BY THE U.S. GENERAL ACCOUNTING OFFICE

Report To The Secretary Of Defense

DOD Energy Monitoring And Control Systems --Potential For Nonenergy Savings --Better Planning And Guidance Needed

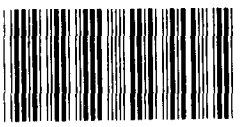
In addition to reducing energy costs, computerized energy monitoring and control systems offer the potential to reduce personnel and maintenance costs. Funding these systems under current energy savings criteria does not permit the Department of Defense to take full advantage of the nonenergy savings features. Also:

--Installations program systems without knowing if they have selected those buildings which will be the most cost effective in saving energy.

--Expected savings due to using such systems are not achieved because of reduced project scopes or inaccurate assumptions.

--The military services need to further consider the potential economies of joint-use systems.

GAO recommends actions which will assist the Secretary of Defense in overcoming these problems.



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

LOGISTICS AND COMMUNICATIONS
DIVISION

B-199081

The Honorable Harold Brown
The Secretary of Defense

Dear Mr. Secretary:

This report discusses the acquisition by military installations of energy monitoring and control systems and the need for better planning and guidance. We made the review to evaluate the planning, justification, expansion, and use of such systems in view of their costs and increasing popularity.

We discussed the report with Department of Defense officials and have incorporated their comments as appropriate.

This report contains recommendations to you on pages 13, 14, 21, and 29. As you know, section 236 of the Legislative Reorganization Act of 1970 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, House Committee on Government Operations, Senate Committee on Governmental Affairs, and House and Senate Committees on Appropriations and on Armed Services. We are also sending copies of the report to the Director, Office of Management and Budget, and the Secretaries of the Army, the Navy, and the Air Force.

Sincerely yours,

R. W. Gutmann

R. W. Gutmann
Director

GENERAL ACCOUNTING OFFICE
REPORT TO THE SECRETARY
OF DEFENSE

DOD ENERGY MONITORING AND CONTROL SYSTEMS
--POTENTIAL FOR NONENERGY SAVINGS
--BETTER PLANNING AND GUIDANCE NEEDED

D I G E S T

To help meet energy conservation goals for federally owned buildings, the Department of Defense (DOD) is installing energy monitoring and control systems at military installations. These systems provide central control over heating, ventilating, and air-conditioning systems to maintain temperatures at predetermined levels. Personnel requirements can be reduced through the use of these systems for centralized monitoring of boiler plants, water treatment, and sewage disposal systems. Since fiscal year 1976, the Congress has appropriated about $144 million for 131 projects at 115 locations under DOD's Energy Conservation Investment Program.

Although energy systems can contribute to economical and efficient operation of facilities, present funding criteria, which require projects to be justified on the basis of energy savings, do not permit DOD to take full advantage of other savings, such as reductions in staffing needs. GAO believes the military services should continue to evaluate and fund energy systems on their abilities to save energy. However, in order to obtain the most efficient and cost-effective systems, those projects which have substantial nonenergy cost reduction potential should be given further consideration for inclusion in the military construction program. GAO's review of 16 projects at 14 Army, Navy, and Air Force bases disclosed the following problems:

--Thirteen bases programed systems without the benefit of master plans. GAO believes master plans would help installations systematically plan for installing and expanding energy systems. (See pp. 8 and 9.)

--Nine installations did not consider all buildings which might be serviced by the system, or included buildings (due to cusory evaluations) which had been demolished or were not suitable for

an energy system. As a result, the services did not know if they had selected the most cost-effective buildings. Also, insufficient planning and poor cost estimating resulted in reduced scopes for six projects. (See pp. 10 to 12.)

--Inaccurate savings or cost estimates were used by the services to justify 10 projects. Programed savings for nine projects will not be achieved because of reduced scopes, inaccurate savings assumptions, or failure to offset savings with recurring costs. In one case, savings were so low after reducing the project scope that the project would not be justified under DOD criteria. (See pp. 15 to 19.)

Although DOD has issued instructions for justifying and revalidating energy projects, GAO believes that more thorough analyses are needed to assure energy system projects are adequately justified and that funds will be available to repair building systems before projects are approved. (See pp. 15 to 21.)

Generally, systems have been installed to service a single installation. Although the services have given limited consideration to joint-use systems by activities belonging to the same command or where maintenance is under the same command, there needs to be further study of their potential use by two or more installations or activities under different commands. (See pp. 22 to 26.)

Except for the Air Force, the services lack guidance on providing staff to manage energy systems. Adequate and timely staffing is necessary if an installation expects to achieve efficient and full use of its system. Recently, the Air Force Audit Agency noted poor utilization of systems because of poor staffing. As of June 1980 the Army and Navy said they were either in the process of developing or planned to develop staffing guidance. (See pp. 27 to 29.)

