Department of the Navy; and the Defense Fuel Supply Center (DFSC).

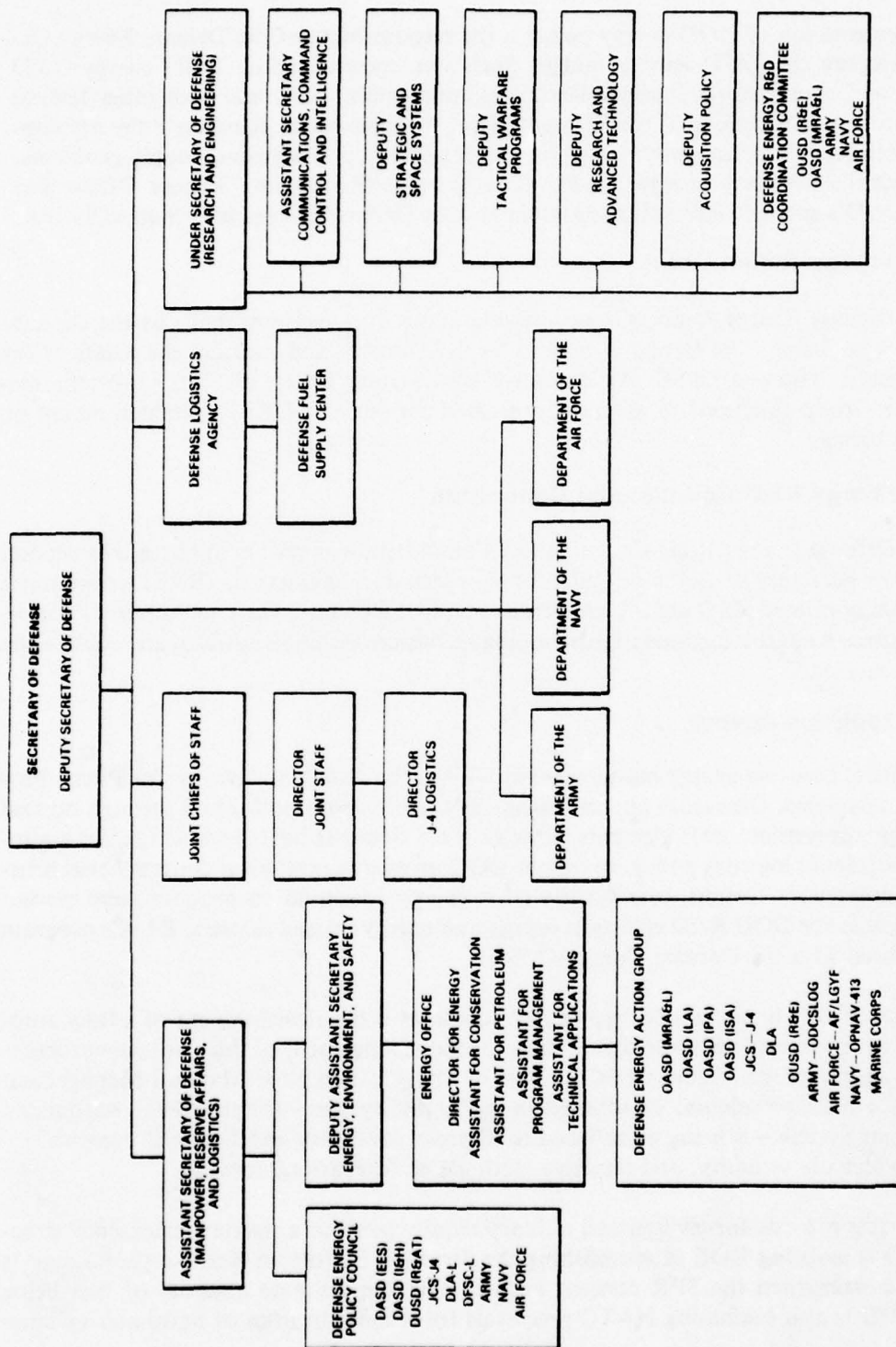


Figure B-2. DEPARTMENT OF DEFENSE ENERGY ORGANIZATION



## **Defense Energy Office**

Implementation of DOD energy policy is the responsibility of the Defense Energy Office. Developing the DOD energy budget (including recommending DOD energy R&D priorities) and coordinating energy-related programs within DOD and with other federal agencies are major functions of the Energy Office. Another major function is the development of petroleum logistics policy based on current energy procurement, supply problems, and projected emergency energy allocation programs. The Defense Energy Office also manages DOD's energy conservation program and the Defense Energy Information System.

## **Defense Energy Action Group**

The Defense Energy Action Group provides input into decisions made by the Director of the Energy Office. The Group is chaired by the Director and includes the chiefs of the Service energy offices, a DFSC representative, and a Joint Chiefs of Staff (J-4) representative. The Group functions to assure coordinated Service and DFSC-expedited action on energy problems.

## **Defense Energy R&D Coordination Committee**

The Defense Energy R&D Coordination Committee, a special committee that reports to the Under Secretary of Defense (USD) for Research and Engineering (R&E), coordinates defense energy-related R&D among the Services and USD(R&E). The Committee comprises representatives from the Engineering Technology Division, ASD(M,RA&L), and each of the Services.

## **Defense Logistics Agency**

The focal point on energy matters within DLA is the Assistant Director for Plans, Programs, and Systems. Operation and management functions are performed through normal channels by appropriate staff elements. Specific staff elements have been designated to implement petroleum logistics policy, represent DOD on energy matters at congressional hearings and interagency forums, manage the DLA energy conservation program, and recommend priorities for DOD R&D efforts in energy and energy-related matters. DLA's program is coordinated with the Defense Energy Office.

One of DLA's important energy-related functions is the establishment of a fully automated system operating on a worldwide basis for the management of the wholesale procurement and supply of petroleum fuels. As part of DOD's Integrated Material Management program for bulk petroleum, established in 1972, this system—Defense Fuel Automated Management System—is being established to improve inventory and financial controls, increase product use visibility, and improve methods of forecasting demand.

To better provide for civilian and military requirements in a wartime emergency situation, DOD is assisting DOE in establishing the Strategic Petroleum Reserve (SPR) and is working to strengthen the SPR concept and increase the ultimate quantity of fuel being stored. DOD is also evaluating NATO proposals for standardization of naval and aviation fuels.

## **Other Military Departments**

Within DOD, each Service is conducting energy programs directed toward meeting its particular energy requirements. While addressing problems that are unique to the different missions of the Services, these programs have applicability throughout DOD. Guidelines established by DOD assign primary responsibilities for specific energy programs, within their areas of major concern, to each of the military Services. DOD guidelines, for example, designate the Air Force as the lead Service in improving aircraft propulsion systems to include drag reduction and development of a multifuel capability. The Air Force in turn supports the Navy, which has lead responsibility for developing and proof-testing fuels derived from synthetic crude oil. The Army has the lead for development of land-based, fixed and mobile, propulsion and power systems, including fuel cells and solar photovoltaics. These guidelines assist the Services in focusing their R&D efforts and reduce program duplication.

## **DEPARTMENT OF ENERGY**

Established on 1 October 1977 by the Department of Energy Organization Act (P.L. 95-91), DOE comprises the many fragmented federal energy offices and programs created over the years. All of the programs and resources of the Energy Research and Development Administration (ERDA), Federal Energy Administration (FEA), and Federal Power Commission (FPC) were absorbed by DOE, and energy programs of the Department of Commerce (DOC), Department of Defense (DOD), Department of Housing and Urban Development (HUD), Department of Interior (DOI), and Interstate Commerce Commission were transferred to DOE. Table B-1 lists federal energy programs by responsible agency before 1 October 1977 and shows the DOE office now responsible for those programs. P.L. 95-91 also provides that DOE coordinate responsibilities for energy leasing policy with DOI, rural electrification loans with the Department of Agriculture, and fuel efficiency standards with the Department of Transportation (DOT). As a result of the consolidation of these programs, DOE employs almost 20,000 people and has an FY 1978 budget of \$10.4 billion.

In addition to reorganizing the management of the federal energy program, the Department of Energy Organization Act reshaped the existing energy programs and functions to accomplish the goals of the proposed national energy plan. Instead of categorizing technologies by fuel type, DOE is categorizing technologies by their evolution through the research, development, and application process.

