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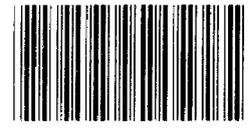
Report To The Secretary Of Defense

Improved Energy Management In The Facility Design Process Should Reduce Operating Costs For DOD

DOD spends billions of dollars annually for the energy its buildings consume. DOD's efforts in recent years have reduced buildings' energy use, but more needs to be done to better insure that new buildings are designed and constructed to be energy efficient. GAO found that:

- DOD was providing building designers unrealistic energy usage objectives.
- The services have issued inconsistent energy design guidelines.
- The Army and Navy implemented energy conservation requirements differently, inadequately controlled and reviewed designers' submissions, and selected designers without proper attention to their energy conservation expertise.

GAO is recommending actions to better insure the design of energy efficient military buildings.



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UNITED STATES GENERAL ACCOUNTING OFFICE
WASHINGTON, D.C. 20548

PROCUREMENT, LOGISTICS,
AND READINESS DIVISION

B-210614

The Honorable Caspar W. Weinberger
The Secretary of Defense

Attention: Office of GAO Report Analysis

Dear Mr. Secretary:

This report discusses the efforts by the Department of Defense to design energy efficient buildings for military use and the need for improved procedures in this regard. We made this review because of problems in the Department's establishment and implementation of building energy usage goals and because of the significant annual expenditures for military buildings' energy use.

This report contains recommendations to you on pages 16, 17, and 33. As you know, 31 U.S.C. § 720 requires the head of a Federal agency to submit a written statement on actions taken on our recommendations to the House Committee on Government Operations and the Senate Committee on Governmental Affairs not later than 60 days after the date of the report and to the House and Senate Committees on Appropriations with the agency's first request for appropriations made more than 60 days after the date of the report.

We are sending copies of this report to the Chairmen of the above Committees, the House and Senate Committees on Armed Services, and the Subcommittees on Energy and Natural Resources and on Energy Conservation and Power of the House Committee on Energy and Commerce. We are also sending copies to the Director, Office of Management and Budget, and the Secretaries of the Army, the Navy, and the Air Force.

Sincerely yours,

A handwritten signature in cursive script that reads "Donald J. Horan".

Donald J. Horan
Director



D I G E S T

Energy management methods used by the Department of Defense (DOD) in the design process do not insure that the most economical, energy efficient, new buildings are built for military use. While DOD has developed energy guidelines, set energy usage objectives (referred to by DOD as energy budgets), and required energy analyses of designs in order to reduce energy usage in new facilities, these actions are not insuring that energy reduction goals are being met.

GAO found that:

- Energy budgets do not provide a means for determining whether design goals have been met.
- Energy guidelines are inconsistent among the services, and the Army and the Navy implement conservation requirements differently.
- Energy analyses are not always submitted by the architect-engineer, although required; those received are not being adequately reviewed; and the Army and Navy construction agencies are not insuring that errors in them are corrected.
- The Army and Navy are not always insuring that firms hired have the expertise needed to design energy efficient facilities.

ENERGY BUDGETS NEED TO BE REVISED

Energy budgets are DOD's estimates of the annual amount of energy required, in terms of British thermal units per gross square foot (Btu/sq. ft.), to heat, cool, and light space and produce hot water in its facilities. DOD developed the budgets as one method to insure that designers design new facilities to be energy efficient and to reduce the energy they

consume. Executive Order No. 12003, dated July 20, 1977, set a goal, to be achieved by 1985, to reduce new facility energy use by 45 percent compared to 1975 use. (See pp. 1 and 13.)

Energy budgets are inadequate for comparing the design objectives with the estimated energy usage of designs or with actual energy use because not all the variables are included. For example, budgets are not adjusted to consider actual planned hours of operation or occupancy, removal of heat generated by special equipment to be installed or used in the facilities, or local environmental and operating conditions. As a result, design firms are given energy design objectives which do not realistically represent the planned operation of the buildings in their locations. (See pp. 8 to 12.)

The existing budgets were set in March 1979 to use until better data became available and more realistic design objectives could be set. Although better data has been available for some time, the budgets have not been revised and are still considered as interim. According to DOD, administrative problems have prevented new budgets from being issued. (See pp. 8, 13, and 14.)

ENERGY REQUIREMENTS ARE INCONSISTENT
AND ARE IMPLEMENTED DIFFERENTLY

The services have not consolidated their energy requirements and guidelines into a single document. Design firms find some energy requirements in their contracts and other requirements and guidelines specified in numerous technical letters and instructions. These documents are sometimes inconsistent, especially among the services. For example, the Air Force has set standard assumptions for hours of operation for its facilities, whereas the Army and Navy have not. This is significant because the Army and Navy administer the design contracts and review the designs for most Air Force projects. The differences in guidance create confusion not only within the design firms, but also on DOD's design review staffs. (See pp. 1, 2, 10, 19 to 24, 30, and 31.)

The Army and Navy field offices have established different methods, such as guidelines, procedures, and organizational structures, to implement energy conservation requirements for new facilities. While each field activity has developed its own organizational structure, each has designated at least one individual to oversee energy conservation issues. (See pp. 19 to 24.)

QUALITY ASSURANCE OVER THE PREPARATION,
REVIEW, AND CORRECTION OF ENERGY ANALYSES
IS INADEQUATE

Analysis of facility designs is the primary method services use to insure that facilities are energy efficient. These analyses are generally computer simulations of design decisions, which are supposed to be based on DOD's energy conservation requirements and the users' mode of operations. The analyses are to include alternative heating, ventilating, and air-conditioning systems to insure that the most appropriate systems are selected. (See p. 1.)

But according to Army and Navy records, many energy analyses were not prepared, reviewed by their engineers, or corrected when reviewers found significant deficiencies. In addition, analyses contained errors and omissions which Army and Navy engineers had not identified. As a result, there are no assurances that designers are designing facilities as required by DOD. (See pp. 24 to 29.)

MORE EMPHASIS ON ENERGY EXPERTISE
IS NEEDED IN SELECTING DESIGNERS

In October 1980, GAO recommended that Federal agencies evaluate computer capabilities and expertise when hiring design firms for projects requiring computer-aided methods, such as energy analyses. DOD strongly concurred. Still, GAO found on its current review that although energy analyses were required, the Army and Navy generally had not stated the need for energy analysis expertise when advertising for design services or when interviewing firms. (See pp. 31 and 32.)

DOD needs to (1) insure that designers clearly understand the energy conservation requirements and can meet them and (2) strengthen control over designs and their review to insure that energy conservation has been adequately considered in designs. (See p. 32.)

RECOMMENDATIONS

GAO recommends that the Secretary of Defense:

- Develop and issue new DOD energy budgets for the various building types and climatic zones and rescind the interim budgets.
- Issue guidance to the services clearly describing all the factors and assumptions used to calculate the budgets and how they are to be used.
- Require the services to perform additional energy analysis to take into account local environmental conditions, operations, and special project characteristics not considered in the budgets which might significantly affect energy usage.
- Require the services to consolidate, for easy reference, all the energy conservation requirements applicable to facility designs. (See p. 17 for additional recommendations.)

GAO also recommends that the Secretaries of the Army and the Navy direct the Chief of Engineers, Army, and the Commander, Naval Facilities Engineering Command, to:

- Establish quality assurance procedures over energy analyses to insure that all are properly reviewed for completeness and reasonableness and that design firms correct all significant errors and omissions in them.
- State, when appropriate, that energy conservation expertise is a significant factor in the selection process and require that such expertise be evaluated during the selection process when the contract requires an energy analysis. (See p. 33 for additional recommendations.)

AGENCY COMMENTS

DOD generally concurred in GAO's findings, conclusions, and recommendations. (See pp. 17 and 33.)

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ABBREVIATIONS

A/E	architect-engineer
AFB	Air Force Base
BLAST	Building Loads Analysis and System Thermodynamics
Btu/sq. ft.	British thermal units per gross square foot
DOD	Department of Defense
DOE	Department of Energy
EIC	engineer-in-charge
GAO	General Accounting Office
NAVFAC	Naval Facilities Engineering Command
TRACE	Trane Air Conditioning Economics

CHAPTER 1

INTRODUCTION

In 1973, before the Federal energy conservation program, the Department of Defense (DOD) established a program to design new housing facilities to consume less energy. On July 20, 1977, the President issued Executive Order No. 12003 requiring that all Federal agencies reduce, by 1985, the energy consumed in all new buildings by 45 percent based on the average 1975 consumption in similar buildings.

DOD anticipated being required by law to use the Building Energy Performance Standards, known as energy budgets, by the Department of Energy (DOE). On March 1, 1979, DOD issued guidance requiring the services to use its energy budgets in designing new facilities. These budgets were based on modified DOE energy performance standards for commercial and private facilities. The budgets represent the amounts of energy that should be used in 1 year for each gross square foot of a facility. According to DOD, use of these budgets will help DOD achieve the 45-percent reduction.

DOD's energy budgets are its estimates of the annual amount of energy to heat, cool, and light the space and heat the water for the facilities being designed. However, the budgets are based on average annual energy usage and not the number of hours facilities will be operated or occupied. Architect-engineer (A/E) firms and military designers are required to use or consider using the energy conservation features in DOD and services' publications. These include DOD's "Construction Criteria" manual (DOD 4270.1M) and other documents; the Naval Facilities Engineering Command's (NAVFAC'S) "Technical Guidelines for Energy Conservation in New Buildings"; the Army Corps of Engineers' engineer technical letters on energy conservation; the Air Force Directorate for Engineering and Services' "General Design Instruction No. 1, Military Construction Programs"; and other documents issued by the services.

Facility designers also must analyze their designs to estimate the annual energy usage and determine whether the designs meet the energy budgets. The analyses are generally computer simulations of design decisions based on DOD's energy conservation requirements and users' mode of operations. The analyses include alternative heating, ventilating, and air-conditioning systems to insure that the most appropriate ones are selected.

DOD's use of energy budgets affected the military construction programs for fiscal year 1981 and subsequent years. Fiscal years before 1981 were not affected because the designs for facilities in these years were completed before use of energy budgets was required. Because the designs for new facilities are started about 2 years before the construction

program year, the fiscal year 1983 military construction program request contains many facilities that are being designed using energy budgets. The following table shows the requested construction funds for classes of facilities being designed using energy budgets, excluding family housing.