DOD has adopted tri-service specifications to provide competitive procurement. Using these specifications to obtain competition in expanding proprietary systems may result in duplication of system hardware and software because

DOD does not have access to manufacturers' information about how the systems work or how they may be made compatible with other systems.

Although the Army and the Air Force have flexible policies for expanding proprietary systems, the Navy insists on using the tri-service specifications. In one instance where the specifications were used, only one bid was received from a vendor backed by the proprietary system manufacturer.

Tri-service specifications, if used properly, can be an effective tool to obtain competition on new systems. However, Defense procurement officials should be aware of the problems in using the tri-service specifications on proprietary system expansions and be alert to cases where it may be more cost effective to use negotiated procurement. (See pp. 31 to 37.)

RECOMMENDATIONS

The Secretary of Defense should:

--Assure that energy system projects with substantial nonenergy cost reduction potential be given full consideration for inclusion in the military construction program. (See p. 13.)

--Issue guidelines requiring the services to prepare energy system master plans. Such plans should evaluate, by building, the cost and savings for energy, as well as nonenergy features, and should be revised periodically to reflect updated costs. (See p. 14.)

--Oversee and evaluate the services' efforts in carrying out DOD's economic analysis policy and closely review energy system projects. (See p. 21.)

--Establish policy on joint use of energy systems which will require consideration when planning and evaluating systems. (See p. 29.)

AGENCY COMMENTS

DOD representatives generally agreed with the information and recommendations in this report and said they would give them further consideration. Although agreeing with the concept of master plans,

DOD felt it would be too costly to evaluate each building for such a purpose. GAO believes that an early evaluation of buildings will result in a more timely determination of a project's validity, a more accurate identification of project buildings, and a possible reduction in the scope of the architect/ engineer's feasibility study. (See p. 14.)

Contents

ABBREVIATIONS

A/E	architect/engineer
AFB	Air Force Base
DOD	Department of Defense
EMCS	Energy Monitoring and Control System
GAO	General Accounting Office
NASA	National Aeronautics and Space Administration

GLOSSARY

Central processing unit (CPU)	The portion of the computer that performs the interpretation and execution of instructions.
Demand	The term used to describe the maximum rate of use of electrical energy averaged over a specific interval of time and usually expressed in kilowatts.
Demand limiting program (load shedding)	Consists of shedding electrical loads in order to prevent exceeding an electrical demand peak contract value and thus increasing electrical costs where demand-oriented rate schedules apply. The Energy Monitoring and Control System (EMCS) monitors the electrical demand continuously by comparing it to the existing peak demand rate. Based on the monitored data, demand predictions will be made by the EMCS. When these predictions exceed preset limits, certain scheduled electrical loads must be shut off by the EMCS to reduce the rate of consumption before the predicted peak demand is exceeded.
Duty cycle program	Consists of the shutdown of a ventilating and air-conditioning system for predetermined short periods of time during normal operating hours. Although the interruption does not reduce the net heating or cooling energy, it does reduce total electric energy consumption of loads, such as fans and pumps, since they are not operating for the entire cycle.

Field Interface Device (FID)	A small intelligent microprocessor based hardware device containing software which implements the distributed processing aspects of operation with the central computer.
Operator console	An input/output device or group of devices used to communicate with the central system.
Hardware	EMCS equipment, such as central processing unit, central control unit, etc.
Point	Actual input to or output from the EMCS from or to the systems being monitored and controlled.
Sensors	Devices used to detect or measure physical phenomena.
Start/stop optimization	Provides a means for shutting down mechanical or electrical systems during the unoccupied hours. Traditionally, the systems are started prior to occupancy in order to cool down or heat up the space. Normally, this function is performed on a fixed schedule independent of weather, space, or other conditions. The optimized start/stop feature automatically starts and stops the system to minimize the energy necessary to provide the required environmental conditions during occupied hours.
Timed start/stop control	Consists of the starting and stopping of a system or equipment based on the time and type of day. This is the simplest of all EMCS functions to install, maintain, and operate. It also provides the greatest potential for energy conservation by preventing equipment or systems from being operated unnecessarily during unoccupied hours.

CHAPTER 1

INTRODUCTION

The Department of Defense (DOD) Energy Conservation Program began with the oil embargo of 1973. With the issuance of Executive Order 12003 in July 1977 mandating specific energy savings goals by 1985, DOD's emphasis on identifying retrofit projects for its military installations became more urgent. According to DOD, the single most powerful tool for meeting these goals is to install Energy Monitoring and Control Systems (EMCSs) at many of its installations throughout the continental United States. EMCSs provide centralized control over heating, ventilating, and air-conditioning systems in a building or complex of buildings to ensure that temperatures in the buildings are maintained at the most efficient levels to provide energy savings. Savings in areas other than energy, such as personnel and maintenance costs, can also be achieved through EMCSs.