DOE is organized with a Secretary, a Deputy Secretary, an Under Secretary, and eight Assistant Secretaries (Figure B-3). Divided among the Assistant Secretaries is responsibility for 11 areas: energy resource applications, energy R&D, environmental concerns, international programs and policies, national security functions, intergovernmental policies and relations, competition and consumer affairs, nuclear waste management, energy conservation programs, power marketing regulations, and public and congressional liaison. These 11 areas represent programmatic responsibilities that were once assigned to agencies and departments absorbed by or partially transferred to DOE. To accommodate functions outside the responsibilities of the Assistant Secretaries, the Act provides for the establishment of an Economic Regulatory Administration (ERA), an Energy Information Administration (EIA), a Federal Energy Regulatory Commission (FERC), and an Office of Energy Re-

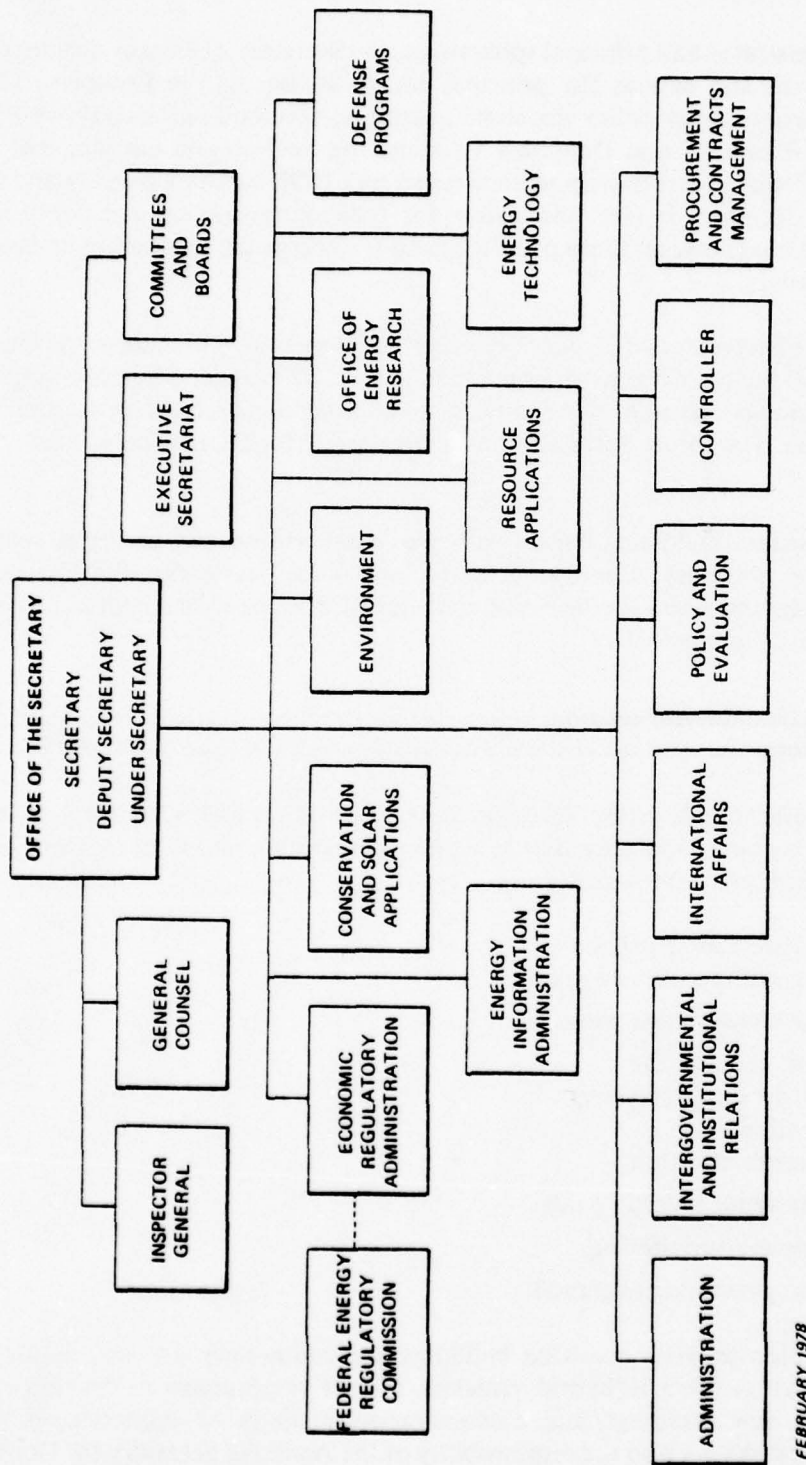
search, as well as offices to perform legal and management functions and various committees and boards.

**Table B-1. FEDERAL ENERGY PROGRAMS TRANSFERRED TO DOE**

Program	Responsible DOE Office	Program	Responsible DOE Office
<b>ENERGY RESEARCH AND DEVELOPMENT ADMINISTRATION</b>		Naval Reactor Development Program	ET
All Functions Including:		Space Nuclear Systems Program	ET
Fossil Fuels		Nuclear Explosives Applications	DP
• Coal		National Security	
• Liquefaction	ET	• Weapons Program	DP
• High-Btu Gasification	ET	• Weapons Materials Program	DP
• Low-Btu Gasification	ET		
• Advanced Power Systems	ET	<b>FEDERAL ENERGY ADMINISTRATION</b>	
• Direct Combustion	ET	All Functions Including:	
• Advanced Research and Supporting Technology	ET	Energy Policy and Analysis	PE
• Magnetohydrodynamics	ET	Energy Regulatory Programs	ERA
• Demonstration Plants	ET	Energy Conservation and Environment	
• Petroleum and Natural Gas		• Utilities	CS
• Enhanced Recovery	ET	• Federal Energy Management Program	CS
• Drilling, Exploration and Offshore Technology	ET	• Residential/Commercial	CS
• Processing and Utilization	ET	• Transportation	CS
• In-Situ Technology Development		• Industry	CS
• Oil Shale	ET	• State and Local	CS
• Coal Gasification	ET	Energy Resource Development	
• Commercial Application	RA	• Development of Oil, Natural Gas, Coal, Oil Shale, Nuclear, Solar, Geothermal	RA
Solar		• Solar Applications in Federal Buildings	CS
• Solar Thermal Applications	ET	Strategic Petroleum Reserves Office	RA
• Photovoltaic Applications	ET	International Energy Affairs	IA
• Wind Energy Conversion	ET		
• Ocean Thermal Energy Conversion	ET	<b>FEDERAL POWER COMMISSION</b>	
• Fuels from Biomass	ET	All Functions Including Natural Gas Regulation, Interstate Wholesale Rate Setting, and Hydroelectric Licensing	FERC
Geothermal		<b>DEPARTMENT OF COMMERCE</b>	
• Engineering R&D	ET	Industrial Energy Conservation	CS
• Hydrothermal Technology	ET		
• Advanced Technology Applications	ET	<b>DEPARTMENT OF DEFENSE</b>	
• Demonstration Projects	EV	Naval Petroleum and Oil Shale Reserves	RA
• Environmental Control and Institutional Studies	ET		
• Resource Exploration and Assessment	ET	<b>DEPARTMENT OF HOUSING AND URBAN DEVELOPMENT</b>	
• Loan Guarantees	RA	Authority to Set Energy Conservation Standards for New Buildings	CS
Conservation		Conservation/Renewable Resources Demonstrations	CS
• Building and Community	CS		
• Industrial	CS	<b>DEPARTMENT OF INTERIOR</b>	
• Transportation—Electric/Hybrid Vehicle Systems	CS	Four Power Administrations	RA
• Electrical Energy Systems	ET	Bureau of Reclamation	
• Energy Storage Systems	ET	• Power Marketing Functions	RA
• Energy Conversion	ET	• Economic Terms for Leasing on Mineral Lands	RA
• Waste Recovery Systems	CS	Bureau of Mines	
Fusion		• Data Gathering on Fuel Supplies	EIA
• Magnetic Fusion	ET	• R&D on Mining Technology	ET
• Laser Fusion	DP	• Coal Preparation Analysis	ET
Fuel Cycle R&D		<b>INTERSTATE COMMERCE COMMISSION</b>	
• Support of Nuclear Fuel Cycle Waste Management	ET	Functions Related to Transportation of Oil by Pipeline, Including Pipeline Valuations and Rate Setting	ERA/FERC
Uranium Resource Assessment	RA		
Uranium Enrichment Technology	RA		
Nuclear Fuel Cycle	ET		
Waste Management	ET		
Fission Power Reactor Development	ET		
Environmental and Safety Research			
• Biomedical and Environmental Research Program	EV		
• Operational Safety	EV		
• Environmental Control Technology	EV		
High Energy Physics	ER		
Basic Energy Sciences	ER		
Nuclear Materials Security and Safeguards	DP		

CS—Assistant Secretary for Conservation and Solar Applications, DP—Assistant Secretary for Defense Programs, EIA—Energy Information Administration, ER—Office of Energy Research, ERA—Economic Regulatory Administration, ET—Assistant Secretary for Energy Technology, EV—Assistant Secretary for Environment, FERC—Federal Energy Regulatory Commission, IA—Assistant Secretary for International Affairs, IR—Assistant Secretary for Intergovernmental and Institutional Relations, PE—Assistant Secretary for Policy and Evaluation, RA—Assistant Secretary for Resource Applications.





FEBRUARY 1978

Figure B-3. DEPARTMENT OF ENERGY ORGANIZATION

## **Office of the Secretary**

As DOE's administrator and principal spokesman, the Secretary of Energy decides major energy policy issues and acts as the principal energy adviser to the President. (The Secretary of Energy coordinates policy decisions relating to international energy with the Secretaries of State, Treasury, and Defense.) To assist the Secretary in carrying out his responsibilities, the Deputy Secretary sometimes represents DOE before Congress and the public. The Deputy Secretary is also responsible for formulating policy and overseeing DOE's regulatory functions (except those of FERC) and the energy data gathering, analysis, and reporting functions.