Fiscal Year 1983 Military Construction Funds
Requested for Facilities Being Designed
Using Energy Budgets

<u>Type of facility</u>	<u>Army</u>	<u>Navy</u>	<u>Air Force</u>
	----- (000,000 omitted) -----		
Operations	\$ 82	\$121	\$993
Training	169	74	56
Maintenance and production	324	153	199
Research and development	45	32	59
Supply	7	16	62
Hospital and medical	49	15	100
Administration	4	21	76
Troop housing	248	145	125
Community	53	30	56
Support	3	6	-

The Army Corps of Engineers and the NAVFAC are design and construction agents for the Army, Navy, and Air Force major commands which determine the military construction needs at installations in the United States. The Corps, NAVFAC, and the Air Force Directorate for Engineering Services establish the policies for their military construction programs and provide guidance to the major commands. The Corps and NAVFAC are the design and construction agents for Air Force projects, except for family housing and an overseas area, and they follow the Air Force requirements. Each service derives its design policies from DOD's construction criteria manual and memorandums. The Office of the Assistant Secretary of Defense for Manpower, Reserve Affairs, and Logistics is responsible for keeping this manual current.

ENERGY COSTS FOR DOD FACILITIES

DOD spends billions of dollars annually for the energy its buildings consume. In fiscal year 1981, for example, it cost DOD over \$2.9 billion in operations and maintenance funds for energy costs, as shown below:

Fiscal Year 1981 Energy Use and Cost by Energy Source for DOD Installations

<u>Type of fuel</u>	<u>Cost</u> (millions)	Btu's consumed (note a) (trillions)
Purchased electricity	\$1,316.1	304.3
Fuel oil	966.8	122.2
Natural gas	355.2	102.0
Coal	222.9	42.2
Liquid propane gas/propane	18.3	2.2
Purchased steam	<u>24.8</u>	<u>3.7</u>
Total	<u>\$2,904.1</u>	<u>576.6</u>

a/British thermal units.

In its energy management plan, DOD is approaching energy conservation and efficiency in building operations from several angles. It has set energy efficiency goals for existing DOD-owned buildings, new DOD-owned buildings, leased buildings, and industrial or process activities. Efforts to reduce energy consumption are measured from 1975. Through fiscal year 1981, DOD had reduced the amount of energy consumed by the installations it operates by 11.4 percent through energy management efforts in the four areas mentioned above, as follows:

Change in Energy Consumption
DOD Installations
Fiscal Years 1975-81

<u>Military department</u>	<u>Btu's consumed</u>		<u>Change</u>	<u>Percent of change</u>
	<u>FY 1975 consumption</u>	<u>FY 1981 consumption</u>		
	(trillions)			
Army	239.2	207.0	-32.2	-13.5
Navy (note a)	151.4	140.9	-10.5	-6.9
Marines	22.4	22.5	+1	+4
Air Force	213.3	184.8	-28.5	-13.4
Other DOD	<u>3.7</u>	<u>3.1</u>	<u>-0.6</u>	<u>-16.2</u>
Total	<u>630.0</u>	<u>558.3</u>	<u>-71.7</u>	<u>-11.4</u>

a/Navy "Cold Iron" energy usage by dockside ships excluded.
This is energy brought from shore utilities to service dockside ships whose own powerplants are shut down.

When energy consumption is converted to thousands of Btu's per square foot, the reduction in consumption equals 14.5 per cent from fiscal year 1975 to fiscal year 1981 because the square footage of DOD's building inventory is growing slowly. Energy consumption in thousands of Btu's per gross square foot (Btu/sq. ft.) has decreased from 270,900 in fiscal year 1975 to 231,600 in fiscal year 1981. A reduction in Btu/sq. ft. energy consumption is an increase in the energy efficiency of the building inventory. DOD's energy management reports do not attribute energy use reductions to specific goals. For example, reports do not show how much energy was saved in building operations through the energy conservation investment program or through designing more energy efficient new buildings.

Our report is limited to efforts to improve energy conservation through design of new buildings. Measuring accomplishments in this area is very difficult because individual buildings were not generally metered on DOD installations in fiscal year 1975. Therefore, 1975 baselines for energy usage by building types are not based on actual consumption data. Further, most new buildings are not being metered, so actual usage data on new buildings is not readily available either.

It is generally recognized that much energy can be saved through the design process. Designing good energy efficiency into a building before it is built is much less costly than going back later and improving efficiency through costly energy conservation retrofit projects. Exactly how new

energy efficient buildings will affect the total energy consumption costs of DOD's inventory of facilities cannot be easily determined. Many variables must be considered for which data is not readily available.

Nevertheless, it is not impossible to develop order of magnitude estimates which show the significance of efforts to conserve energy through design of more energy efficient new buildings. Using historical data provided by DOD, we developed, with DOD's assistance, the following two examples of the annual savings which could result from concentrated efforts to achieve the 45-percent energy use reduction.

Example A

1975 data:

Total energy consumed by DOD facilities	630,000 billion Btu's
Thousands of Btu/sq. ft. of inventory	200,000 Btu/sq. ft.

1981 data:

Total energy consumed by DOD facilities	558,300 billion Btu's
Thousands of Btu/sq. ft. of inventory	175,000 Btu/sq. ft.
Cost per million Btu's	\$5.19/million Btu's
\$2.9 billion ÷ 558,300 billion Btu's	

Therefore:

The inventory increased 91 million square feet from 1975 through 1981, or 13 million square feet per year. Assume this is the new building increment added to the inventory annually. (This is conservative because the size of the military construction program has been increasing since 1980.)

If:

New buildings had continued to be designed as they had been before 1975, the 13-million-square-foot increase in inventory would have caused an increase of 2,600,000 million Btu's per year in the amount of energy consumed by DOD facilities (13 million sq. ft. x 200,000 Btu/sq. ft.).

If: The 45-percent energy use reduction goal was achieved in each year through more energy efficient designs for new buildings, 1,170,000 million Btu's per year would be saved. At 1981 costs, the potential savings is \$6.1 million per year (1,170,000 million Btu's x \$5.19).

EXAMPLE B

Assume:

\$2 billion in annual new building construction costs.
\$65 per square foot as cost of construction.
\$5.19 per million Btu's used (1981 energy costs).

Therefore:

Annual new construction would equal 30.77 million square feet per year (\$2 billion ÷ \$65/sq. ft.). Using fiscal year 1981 average energy use per square foot of 175,000 Btu sq. ft./year, energy use would increase 5.385 trillion Btu's annually (30.77 million sq. ft. x 175,000 Btu/sq. ft./year) if designs did not incorporate energy conservation features.

If designs for new buildings are energy efficient and the 45-percent reduction goal is achieved, 2.423 trillion Btu's will be added to total consumption (5.385 x 0.45). This equals a savings of \$12.6 million per year (using 1981 dollars).

Using these two different approaches to estimate potential savings, we developed a range of about \$6 million to \$13 million potential savings annually if DOD achieves the 45-percent goal. We do not know, nor does DOD, how much of this potential is being realized. This report discusses why savings cannot be determined and suggests ways to establish better methods to measure accomplishments and provide better quality assurances in the design process.

OBJECTIVES, SCOPE, AND METHODOLOGY

Our objectives were to determine if (1) DOD's energy budgets were realistic, (2) the services were using the budgets to achieve maximum energy conservation in new facilities, and (3) the design process was adequate to insure energy efficient facilities.

We did work at the Office of the Deputy Assistant Secretary of Defense for Facilities, Environment, and Economic Adjustment; the Corps, NAVFAC, and the Air Force Directorate for Engineering and Services headquarters in Washington, D.C.; the Corps' district offices at Savannah, Georgia, and Fort Worth, Texas; the Corps' South Atlantic and Southwestern Divisions, Atlanta, Georgia, and Dallas, Texas, respectively; and NAVFAC's Chesapeake and Southern Divisions, Washington, D.C., and Charleston, South Carolina, respectively. We met or contacted officials of the Air Force Regional Civil Engineer, Eastern and Central Regions, Atlanta and Dallas, respectively. The locations outside Washington, D.C., were selected because of the large amounts of military construction projects planned there.

We reviewed Executive Order No. 12003 and DOD, Army, Navy, and Air Force memorandums, regulations, guidelines, instructions, reports, engineering technical letters, and manuals on the process for designing new facilities. We also reviewed files for selected projects and supplemented this data with interviews with DOD and service officials and representatives of A/E firms.

We looked at 57 projects to ascertain the adequacy of designers' energy consumption studies as compared to energy budgets and energy conservation requirements. This number, we felt, would be sufficient to evaluate the services' design process. We selected different types of projects which (1) were 100 percent designed, (2) were in different functional categories, and (3) were of large dollar value (over \$1 million). Also, we reviewed the services' procedures and practices for selecting A/E firms, instructing firms in energy conservation requirements, reviewing computerized energy usage simulations and designs, and controlling actions to correct design deficiencies.

This is our second report on designing Federal buildings to conserve energy. Previously, we reported on the General Services Administration's need to improve energy conservation in new Federal buildings. 1/ This review was conducted in accordance with generally accepted government audit standards.

1/"GSA Could Do More To Improve Energy Conservation in New Federal Buildings," PLRD-82-90, July 12, 1982.

CHAPTER 2

INTERIM ENERGY BUDGETS ARE NOT EFFECTIVE

DESIGN GOALS FOR NEW FACILITIES

Properly implemented energy budgets can provide an effective management tool for evaluating designer performance in the area of energy usage. DOD's interim budgets are not realistic design goals for measuring and evaluating the adequacy of energy conservation in designs. These budgets are not an effective management tool because (1) the assumptions used to develop them have not been published and, therefore, designers include erroneous assumptions when preparing energy analyses (see p. 9), (2) the budgets are based on historic data modified with engineering judgments that do not reflect current energy conservation technology and practices, and (3) facility types with different modes of operations are inappropriately grouped together for energy budget purposes. DOD needs to revise the budgets to establish more realistic design energy goals and insure that the revised budgets are properly implemented.

DESIGNERS' ASSUMPTIONS ACCOUNT FOR SIGNIFICANT VARIANCES BETWEEN DESIGN ENERGY USAGE AND THE BUDGETS

On March 1, 1979, when the interim energy budgets were initiated, DOD directed the services to obtain from their field activities notification when the anticipated energy usage of any facility varied 10 percent over or under its energy budget. In addition, when the anticipated energy usage of any facility exceeds its energy budget by 15 percent, the activities must identify and report the reasons to their headquarters offices.

On July 16, 1980, DOD requested a report from each service on data about design energy usage for all newly designed facilities. The reports compared the designers' computed energy usage with DOD's energy budgets, described the major energy conservation features for each facility, and stated the reasons for design energy consumption exceeding DOD's budgets by 15 percent. The purpose of these one-time reports was to obtain data to use in revising the interim energy budgets. However, the interim budgets have not yet been revised. The DOD officials responsible for this function said that personnel turnover and heavy staff workload had precluded revising them.