HISTORY OF EMCS

An EMCS is a system for monitoring and controlling remote mechanical, electrical, utility, and life-safety systems from a central location, usually the base engineer facility. EMCSs monitor and control these systems using one or more computers linked to sensors installed on heating, ventilating, and air-conditioning equipment. Often, to reduce costs, existing spare telephone lines may be used to connect the centralized equipment to the systems.

The Air Force began installing central control systems in 1970. The first such system was located at Luke Air Force Base (AFB), Arizona. These earlier systems were designed as central monitoring systems and not specifically to save energy. Some features, such as timed start/stop control, were installed in these systems, and although not included for saving energy, they later proved beneficial in this regard. With DOD's establishment of an Energy Conservation Investment Program in 1976, the military services began to design central control systems to save energy and these systems became known as EMCSs. More recent EMCSs include computers to manage heating, ventilating, and air-conditioning systems.

EMCS funding

Since fiscal year 1976 DOD has funded most of its EMCSs under its Energy Conservation Investment Program--a designated allocation of military construction funds used to finance construction under DOD's Energy Conservation Program. Appendix I shows the relationship of EMCS funding to the total program from fiscal year 1976 through fiscal year 1980. DOD has also funded EMCS projects using other funding sources, such as military construction appropriations not designated for energy projects, and operation and maintenance funds. Data was not readily available from the services on amounts spent from these sources.

The Congress appropriated about $144 million for EMCSs under this program during fiscal years 1976 through 1980 for 131 EMCS projects at 115 locations (1 or more projects may be included in an EMCS).

	Project amounts			
Fiscal year	Army	Navy (note a)	Air Force	Total
	----------(000 omitted)---------			
1976	$ 885	$ 1,993	$ 7,650	$ 10,528
1977	15,570	4,467	10,781	30,818
1978	2,905	2,485	14,348	19,738
1979	21,888	19,795	21,996	63,679
1980	b/ 5,500	7,220	6,367	19,087
Total	$46,748	$35,960	$61,142	$143,850

a/Includes Marine Corps.
b/Amounts requested.

At the time of our review, DOD had installed 30 EMCSs under the Energy Conservation Program. Appendix II shows the status of all funded EMCSs as of the latter part of calendar 1979.

We reviewed DOD's acquisition of EMCSs because of the rapid growth in this area. In a March 1977 letter to DOD following an earlier survey of EMCSs, we advised DOD of certain problems in the procurement, planning, use, and funding of EMCSs. Some of these problems have been addressed with DOD's subsequent adoption of (1) the tri-service specifications (see pp. 31 and 32) which have been designed to provide competition in the expansion of new systems and (2) the Energy Conservation Investment Program criteria which require energy savings--earlier criteria merely emphasized savings--therefore, energy conservation projects, including EMCSs, could be funded which have little or no energy savings.

Since this 1977 survey, other reviews have been made of DOD's program by the Surveys and Investigations Staff, Committee on Appropriations, House of Representatives; DOD's Defense Audit Service; and the Air Force Audit Agency. Each of these reviews states that DOD needs to improve its procedures to acquire EMCSs. Matters covered included

--the need to consider whether EMCS produced energy savings could be achieved through simpler, less costly energy conservation measures; 1/ 2/

--the need for improved guidance in the Air Force establishing and reemphasizing criteria for designing, acquiring, accepting, manning, and maintaining an EMCS; 2/

--use of EMCS funds to upgrade an EMCS to meet the tri-service specifications which will not result in energy savings; 3/

1/"Improvements Needed in Department of Defense Energy Conservation Investment Program" (EMD-78-15, Jan. 18, 1978).

2/Air Force Audit Agency Summary Report 95443, Air Force Energy Conservation Management and Control Systems (July 6, 1979).

3/Defense Audit Service Report 79-054, Report on the audit of the Department of Defense Energy Conservation Investment Program (Feb. 28, 1979).

--the need for DOD to demonstrate the benefits of EMCSs before buying so many; 1/

--the need for a formal, well conceived and designed, centrally controlled plan of action; 1/ and

--the need for an exchange of EMCS information within and among the services. 1/

Certain of the recommendations contained in the above reports were either rejected by DOD or are still under consideration. DOD believes there are no alternatives to a basewide EMCS in meeting mandated energy conservation goals. Therefore, it generally does not consider, for example, the proposed use of simple time clocks to turn electrical equipment and lighting on and off to save energy in lieu of a basewide EMCS. DOD has rejected time clocks for basewide control because they (1) are subject to tampering which is not immediately identifiable, (2) are inflexible, and (3) do not provide energy conservation savings beyond start-stop control. Likewise, most EMCS savings to date have been based upon calculated engineering estimates. Until 1977 metering was not authorized by DOD for EMCS projects because meters do not save energy. Attempts to measure actual savings through establishment of metered data are now in process on a limited, sample basis. Because metering is costly, DOD believes instrumenting and monitoring each project will seriously erode cost effectiveness. For example, the Army plans to meter only one of its EMCSs. Therefore, the actual effectiveness of some EMCSs may never be known.