In contrast to the Secretary and Deputy Secretary's administrative functions, the Under Secretary's responsibilities are more programmatic in nature. The Under Secretary oversees DOE's programs in energy research, development, and application; related environmental programs; and defense. The Under Secretary is also responsible for DOE's energy conservation programs.

The Special Assistant maintains liaison with the White House and performs special tasks assigned by the Secretary, Deputy Secretary, or Under Secretary. The Executive Secretariat coordinates and oversees the Secretarial decision process and maintains comprehensive records of DOE's activities.

## **Assistant Secretary for Conservation and Solar Applications**

The programs under the Assistant Secretary for Conservation and Solar Applications are directed toward the commercialization of available conservation and solar technologies. The energy conservation program includes:

- Utilities
  - Rate structure demonstration
  - Office of consumer service grants
- Federal energy management program
- Residential and commercial
  - Consumer product efficiency
  - Weatherization
  - Solar commercialization
- Transportation (auto mileage guides)
- Industry (reporting/monitoring)
- State and local government (grants).

Energy conservation projects involving buildings and community systems, industrial energy, and transportation (electric/hybrid vehicles), as well as programs to develop efficiency standards for new buildings and demonstration projects of conservation and renewable resources systems are also the responsibility of the Assistant Secretary for Conservation and Solar Applications.

The solar program includes agricultural and industrial process heat projects, projects involving the use of fuels from municipal waste, and demonstrations of solar heating and cooling in federal buildings.

#### **Assistant Secretary for Defense Programs**

The nation's nuclear weapons research, development, testing, production, and surveillance is under the direction of the Assistant Secretary for Defense Programs. This responsibility includes the administration of nuclear safeguards, security, arms control, and intelligence programs. The Assistant Secretary also provides support for the United States in various international negotiations dealing with nonproliferation controls. Laser fusion R&D, which may have applications in both national security and energy areas, is also under the Assistant Secretary's purview.

#### **Assistant Secretary for Energy Technology**

The Assistant Secretary for Energy Technology is responsible for R&D of new energy technologies to prove their technical feasibility before they are tested on a commercial scale. (Responsibility for commercialization of new technologies belongs to either the Assistant Secretary for Resource Applications or the Assistant Secretary for Conservation and Solar Applications.) Among his designated functions, the Assistant Secretary is to develop mid- and long-term energy technology development strategies; serve as the primary DOE source of energy technology information; implement assigned programs in solar, geothermal, fossil, nuclear, fusion, and other technologies; conduct nuclear waste storage activities; and support naval reactor development. Technologies being developed include:

- Solar energy systems
  - Solar electric applications (photovoltaic, ocean thermal, solar thermal electric, and wind energy conversion)
  - Technology support and utilization
  - Fuels from biomass
- Geothermal energy systems
  - Resource exploration and assessment
  - Environmental control and institutional studies
  - Hydroelectric power programs
  - Hydrothermal technology applications
  - Utilization experiments
  - Engineering research and development
  - Advanced technology applications
- Fossil energy systems
  - Coal (liquefaction, high-Btu gasification, low-Btu gasification, advanced power systems, direct combustion, advanced research and supporting technology, magnetohydrodynamics, and demonstration plants)
  - Oil shale and in situ gasification
  - Petroleum and natural gas (enhanced recovery; drilling, exploration and off-shore technology; processing; and utilization)
  - Mining research (R&D on production technology of solid fuels and coal preparation)



- Electric energy systems
- Improved conversion efficiency
- Energy storage systems
  - Water-cooled breeder reactors
  - Gas-cooled breeder reactors
  - Gas-cooled thermal reactors
  - Technology development and special projects
  - Space technology
  - Nuclear energy assessments
  - Light water reactor technology
  - Advanced isotope separation projects
- Breeder reactors
  - Clinch River breeder reactor
  - Fast flux test facility
- Naval reactors
- Fuel cycles
  - Support of nuclear fuel cycle
  - Waste management
- Light water reactor facilities, fuel storage, and international spent fuel disposition
- Magnetic fusion.

#### **Assistant Secretary for Environment**

The Assistant Secretary for Environment is responsible for ensuring that DOE's programs meet the environmental and safety standards established by federal laws, regulations, and policies. This responsibility requires that the Assistant Secretary review and approve environmental impact statements, advise the Secretary of Energy on environmental questions, and monitor DOE programs with respect to the health and safety of workers and the general public. The Assistant Secretary is also responsible for R&D in the areas of health and the environment. The Assistant Secretary's specific functions are to conduct environmental R&D, provide National Environmental Protection Act (NEPA) technical and policy guidance to DOE program and regulatory offices; prepare policy and legislative environmental impact statements; develop DOE NEPA policies and internal directives; review and comment upon environmental impact statements from other agencies; review and assess environmental, analytical, and technical products prepared by other DOE program offices; act as a link to environmental agencies and the environmental community; assure adequate health and safety measures in DOE programs; and assure implementation of health and safety measures by DOE contractors.

#### **Assistant Secretary for Intergovernmental and Institutional Relations**

The Assistant Secretary for Intergovernmental and Institutional Relations oversees DOE's relations with states, regional and local agencies, educational institutions, citizens groups, trade associations, labor unions, and corporations, and is DOE's point of contact

with Congress and the news media. The Assistant Secretary is responsible for providing mechanisms through which consumers can be heard, responded to, and appropriately involved in decision making. The Oak Ridge Technical Information Center and the Energy Extension Service are also the responsibility of the Assistant Secretary for Intergovernmental and Institutional Relations.

#### **Assistant Secretary for International Affairs**

DOE's formulation of international energy policy and participation in intragovernmental and international discussions on energy matters is the responsibility of the Assistant Secretary for International Affairs. To perform these functions, the Assistant Secretary assesses world energy price and supply trends, technological developments, and their effect on the U.S. energy supply. The Assistant Secretary also directs U.S. involvement in cooperative international energy programs, supports the development of U.S. policies on international nuclear nonproliferation and the international fuel cycle, and maintains relationships with foreign governments and international organizations.

#### **Assistant Secretary for Policy and Evaluation**

The Assistant Secretary for Policy and Evaluation formulates and recommends DOE's overall policy direction. This requires that the Assistant Secretary conduct a continual assessment of the nation's energy situation in conjunction with the evaluation of DOE's policies and programs. The Assistant Secretary is also responsible for preparing DOE's annual report and the national policy plan, in addition to developing legislative proposals to support DOE's policy objectives.

#### **Assistant Secretary for Resource Applications**

The Assistant Secretary for Resource Applications is responsible for the commercial-scale development of energy resources other than conservation and solar heating and cooling systems. A significant portion of this responsibility is the identification and resolution of institutional and other barriers that have retarded the commercialization effort. The Assistant Secretary's functions are to develop and implement voluntary and incentive programs to increase domestic energy supplies, reduce infrastructure impediments to resource development, produce and market energy resources, direct energy supply commercialization activities, manage DOE aspects of the federal energy resource leasing procedures, and administer assigned regulatory programs. As part of DOE's resource development plan, the Assistant Secretary is responsible for the national petroleum and oil shale reserves, the SPR system, and what was FEA's energy resource development program, including the Coal Loan Guarantee Program, Indian Resource Development Program, and Materials Allocation Program. DOE's energy marketing efforts include responsibility for the Bonneville, Southeastern, Southwestern, and Alaska Power Administrations, and for a transmission and marketing program. Energy commercialization programs include commercial demonstration of alternative fossil energy systems, uranium enrichment, and geothermal energy loan guarantees.

### **Economic Regulatory Administration**

ERA, a semi-independent division of DOE, is responsible for administering oil pricing, allocation, and import programs. ERA is also responsible for programs involving the conversion of oil- and gas-fired utility and industrial facilities to coal, natural gas import and export controls, natural gas curtailment priorities and emergency allocations, regional coordination of electric power system planning, and emergency and contingency planning. In compliance with the Department of Energy Organization Act, ERA is organized with separate regulatory and enforcement divisions to accomplish those two functions. ERA acts as a spokesman for policy before FERC and other federal and state regulatory agencies.

### **Energy Information Administration**

EIA's primary function is to provide the federal government with comprehensive and coordinated gathering and analysis of energy data. Included in this broad responsibility is the collection, analysis, and publication of data on energy reserves; energy demand, production, and consumption; and financial status of energy-producing companies.

Using the information it collects, EIA is responsible for analyzing long-term energy trends. Specifically, it is required to assess competition within the energy industries, capital and financial structure of energy companies, and interfuel substitution. Also, EIA is to establish a national reserves system to determine the best estimates of fuel reserves and a financial reporting system for energy-producing companies.

EIA serves as a clearinghouse for general information on energy and is also responsible for disseminating information to the public and Congress as required by the Department of Energy Organization Act.

### **Federal Energy Regulatory Commission**

FERC is an independent, five-member board responsible in part for regulating energy resources. FERC establishes and enforces rates and charges for the sale and transmission of electricity and sets rates for the transportation of oil by pipeline. FERC also sets rates and charges for the transmission and sale of natural gas and establishes and enforces curtailments of natural gas. Enforcement of provisions of the Natural Gas Act and the Federal Power Act regarding the regulation of mergers and securities acquisitions also comes under FERC's jurisdiction, as does authority to increase crude oil price ceilings in excess of the statutory ceiling or exempt petroleum products from price and/or allocation controls. FERC also hears appeals from certain denials of request for adjustments and from remedial orders issued by the Secretary of Energy.