In its 1982 energy management plan, DOD acknowledged that it was having difficulty determining whether it was meeting the 45-percent energy use reduction goal for new buildings. The energy budgets are purported to have the 45-percent reduction

already built in. If the budgets were based on valid energy consumption data, it would be easy to determine whether the goal was being achieved. The budgets, as reported in the energy management plan, are not based on actual fiscal year 1975 consumption data. Further, the assumptions and actual factors considered and used in developing the budgets have never been published. Consequently, budget users must make their own assumptions on what has been included in the budget calculations.

Designers assumed budgets were exceeded because of operating hours

DOD's energy budgets are not based on the estimated number of hours a day new facilities are to be operated. For the facilities whose designs indicated that energy usage exceeded the budgets, the services often stated that one reason was the differences in hours of operation. For example, the Army, Navy, and Air Force reports to DOD stated that they had exceeded the budgets on certain facilities because the facilities had been planned to operate 16 hours or more a day, as shown below. Had the budgets been adjusted to reflect the planned hours of operation for the new facilities, at least two of these projects (Georgia and Idaho projects) may not have exceeded the budgets.

<u>Type of facility</u>	<u>Location</u>	<u>Btu/sq. ft.</u>		<u>Stated reason for variance</u>
		<u>DOD energy budget</u>	<u>Design energy usage</u>	
		(000 omitted)		
Squadron Office	Selfridge Air Force Base (AFB), Michigan	70	272	Operated 24 hours a day
Dining	Fort Stewart, Georgia	82	112	Operated 18 hours a day, 6 days a week
Aircraft maintenance	Mountain Home AFB, Idaho	100	131	Operated 24 hours a day 7 days a week
Tactical air navigation and tower	Naval Air Station, Norfolk, Virginia	50	698	Operated 24 hours a day and large amount of venting required

The Army and Navy have not established standards for hours of facility operations, although the Air Force has, as shown below.

- 24 hours a day, 7 days a week, for hospitals, prisons, family and bachelor housing, utilities, and storage and other facilities.
- 24 hours a day, 6 days a week, for maintenance facilities.
- 16 hours a day, 7 days a week, for gymnasiums, dining facilities, and clubs.
- 12 hours a day, 6 days a week, for commissaries.
- 10 hours a day, 5 days a week, for research and development facilities, office buildings, laboratories, dental clinics, dispensaries, schools, personnel community facilities, museums, memorials, industrial facilities, and laundry and drycleaning facilities.
- 8 hours a day, 7 days a week, for theaters and auditoriums.

The Air Force has instructed its field activities to use these operating hours when designing new facilities and analyzing energy usage. However, the Air Force field office in Dallas had not notified its design agent, the Fort Worth District of the Corps, of these standard hours. The district had been following a previous Air Force instruction that had established hours of operations for all facilities as 8 hours a day, 40 hours a week.

On those Air Force projects on which the standards were used, designers erroneously believed their design energy usages met DOD's energy budgets. For example, the designer's energy usage analysis for a gymnasium at Sheppard, AFB, Texas, was 184,429 Btu/sq. ft. for 88 hours of operations a week. The designer factored this down to 83,800 Btu/sq. ft. for 40 hours a week. The designer assumed that the DOD budget was 94,000 Btu/sq. ft. But DOD's energy budget was 55,000 Btu/sq. ft.

Designers assumed budgets were exceeded
because of special environmental requirements

When DOD developed the energy budgets, it did not provide for energy used to compensate for special environmental requirements, such as cooling or removing the heat generated by computers.

DOD's guidance, however, is not clear, and the services indicate this as a reason why budgets were exceeded, as shown below.

<u>Type of facility</u>	<u>Location</u>	<u>Btu/sq. ft.</u>		<u>Reason for excess usage</u>
		<u>DOD energy budget</u>	<u>Design energy usage</u>	
(000 omitted)				
Flight simulator	Griffiss AFB, Rome, N.Y.	75	145	Special environmental requirements for computers, which require 50 percent for cooling
Health clinic	Lexington-Blue Grass Depot, Ky.	61	114	Outside air requirements
Firefighter-training facility	Submarine Base, New London, Conn.	70	110	Special environmental requirements
Transmitter building	Naval Air Station, New River, N.C.	50	178	Very high equipment loads

DOD's budget guidelines are not clear regarding this type of energy requirement. Had the budgets been adjusted to account for it, the projects might not have exceeded their budgets and might actually be more energy efficient than current budgets imply. Still, the guidelines define energy budgets as the amount of energy required to heat and cool space; heat water for domestic use, such as bathing; and light buildings.

DOD energy officials told us that special environmental requirements had intentionally not been considered and acknowledged that this fact could account for the deviations from the budgets. They stated that they considered these requirements as process energy and, consistent with the DOE building energy performance standards concept, were not to be included in the energy budgets. However, they did agree that these requirements should be considered in determining whether the final design is energy efficient.

Budgets should be revised as design techniques improve

Many facilities were designed to use significantly less energy than that in DOD's budgets. One reason, as reported by the services, was the use of specific energy conservation

features. These features probably were not adequately considered in DOD's energy budgets because, according to the developer of the budgets, they were developed using energy conservation criteria in effect during 1972. The following table shows some of the energy conservation features included in designs for which the estimated energy usage was significantly less than that in DOD's budgets.

<u>Type of facility</u>	<u>Location</u>	<u>Btu/sq./ft.</u>		<u>Major energy conservation feature</u>
		<u>DOD energy budget</u>	<u>Design energy usage</u>	
(000 omitted)				
Exchange retail store	Submarine Base, New London, Connecticut	100	66	Exhaust heat recovery system
Administration building	Picatinny Arsenal, New Jersey	70	45	Small percent of glazed area with solar glass
Army Reserve Center	Fort Snelling, Minnesota	70	57	Increased insulation, reduced glazed area, double glazing, insulated exterior doors
Vehicle maintenance facility	Travis AFB, California	85	32	Economy cycle and energy monitoring and control system
Base supply administration building	Beale AFB, California	50	45	Variable air volume system with 100 percent hydroelectric heating and energy monitoring and control system

Adjusting budgets for all innovative energy conservation features may not always be feasible or practical. However, when evaluating budget differences, the designer should be able to demonstrate that the energy usage was lower than that in the budget due to new features being used. We believe this would be acceptable justification for the difference.

INTERIM ENERGY BUDGETS
ARE BASED ON OUTDATED DATA

The interim energy budgets are based on DOE data developed from the private and commercial sectors and data on actual energy used by military facilities designed before energy conservation in new facility designs became a requirement. This data was modified using engineering judgments to reflect current energy conservation requirements. The modified data was reduced by 45 percent to arrive at the energy budgets to be used to attain the energy use reduction required by Executive Order No. 12003. Although the energy budgets are based on the best information available when they were developed in fiscal year 1979, they do not reflect the current energy conservation design capabilities.

The interim budgets, which became effective on March 1, 1979, were developed by the Army Corps of Engineers. DOD intended to update them as soon as better data became available. The Corps had developed and was using energy budgets for Army facilities starting in October 1978 to reduce energy usage in new facilities by 45 percent, as required by Executive Order No. 12003. The Corps anticipated congressional legislation and DOE guidelines for energy conservation performance standards for new facilities. It developed energy budgets using the data developed by DOE for 16 categories of commercial facilities and the 7 climatic zones developed by the Department of Housing and Urban Development. The categories were: clinic, community center, gymnasium, hospital, hotel and motel, multifamily high rise, multifamily low rise, nursing home, large office, small office, elementary school, secondary school, shopping center, store, theater and auditorium, and warehouse.

According to the Corps official who developed the budgets, only limited actual energy usage data by types of facilities was available to use. Using the energy usage data available and the energy conservation requirements effective at the time of facility design, the Corps developed energy budgets for 12 categories of military facilities and 7 climatic zones. These categories were based on DOE categories and the assumption that they were the primary energy users.

The documentation for the DOD energy budget calculations was not available. The Corps official responsible for developing the budgets said the designs of the buildings completed by fiscal year 1975 were based on energy conservation requirements of several years earlier. Therefore, changed requirements were applied to these building designs to determine their effect on anticipated energy usage. This result was then reduced by 45 percent to reflect the requirements of Executive Order No. 12003.

Data on hours of operation for facilities in the 12 categories was not considered because it would have been very difficult to obtain.

DOD's energy budgets were set at about twice the amounts of the Corps' first budget levels for family and bachelor housing. According to a Corps official, DOD's budgets were increased because the Navy and Air Force believed the Corps' budgets were understated. Still, the Navy has developed and is using energy budgets that are significantly less than DOD's energy budget for some facility types. For example, the Navy said that from its experience it could design hospital buildings to use 110,000 Btu/sq. ft., its national budget, while DOD's budget is 161,000 Btu/sq. ft., and that it could design a dental clinic for 60,000 Btu/sq. ft., while DOD's budget is 68,000 Btu/sq. ft.

DOD's energy budget for office facilities of 55,000 Btu/sq.ft. is based on the General Services Administration's experience of about 1978. However, we reported ^{1/} that the General Services Administration had reduced its energy budgets for new office buildings to about 32,000 Btu/sq. ft. DOD has not yet adjusted the energy budgets for office facilities.

MILITARY FACILITIES ARE NOT APPROPRIATELY
GROUPED FOR ENERGY BUDGETS

DOD has grouped military facilities into 12 categories for energy budget purposes. These categories are not adequate to accommodate the many different types of facilities used in a wide variety of military operations. The groupings being used, according to the Corps, are based on engineering judgments to complement the DOE categories.

Not all the categories are adequate because they include types of facilities which are similar in purpose but which have vastly different energy use requirements due to the different operations to be done in the facilities. Such categories are: schools with subcategories of training facilities and nursery schools; institutional with subcategories of clubs, theaters, and dining facilities; service with subcategories of maintenance facilities and commissaries; and other with subcategories of communications, navigational aids and airfield lighting, and waterfront operation facilities.

1/PLRD-82-90.

Maintenance facilities in the service category include a wide variety of facilities, such as facilities for maintenance of aircraft, ships, tanks, trucks, weapons, ammunition, and electronics and communication equipment and facilities for miscellaneous equipment. While all maintenance facilities are covered by the same DOD energy budget, a single budget figure does not give designers a realistic design goal. For example, the budget for a submarine repair facility at Portsmouth, Virginia, is 85,000 Btu/sq. ft. This facility is a pipefitting shop in the category of ship maintenance facility. The design energy usage is 38,000 Btu/sq. ft., and the major energy conservation feature is a variable air volume system. In comparison, the design energy usage is 106,000 Btu/sq. ft. for the ordnance equipment maintenance facility at the Marine Corps Air Station, Cherry Point, North Carolina. The facility is a missile equipment maintenance shop in the category of guided missile maintenance. The reason for exceeding the budget of 85,000 Btu/sq. ft. was the high ceiling and large rollup doors.