1/Surveys and Investigations Staff, House Committee on Appropriations, Department of Defense Energy Conversation Program (Apr. 1978).

CHAPTER 2

DOD SHOULD EXPAND NONENERGY USES OF EMCSs AND IMPROVE SYSTEM PLANNING

Although EMCSs have the potential for increasing the operating efficiency of military installations through savings in such areas as energy, personnel, maintenance, and reduced electrical demand charges, the military services are not taking full advantage of this capability. To meet the requirements of the energy program under which most systems are funded, the services have limited system features generally to those resulting in only energy savings. In addition, the services have not sufficiently planned the systems to take full advantage of either energy or nonenergy savings.

MORE NONENERGY USES OF EMCSs ARE POSSIBLE

EMCSs afford the military services an opportunity not only to reduce energy use but also to operate and maintain their facilities in a more economical and efficient manner. However, DOD's guidance on implementing its energy program, under which most systems are funded, does not permit the services to take full advantage of the systems' potential, since it requires projects to be justified on the basis of energy savings.

Although 15 of the 16 EMCS projects we reviewed contained some nonenergy features, officials at 13 of the 14 installations visited felt that additional nonenergy features should be included in their EMCSs.

DOD's energy program limits EMCS uses

During the first 3 years of DOD's Energy Conservation Investment Program, DOD evaluated program projects based on their ability to quickly recover initial costs through energy savings, as well as nonenergy savings, such as reduced labor and maintenance costs or lowered electrical demand charges. In October 1977 DOD issued guidance for justifying program projects to be funded in fiscal year 1979 and later. Under this guidance projects must meet two requirements. First, the cost of projects must be amortized through energy and nonenergy savings (discounted to present values) within their economic lives. The discounted benefit-to-cost ratio must be greater than one. Second, projects are required to meet an established minimum ratio of energy savings

(million Btu's) to each $1,000 increment of investment. In a January 1978 report 1/ to the Secretary of Defense, we recognized the need for such analyses in evaluating and selecting program projects.

Although nonenergy savings resulting from functions, such as reducing demand charges and equipment runtime, monitoring equipment, and scheduling preventive maintenance, can be used in computing a project's discounted benefit-to-cost ratio, such savings do not improve the project's energy savings-to-cost ratio which is needed to justify a project under the energy program.

According to an official from the Office of the Deputy Assistant Secretary of Defense (Installations and Housing), the Energy Conservation Investment Program fulfills DOD's responsibility for implementing Executive Order 12003, which established energy conservation goals for federally owned buildings. While recognizing that EMCSs can produce nonenergy savings, the official believes DOD should justify funding program projects based on energy savings because the Congress appropriates energy funds for that purpose.

Army, Navy, and Air Force engineer officials recognize that EMCSs can produce nonenergy savings. A Naval Facilities Engineering Command official said that systems designed to meet tri-service guide specifications would contain the basic framework to which an installation could subsequently add nonenergy related functions, such as maintenance scheduling. (See pp. 31 and 32.) However, adding such features after the basic system is installed would be costly. According to service engineer officials, the extent to which nonenergy functions can be incorporated into EMCS projects funded under the energy program is limited because, while resulting in dollar savings, EMCSs add to the project cost and not to energy savings. Thus, adding nonenergy features to an EMCS may improve its discounted benefit-to-cost ratio while possibly lowering the energy savings to $1,000 investment ratio below the minimum for the program year.

Some EMCSs produce significant nonenergy savings: others do not

One EMCS, at Fort Eustis, Virginia, has resulted in significant nonenergy savings. Base officials justified their fiscal year 1976 EMCS project under criteria which

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1/"Improvements Needed in Department of Defense Energy Conservation Investment Program" (EMD-78-15, Jan. 18, 1978).

allowed the base to include nonenergy savings. The EMCS has nonenergy features, such as maintenance management and demand control programs, and it monitors and controls the base's 14 boiler plants. Automating the boiler plants allowed the base to reduce its boiler plant work force from 54 to 18 people. Of the 36 positions, the base reassigned 30 people and subsequently reduced its total work force by 6 positions. The base used some of the eliminated positions to establish and staff an energy branch which includes an energy chief, an EMCS supervisor, five EMCS operators, and three EMCS maintenance personnel. In the future, the base plans to operate a programed refuse-fired steam plant with the EMCS. According to a base official, connecting the plant to the EMCS will eliminate the need for separate plant operators.

The base's demand control program also resulted in reducing the base's electrical demand. According to a base official, the EMCS was used to reduce the 1979 electrical demand from 21,000 kilowatts to about 16,500 kilowatts. This reduction will save the base about $300,000 a year.