### **Office of Energy Research**

The Office of Energy Research monitors DOE's energy R&D programs; manages the basic sciences programs, including high-energy physics; and administers financial support programs for R&D not funded elsewhere in DOE. Based on independent assessments of DOE's physical research programs, multipurpose labs, education and training research, and



the financial mechanisms used to support research, the Director of the Office of Energy Research advises the Secretary and Under Secretary on budgetary priorities. To assure that R&D activities of all the assistant secretaries are coordinated, the Director serves as Chairman of DOE's R&D Coordination Council.

#### **Other DOE Offices**

In addition to the offices involved with energy programs, there are several offices within DOE that perform legal and management functions:

- General Counsel, which assists in developing and executing program and policies, preparing legislation and legislative comments, and handling DOE litigation.
- Controller, which is responsible for DOE finance, accounting, and budgeting; program management review and control; project review; independent cost estimating; and management report systems.
- Procurement and Contracts Management, which negotiates and administers all DOE contracts and grants.
- Administration, which has personnel management responsibility.
- Inspector General, which conducts audits and investigations of DOE activities to ensure economy and prevent fraud.

Committees and boards associated with DOE include the Leasing Liaison Committee, which coordinates federal energy resource leasing policies with DOI; Military Liaison Committee; Board of Contract Appeals; and Patent Compensation Board.

#### **OTHER FEDERAL AGENCIES WITH ENERGY PROGRAMS**

##### **Council on Environmental Quality**

The Council on Environmental Quality (CEQ) was established to formulate and recommend to the President national policies to improve the quality of the environment. Because of the potential impact of energy development on the environment, CEQ has an energy program staff to initiate energy studies through the National Science Foundation (NSF) and various academic organizations. These studies address such issues as the environmental impact of oil and gas operations on the Outer Continental Shelf (OCS) off the East Coast and Alaska, effects of siting and safety of liquid natural gas facilities, impact of end uses of various types of energy, and effect of interfuel competition on environmental concerns.

##### **Department of Commerce**

Energy programs within DOC are being carried out by the Office of Energy Programs, National Bureau of Standards, Maritime Administration, U.S. Maritime Marine Academy, and National Oceanic and Atmospheric Administration. DOC's Office of Energy Programs is responsible for promoting energy conservation throughout business and industry. The programs focus on encouraging business firms to conserve energy in the operation of their

own building and manufacturing processes; emphasizing the need for industry to manufacture and market more energy-efficient products; and asking business and industry to encourage energy conservation by their employees, customers, and communities.

The National Bureau of Standards is responsible for developing computer techniques for estimating energy requirements, establishing performance criteria to evaluate solar systems designed under the Solar Heating and Cooling Demonstration Act, and conducting studies related to magnetohydrodynamics and liquid natural gas. The Bureau also oversees and coordinates energy conservation programs for buildings, appliances, and community services such as utilities.

The Maritime Administration, through its association with industry representatives, encourages the reduction of petroleum consumption through the elimination of waste, conservation of energy, and utilization of energy-efficient procedures.

The U.S. Maritime Marine Academy has started a project to develop an improved combustion technique to increase marine boiler efficiency by at least 6 percent. One of its more unique programs is a joint effort with the Office of Science and Technology, Office of Telecommunications, and DOE to develop a telecommunication plan to cut down business travel. The plan is being tested using a decentralized federal agency.

The National Oceanic and Atmospheric Administration is responsible for coastal-zone management and planning involving OCS oil and gas development, including assessment of environment and onshore impacts. This effort includes deep-water ports, coastal-zone refineries, and nuclear power plants.

#### **Department of Housing and Urban Development**

HUD is responsible for several solar heating and cooling activities. Included is the first large-scale test of solar energy, set up under the Solar Heating and Cooling Demonstration Act as a joint DOE-HUD-DOD program. The purpose of the program is to investigate the practicality of widespread use of solar energy in homes.

#### **Department of Interior**

DOI is responsible for several energy-related activities, including preparation of environmental impact statements for the leasing of federal lands and authority over Indian lands and resources. The determination of leasing of federal lands, however, is shared with DOE. The Assistant Secretary for Energy and Minerals coordinates DOI's energy-related activities and serves as DOI's spokesman on energy issues at interagency meetings and before Congress.

DOI's Office of Mineral Policy Development assesses proposed plans and programs for the development of minerals on federal lands. The recommendations provided by this office are based on forecasts of resource depletion and appraisal of mineral formations. DOI's Bureau of Land Management determines land and resource values, evaluates environmental

impacts caused by resource development, and recommends specific provisions for individual leases on the 310 million acres of federal land and 1.1 billion acres of OCS.

The U.S. Geological Survey (USGS) is responsible for classifying all public lands and examining "the geological structure, mineral resource, and products of the national domain." To obtain data for evaluating the nation's mineral resources, USGS conducts geophysical and geochemical studies, and is also involved in research and development of ways to improve resource identification and estimates. USGS data on OCS and onshore oil and gas, coal, oil shale, geothermal, uranium/thorium, and water resources are used to support DOE resource studies.

Among its other energy-related duties, USGS is responsible for establishing maximum production rates for OCS oil wells, maintaining production accounts, and preparing and publishing maps and reports of mineral resources of federal land. It maintains a Computerized Resources Information Bank designed to include both domestic and international entries on minerals and mineral resources. USGS is also responsible for administering the National Petroleum Reserve in Alaska.

DOI's Office of Water Research and Technology is responsible for several programs having critical input into energy planning. These include programs such as assessing the impact of coal mining and oil shale development on local and regional water resources, studying water conservation, developing water recycling and water reuse technologies, and modeling water supply allocation.

#### **Department of State**

The Department of State (DOS) plays an important role in the development of international energy policy. The Secretary of State works with the Secretary of Energy in the development of that policy and is responsible for conducting foreign policy relating to energy and nuclear nonproliferation.

DOS's Office of Fuels and Energy is responsible for implementing energy-related programs and coordinating these programs with other agencies. This office also provides support for U.S. participation in the International Energy Agency (IEA). This involvement has included the establishment of an oil-sharing agreement to meet the petroleum needs of IEA members in the event of an embargo, as well as the establishment of energy conservation programs within member countries.

The Office of Nuclear Energy and Energy Technology Affairs at DOS works to obtain cooperation among nations in long-term energy development projects, primarily nuclear energy safeguards and security, and works closely with other federal agencies to monitor international energy R&D. This office also provides input for U.S. participation in IEA activities.

#### **Department of Transportation**

DOT's energy program involves establishing fuel economy standards under the Motor Vehicle Information and Cost Savings Act. The Secretary of Transportation consults the



Secretary of Energy in carrying out the responsibilities associated with the fuel economy standards.

The Coast Guard, which is under DOT's jurisdiction during peacetime, has an R&D office responsible for meeting the Coast Guard's needs for new or improved equipment and procedures. The programs include R&D of energy technologies. The Coast Guard has two primary objectives in its energy R&D program:

- Conservation through the application of alternative strategies and engineering.
- Substitution of conventional energy sources by nonconventional sources, such as solar, wind, and wave energy, and development of more efficient ways to use conventional sources.

Currently, the Coast Guard's energy R&D program includes conservation projects for the cutter fleet; a solar heating and cooling demonstration program for shore facilities; and a program to develop solar-, wind-, and wave-operated power packages for aids to navigation.

#### **Environmental Protection Agency**

The Environmental Protection Agency's (EPA) mandate to protect the public's health and welfare requires that it closely monitor the environmental effects of the nation's various energy programs. EPA is required by the Clean Air Act, the Federal Water Pollution Control Act, and the Resource Recovery Act to develop the data necessary to assess the potential hazards associated with various energy technologies. To meet these requirements, EPA has four programs:

- Conversion utilization and technology assessment, a program to identify and develop technologies that will aid in the control of pollutants associated with utility and industrial combustion sources.
- Energy extraction and processing technology, a program to expedite the extraction and processing of domestic energy resources and encourage these energy sources to be used effectively in an environmentally compatible manner.
- Energy health and ecological effects, a program to identify adverse environmental effects associated with energy extraction, conversion, and use; recommend technical solutions to environmental problems; and formulate environmental control regulations.
- Technical support, a program to provide information used to establish regulations, which involves developing cooperative regional R&D projects, monitoring the development of scientific data, etc.

EPA's investigations are focused on the effects of converting oil- and gas-fired boilers to coal and increasing the use of coal and shale oil.

#### **National Aeronautics and Space Administration**

National Aeronautics and Space Administration energy programs emphasize the application of aeronautics and space program technology to energy problems. The FY 1978

energy programs are funded by DOE. These reimbursable projects include support of residential and commercial solar heating and cooling, wind energy, solar photovoltaics, and geothermal energy programs, and assessment of the Satellite Solar Electric Power Generation System.