A comparison of the automotive maintenance shop at Warner Robins AFB, Georgia, and the avionics maintenance facility at Nellis AFB, Nevada, also shows the inadequacy of the energy budgets to serve as design targets. The energy budgets for both facilities are 95,000 Btu/sq. ft. However, the design energy usage was 48,000 Btu/sq. ft. for the Warner Robins AFB facility and 109,000 Btu/sq. ft. for the Nellis AFB facility. The Air Force did not indicate the reasons for the variances. The automotive maintenance facility contains shops to maintain and repair combat and noncombat vehicles. The avionics facility contains shops to maintain and repair radio and radar equipment.

CONCLUSIONS

DOD's interim energy budgets were established as one tool to accomplish the reduced energy usage in newly designed facilities. However, DOD's instructions for using energy budgets do not give designers adequate guidance to permit the budgets to be used for designer performance evaluation purposes. The interim budgets do not adequately establish goals on which to evaluate design accomplishments.

Before energy budgets were used, DOD and the services required designing energy conservation features for new facilities. These requirements are provided in DOD's construction criteria manual and other documents and the services' various instructions, manuals, and regulations.

DOD's and services' energy conservation requirements and guidelines continue in force, and designers of military facilities must comply with them. In addition, designers must meet DOD energy budgets which are based on incomplete and out-dated data. By applying the energy conservation requirements and guidelines to facility designs, the designers are expected to meet DOD's energy budgets or justify the reasons for exceeding them. The services reported once to DOD the reasons they believed energy budgets were exceeded and identified the major energy conservation features used to design significantly less energy usage than the budgets. Although DOD intends to revise its interim energy budgets using data such as that reported by the services, we believe that the services' reasons for significant variances indicates that better direction is needed in using energy budgets.

For example, the services indicate that variances occur because of hours of operation. They assume that DOD energy budgets are based on hours of operation. They also indicate that special environmental requirements cause excessive energy usage and assume that the budgets do not adequately allow for this type of function. The services also seem to assume that some energy conservation features designed for facilities may not have been considered in the budgets. Therefore, based on the services' data, we believe that energy budgets established and managed at the national level without using the design experiences and expertise at the local levels is not an effective way to administer budgets.

DOD should (1) set forth the assumptions that should be included in the budgets, (2) revise the interim budgets to reflect current design energy conservation requirements and define them as goals to be achieved or bettered, (3) revise the 12 categories of facilities to group together facilities with the same modes of operations, (4) establish a procedure for the services to modify DOD energy budgets based on their energy conservation requirements and guidance and to group facilities into appropriate categories by function, and (5) monitor the revised procedures to insure that the services adequately modify and update the energy budgets.

RECOMMENDATIONS

We recommend that to improve the use of DOD's energy budgets, the Secretary of Defense require that the Assistant Secretary of Defense for Manpower, Reserve Affairs, and Logistics:

- Develop and issue new DOD energy budgets for the various building types and climatic zones and rescind the interim budgets.

- Issue guidance to the services clearly describing all the factors and assumptions used to calculate the budgets and how they are to be used.
- Require the services to perform additional energy analysis to take into account local environmental conditions, operations, and special project characteristics not considered in the budgets which might significantly affect energy usage.
- Give the services technical assistance in implementing energy budgets.
- Require services to report to the Deputy Assistant Secretary of Defense for Installations and justify instances when the estimated energy usage for a design deviates from its energy budget by 15 percent.

AGENCY COMMENTS AND OUR EVALUATION

DOD advised us that it basically concurred in our findings, conclusions, and recommendations. DOD reiterated that its energy budgets had not been updated since 1979 because of its belief that DOE's Building Energy Performance Standards for energy use could have been required at any time.

Although DOD agreed to implement our recommendations, it believed that our report placed too much emphasis on energy budgets as a means for insuring that energy efficient facilities are designed. DOD said that the 45-percent reduction of energy usage in new facilities could be accomplished, in most instances, with the use of its prescriptive design requirements for energy conservation, such as the amounts of insulation and the levels of lighting used. DOD said that, in the design process, budgets were only one means of insuring that these design requirements were met.

We agree that the use of energy budgets is only one tool in the design process for insuring that energy efficient facilities are designed. As pointed out in this chapter, however, the current budgets are not an effective management tool for this purpose because the assumptions, such as hours of operations, included in their development are not known by designers and they are outdated and do not always group together compatible facilities. DOD agrees that its budgets need to be clarified and improved and plans to update them, revise the procedure for their implementation by the services, and revise its instruction on budgets to require the reporting of significant variances between the energy analyses and budgets. DOD also agreed to group together facilities with the same modes of operations

with the provision that any revision of the 12 facility categories must be able to accommodate any required future DOE standards on energy use. We believe that these actions, if adequately implemented by the services, will insure that budgets are a better tool for measuring the adequacy of designers' efforts in designing energy efficient new facilities.

CHAPTER 3

DESIGN PROCESS DOES NOT INSURE THE DESIGN OF ENERGY EFFICIENT FACILITIES

DOD's construction agencies' (the Corps' and NAVFAC's) design processes contain problems which, if not corrected, will not insure that new facilities are designed for minimum energy consumption. To design energy efficient new facilities, the services have established energy conservation requirements which are provided to designers. However, Corps and NAVFAC officials' opinions vary regarding how these requirements should be implemented, which reflects the different methods used to manage the design process. Each method, however, contains weaknesses which, we believe, result in lack of sufficient attention to (1) controlling the preparation of energy usage analyses, reviewing them adequately for errors and omissions, and controlling designers' corrective actions and (2) consolidating energy requirements to facilitate compliance by A/E firms and emphasizing energy expertise when selecting A/E firms.

THE CORPS AND NAVFAC IMPLEMENT ENERGY CONSERVATION REQUIREMENTS DIFFERENTLY

Corps and NAVFAC field organizations have established different guidelines, procedures, and organization structures to implement energy conservation requirements in designing new facilities. The strengths and weaknesses of the methods are reflected in staff responsibilities, guidelines, requirements, and opinions of responsible officials, as discussed below.

NAVFAC Southern Division

The Southern Division in March 1982 designated a mechanical engineer in the Design Division as energy conservation coordinator to insure that energy conservation requirements are met. The Division also prepared a manual for engineers-in-charge (EICs) to administer A/E firms' contracts and in-house designs.

In April 1982, the Division revised its "Technical Guidelines and Criteria for Energy Conservation in Buildings," which summarizes NAVFAC's instructions and guidance. The purpose of this publication is to advise A/E firms that they should approach the design of each new project as a challenge to their ingenuity to produce designs which accomplish the greatest energy savings possible while maintaining the principles of practicality and economy. Also, contracts with A/E firms require that they give the EIC the design alternatives to review before they are used in energy analyses.

According to the head of the Mechanical Branch, the energy conservation coordinator, and a mechanical engineer, there are

problems in designing energy conservation features for new buildings. For example:

- Not all EICs are knowledgeable of energy budgets. Some A/E firms are not accustomed to performing energy analyses and often overlook important aspects, such as operating hours and heat recovery.
- Energy analyses are a good idea and serve as useful indications of how efficient facilities are designed. However, DOD's energy budgets, according to NAVFAC Southern Division officials, are too strict and do not state the assumptions used.
- A/E firms find it difficult to incorporate energy conservation features in facilities because many factors, such as siting, are fixed before architects get involved with the projects.
- The process for reviewing A/E firms' compliance with energy conservation requirements needs to be improved because EICs and project managers do not always understand the requirements.

NAVFAC, Chesapeake Division

The Director, Design Division, has designated the Chief of the Mechanical Branch as responsible for reviewing designers' energy analyses. In addition, the Division has prepared a "Guide for Architect-Engineer Firms" for preparing drawings, specifications, and cost estimates to insure uniformity of A/E firms' submissions. Regarding the design process and energy conservation matters, the guide requires that:

- Only cursory reviews be made of A/E firms' work unless detailed technical reviews are found necessary.
- Each facility be designed for minimum energy consumption to comply with Executive Order No. 12003. A/E firms must explore and investigate all innovative energy-conserving features to determine feasibility before initiating a fixed design.

Other guidance for designing energy efficient facilities is referred to in the Chesapeake Division's contracts with A/E firms. This guidance includes: NAVFAC's publication entitled "Technical Guidelines for Energy Conservation in New Buildings," dated January 1975, which describes and illustrates energy

conservation features to be used by A/E firms in designing new facilities, and NAVFAC Instruction 4100.5A, entitled "Design Criteria Guidance for Energy Conservation," dated November 10, 1977, which summarizes typical items that should be considered in designs to reduce energy consumption.

The Director of the Design Division and the Chief of the Mechanical Branch expressed the following opinions on DOD's energy budgets and the design process.

- Energy budgets should be used as goals, not absolutes, and design energy analysis variances above the energy budgets should be documented.
- Budgets should be only goals because engineers are limited in their ability to improve energy conservation in certain areas, such as insulation and building outside shells.
- DOD's energy budgets are good averages of design energy usage. However, they do not adequately consider special features, such as computer facilities, which use significant amounts of energy.
- The Division does not review A/E firms' energy analyses in detail because these reviews would not be cost effective. In addition, A/E firms are expected to provide accurate submissions. So long as the analyses do not exceed DOD's energy budgets by 15 percent, any inaccuracies are generally disregarded.

Corps of Engineers, Savannah District

The district established an Energy Analysis Section in the Design Branch on July 1, 1980, and assigned three mechanical engineers to review designers' energy analyses. Engineers in this section are required to compile applicable criteria and provide complete and detailed instructions to A/E firms.

Contracts with A/E firms require them to carefully analyze environmental requirements and select and rank the mechanical systems best suited for the facilities. For these analyses, A/E firms must use either the Trane Air Conditioning Economic (TRACE) or the Building Loads Analysis and System Thermodynamics (BLAST) computer simulations. The Energy Analysis Section approves the facility data used in these simulations and the heating, ventilating, and air-conditioning systems selected.

We had discussed the issue of requiring A/E firms to use specific energy analysis programs on Federal projects in two previous reports.

In LCD-81-7 1/ we reported that A/E firms had complained about NAVFAC's practice of restricting the use of energy analysis programs to those appearing on a list of approved programs. On April 15, 1980, NAVFAC directed all its field divisions to stop using the list.

In PLRD-82-47 2/ we reported that in some instances the Air Force had required the use of BLAST on projects and that the Army had been considering making BLAST mandatory for building energy analyses. The Office of the Deputy Assistant Secretary of Defense, Facilities, Environment and Economic Adjustment, had acknowledged that requiring the use of BLAST on all DOD projects could restrict competition on design contracts, increase contract cost, and prohibits the use of new and innovative tools which DOD might want used. The official said that DOD was drafting a change to its construction criteria manual which would state that projects "* * * shall be analyzed using BLAST, or one of the other professionally recognized and proven energy conservation design computer programs." At the time of our prior review, the manual's chapter on energy conservation, which would probably contain this requirement, was being drafted.