The EMCS which the Army is installing at Fort Belvoir, Virginia, can be contrasted to the one at Fort Eustis. Although the system will provide equipment runtime for maintenance purposes and control demand, it will be limited to monitoring, not controlling, the base's boiler plants. Consequently, the base will not be able to reduce its boiler plant work force as did Fort Eustis. According to a base official, an EMCS capable of controlling the base's boiler plants would be desirable; however, it would be costly and would not provide sufficient energy savings to meet the energy program's justification requirements.

Funding EMCSs not in the energy program

According to service engineer officials, EMCSs not funded under the energy program receive a low priority in competing with other military construction projects and, thus, are not funded.

For example, the Naval Academy, Maryland, is planning a $5.6 million project to rehabilitate and expand its utility system which includes about $1 million for EMCS expansion. The Academy funded the project as a military construction project not in the energy program.

Because the project was not under the energy program, the Academy included nonenergy features in the project with estimated personnel savings accounting for about 73 percent of the system's estimated $143,000 savings. The Academy

had programed the project for fiscal year 1980 funding; however, the Navy has deferred the project until fiscal year 1983 because of its low priority. According to an Academy official, the EMCS segment could be funded under the energy program, but this would require eliminating many of the personnel savings features which would be more costly to add later.

The National Aeronautics and Space Administration uses nonenergy savings to justify projects

The National Aeronautics and Space Administration (NASA) acquires EMCSs with its construction appropriations. NASA considers the systems as a means to meet its energy reduction goals. It includes nonenergy savings features, such as those resulting from staff reductions, as well as energy savings in planning and justifying its systems. However, the DOD Investment Program criteria, which rank projects based on an energy savings ratio, does not permit the services to take full advantage of nonenergy features. In a current project to install EMCSs at nine installations, NASA has included nonenergy functions, such as electrical demand peak load shedding, intrusion alarms, damper closure upon dust detection, and maintenance management. About $600,000, or 20 percent of the project's $2.9 million estimated savings, are in the form of personnel savings and the remaining savings are energy. For example, NASA justified the system for the Dryden Flight Research Center, California, on the basis of conserving energy resources, reducing maintenance and operating personnel, and, thus, contributing to better management of the Center's facilities. About 38 percent of this project's $58,000 estimated savings are from personnel reductions.

PROJECTS SHOULD BE BETTER PLANNED

Thirteen of 14 bases we visited had programed EMCSs without the benefit of any type of system master plans, and only 5 of the bases had evaluated all base buildings for connection to their systems. As a result, installations programed projects without knowing total system requirements or if they had selected the most cost-effective buildings for their systems. Consequently, in some cases, installations had to reduce the projects' scopes.

Eleven of the 14 bases have expanded, or plan to expand, their systems. Because of the continued expansion of EMCSs, we believe that system master plans would be beneficial in planning systems, including both energy and nonenergy features, and in expanding them.

EMCS design manual

The Army is presently drafting a technical manual for designing EMCSs. According to a chapter in an April 1980 draft of the manual, the first step in implementing an EMCS is to have a facility engineer make a predesign survey and feasibility study which involves preparing an energy and economic analysis to determine that an energy reduction is possible. The second step involves a design agent designing the EMCS. The economic analysis, performed on either an individual building or building system basis, provides a method for listing buildings and systems by priority for connection to the EMCS. The manual includes the following steps as necessary for the predesign survey and feasibility study:

--Develop a master list of buildings and systems for connection to the EMCS.

--Survey field equipment to determine what exists and how it can be modified to save energy.

--Prepare an energy and economic analysis to determine if the EMCS meets energy program guidelines.

Also, an Army official said that the current manual draft will be revised to restore a statement contained in an earlier draft that consideration should be given to expanding the system and to subsequently adding nonenergy features.

According to an Army Corps of Engineers official, the manual will be a joint-service publication. The Navy and Air Force have cooperated in developing the manual by reviewing and commenting on drafts of the manual. However, the official further said that because the manual was basically a design manual (i.e., it would provide for a methodology for designing EMCSs), it would not necessarily lead to better system planning. The official later said that the design manual is being revised further to eliminate the section dealing with the predesign survey and the feasibility study, since they do not relate to actual system design. The Army official, responsible for the manual's development, hopes this section could be issued as a basic instruction to assist installations in preparing for programing an EMCS. Naval Facilities Engineering Command and Air Force engineering officials indicated that those services would use the manual, but were not certain to what extent it would be implemented.

Evaluation of buildings for EMCS should be improved

Nine of the 14 bases visited (1) did not evaluate all base buildings for connection to their EMCSs, (2) included buildings which were not evaluated and had no potential for energy savings, or (3) included buildings which had been demolished or were not suitable for EMCS. As a result of not evaluating all buildings or making cusory evaluations, the services had no way of knowing if the programed systems included those buildings which would be the most cost effective in saving energy.