#### **National Science Foundation**

NSF, through its Research Applied to National Needs (RANN) program, supports energy R&D in five areas: resources, environment, productivity, intergovernmental science and R&D incentives, and exploratory research and technology assessment. The FY 1978 RANN program is focused on research of renewable resources, particularly biomass conversion, and management of resource systems and nonrenewable resources.

#### **Nuclear Regulatory Commission**

The Nuclear Regulatory Commission (NRC) is the federal agency responsible for nuclear regulatory research, safeguards, and enforcement. NRC was established by the Energy Reorganization Act of 1974. The regulatory and licensing authority of the former Atomic Energy Commission were transferred to NRC, including the functions of the Atomic Safety and Licensing Board Panel, Atomic Safety and Licensing Appeal Panel, and Advisory Committee on Reactor Safeguards.

#### **Office of Technology Assessment**

The Office of Technology Assessment is responsible for providing Congress with early indications of the probable beneficial and adverse effects of technology applications. This office also identifies and analyzes alternative implementation methods, and identifies areas in which additional research or data collection is required to assess a technology program. Its research effort is coordinated with that of the Congressional Research Service, General Accounting Office, and NSF.

**APPENDIX C**  
**REVIEW OF FEDERAL ENERGY STATUTES**



## **APPENDIX C**

### **REVIEW OF FEDERAL ENERGY STATUTES**

The Department of Defense (DOD) and the Navy have become more involved in energy-related programs since the 1973 oil embargo threatened the security of the United States. This increased involvement has developed in part because of DOD's initiation of programs to guarantee the availability of energy to support the military, but also as the result of congressional and executive actions that require DOD participation in federal energy programs. This appendix summarizes laws that direct DOD action and others that indirectly affect DOD through energy pricing and allocation regulations.

#### **SOLAR HEATING AND COOLING DEMONSTRATION ACT OF 1974 (P.L. 93-409)**

The Solar Heating and Cooling Demonstration Act, approved by the president on 3 September 1974, provides for demonstration of solar heating and combined solar heating and cooling. Responsibility for implementing this program was assigned initially to the National Aeronautics and Space Administration and the National Science Foundation (NSF); however, the Energy Reorganization Act transferred the program to the Energy Research and Development Administration (ERDA). Section 5 of the act directs DOD and the Department of Housing and Urban Development (HUD) to participate in the demonstration program by installing solar equipment in facilities as directed by ERDA, now the Department of Energy (DOE).

#### **ENERGY REORGANIZATION ACT OF 1974 (P.L. 93-438)**

ERDA was created by P.L. 93-438 to coordinate all energy research and development (R&D) and to provide alternative energy sources. This act also abolished the Atomic Energy Commission (AEC) and established the Nuclear Regulatory Commission to assume AEC's licensing and related regulatory functions. An Energy Resources Council was established to advise the president and Congress and to coordinate energy policy. The Council comprised the secretaries of the Departments of the Interior (DOI) and State, the administrators of ERDA and the Federal Energy Administration (FEA), and the director of the Office of Management and Budget.

With the creation of ERDA, the energy R&D functions of several federal agencies were combined by the Energy Reorganization Act. The act merged AEC's nonregulatory functions with the functions of DOI's Office of Coal Research, the functions of DOI's Bureau of Mines associated with underground electric power transmission, NSF's functions related to solar heating and cooling and geothermal power, and the nonregulatory R&D functions of the Environmental Protection Agency.

### **ELECTRIC VEHICLE RESEARCH, DEVELOPMENT, AND DEMONSTRATION ACT OF 1976 (P.L. 94-413)**

The Electric Vehicle Research, Development, and Demonstration Act authorizes ERDA (now DOE) to establish a program to promote electric vehicle technologies and to demonstrate the commercial feasibility of electric and hybrid vehicles. As part of the demonstration program, DOD, the Postal Service, General Services Administration, and other federal agencies are directed by Section 8 of the act to incorporate electric vehicles into their fleets.

### **DEPARTMENT OF ENERGY ORGANIZATION ACT OF 1977 (P.L. 95-91)**

The DOE Organization Act provided for consolidation of ERDA, FEA, and the Federal Power Commission (FPC), as well as energy functions of DOI, DOD, HUD, Department of Commerce, and the Interstate Commerce Commission. The new department, DOE, is charged with the development and implementation of the nation's energy programs and policies, including economic regulations, energy information distribution, energy technology application, energy conservation, and energy R&D. The act establishes that DOE is to combine and direct federal activities relating to R&D on various sources of energy, and provides the basis for DOD and DOE cooperative R&D programs.

One of the purposes of P.L. 95-91 is “. . .to establish and implement through the Department, in coordination with the Secretaries of State, Treasury, and Defense, policies regarding international energy issues that have a direct impact on research, development, utilization, supply, and conservation of energy in the United States. . .” (Section 102(10)). Section 307 affects the Navy directly in that it calls for the transfer of the Naval Petroleum and Oil Shale Reserves to the DOE.

### **SOLAR ENERGY RESEARCH, DEVELOPMENT AND DEMONSTRATION ACT OF 1974 (P.L. 93-473)**

P.L. 93-473 was approved by the president on 26 October 1974. The act provides for the pursuit of a vigorous program of research to use solar energy on a commercial scale. Included is a provision for the creation of a “Solar Energy Coordination and Management Project,” which has overall responsibility for managing and coordinating a solar energy R&D and demonstration program. Unlike the Solar Heating and Cooling Demonstration Act, P.L. 93-473 does not specifically provide for DOD involvement. Some of the work funded under the act has involved use of DOD facilities, however.

### **NAVAL PETROLEUM RESERVES PRODUCTION ACT OF 1976 (P.L. 94-258)**

The Naval Petroleum Reserves Production Act represented a dramatic change in national policy toward the Naval Petroleum Reserves (NPR). The act provided that the respon-

sibility for NPR 4 be transferred from the Navy to DOI on 1 June 1977, and that the Navy produce oil from NPR 1, 2, and 3 at a "maximum efficient rate."

Procedural guidelines for the transfer of NPR 4 are included in Title I of the act along with the requirements that various studies be made. Title II addresses how the Navy should produce and sell petroleum from NPR 1, 2, and 3. (More recently, the petroleum and oil shale reserves have been transferred to the DOE.)

## OTHER LEGISLATION

Legislation affecting DOD through influence on pricing and allocation programs includes:

- Tax Reduction Act of 1975 (P.L. 94-12), which provided for the repeal of the 22 percent depletion allowance for oil and gas produced on or after 1 January 1975 (with exceptions) and eliminated the limitations on the use of foreign tax credits by oil and gas companies. These actions served to increase the cost of petroleum and petroleum products to all consumers, including DOD.
- Energy Policy and Conservation Act of 1975 (P.L. 94-163), which contains amendments (to the Emergency Petroleum Allocation Act) establishing a new oil pricing policy. The new policy establishes a three-level pricing formula for domestically produced crude oil based on an initial crude oil price rollback and gradual increases in the prices received by domestic producers over a 40-month period. The president is given broad flexibility to set prices for various categories of oil production including the authority to recommend to Congress that various products be decontrolled. The authority to decontrol provided for in this act has the potential to result in substantially higher prices for petroleum products such as jet fuels, used in large quantities by the DOD.
- Energy Conservation and Production Act (P.L. 94-385), which provides price incentives for the production of petroleum from stripper wells and other more expensive techniques. While the amount of petroleum produced by these means now represents only a small percent of what the DOD uses, this amount is expected to increase as petroleum resources diminish.



**APPENDIX D**  
**ENERGY STANDARDS AND GUIDELINES**

## **APPENDIX D**

### **ENERGY STANDARDS AND GUIDELINES**

This appendix provides an outline of consolidated energy standards contained in applicable federal regulations. Also included are additional conservation guidelines to be considered which will assist in achieving energy conservation goals without investment of additional dollars.

#### **CONSOLIDATED ENERGY CONSERVATION STANDARDS**

##### **Lighting**

During working hours, overhead lighting shall be reduced to 50 footcandles at work stations, 30 footcandles in work areas, and 10 (but not less than 1) footcandles in nonworking areas. Reductions in overhead lighting shall be accomplished with minimum practicable deviation from the specified levels. Illumination levels are to be measured at the place or places where the visual requirements are present. Furthermore, lighting measurements shall be made so as not to allow natural light to influence the footcandle reading. Work station lighting measurements shall be taken at the desk surface, typewriter surface, working surface, etc. Work area lighting measurements shall be read on the walking surface. (Reference FPMR Amendment D-48, Sec. 101-20.116, February 1976.)

##### **Cooling and Heating**

During the seasonably hot months, air cooling systems shall maintain space temperature at no lower than 78° to 80° F during working hours. Necessary adjustments shall be made to cooling system controls so that the temperature in the space shall be maintained at 78° to 80° F with no reheat, except in multizone systems where reheat is an essential element for zone control. Where this is the case, the cooling temperature shall be maintained as high as feasible to minimize the need for reheat. Furthermore, lower temperatures are permissible when obtained without cooling energy, such as with an economizer cycle. The use of heating energy to achieve the temperatures specified for cooling is prohibited.