During this review, DOD advised us that the services may allow professionally recognized techniques, such as computer simulations which are acceptable to the individual design engineer. Therefore, analyses may be done with TRACE, BLAST, and similar computer software packages.

Engineers are designated to review A/E firms' submissions to insure that the firms accurately comply with the district's instructions and meet all project requirements. The engineers are also responsible for tracking projects through the construction phase to insure that the designs are implemented as conceived. Engineers also provide assistance during facility acceptance and maintain data on problems to avoid on future projects.

1/"Agencies Should Encourage Greater Computer Use on Federal Design Projects" (Oct. 15, 1980).

2/"Building Energy Analysis Computer Programs Developed by Federal Agencies--Cost, Use, and Need" (Mar. 22, 1982).

The following comments by the Chief of the Energy Analysis Section and another engineer regarding DOD's energy budgets and energy conservation matters reflect the weaknesses in implementing the above procedures.

- The district pursues energy conservation measures only to the point that DOD's energy budgets are met. Any efforts to improve energy conservation beyond meeting energy budgets are not cost effective.
- Energy budgets do not serve as a tool to insure that all conservation measures are considered. Energy budgets are easy to attain. They are not stringent enough to require any significant effort to meet them.
- Generally, guidance requires meeting the energy budgets without increasing project cost. This guidance discourages consideration of additional conservation measures.
- Energy budgets are useful because they provide a goal for designers; however, their accuracy is doubtful.

Corps of Engineers, Fort Worth District

Sections in the Design Branch are responsible for reviewing A/E firms' energy analyses and other submissions. One mechanical engineer in the Mechanical Section is responsible for reviewing the A/E firms' energy analyses. The A/E Review Section is responsible for monitoring the actions taken by A/E firms on the comments of engineers in the Design Branch.

The following comments by the chiefs of the Mechanical and Army Sections and two engineers indicate the weaknesses in the design process regarding DOD's energy budgets and incorporating energy conservation features in new facilities.

- Energy budgets are an administrative burden which unnecessarily increases the design costs; the budgets do not increase the energy efficiency of facilities.
- Energy budgets do not affect the design of facilities. A/E firms generally do not redesign facilities or change designs if energy budgets are not met. Rather, A/E firms try to give reasons why energy budgets are exceeded, such as different hours of operations.

- Project managers have higher priorities for their work than to insure that energy analyses are made or are accurate.
- The reviewer of energy analyses is not qualified to insure that A/E firms have adequately considered all energy conservation features.
- A/E firms do not always understand the instructions for preparing energy analyses. In addition, analyses results may vary considerably among A/E firms because some criteria provided may be ambiguous.

In addition, A/E firms that had done work for the district indicated significant differences of opinion regarding the usefulness of energy budgets and energy analyses in designing new facilities. For example:

- One firm said that energy analyses were important and helpful because they enabled designers to determine the amount of energy facilities should consume. Energy budgets enable A/E firms not to overdesign facilities regarding energy consumption.
- Another firm said that more funds were spent preparing energy analyses than designing the buildings. Designing facilities to meet energy budgets is a waste of funds.

ENERGY ANALYSES ARE NOT ADEQUATELY CONTROLLED
TO INSURE ENERGY EFFICIENT DESIGNS

New facilities may not be designed as energy efficient as DOD's policy suggests because procedures and practices of the Corps and NAVFAC field organizations do not assure adequate control and review of energy analyses. ^{1/} The Corps and NAVFAC need to establish controls to insure timely submission of analyses, adequate reviews by Corps and NAVFAC personnel, and adequate corrective action by A/E firms.

^{1/}Energy analyses are computer simulations of energy consumption. They are used to (1) simulate the thermal (heating and cooling) loads of buildings and building systems and (2) estimate the annual energy usage for heating, cooling, lighting, and other factors, based on equipment selection and thermal loads. They can be used as an aid in selecting the heating, ventilating, and air-conditioning systems to be installed. Some also have life-cycle costing or economic analysis capabilities.

Controls over submitting energy analyses are not adequate

Energy analyses for certain facilities in the Corps' Fort Worth and Savannah Districts and NAVFAC's Southern Division either were missing or were not completed. Controls were inadequate to insure that analyses were prepared for facilities.

Energy analyses for 32 of 105 projects in the Fort Worth District had not been prepared, according to district records. Project managers do not have controls to insure that A/E firms submit analyses at the concept design phase. For example, 13 of these 32 projects were under construction and 11 were completed. In addition, there were no indications that analyses for 2 of 10 projects in NAVFAC's Southern Division and 4 of 15 projects in the Corps' Savannah District had been completed. Managers for these 38 projects could not locate the analyses. Therefore, since there was no documentation of what energy conservation features had been incorporated into facility designs, there was no assurance that these projects had been designed to use the minimum amounts of energy and energy conservation features that are life cycle cost effective.

Also, an energy analysis for a fire station at Fort Stewart, Georgia, was not prepared because this was a "turnkey" project. Procedures in the Savannah District were inadequate for controlling A/E firms' designs for such projects. Design services for this type of project are procured by formal advertisement rather than negotiation. Qualified sources are requested to submit technical proposals, without pricing data, for the project based on a design of their choice. Corps criteria must be met. Invitations for bids to design the project are requested from the sources whose technical proposals are determined acceptable.

Energy analyses were not always reviewed

A/E firms' energy analyses were not reviewed by the Corps and NAVFAC engineers to determine if they conformed with the services' energy conservation requirements. The Corps and NAVFAC lacked adequate controls to insure that the engineers reviewed all the analyses.

The Fort Worth District mechanical engineer responsible for reviewing energy analyses had not reviewed 47 of the 70 analyses prepared. The A/E Review Section had not established adequate procedures to insure that the responsible mechanical engineer obtained the analyses for review.

NAVFAC's Southern Division has prepared a manual for EICs to administer design contracts with A/E firms. EICs are responsible for insuring that all applicable engineers review A/E firms' design submissions; however, there is no procedure to insure that all energy analyses are reviewed. There was no evidence that 8 of 10 designers' analyses had been reviewed. In March 1982, the Division assigned an energy conservation coordinator to review all energy analyses. However, the coordinator relies on EICs to provide the analyses for review but the procedures do not assure that this will happen.

The Southern Division's failure to insure that energy analyses are reviewed appears to have resulted in the failure to adequately consider energy conservation features. For example, according to the energy conservation coordinator, electric duct heaters should not have been designed for the administrative office building at the Naval Oceanographic Office, Bay St. Louis, Mississippi, because natural gas, a cheaper source of energy, was available. NAVFAC's engineering documentation, however, stated that natural gas was not available. There was no explanation for this discrepancy.

Another Division example is the Radar Air Traffic Control Facility, Corpus Christi, Texas. The energy budget for this project was 55,000 Btu/sq. ft., but the amount in the energy analysis was 315,303 Btu/sq. ft., or 473 percent more than the budget. The stated reason in engineering documentation was that the facility contained special equipment. Details of the use of this equipment, however, were not stated.

For another 6 of 10 projects in the Southern Division, design energy usage exceeded energy budgets and the reasons were not given. Energy budgets were exceeded from 28 percent to 250 percent; however, the engineering documentation did not explain the reasons. This lack of explanation indicates that reviews of these analyses may not have been performed or may have been inadequate.

The Corps' and NAVFAC's review comments were not adequately followed up

Reviews of energy analyses by the Corps and NAVFAC engineers have disclosed significant deficiencies. However, controls are not adequate to insure coordination of review comments and corrective actions by designers.

The Corps's Fort Worth District mechanical engineer reviewed 23 energy analyses but was aware of actions taken by only 2 designers. According to the engineer, designers' corrective actions were not provided apparently because the A/E Review Section did not consider the engineer's approval necessary.

This section of the Design Division is responsible for coordinating the reviews and followup actions.

The mechanical engineer's comments on the energy analyses reviewed were significant, and we believe that the adequacy of the designer's actions was important to the engineer. Some of the engineer's comments were:

- "* * * Ventilation system energy consumption analysis was completely invalid and must be re-accomplished. * * *"
- "* * * The calculations were loaded with computation errors and must be reevaluated and resubmitted. * * *"
- "* * * The BLAST computer simulations, economic analyses, and report were not performed in accordance with applicable criteria. The simulation must be rerun, the analyses reevaluated, and a new report submitted. * * *"
- "* * * The design effort must be directed toward systems using less energy than the budget guidelines -- not more as indicated in the study. * * *"
- "* * * Administrative areas heating and evaporative cooling energy consumption must be included in facility projected energy consumption evaluation--not just the shop area heating energy consumption. Domestic hot water energy consumption must also be included. * * *"
- "* * * Because of the many errors, incorrect methodology, and poor report organization, the study must be reanalyzed, rewritten and resubmitted. * * *"

Until March 23, 1982, NAVFAC's Chesapeake Division lacked adequate procedures to insure that review comments on energy analyses and other design submissions had been adequately resolved. For example only 59 percent of the review comments on the dining hall, Andrews AFB, were annotated with the actions taken and none of the Mechanical Branch's comments were annotated with disposition actions. The Branch is responsible for reviewing energy analyses.

Chesapeake Division Instruction 11012.5A, dated March 23, 1982, requires that the architect- or engineer-in-charge coordinate the input from all reviewers and provide a consolidated set of comments to the A/E firms. Architects or engineers must annotate the review comments with the actions taken.

Energy analyses were not adequately reviewed

Energy analyses contained errors and omissions which reviewers had not identified. These deficiencies could have affected the energy conservation designs of facilities. We believe that the engineers responsible for reviewing energy analyses were not provided adequate guidance, training, or experience in the specific computer simulations used to make these analyses.

The Corps' Fort Worth District mechanical engineer performed detailed reviews of energy analyses. He said, however, that the review function did not require determining whether firms had considered all energy conservation features. In addition, he is not aware of all features that should be considered. The engineer had received training in TRACE and BLAST computer simulations and said he relied on his experience for reviewing energy analyses because the engineering technical letters dealing with energy analyses were not clear.

The Corps' Savannah District has not established guidelines for reviewing energy analyses, and the engineers that review them have limited training and experience in computer simulation programs. We believe these factors contribute to the type of errors found in several analyses. For example:

- A/E firms did not include the energy required for domestic hot water in their analyses for four facilities.
- Design alternatives were not considered in analysis for three facilities, even though this is required when energy budgets are exceeded by 10 percent.
- The square footage in analyses of five facilities was less than the gross square footage required to be used.

The district's Chief of the Energy Analysis Section said that training in energy computer simulations was a problem because of frequent personnel turnover. The two reviewers have a year of experience in reviewing energy analyses and have had training in BLAST, but not TRACE, which is the computer simulation program most frequently used by designers selected by the district. In addition, guidance is not provided to reviewers of analyses.