For example, Andrews AFB, Maryland, evaluated only 27 of its buildings for EMCS connection when planning a fiscal year 1976-77 project. As a result of a Building Energy Audit Program, the Military Airlift Command later programed an energy project for fiscal year 1980 which would expand the system to five additional buildings. (See p. 12.) None of these buildings had been evaluated for the original program. Although not all base buildings may have been suitable for connection to the system, without such an evaluation the base did not know if it had selected those buildings most cost effective for saving energy.

In addition, Andrews AFB included buildings in the fiscal year 1976-77 project which had not been evaluated and had, as shown below, no potential for energy savings. Prior to this project, the base already had installed two central control systems by different manufacturers. Originally, the base had planned to include one of the systems which was operational in the project. To avoid giving the manufacturer of this system a competitive edge on the project, the architect/engineer (A/E) recommended including 27 dormitories in the project which were connected to the other manufacturer's system. In June 1976 the Air Force modified the design contract to include the dormitories. Because the base had demolished or had scheduled to demolish 18 of the dormitories, only 9 of the dormitories remained in the contract bid specifications. These buildings were not evaluated for EMCS. According to an official of the Air Force engineers, the dormitories have no potential for saving energy because they are in full use 24 hours a day, 7 days a week. In January 1980 the Air Force deleted the remaining nine dormitories from the project. (See p. 20.)

In another example, Robins AFB, Georgia, programed a fiscal year 1977 EMCS project by selecting 26 buildings

from real property records without visiting or inspecting them. Later during the design phase, the A/E found that some buildings no longer existed and others were not suited for the project. According to a base engineer involved in planning the project, the base was only given 3 days to plan the project.

In contrast to the bases which did not consider all buildings, Fort Belvoir, Virginia, and Fort Ord, California, planned basewide systems. Although Fort Belvoir considered all its buildings for EMCS, the system was designed primarily for energy saving purposes. Fort Ord had its A/E consider all buildings and nonenergy features, such as load cycling its water systems.

Insufficient planning and poor cost estimating resulted in reduced project scopes

The services have programed EMCS projects based on inadequate plans and poor cost estimates. Eight of the 16 EMCS projects reviewed were supported by project justifications which identified the number of buildings the installations were to connect to the systems. For six of the eight projects, the services subsequently reduced the number of buildings which resulted in reducing the projects' estimated savings. In four cases the bases had programed insufficient funds to complete the programed projects. We believe that system master plans which include evaluating the costs and savings of all buildings on a base for connection to the system result in better planned systems and help avoid reducing project scopes.

In one example, the Army initially justified a fiscal year 1979 Fort Belvoir EMCS based on savings of $804,000 for a 250-building system. According to a base official, the base selected the 250 buildings because they had large heating or air-conditioning systems and were suited for EMCS control. Based on a subsequent A/E study which identified 113 cost-effective buildings for the EMCS, the Army reduced the project's scope to this number of buildings and contracted for a system saving about $470,000 a year.

In another example, McClellan AFB, California, reduced the scope of its fiscal year 1977 EMCS project from 25 to 2 buildings because the base had not programed sufficient funds. The base programed funds based on preliminary in-house estimates without evaluating individual buildings.

The A/E designing the project later estimated the project's cost to be almost double the $824,000 programed. The base reduced the project's scope because the Air Force would not permit the base to revise its original estimate. The effect of the reduction was to reduce the estimated $62,000 annual energy savings by $38,000, or 61 percent.

In a third instance, Robin AFB reduced the scope of its fiscal year 1977 EMCS from 26 buildings to 7 because the project's A/E estimated that the project would cost about three times the original $800,000 estimated.

Recent efforts to better plan EMCSs

The services have developed programs to survey their installations to identify buildings for EMCS and have developed guidance which may lead to better planned systems. Generally, the efforts have focused on providing EMCSs for energy saving purposes only, and it is too early to assess the results of the services' efforts.

In July 1978 the Army's Facilities Engineering Support Agency issued its "EMCS Report Update" which calls for a detailed study of all buildings over 5,000 square feet when planning a system to identify those buildings suitable for central control. Of the 15 EMCS applications suggested in the report, only a few, such as demand control and runtime totalization, result in nonenergy savings. In 1979 the Army also began implementing its facilities energy plan which requires the installations to survey all buildings and utility systems to identify energy consumption as a basis for programing energy projects, including EMCSs.

Shortly after the 1973 oil embargo the Navy surveyed its installations to develop energy projects. The Navy revisited the installations for the fiscal year 1979 energy program to develop capital investment projects of a more complex and technically sophisticated nature. The Navy also issued "EMCS Economic Analysis Guidelines" in February 1979. The guidelines provide for a field investigation to determine which building systems are cost effective for EMCS control. Once these buildings are identified, they are then listed by priority for connection to the system.

Since mid-1977 the Air Force has been carrying out a Building Energy Audit Program which involves surveying all buildings over 1,000 square feet and applying a computerized

energy model to determine energy consumption and to evaluate alternatives for reducing consumption.