During the seasonably cold months, heating temperature control devices shall be set to maintain temperatures of 65° to 68° F during working hours and shall be set to maintain temperatures of not more than 55° F during nonworking hours. Temperatures in warehouse and similar space shall be adjusted lower than the 65° to 68° F range depending on the type of occupancy and the activity in the space. Higher temperatures than those specified for heating are permissible when obtained with normal building operation heat gains, such as solar energy, etc. The use of cooling energy to achieve the temperatures specified for heating is prohibited. (Reference FPMR Amendment D-48, Sec. 101-20.116, February 1976.)

Exceptions to the policies prescribed for cooling and heating as well as for lighting may be necessary for protecting and operating certain specialized equipment such as computers, maintaining the health and efficiency of employees, and maintaining certain installations of high specialization such as greenhouses, hospitals, guard stations, and laboratories. Such exceptions may be granted only after consultation with appropriate technical personnel of the unit requesting the exception and the presentation of necessary supporting evidence. Exceptions will be granted by the office responsible for the operation and maintenance of the facility, and must be concurred in by the official's energy conservation coordinator. (Reference FPMR Amendment D-48, Sec. 101-20.116, February 1976.)

#### **Water Temperatures (Excluding Family Housing)**

Actual measured water temperature delivered to the user will not exceed 100° F in:

- All latrines, heads, and toilet facilities without showers or tubs.
- Buildings with only a few showers and/or showers having a low frequency of use, e.g., duty officer room.

Actual measured water temperature delivered to the user will not exceed 110° F in:

- All latrines, heads, and toilet facilities with showers or tubs.
- In buildings such as BOQs and BEQs where there is both heavy and frequent use of the bathing facilities and there is a common hot water supply system for toilet facilities with and without showers or tubs. Where laundry facilities exist, occupants should be advised to use "cold water" type detergents if washing difficulties are encountered.

In buildings operated on a nominal 40-hour week or in buildings operated on a nominal two-shift basis (either 5- or 7-day week), a clock or other automatic control shall be installed on the domestic hot water circulating pump or pumps to permit operation only during periods of actual occupancy plus 30 minutes prior and 30 minutes after normal working hours.

In some older buildings or in some unusual cases, it may be necessary to do more than reset existing temperature controls. In some cases, added storage tanks, temperature blending equipment, or separate lines might be required. Where the aggregate of this work on any one installation meets the minimum requirements for the Energy Conservation Investment Program (ECIP), consideration should be given to including the work under this program provided the ECIP amortization guidelines can be met.

It is not intended that there be any modification of the temperature of hot water used for dishwashing in dining halls and other food service areas, or hot water used in medical and dental facilities. (Reference ASD (I&L) memo of 15 March 1977 to distribution.)



## Vehicle Procurement

Beginning in FY 1978, procurement of new sedans and station wagons will be governed by the following EPA average miles-per-gallon standards:

Year	Fuel Economy Standard (miles per gallon)
1978	20
1979	22
1980	24
1981	26
1982	28
1983	30
1984	31

(Reference Energy Policy and Conservation Act of 1975 (P.L. 94-163) as expanded by Secretary of Transportation Regulation 42F.R. 33533, 33552, June 30, 1977, and as modified by Executive Order 12003, July 20, 1977.)

## Car Pooling

Agencies shall encourage the conservation of energy by taking positive action to increase car pooling. The following policies shall be reflected in agency plans:

- **Parking.** In assigning all parking spaces assigned to or controlled by each agency, the following policies shall be observed:
  - Agencies shall give first priority to official and visitor parking requirements.
  - Severely handicapped government employees for whom assigned parking spaces are necessary shall be accommodated.
  - A goal of not more than 10 percent of the total space available for employee parking on an agency-wide basis (excluding spaces assigned to severely handicapped) shall be assigned to executive personnel and persons who are assigned unusual hours.
  - All other spaces available for employee parking shall be made available to car pools to the extent practical.
  - Those parking spaces reserved for car pools shall be assigned primarily on the basis of the number of members in a car pool.
  - For the purpose of allocation of parking spaces for car pools, full credit shall be given to any regular member regardless of where he is employed except that at least one member of the car pool must be a full-time employee of the agency.
- **Two-wheeled vehicles.** Subject to the availability of satisfactory and secure space and facilities, agencies shall reserve areas for the parking of bicycles and other two-wheeled vehicles. Bicycles shall be given special consideration including storage type space in buildings and improved bicycle locking devices where practical and appropriate funds are available. Bicycles shall not be transported on elevators or via stairways, or parked in offices.
- **Regular hours.** Agency managers and supervisors shall make every effort to maintain regular arrival and departure times for all employees. Supervisors are reminded

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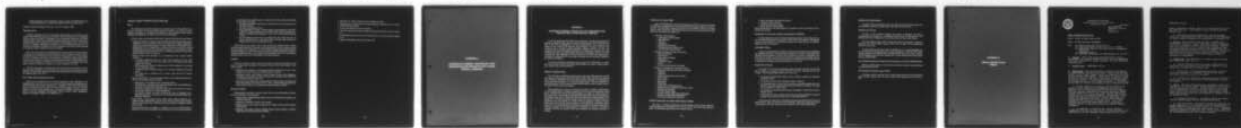
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of their prerogative, within overall agency policy, to adjust the scheduled duty hours of individual employees to facilitate car pooling and the use of mass transit.

(Reference FPMR Amendment D-52, Sec. 101-20.117, February 1976.)

#### **Discharge of Oil**

All Navy commands, activities, and facilities shall conform to the provisions of the Federal Water Pollution Control Act, as amended, and the Oil Pollution Act, as amended, insofar as these acts prohibit the discharge of oil and hazardous substances. The Federal Water Pollution Control Act, as amended, prohibits discharge of oil and oil wastes in the navigable waters of the United States, including the 9-mile contiguous zone. The Oil Pollution Act, as amended, implements the provisions of the International Convention for the Prevention of Pollution of the Sea by Oil, 1954, as amended. Its provisions restrict discharge of oil and oily wastes in specified sea areas worldwide.

Oil or oily wastes shall not be discharged from any Navy activity or ship within any "prohibited zone." Prohibited zones are prescribed in the Oil Pollution Act and 33 CFR. It is noted that the prohibited zone for the United States is designated as waters within 50 miles of the U.S. coastline. In some cases, for other nations, the distance is greater than 50 miles. Any reduction or extension of the zones described under the terms of the International Convention for the Prevention of Pollution of the Sea by Oil, 1954, as amended, will be published in Notices to Mariners as issued by U.S. Coast Guard and U.S. Navy.

The Navy's major goal, to be achieved not later than the end of this decade, is the complete halt of all discharges of oil and oily wastes into streams, harbors, and oceans by naval shore activities and vessels. (Reference OPNAV Instruction 6240.3E, Environmental Protection Manual, dated 5 July 1977.)

#### **Use of Least Fuel-Consumptive Carriers**

Carriers are to be selected with a view toward proximity of carrier equipment to the shipping activity, most direct service from origin to CONUS destination, and minimal positioning or repositioning of carrier equipment in a "Deadhead" status. When more than one mode or more than one carrier within a mode can provide adequate service for a specific shipment at the same lowest aggregate cost, the least fuel-consumptive carriers and modes should be selected. (Reference NAVSUPINST 4600.70, Military Traffic Management Regulation, paragraphs 102002.1C and 202003C (2.1).)



## GENERAL ENERGY CONSERVATION GUIDELINES

### Shore

The utilization of government buildings after working hours by small numbers of personnel for nonessential activities (recreational, educational, religious, etc.) will be reviewed to eliminate, consolidate, or reschedule where possible to achieve maximum energy savings. Marginal-use buildings will be removed from service and dismantled.

Functions, areas, and conditions where electric resistance heating may be used include:

- Family housing where a bathroom has been added and the existing heating system is inadequate to heat the addition (when the heating system requires replacement, restudy the overall heating situation), or where a bathroom has been added and it is unreasonable from the engineering or economic position to extend the existing heating system to the new area. (All electric resistance or infrared heaters in family housing bathrooms shall be controlled by an occupant-activated time switch with a maximum time setting of 30 minutes.)
- Family housing served exclusively by the Bonneville Power Authority (BPA) provided:
  - A detailed engineering study has shown electric heating to be the most economical method on a life-cycle cost basis with the full added demand charge costed in the housing.
  - BPA has stated in writing that adequate power will be available for the housing for the foreseeable future.
  - Thermostats with a maximum setting of 75° F are used throughout the housing project.
  - The living room is equipped with a positive cutoff above 65°F outdoor temperature.
- Small remote facilities where the individual facility (total building) heating load is less than 125,000 Btu per hour provided:
  - Natural gas is not available within a reasonable distance.
  - The facility has a maximum total energy consumption of less than 60,000 Btu per square foot per year (around-the-clock use).
  - The facility is equipped with thermostats with a maximum setting of 75° F and a positive cutoff above 65° F outdoor temperature.
  - All facilities occupied less than 168 hours per week be equipped with a temperature set back to a maximum of 50° F during all unoccupied periods (e.g., nights and weekends).
- Small offices or duty stations located within larger unheated buildings (e.g., warehouse office, dispatch office in a motor pool, duty room in an armory or reserve facility), requiring less than 15,000 Btu per hour provided the conditions outlined above are met.
- Noncritical fuel areas in buildings or facilities of any size if located where a minimum of 85 percent (calculated on an annual basis) of the total power generated

or purchased by the supplying utility is obtained from hydro, nuclear, geothermal, or coal sources, provided:

- An engineering analysis indicates electric heating to be the most economical on a life-cycle cost basis.
- The above requirements are met.
- Heat is generated "off peak" through storage of low-temperature water (190° to 200° F) or medium-temperature water (280° to 300° F) and is used directly or indirectly (through a heat exchanger), as a source for a water source heat pump, or both.
- For all buildings having exhaust air totaling more than 2,000 cubic feet per minute, heat recovery (e.g., run-around system, heat pipe, plant type heat exchanger) shall be used to preheat make-up air.