We found errors and omissions in energy analyses of two facilities in the Chesapeake Division. The analysis for the Ready Crew Facility at Andrews AFB assumed that all the lights would be on 14 hours a day for every day of the year. The energy for this lighting totaled about 70 percent for the total energy usage forecasted. According to the A/E firm, an apparent miscalculation was made since skylights in the hallways were added after the analysis was made.

The analysis for the Marine barracks and dining facility, Henderson Hall, Arlington, Virginia, included an incorrect summer room temperature of 76 degrees when the NAVFAC criterion was 78 degrees, room relative humidity of 50 percent when 60 percent was the required amount, and a wall "U" value $\frac{1}{A}$ of 0.15 when 0.08 was the correct value.

In addition, alternative systems were not evaluated for this facility, according to the Director of the Design Division, because previous energy analyses of similar facilities showed that the selected systems were the most appropriate. The systems were a variable temperature constant volume system for the dining area and a fan coil system for the living quarters.

In the Chesapeake Division, we believe that the lack of training and experience on the part of the engineers reviewing energy analyses and the lack of review guidance may have contributed to the inadequacies in designers' analyses. However, the head of the Division's Mechanical Branch did not agree. He said that training in computer simulation programs, such as TRACE and BLAST, was generally not necessary for reviewers and that review guidance was not provided. Several engineers, however, during our review received training in several computer simulation programs, including TRACE.

On March 23, 1982, the NAVFAC Chesapeake Division revised its procedures for reviewing A/E firms' submissions. Instruction 11012.5A states that everyone involved in projects is encouraged to review the plans and specifications and raise questions if their intent is not clear or provide comments which will improve the designs. All review comments annotated with the actions taken must be part of the permanent contract files.

$\frac{1}{A}$ "U" value is the coefficient, or measurement, of heat transmission. It applies to combinations of different materials, airspaces, and surfaces of walls and roofs.

THE SERVICES NEED TO CONSOLIDATE
ENERGY REQUIREMENTS AND EMPHASIZE
ENERGY EXPERTISE IN SELECTING A/E FIRMS

The services do not clearly state their energy conservation requirements to A/E firms and do not emphasize the need for energy conservation expertise in selecting A/E firms. Therefore, there is no assurance that designers will adequately comply with all the services' requirements.

Clearly stated energy requirements
could help A/E firms

Significant variances between designers' energy analyses and DOD's energy budgets may indicate either (1) that the analyses are adequate and DOD's energy budgets are inadequate, as previously discussed, or (2) the Corps and NAVFAC have not adequately instructed designers to be innovative and to design for minimum energy consumption.

Many projects were designed to equal or better DOD's energy budgets. However, many other projects use significantly more energy than DOD's energy budgets but the reasons were not determined or evaluated. For example, for projects for which energy analyses were made, 27 of 62 projects in the Corps' Fort Worth District and 20 of 80 projects in the Savannah District exceeded energy budgets by 15 percent or more. However, reasons for these excesses had been determined for only seven projects in the Savannah District. The reasons were high ventilation requirements, extended hours of operation, and cooling requirements for large amounts of equipment.

Predesign conferences are conducted to discuss all aspects of projects being designed which may include energy conservation requirements. Also some energy conservation requirements are cited in contracts with A/E firms. In addition, A/E firms must follow other energy requirements which are included in numerous Corps engineering technical letters and NAVFAC and Air Force instructions, as discussed previously. Therefore, to assist designers, the Corps' Savannah District has required, since July 1980, its Energy Analysis Section to compile applicable criteria for projects and provide complete and detailed instructions to A/E firms. Also, NAVFAC's Southern Division summarized in April 1982 NAVFAC's requirements in a single document entitled "Technical Guidelines and Criteria for Energy Conservation in Buildings."

NAVFAC's Chesapeake Division contracts with A/E firms, however, state that A/E firms are responsible for obtaining the criteria for the design of projects. A/E firms doing business with the Division indicate that criteria are voluminous, and located in many different sources, and are constantly changing. They said that they must maintain libraries of NAVFAC criteria, which is difficult to do. Also, more timely, complete, clear, and concise direction from the Division would help them comply with energy requirements.

In contrast, an A/E firm that did work for the Corps' Savannah District was very satisfied with the guidance provided. A firm official said that the predesign conference had been adequate to resolve any questions about energy analysis.

We believe that the Corps' Savannah District's procedure and NAVFAC's Southern Division's compilation of requirements in one document are very helpful to A/E firms in understanding the services' requirements and should be considered for use by other offices.

Energy expertise is not adequately emphasized in selecting A/E firms

In selecting A/E firms, the Corps and NAVFAC generally had not emphasized the need for expertise in designing energy efficient facilities. We believe that requiring this expertise could help A/E firms comply with the services' energy requirements.

Public Law 92-582 requires that design projects costing more than \$10,000 in fees for A/E firms be advertised in the Commerce Business Daily. Advertisements must specify the significant evaluation factors to be applied in making selections. Energy expertise was cited as a significant factor in only 4 of 19 advertisements.

In addition, qualifications of A/E firms must be evaluated in discussions with officials of the firms. However, energy expertise generally was not emphasized. For example, NAVFAC's Chesapeake Division selection committee chairmen, at their discretion, provide committee members questions for interviewing A/E firms. However, one chairman said that A/E firms were questioned about energy conservation only if their presentations did not adequately cover this area. The Corps' Fort Worth District selection boards, according to the Chief of the Military Branch, generally were not concerned with A/E firms' expertise in energy analyses.

We recommended in October 1980 ^{1/} that Federal agencies evaluate A/E firms' computer capabilities and expertise when making selections from design projects on which computer-aided methods could be used, such as energy analyses. DOD strongly concurred.

Executive Order No. 12003 requires significant reductions in energy usage in new facilities. Therefore we believe that energy expertise is a significant factor that should be emphasized in selecting A/E firms.

CONCLUSIONS

Field activity officials in the Corps and NAVFAC have varying opinions on the use of energy budgets and implementing energy conservation requirements. They believe that (1) energy analyses of facilities are good goals, (2) A/E firms should explore all innovative energy conservation features, (3) there is no need to review A/E firms' energy analyses in detail, (4) it is not cost effective to incorporate energy conservation features beyond meeting the energy budgets, and (5) energy budgets increase design costs unnecessarily. These opinions reflect the degree of emphasis officials place on energy conservation in the following areas: selecting and orienting A/E firms, controlling firms' submissions of energy analyses, reviewing these analyses, and following up on corrective actions. Because of the lack of emphasis on energy conservation, energy analyses exceeded energy budgets on certain facilities but the reasons were not determined and evaluated. In addition, analyses either were not made or were not done at the appropriate times. However, because of inadequate recordkeeping, the reasons could not be determined. Also, significant deficiencies were disclosed in energy analyses, but there are no assurances that adequate corrective actions were taken. Significant deficiencies in analyses were not found by the services' engineers.

Since Executive Order No. 12003 requires significant reductions in energy usage in new facilities, the Corps and NAVFAC need to emphasize their commitment more to designing new energy efficient facilities by (1) requiring that their field organizations insure that A/E firms fully understand all the energy conservation requirements and can meet them and (2) establish and implement controls over A/E firms' submissions and their reviews to insure facilities are as energy efficient as economically feasible.

1/LCD-81-7.

RECOMMENDATIONS

We recommend that to insure that new facilities are designed for minimum energy usage, the Secretary of Defense direct the Secretaries of the Army, Navy, and Air Force to:

- Consolidate, for easy reference, all the energy conservation requirements applicable to facility designs.

We also recommend that the Secretaries of the Army and the Navy direct the Chief of Engineers, Army, and the Commander, NAVFAC, to:

- Establish controls to insure that required energy analyses are submitted.
- Establish quality assurance procedures over energy analyses to insure that all are properly reviewed for completeness and reasonableness and that design firms correct all significant errors and omissions in them.
- State, when appropriate, that energy conservation expertise is a significant factor in the selection process and require that such expertise be evaluated during the selection process when the contract requires an energy analysis.
- Identify training needs of staff in energy analyses training.

AGENCY COMMENTS AND OUR EVALUATION

DOD stated that:

- The above recommendations would be included in its revised instruction on energy budgets.
- It believed that the Corps and NAVFAC would make every effort to reemphasize energy conservation in their design processes within limits of resources and other constraints.
- It agreed that it needed to improve its implementation of energy conservation policy guidelines.

--In varying degrees, steps had been taken by the Corps and NAVFAC on many of the matters discussed but more could be done.

Some of the comments on specific problems cited above were:

--The Corps and NAVFAC need to reemphasize the importance of adequate controls over the preparation and review of energy analyses and insure that adequate followup of corrective actions is taken. They also need to raise their priorities for energy conservation in their design and construction processes.

--The Corps and NAVFAC have exerted considerable effort within their resources to insure energy efficient design of facilities. Energy analyses alone do not insure that the planned energy consumption will be met in completed facilities. Other techniques, such as design energy conservation requirements, guidelines, and prescriptive specifications, help provide the assurance that completed facilities will be energy efficient. We agree. However, our point is that the energy analysis is a tool which managers can use to measure design performance and should be prepared properly or it is of little value.

--The Corps and NAVFAC's major goal in facility construction is to provide mission support facilities to users in the time required. Energy conservation is but one consideration in the design and construction of facilities.

--When selecting A/Es, an appropriately weighted constant evaluation factor should help emphasize their capabilities in energy conservation.

--The Corps and NAVFAC have long encouraged their personnel to attend educational and training sessions on energy analysis techniques and energy conservation technology.

DOD was concerned that even if the recommended steps were taken, the problems identified would not be fully corrected. We share this concern because the problems stem primarily from practical application rather than policy. Consequently, periodic followup will be required to insure that actions are being properly implemented and new procedures are being followed.



MANPOWER,
RESERVE AFFAIRS
AND LOGISTICS

ASSISTANT SECRETARY OF DEFENSE

WASHINGTON, D.C. 20301

24 FEB 1983

Mr. Donald J. Horan
Director, Procurement, Logistics
and Readiness Division
U.S. General Accounting Office
Washington, D.C. 20548

Dear Mr. Horan:

This is in response to your draft report of December 2, 1982, "Improved Energy Management in Facility Design Process Should Reduce Operating Costs for DoD", Code 945804 (OSD Case #6144).

Members of the Office of the Secretary of Defense and the Services reviewed the report with representatives of your staff on January 5, 1983. We concur with the recommendations of the report as modified during that meeting. Enclosed are specific responses to the individual conclusions and recommendations. Basically, our comments clarify the fact that the Interim Energy Budgets (IEBs) were designed in 1979 for two reasons; first, as goals to ensure that the building envelope portion of the design process is rigorous and second to ensure that the Service engineers were ready for the impending Department of Energy's Building Energy Performance Standards (BEPS). Much of the delay in updating the IEBs is a result of not wanting to implement new standards which would be shortly superseded by the final BEPS.