CONCLUSIONS

Although EMCSs afford the military services the opportunity to operate and maintain their facilities in a more economical and efficient manner, the services have not taken complete advantage of the systems' potential because they have funded EMCS projects under the energy program. While we believe that the services should continue to evaluate energy projects on their ability to save energy and only fund energy projects under the Energy Conservation Program, we also feel that the services are not obtaining the most efficient and cost-effective systems by not fully considering nonenergy features. EMCSs which are not justifiable on the basis of energy savings, but are economical considering energy, as well as nonenergy savings, will result in more efficient and economical facilities management. Those projects which have substantial cost reduction potential should be given further consideration for inclusion in the military construction program.

Because installations programed EMCSs without considering all buildings, they had no way of knowing if they were scheduling those buildings which were the most cost effective in saving energy for connection to the systems. In some cases, project scopes had to be reduced because of poor cost estimating. We believe EMCS master plans would be effective tools for installations to systematically plan for installing and expanding EMCSs, as well as incorporating nonenergy features in EMCSs. Although the services have made efforts to improve planning, it is too early to assess the results.

RECOMMENDATIONS

For those EMCS projects that have substantial cost reduction potential but do not meet DOD criteria to be included in the Energy Conservation Investment Program, we recommend that the Secretary of Defense assure that such projects are given full consideration for inclusion in the military construction program, especially in view of the fact that they do contain energy savings.

DOD officials agreed with this recommendation and said that they would consider revising their guidance to accomplish what we were recommending.

To improve EMCS planning, we recommend that the Secretary establish controls to assure that the services prepare EMCS master plans. Such plans should evaluate, by building, the costs and savings for both energy and non-energy features and should be revised periodically to reflect updated costs.

DOD representatives agreed EMCS master plans were needed, but believed it would be too costly to evaluate each building prior to the feasibility study. According to DOD representatives, base officials list by priority buildings for connection to the EMCS based on their knowledge of the building systems, occupancy, and schedules. Later, the A/E evaluates buildings as part of the project's feasibility study which is completed when the project is submitted to the Congress. In this manner, large amounts of money are not spent on evaluating buildings prior to determining if the project is valid. We believe it is necessary for installations to evaluate all buildings as an initial step in planning EMCSs. Since installations initially select the buildings on which the EMCS project submitted to the Congress is based, we believe that an early evaluation of buildings will result in a more timely determination of a project's validity, a more accurate identification of project buildings, and a possible reduction in the scope of the A/E's feasibility study.

CHAPTER 3

PROJECT JUSTIFICATIONS OVERSTATED SAVINGS AND/OR UNDERSTATED COSTS

Many EMCS projects programed by the military services were justified on the basis of overstated savings and/or understated costs. Because the justifications were not valid, the services did not know whether or not they had programed the best projects or if the projects were justifiable. Also, the unavailability of funds to repair building systems to which EMCSs are to be connected will eliminate savings on which some systems were justified.

PROJECTS JUSTIFIED WITH INACCURATE ANALYSES

The services used inaccurate savings or cost estimates to justify 10 of the 16 EMCS projects we reviewed. 1/ From fiscal year 1976 through fiscal year 1978, DOD justified energy conservation investment projects, including EMCSs, based on payback periods (i.e., recouping the projects' initial costs through project savings). Five of 11 projects reviewed 1/ fell under this criteria, and they were justified by the services on estimated savings which were later reduced based on results of either actual operations or A/E studies.

In October 1977 DOD issued guidance on preparing economic analyses for energy projects programed for fiscal year 1979 and later. The guidance required that in addition to system costs, operating and maintenance costs be amortized over the economic life of the project. It established minimum energy savings to cost ratios for programs from fiscal year 1979 through fiscal year 1984. It required that each project's energy to cost ratio be greater than the established minimum for the year in which the project was programed. The guidance also required projects to be revalidated before contract award. However, the five projects reviewed which came under the revised guidance had justifications which either overstated savings and/or understated costs.

1/Sufficient information was not available to evaluate one project.

Programed savings are not achievable

Programed savings for 9 of the 16 EMCS projects reviewed will not be achievable because of reduced project scopes or inaccurate assumptions on which savings were estimated. In one case, China Lake Naval Weapons Center, California, savings were overstated to the extent that the project should not have been justified under the energy program criteria.

For the China Lake Naval Weapons Center, the Navy reduced the scope of the fiscal year 1979 EMCS project because base engineers believed the cost of the original project scope would exceed the programed amount. The reduction eliminated $48,858, or about 6 percent, of the A/E's estimated $737,000 savings. In addition, the A/E estimated savings from shutting off heating, ventilating, and air-conditioning equipment during nonworking hours. However, according to facility users, these savings will not be achieved because temperature and humidity requirements of volatile chemicals, computers, and testing equipment preclude shutting off the equipment. Therefore, savings were reduced by $303,685 or another 41 percent. As a result of energy savings lost because of reducing the scope and not being able to shut off equipment, the project's Btu energy savings to $1,000 investment ratio was reduced from 69.2 million Btu's to 15.3. The minimum for the project year was 23 million Btu's, therefore the project did not meet DOD criteria.