Where facilities are heated at 68° F and an individual employee with a medical problem presents a physician's statement that the employee must work in a warmer environment, soft heating with a maximum of 1.5 kW of electric heating is authorized provided the auxiliary heating unit is turned off during all nonworking periods and an effort is made to relocate the employees desk or work station away from windows and doors. Consideration should be given to the use of infrared lamps as a possible solution.

#### **Vehicles**

There are a number of actions that are to be taken to reduce the consumption of all types of transportation equipment to a minimum consistent with mission support. These actions include:

- Reducing vehicle mileage to a minimum through the increased use of buses, vehicle pooling, taxi service, bicycles, and walking wherever practical.
- Maintaining vehicle fuel efficiency through adequate tuneups, wheel alignments, lubrication, and tire inflation. Vehicle tune-ups will be conducted every 12,000 miles or 12 months, whichever comes first.
- Operating vehicles efficiently by using the lightest vehicle practical, enforcing speed limits, and offering driver education clinics. Also, consider mileage-per-gallon-per-driver contests and other such energy conservation awareness publicity.

#### **Aircraft and Ships**

General actions to be taken to conserve energy used in air and ship operations include, but are not limited to, where practical:

- Energy-efficient steaming/flying speeds and courses during normal transiting and underway operations.
- Minimal hot refueling of aircraft where possible.
- Minimal levels of fuel carried on aircraft ferry flights and for carrier airborne tanker aircraft.
- Shipboard conservation practices including efficient boiler operation, freshwater conservation, and boiler feed-water reduction.

- Maximum use of shore utilities (cold iron facilities) by ships.
- Maximum use of energy-efficient training approaches (simulators, etc.) as operational requirements permit.
- Periodic hull inspections and hull cleaning.
- Automatic operational procedures (flight planning, ship/aircraft routing, training, etc.)
- Fuel management practices that will minimize fuel loss from ship fuel tank stripping at sea.
- Necessary maintenance support in all other areas.



**APPENDIX E**

**COOPERATIVE ENERGY TECHNOLOGY AND  
DEMONSTRATION PROJECTS WITH OTHER  
FEDERAL AGENCIES**

## **APPENDIX E**

### **COOPERATIVE ENERGY TECHNOLOGY AND DEMONSTRATION PROJECTS WITH OTHER FEDERAL AGENCIES**

To provide operational naval forces with the equipment, procedures and energy forms required to achieve the energy objectives and goals promulgated in OPNAVINST 4100.5A, dated 9 May 1978 (see Appendix F), the Navy depends heavily on the technology base created by both national and industrial energy programs. The major portion of this technology base is acquired through information exchange. However, the Navy does cosponsor joint energy technology development and demonstration programs with other federal agencies when such cosponsorship is particularly advantageous to the Navy's role as an energy user. Most agreements of this type involve the use of the Navy operational environment as a testing ground for new energy technologies that are particularly suitable for the nautical environment.

The various cooperative arrangements are discussed by the federal agency or component involved under the three Navy energy R&D strategies they support: energy conservation, synthetic fuels, and self-sufficiency.

#### **ENERGY CONSERVATION**

The Navy shares considerable common interest with other federal agencies in meeting the energy conservation goals specified in Executive Order 12003. The Navy also maintains close cooperative relationships with those federal agencies responsible for developing the various conservation segments of the national energy program. Within the framework of these relationships the Navy conducts its applied R&D program to meet its energy conservation goals for ships, aircraft and facilities.

When agreement on the scope of a particular joint project is reached, a Memorandum of Understanding (MOU) is prepared and approved by the Navy and the appropriate federal agency. Interaction between the Navy and the agency with respect to a given project may take several forms. The exchange of technical information between the two organizations is encouraged through direct working level contact and information exchange groups. Other possible forms of interaction are the sharing of resources (such as personnel, facilities, or equipment) or the joint funding of a project. When an agreement is reached to transfer funds, fund a project jointly, or share resources, it is documented in an Interagency Agreement (IA). An IA, which identifies the working level personnel in each agency, promotes information exchange, and provides guidelines for exchange of resources. A number of cooperative activities are specified under these guidelines and increased interaction is enjoined.



## **Department of Energy (DOE)**

Under a DOD/DOE MOU, the Navy has cosigned three MOUs with those components of DOE that are developing most of the conservation technology anticipated to be useful to the Navy. This technology is expected to be most useful for facilities, while also providing benefit to ships and aircraft. The DOE divisions and the areas of technical interest within them that are involved in the MOUs are:

- Division of Power Systems
  - Components and heat engines
  - Heat utilization
  - Fuel cells
  - Combustion
  - Materials and fabrication
  - Thermodynamics and heat transfer
  - Controls and process efficiency
- Division of Industrial Energy Conservation
  - Industrial processes
  - Heat recovery
  - Heat pump technologies
  - Cogeneration
  - Technology transfer
  - Surveys
  - Innovative energy-saving technologies
- Division of Buildings and Community Systems
  - Energy data gathering and analysis techniques
  - Infiltration
  - Ventilation
  - Energy monitoring and control systems
  - Heat recovery
  - Service water
  - Illumination
  - Heat pumps
  - Energy used in building processes
  - Standard testing of building components/systems
  - Thermal mass utilization
  - Innovative shelter design
  - Innovative shelter energy-saving technologies
  - Innovative energy-saving methodologies
  - Construction methods and materials.

## **National Aeronautics and Space Administration (NASA)**

The Navy is currently monitoring the NASA-funded Aircraft Energy Efficiency (ACEE) Program that was initiated in FY 1976, as well as other aircraft technology programs. The following technical areas are of specific interest:



- Engine and engine component development
- Composite aircraft structures
- Advanced aerodynamics design
- Energy-efficient transport design

Many technical aspects of the ACEE program are valuable to the Navy's planning for an advanced patrol aircraft.

#### **Department of Commerce, Maritime Administration (MARAD)**

The Navy maintains an active information exchange program in ship energy conservation with MARAD, particularly in the areas of prime movers and propulsors. Although the current level of interaction is information exchange, joint testing activities of MARAD-deployed systems are envisioned.

#### **SYNTHETIC FUELS**

As part of the national energy program, efforts are being directed towards establishing the technology required for the commercial development of synthetic liquid hydrocarbon fuels derived from domestic sources of coal, oil shale and tar sands. In cooperation with DOE, the role of DOD is to encourage the production of synthetic fuels for military use and to become an informed customer for the products of the developing synthetic fuels industry by assessing the suitability of these synthetic fuels for service use.

#### **Department of Energy**

An IA (EF-77-A-01-2730) was negotiated between NAVMAT and ERDA (now DOE) for the conduct of a program entitled "Shale Oil Production, Refining, and End Use Testing." The principal program objectives of this IA are:

- To produce full-specification military fuels in sufficient quantities for significant operational testing.
- To produce such fuels under commercial refinery conditions.
- To accumulate data on the extraction technology, processing requirements, yield, economics, and other parameters that effect the utilization of domestic crude shale oil as a feedstock for military fuels.
- To determine the operational and hardware compatibility of shale-derived fuels in military systems.
- To determine the extent to which current fuels and system specifications should be modified to best utilize fuels derived from crude shale feedstocks.

The initial project under this IA will utilize crude shale oil produced from the Naval Oil Shale Reserves, using the Paraho retorting technology. Additional refining and end-use testing projects will utilize crude shale oils produced by other retorting technologies.

## **ENERGY SELF-SUFFICIENCY**

Interagency MOUs and agreements have been signed in the following technology areas: coal utilization, geothermal, energy storage, solar, and refuse-derived fuel.

### **Department of Energy**

The Navy, in an IA signed in October 1976, agreed to participate with DOE in demonstrating the feasibility of a fluidized-bed boiler central coal heating plant. This demonstration will be conducted at the naval base located at Great Lakes, Illinois.

The Naval Weapons Center (NWC), China Lake, California, has signed a cooperative agreement (No. E(49-27)-1006) to support DOE's effort to assess the Coso geothermal resource at China Lake.

The Naval Research Laboratory (NRL) in Washington, D.C. is performing R&D support for DOE in the following areas: bulk storage (Agreement No. E(49-28)-1024), battery storage (Agreement No. E(49-28)-1003), and ocean thermal electric conversion—determining environmental impact and flow characteristics of ocean thermal power plants (Agreement No. E(49-26)-1005).