The IEBs can be an effective tool to assist in achieving least life cycle cost building design and they are in need of clarification and improvement. An updated version, incorporating the recommendations of your report is in the final stages of preparation and will be forwarded to the Services in February. Within the limits of their resources and the constraints and basic requirements of the construction process, the Services will make every effort to reemphasize energy conservation in their design process. The Office of the Deputy Assistant Secretary of Defense (Installations) will follow up to ensure that the Services implement the report recommendations.

The opportunity to review the draft report and your staff's thoughtful analysis and positive assistance in identifying areas of improvement in our program are appreciated. DoD will continue to work to increase the effectiveness of ongoing conservation efforts.

Sincerely,

James N. Juliano
Principal Deputy Assistant
Secretary of Defense
(Manpower, Reserve Affairs, and Logistics)

Enclosure

DEPARTMENT OF DEFENSE
GAO DRAFT REPORT, DATED DECEMBER 2, 1982
(GAO CODE NO. 945804)
OSD CASE NO. 6144

FINDINGS, CONCLUSIONS AND RECOMMENDATIONS

* * * * *

FINDINGS

FINDING A: Interim Energy Budgets Not Effective Design Goals for New Facilities. GAO found that DoD's interim energy budgets do not represent realistic design objectives or goals for measuring and evaluating the adequacy of energy conservation in design. The budgets cannot be used effectively as a management tool because, (1) the developmental assumptions have not been published, (2) the budgets are based on data which does not reflect current conservation technology and practices and (3) facility types are inappropriately grouped. (p. 11, GAO Draft Report).

DOD CONCURS. The interim energy budgets (IEB) by themselves do not, and were not designed to, assure that DoD is accomplishing the most energy efficient facilities. Current design guidance promulgated by the Defense Construction Criteria Manual DoD 4270.1M and appropriate technical memoranda require the incorporation of cost effective energy conservation features which we believe provide energy efficient facilities that meet the intent of Executive Order (E.O.) 12003 (new facilities are to use 45 percent less energy than similar buildings of 1975). The Services have incorporated all such appropriate guidance into their design and construction process. DoD concurs with the statement that building hours of operation used as a basis to develop each IEB must be identified for the architect-engineer firm (A/E) to provide a realistic design energy budget figure (EBF) to compare with the IEB. The draft DoD Energy Budgets revision, soon to be circulated, contains assumptions, such as the hours of operation, used as the basis for each EBF, will use recent design experience with the interim budgets to develop "tighter" targets and will move realistically group facility types.

FINDING B: Designers' Assumptions Account for Significant Variances Between Design Energy Usage and the Budgets. GAO found that because DoD's energy budgets do not include basic assumptions and have not been updated, budget users must make their own assumptions on what has been included in the budget calculations. GAO noted that in July 1980 DoD requested a report from each of the Services on data about design usage for all newly designed facilities, the purpose of which was to revise the interim energy budgets but that two years after the data had been provided, the interim budgets still had not be revised. (pp. 11-13, GAO Draft Report)

DOD CONCURS. DoD concurs that the budgets need to be revised. Further guidance is being developed to exclude special type facilities, such as flight simulators, data/communications centers, etc., and will contain additional clarification on how to apply the IEBs. It must be pointed out, however, that the IEBs were designed to comply with expected Building Energy Performance Standards (BEPs) being developed by the Department of Energy (DOE). DOE has, to date, not finalized their BEPs and this delay has been a major factor in the delay in DoDs updating the IEB's.

Enclosure

FINDING C: Designers Assumed Budgets Exceeded Because of Operating Hours. GAO found that, because DoD's energy budgets are not based on the estimated number of hours a day new facilities are to be operated, for those facilities whose designs indicated that energy usage exceeded DoD's energy budgets, the Services often stated that one reason was the difference in hours of operations. (GAO cited examples of Service facilities planned to operate 16 hours a day and noted that had budgets been adjusted to reflect the planned hours of operation some of the projects may not have exceeded the energy budgets.) (p. 14, GAO Draft Report)

DOD CONCURS. The budget revision, to be sent to the Services in February 1983, will clarify specific parameters.

FINDING D: Designers Assumed Budget Exceeded Because of Special Environmental Requirements. GAO found that DoD's energy budgets do not appear to provide for energy used to compensate for special environmental requirements (such as cooling or removing the heat generated by computers), that DoD's guidelines are not clear regarding this type of energy requirement and that the Services also indicated this as a reason why budgets were exceeded. (pp. 16-17, GAO Draft Report)

DOD CONCURS. The IEB's were developed to encourage cost effective, energy conservative building envelope design. Present DoD guidance states that the IEBs include only the energy required for space heating, space cooling, domestic hot water and lighting. Anything else is to be considered process energy and is not to be included in the analyses. This approach is consistent with the DOE BEPs concept. Greater clarification will be given in future guidance to ensure that process energy is excluded from IEB analyses. Other steps in the design process allow the implementation of innovative energy conservative design features, the use of, alternative energy, etc.

FINDING E: Budgets Should be Revised as Design Techniques Improve. GAO found that many facilities were designed to use significantly less energy than DoD's budgets—one reason, according to the Services, was the use of specific energy conservation features. (GAO noted such features probably were not adequately considered in DoD's energy budgets because they were developed using energy conservation criteria in effect during 1972. (pp. 17-18, GAO Draft Report)

DOD CONCURS. The IEBs should be improved as envelope design techniques improve and the draft budget data have been made more stringent based on current design feedback. In November of 1972, the DoD design criteria was significantly improved. In fact, it was much more conservative than state of the art practice, and current DoD prescriptive design standards are at least as conservative compared with standard practice. These prescriptive standards will be assumed in the upcoming revision.

FINDING F: Interim Energy Budgets Are Based on Outdated Data. GAO found that although the energy budgets are based on the best information available at the time they were developed in fiscal year 1979, they do not reflect the current energy conservation design capabilities. (pp. 20-22, GAO Draft Report)

DOD CONCURS. The budget revision will be based on the most recent design capabilities.

FINDING G: Military Facilities Not Appropriately Grouped for Energy Budgets. While DoD has grouped military facilities into 12 categories for energy budget purposes, GAO found these categories are not adequate to accommodate the many different types of facilities used in a wide variety of military operations. (GAO noted that according to the Corps, the DoD facility groupings being used are based on engineering judgments to complement the DOE categories.) (pp. 22-24, GAO Draft Report)

DOD CONCURS. The category codes were deliberately developed to parallel the DOE BEPs. The revision will allow the Services to break down the IEB's further to consider specific operational and unique requirement categories.

FINDING H: Design Process Does Not Assure the Design of Energy Efficient Facilities. GAO found that the Services' design processes contain problems which do not ensure that new facilities are designed for minimum energy consumption and that the Services need to improve their management of the design process to assure that designers are producing adequate energy conservation designs of facilities. (p. 28, GAO Draft Report)

DOD CONCURS. It is not, however, the intent of the energy budget process to determine how energy efficient each facility is. The quality of overall design guidance and professional practice maximizes the energy conservation in each facility. The IEB assists in assuring the most conservative envelope design and we concur that it should be improved. It must not be viewed as the only technique to ensure minimum consumption facilities.

FINDING I: Services Implement Energy Conservation Requirements Differently. GAO found that the Corps and NAVFAC field organizations have established different guidelines, procedures and organization structures to implement energy conservation requirements in designing new facilities and noted that the strength and weaknesses of the various methods used are reflected in staff responsibilities, guidelines and requirements. (In connection with this findings, GAO also reported extensively on opinions of responsible officials at NAVFAC, Southern Division; NAVFAC, Chesapeake Division; Corps of Engineers, Savannah District; and Corp of Engineers, Forth Worth District. GAO noted the different comments also reflected the varying methods the Services have used to implement energy conservation.) (pp. 28-34, GAO Draft Report)

DOD CONCURS. The budget revision will request Services to standardize practices where possible and provide justification where determined to be infeasible.

FINDING J: Energy Analysis Not Adequately Controlled to Assure Energy Efficient Designs. GAO found that new facilities may not be designed as energy efficient as DoD's policy suggests because procedures and practices of the Corps and NAVFAC field organizations do not assure adequate control and review of energy analyses. (p. 36, GAO Draft Report)

DOD CONCURS WITH COMMENT. Energy conservation is one subsidiary consideration in the construction of facilities to meet operational needs. Within the constraints of resources, priorities and the need to meet occupancy deadlines, the Services are striving to accomplish minimum energy use designs. The budget revision will require additional effort to increase this control through increased priority emphasis.

FINDING K: Control Over Submitting Energy Analyses Not Adequate. GAO found that energy analysis for certain facilities in the Corps' Fort Worth and Savannah Districts and NAVFAC's Southern Division were either missing or not completed and that controls were inadequate to assure that energy analyses were prepared for all facilities. GAO also found that an energy analysis for a fire station at Fort Stewart, Georgia, was not prepared because it was a "turn key" project and that procedures in the Savannah District were inadequate for controlling A/E firms' designs for these type projects. (pp. 36-37, GAO Draft Report)

DOD CONCURS. The Services need to reemphasize this aspect of new design consideration and raise the priority of conservation within the overall design and construction process. The budget revision will direct this reemphasis through formal incorporation of energy considerations in the process.

FINDING L: Energy Analyses Were Not Always Reviewed. GAO found A/E firm's energy analyses were not reviewed by Services' energy conservation engineers and that the Services lacked adequate controls to assure that the engineers reviewed all the energy analyses submitted by A/E firms. (GAO cited specific deficiencies observed in the Corps' Fort Worth District, NAVFAC's Southern Division and Radar Air Traffic Control Facility, Corpus Christi, Texas, which supported this finding.) (pp. 37-39, GAO Draft Report)

DOD CONCURS. In November 1982 and May 1982, the Air Force issued to its field offices additional guidance to review energy analyses and established a reporting system for these analyses. The other Services plan to reemphasize these requirements in their implementation of the budget revision.

FINDING M: Services Review Comments Were Not Adequately Followed Up. GAO found its reviews of energy analyses by the Services' engineers disclosed significant deficiencies and that the Services' controls are not adequate to assure coordination of review comments and corrective actions by designers. (As an example, GAO cited the Corps' Fort Worth District which received 23 energy analyses but was aware of actions taken by only two designers. GAO also cited deficiencies at NAVFAC's Chesapeake Division.) (pp. 39-41, GAO Draft Report)

DOD CONCURS. The budget revision will require follow up improvement through the initiation of a formal analysis review process.

FINDING N: Energy Analyses Were Not Adequately Reviewed. GAO further found that those energy analyses (which were done) contained errors and omissions which reviewers had not identified and that these deficiencies could have affected the energy conservation designs of facilities. (GAO specifically noted that the Corps' Fort Worth District review functions does not require determining whether A/E firms have considered all energy conservation features; and that not only has the Corps' Savannah District not established guidelines for reviewing energy analyses, but that the engineers that review energy analyses have limited training and experience in computer simulation programs. GAO also cited deficiencies at other locations.) (pp. 41-43, GAO Draft Report)

DOD CONCURS. The budget revision will require that improved analysis review be formally implemented by the Services and implementation documents be forwarded to OSD(MRA&L) to verify compliance.

FINDING O: Need to Consolidate Energy Requirements and Emphasize Energy Expertise in Selecting A/E Firms. GAO found the Services do not clearly state their energy conservation requirements to A/E firms nor do they emphasize the need for energy conservation expertise in selecting A/E firms, therefore, there is no assurance that designers will adequately comply with all the Services requirements. (p. 44, GAO Draft Report)

DOD CONCURS. The budget revision will require improved A/E selection process for energy related projects. DASD(I) will convene a Tri Service Committee to develop a uniform process in March 1983.

FINDING P: Clearly Stated Energy Requirements Could Help A/E Firms. GAO found the significant variances between designers' energy analyses and DoD energy budgets could indicate either (1) that the designers' energy analyses are adequate and DoD's energy budgets are inadequate (as previously discussed), or (2) that the Services have not adequately instructed designers to be innovative and design to minimum energy consumption. (GAO cited the Corps' Savannah District's procedures and NAVFAC's Southern Division's compilation of requirements in one document as examples of improved guidance at the Service level. GAO also discussed local situations which appeared to emphasize a lack of clear guidance from the Services.) (pp. 44-46, GAO Draft Report)

DOD CONCURS. The Services have all made efforts to clarify and consolidate the pertinent information since the GAO study was initiated. The revised guidance will require that consolidation be expedited.

FINDING Q: Energy Expertise Is Not Adequately Emphasized in Selecting A/E Firms. GAO found that in selecting A/E firms, the Services generally had not emphasized the need for expertise in designing energy efficient facilities--- and that requiring such expertise could help A/E firms to comply with the Services' energy requirements. (pp. 46-67, GAO Draft Report)

DOD CONCURS. The budget revision will require Services to increase their emphasis on expertise necessary to achieve improved conservation services from A/Es through an improved formal selection process which will increase the weighting factors given to those firms with conservation experience.

CONCLUSIONS

CONCLUSION 1. GAO concluded that, while DoD's interim energy budgets were established as one tool to accomplish the reduced energy usage in newly designed facilities, DoD's instructions for using energy budgets do not provide designers adequate guidance to permit the budgets to be used for design performance evaluation. Further, the interim budgets do not adequately establish design goals on which to evaluate design accomplishments. (p. 24, GAO Draft Report)

DOD CONCURS WITH COMMENT. Design criteria and construction instructions do provide designers with adequate guidance to meet new buildings goals for most facilities. The energy budgets are another tool to ensure that additional attention is paid to the building envelope design. DoD concurs that additional guidance is necessary for analysis of buildings with special environmental conditions and to incorporate additional experience gained in the last two years and this information will be contained in the guidance update to be sent to the Services in February.

CONCLUSION 2. GAO concluded that the DoD energy budgets are based on incomplete and outdated data. (p. 24, GAO Draft Report)

DOD CONCURS. The budget revision will include the most recent design practices available.

CONCLUSION 3. GAO concluded that the Services' reasons for significant over and under-variances (reported two years prior but not yet reflected in revised DoD energy budget) indicates that a different approach is needed in use of energy budgets. (pp. 24-25 GAO Draft Report)

DOD CONCURS. As has been stated, DoD agrees that better direction in the use of the budgets and improvements such as standard operating hours is necessary. DoD also agrees that additional latitude in IEB development for Service unique buildings should be given in forthcoming directives. DoD still, however, expects some design EBFs to be less, and in some cases much less, than the IEBs because of the A/Es abilities to incorporate energy features in the design of specific building with unique requirements.

CONCLUSION 4. GAO concluded that because each facility is designed to consider local environmental and operating conditions, energy budgets established and managed at the national level without utilizing design experiences and expertise at the local levels is not an effective way to administer energy budgets--that energy budgets are best managed at the local level where intimate knowledge of local conditions exists. (p. 25, GAO Draft Report)

DOD CONCURS WITH COMMENT: While concurring that additional latitude should be given to the Services to consider unique variations from the norms, the IEBs are divided into seven climate regions for each type facility, it is DoD's position that the energy budgets are adequate to determine the integrity of the building envelope in any specific location. As indicators of design quality, the updated IFB's should be adequate without requiring a much more resource intensive, complex process.

CONCLUSION 5. GAO concluded that the proper functions for DoD in administering energy budgets are (1) to set forth the assumptions that should be included in the budgets, (2) to revise the interim energy budgets to reflect current design energy conservation requirements and define them as goals to be achieved and bettered, (3) to revise the 12 categories of facilities to group together facilities with the same modes of operations, (4) to establish a procedure for the Services to modify DoD energy budgets based on their energy conservation requirements and guidance, and grouping facilities into appropriate categories by function, and (5) to monitor the revised procedures to ensure that the Services adequately modify and update the energy budgets. (pp. 25-26, GAO Draft Report)

DOD CONCURS. DoD concurrence is based on the clarification that any revision to the 12 categories of facilities (3) must recognize the need to be compatible with future DOE BEPs to avoid extensive field disruption when finally implemented. These improvements will be included in the revision in February.

CONCLUSION 6. GAO concluded that while local managers have varying opinions regarding the use of energy budgets and the reasons for inconsistent energy saving results, the validity of such reasons cannot be determined because of inadequate record keeping. (pp. 47-48, GAO Draft Report)

DOD CONCURS. In May 1982, the Air Force established a reporting system for the A/E's EBFs to be included in the Design and Construction Management System for all new facility designs. The other Services are developing similar systems which should be implemented by October of this year.

CONCLUSION 7. GAO concluded that since Executive Order 12003 requires significant reductions in energy usage in new facilities, the Services need to emphasize their commitment more to designing new energy efficient facilities by (1) requiring that their field organizations assure that A/E firms fully understand all the energy conservation requirements and can meet them and (2) establishing and implementing controls over A/E firms' submissions and their reviews to assure facilities are as energy efficient as economically feasible. (p. 48, GAO Draft Report)

DOD CONCURS. The Services have recently improved their emphasis on lowest life cycle cost design but the priority of this goal must be put in context with the major goal of providing mission support facilities--on time. DoD will continue to make every effort to improve this emphasis in the design process and the forthcoming IEB guidance will include such direction.

RECOMMENDATIONS

RECOMMENDATION 1. GAO recommended that the Secretary of Defense require that the Assistant Secretary of Defense for Manpower, Reserve Affairs and Logistics [ASD(MRA&L)] develop and issue DoD energy budgets for the various building types and climatic zones, and rescind the interim budgets. (p. 26, GAO Draft Report)

DOD CONCURS. A revision to the DoD energy budgets is in the final stages of development and will be circulated to the Services in February. Every effort will be made to make the IEBs compatible with expected DOE BEPs.

RECOMMENDATION 2. GAO recommended that the Secretary of Defense require that guidance be issued to the Services clearly describing all the factors and assumptions used to calculate the budgets and how the budgets are to be used. (p. 26, GAO Draft Report)

DOD CONCURS. The budget revision referred to in response to Recommendation 1 will include all the pertinent parameters.

RECOMMENDATION 3. GAO recommended that the Secretary of Defense require the Services to perform additional energy analysis to take into account local environmental conditions, operations, and special project characteristics not considered in the budgets which might significantly affect energy usage. (pp. 26-27, GAO Draft Report)

DOD CONCURS. This additional energy analysis step will be included in the forthcoming revision to the DoD energy budgets.

RECOMMENDATION 4. GAO recommended that the Secretary of Defense require that the ASD(MRA&L) provide the Services with technical assistance in implementing their energy budgets. (p. 27, GAO Draft Report)

DOD CONCURS. The ASD(MRA&L) will continue to work with DOE and professional organizations such as AIA to develop technical assistance for Service professionals.

RECOMMENDATION 5. GAO recommended that the Secretary of Defense require the Services to report to the Deputy Assistant Secretary of Defense for Installations and justify instances when the estimated energy usage for a design deviates from its energy budget by 15 percent. (p. 27, GAO Draft Report)

DOD CONCURS. The revised IEB directive will include the requirement for reporting significant deviations from the budgets to allow future budget improvement.

RECOMMENDATION 6. GAO recommended that the Chief of Engineers, Army, and the Commander, Naval Facilities Engineering Command, consolidate for easy reference, all the energy conservation requirements applicable to facility design. (p. 48, GAO Draft Report)

DOD CONCURS. The Services have started the compilation of all pertinent information and the budget revision will emphasize the need for this effort and require consolidation of requirements by October of this year.

RECOMMENDATION 7. GAO recommended that the Chief of Engineers, Army, and the Commander, Naval Facilities Engineering Command, establish controls to insure that required energy analyses are submitted. (p. 48, GAO Draft Report)

DOD CONCURS. The budget revision will direct that such action be taken by the Services.

RECOMMENDATION 8. GAO recommended that the Chief of Engineers, Army, and the Commander, Naval Facilities Engineering Command, establish quality assurance procedures over energy analyses to insure that all are properly reviewed for completeness and reasonableness, and that design firms correct all significant errors and omissions in them. (p. 49, GAO Draft Report)

DOD CONCURS. The Services will be directed to establish quality assurance procedures by October of this year and implementation of the budget revision will contain the improved procedures recommended.

RECOMMENDATION 9. GAO recommended that the Chief of Engineers, Army, and the Commander, Naval Facilities Engineering Command, state when appropriate, that energy conservation expertise is a significant factor in the selection process, and require that such expertise be evaluated during the selection process when the contract requires analysis. (p. 49, GAO Draft Report)

DOD CONCURS. An appropriately weighted, consistent evaluation factor should help emphasize energy conservation design capability during the selection process and will be included in the budget revision implementation.

RECOMMENDATION 10. GAO recommended that the Chief of Engineers, Army, and the Commander, Naval Facilities Engineering Command, identify training needs of staff in energy analyses and energy conservation technology and provide such training. (p. 49, GAO Draft Report)

DOD CONCURS. The Services have long encouraged their staffs and field personnel to attend educational and training sessions in energy analyses techniques and energy conservation technology. Recent cooperation with DOE has led to their sponsoring a new buildings, energy conservation design course, developed by the American Institute of Architects (AIA), in which DOE pays the tuition for DoD architects and engineers who attend. The Services will increase their emphasis on related training.

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