### **Army Mobility Equipment Research and Development Command (MERADCOM)**

NWC is providing support to the photovoltaic utilization program being administered by MERADCOM for DOE.

### **Environmental Protection Agency (EPA)**

A process to convert municipal waste to high octane gasoline has been developed by NWC with EPA funding. This work was completed under Agreement No. EPA-(AC-07-078).



**APPENDIX F**

**OPNAV INSTRUCTION  
4100.5A**





DEPARTMENT OF THE NAVY  
OFFICE OF THE CHIEF OF NAVAL OPERATIONS  
WASHINGTON, D.C. 20350

IN REPLY REFER TO

Ser 00/500242  
OPNAVINST 4100.5A  
Op-413  
9 May 1978

OPNAV INSTRUCTION 4100.5A

From: Chief of Naval Operations

Subj: Energy Resource Management

Ref: (a) Navy Energy Plan of 26 Jan 77  
(b) Executive Order 12003 of 20 Jul 77 (NOTAL)  
(c) NAVSUPINST 4600.70, Military Traffic Management Regulation  
(d) OPNAVINST 4100.6  
(e) DOD-ERDA Memorandum of Understanding of 15 Jan 77

1. Purpose. This instruction provides policy, goals, objectives, and assigns responsibilities for the management of energy resources for ships, aircraft, vehicles and shore installations.

2. Cancellation. OPNAVINST 4100.5.

3. Background. Many of the Navy's current and projected military systems use petroleum fuels. These fuels are projected to be in short supply within the expected life cycle of the systems they support. This source of energy is also subject to interdiction and to capricious economic actions by foreign nations. The diminishing sources of petroleum and escalating prices could impact seriously on the ability of the Navy to fulfill its primary mission responsibilities.

a. Energy conservation efforts through FY1977 have realized a 27% reduction in consumption since FY1973. However, 60% of these savings have resulted from reduced ship and aircraft strengths and reduced operating tempos. Further reduction of this type would degrade operational readiness to an unacceptable degree. Accordingly, future energy savings must be obtained through improvements in energy conversion efficiencies, use of energy efficient procedures and reduction of energy waste. Fuel saved through more efficient operations can be utilized to increase levels of operating tempos and thereby improve readiness.

b. In addition to conservation, energy resource management requires rational use of critical materials, and substitution of more abundant energy forms such as coal,

solar, geothermal, refuse, waste oil (contaminated fuel oil and used lube oil), and synthetic fuels for petroleum and natural gas.

c. The Navy's energy organization, energy programs, historical consumption data and initiatives to be undertaken to reduce energy consumption are described in reference (a).

4. Policy. Every effort shall be made to achieve the objectives and goals of this instruction without compromise to military readiness, safety, and effectiveness. Waivers from this requirement due to operational commitment should be sought directly from the Chief of Naval Operations via the appropriate administrative chain of command. Except for specific projects the resources required to execute this direction are considered to be within assets currently available or programmed.

5. Objectives. The objectives of energy resource management within the Navy are to:

a. Achieve maximum practical energy conservation for facilities and operations with particular emphasis on conservation of petroleum and natural gas.

b. Substitute, when economically practical, alternative, more abundant or renewable energy sources where petroleum and natural gas are now used.

c. Consider the effect of energy policy and actions on the health, welfare, and safety of Navy personnel and the environment.

6. Goals. The Navy Energy Resource management goals are in support of the federal energy program outlined in reference (b) and DOD energy programs. Accomplishment of the goals will be measured at the activity level except where noted. Every effort shall be made to achieve these goals by 1985. Goals are measured from the 1975 baseline (1 October 1974 to 30 September 1975):

a. Existing Facilities: 20 percent energy use reduction per gross square foot of building floor area.

b. New Facilities: 45 percent energy use reduction per gross square foot to be achieved in all new construction design specifications measured relative to FY 1975 designed average energy consumption per gross square foot. (Approved projects underway on effective date of this instruction will be accommodated through the retrofit program).

c. Ground support equipment energy savings of 15 percent.

d. 20 percent reduction in fossil fuel energy consumption per ship underway steaming hour.

e. 90 percent reduction in fleet and shore fuel surveys.

f. 5 percent reduction in fossil fuel energy consumption per flight hour.

g. 9 percent energy savings per year by 1985 through simulator substitution. (Measure at overall Navy level)

h. Substitution of more abundant or renewable energy forms for petroleum or natural gas used ashore, culminating in a total substitution of 5 percent. (Measure at overall Navy level)

7. Action. The following specific actions will be taken by responsible commanders:

a. Office of the Chief of Naval Operations

(1) The Deputy Chief of Naval Operations (Logistics) or his designee shall:

(a) Have responsibility for establishing policy, directing, coordinating, and monitoring the energy program within the Navy.

(b) Include energy resource requirements in the POM.

(c) Establish requirements for development of new methods and technology relating to energy conservation and alternate energy sources.

(d) Assure effective coordination with the Department of Defense and other government agencies involved in energy resource management.

(2) The Director, Research, Development, Test and Evaluation shall implement the CNO's responsibilities with respect to planning, programming and appraising the Energy R&D program. He recommends funding profiles which give proper weight to energy R&D requirements within the context of the total Navy R&D budget.



(3) Deputy Chiefs (DCNO's) and Directors of Major Staff Offices (DMSO's) of Naval Operations shall:

(a) As Program Sponsors, make provisions in their respective plans, programs, and budgets for improving management of energy resources consistent with the provisions of this instruction.

(b) Incorporate an energy effectiveness review into the system acquisition and planning process. All Navy systems in the program initiation, demonstration and validation, full-scale engineering development, and production and deployment phases will be subject to this review. The objective is to integrate energy consumption data as an element of operating and support cost in the Life Cycle Cost (LCC) and Design to Cost goals. These energy effectiveness reviews will include major systems, components, and sub-systems within the acquisition process.

(4) The Chief of Information (CHINFO) shall coordinate and supervise the release of information concerning energy resource matters to internal and external publics through appropriate media.

b. Major Claimants shall:

(1) Establish energy resource management plans to achieve the objectives and goals of this instruction, and to comply with the shore, vehicle, ship and aircraft energy standards as promulgated by the Chief of Naval Material. Insure subordinate commands and activities initiate similar plans.

(2) Assign line responsibility for energy resource management. The assignment will be a primary or major collateral duty.

(3) Identify, submit, and implement projects for the most effective conservation actions.

(4) Include in contract pre-award surveys and negotiated procurement evaluation factors the consideration of energy consumption, and availability of alternate energy sources.

(5) Use the least fuel-consumptive carriers and modes of transportation in accordance with reference (c).

(6) Discontinue the disposal of waste oils as road cover and minimize where possible the sale of waste oils to commercial vendors.

(7) Maximize availability of shore power and steam for utilization by ships in port. Include projected requirements in "MILCON" requests.

c. Chief of Naval Material shall:

(1) Provide the necessary criteria, operations and maintenance standards, management guidance and engineering expertise necessary to identify and implement those shore facilities conservation actions which will best assist the Major Claimants in meeting the objectives and goals of this instruction.

(2) Develop and provide design criteria necessary to achieve 45% energy use reduction goal for new buildings outlined in paragraph 6b.

(3) Promulgate procedures for the collection, reprocessing, recycling, blending, and burning of waste oils in land based Navy combustion equipment.

(4) Analyze and recommend where economical and practical the use of alternative, renewable energy sources or more abundant non-renewable energy sources, when constructing new facilities/systems or replacing existing facilities/systems. At a minimum compliance with reference (d) is required.

(5) Maintain and validate energy consumption data, flying hour data, and steaming hour data, as part of the Navy Energy Usage Profile and Analysis System (NEUPAS).

(6) Review all proposed agreements on energy R&D matters between Navy activities and organizations outside the Navy to ensure conformity with Navy mission requirements, policy, and objectives. Final approval authority and coordination responsibility for all such agreements will reside with the Chief of Naval Material. Ensure that all such agreements with Department of Energy (DOE) conform with the terms of reference (e).

(7) Develop Contract procedures for consideration by the Armed Service Procurement Regulations (ASPR) committee

directed at minimizing procurement interruptions in time of energy shortage.

(8) Conduct R&D to develop new methods and technology relating to energy conservation and alternate energy sources.

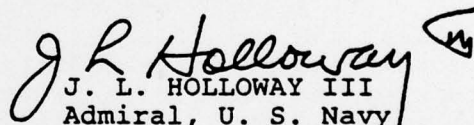
(9) Act as the Defense Energy Information System (DEIS) administrator, responsible for liaison with Defense Logistics Agency (DLA) and Major Claimants to insure that energy consumption reporting is timely and accurate.

d. Inspectors General shall, during command inspections:

(1) Review the effectiveness of the organization established by the Command to review and control Command energy conservation actions and programs.

(2) Review the Command's implementation of conservation recommendations made by the Engineering Field Divisions (EFDs) during their Energy Conservation Surveys.

(3) Review the Command's monitoring for accuracy of DEIS data and verifying that their activities are reporting only approved baselines.

  
J. L. HOLLOWAY III  
Admiral, U. S. Navy  
Chief of Naval Operations

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