Although other projects met DOD energy conservation criteria, they also had overstated savings. For example:

--The Army reduced the scope of the Presidio of Monterey, California, EMCS from 22 to 11 buildings to keep the project costs within the programed funds. This reduction eliminated about $17,000, or 16 percent, of the calculated savings used to justify the project.

--The Army used a work force reduction of 34 people to justify a fiscal year 1976 Fort Eustis EMCS. Also, for a fiscal year 1980 project, the A/E calculated about $191,000 in personnel savings based on savings for every 350 points the system monitored. According to a base official, only six positions were eliminated as a result of the 1976 project because other new positions were created. Personnel savings for the 1980 project would not be achievable because the base did not normally monitor the points on which the A/E based the savings.

--Robins AFB determined the cost of a fiscal year 1979, 116-building EMCS project based on the manufacturer's estimates of the base's original system. The project's estimated $404,000 savings were reduced to about $240,000 when the project's scope was reduced to 54 buildings.

All costs were not included in economic analyses

The economic analyses used to justify four of the five projects under DOD's 1977 Energy Conservation Investment Program guidance did not include all recurring costs.

Fort Belvoir

In an October 1978 concept report on the Fort Belvoir EMCS, the A/E estimated the annual recurring costs were about $91,000; benefits were not included. The A/E estimated the amount as 5 percent of capital equipment and then pro rated it as follows:

Description	Amount
Operational cost--one part-time supervisor and three part-time operators	$20,000
Maintenance cost for EMCS equipment (5 percent of central equipment costs)	40,000
Personnel cost to respond to early warning signals and alarms	31,000
Total	$91,000

According to a base official, the Army plans to staff the EMCS with a full-time supervisor and five full-time operators. Using the U.S. Army Facility Engineering Support Agency's July 1978 EMCS Report Update and the base's current staffing plans, we estimated the system's operating cost was $68,000 a year or $48,000 more than the Army used in the project's justification.

The EMCS Report Update also described three possible levels for maintenance: full maintenance estimated to cost

15 percent of the equipment purchase price, an on-call agreement estimated based on an hourly rate plus the cost of parts, or in-house maintenance with costs estimated at 5 percent of the equipment cost plus the salary and training expense for maintenance personnel. The A/E did not follow the above guidance for estimating system maintenance costs and included the costs of operation and maintenance personnel as part of the 5 percent estimate for parts--not as additional costs.

In August 1979, before the Baltimore District, Corps of Engineers, requested bids for the project, the A/E revalidated the project using the same estimates. The District questioned the calculations and had the A/E revise the economic analysis. The revised analysis follows:

Description	Amount
Operational cost--one part-time supervisor and three part-time operators	$ 20,000
Maintenance cost for EMCS equipment (5 percent of central system equipment cost)	40,000
Personnel costs to maintain heating, ventilating, and air-conditioning systems	100,000
Savings from increased productivity	(30,000)
Savings resulting from decreased equipment replacement and servicing	(15,000)
Savings resulting from lengthening equipment life	(25,000)
Total	$90,000

In the revised analysis the A/E did not increase operating costs to reflect current base staffing plans. The cost estimate still did not follow the Army's guidance. The A/E replaced the $31,000 personnel cost to respond to early warning signals and alarms with a $100,000 personnel cost to maintain heating, ventilating, and air-conditioning systems. The A/E partially offset the increased maintenance costs with $70,000 in savings ($30,000 in increased productivity,

$15,000 in decreased maintenance, and $25,000 in lengthened equipment life) which had been identified previously in the October 1978 concept study, but was not used in the project analysis. According to a Baltimore District official, the savings had not been used in that analysis because they were intangible and could not be readily measured.

In summary, in preparing the economic analysis for Fort Belvoir, the A/E used two different estimates for recurring costs. In these estimates, the A/E did not include all operation and personnel costs nor did it follow the Army's criteria for estimating recurring maintenance costs.

Fort Eustis

The A/E did not include recurring maintenance costs in its analysis of Fort Eustis' fiscal year 1980 project. We brought this to the attention of the Norfolk District, Corps of Engineers, who consulted with the A/E and learned that the maintenance costs were left out by oversight. The A/E revised the analysis to include about $67,000 for maintenance.

Other bases

Two other bases, Robins AFB and China Lake Naval Weapons Center, had similar deficiencies. Robins did not include maintenance costs in evaluating its fiscal year 1979 EMCS, and China Lake underestimated operator costs by about $23,000.

Our prior report on economic analysis 1/

Our report to the Secretary of Defense concluded that a need existed for the services to assure that their requirements for preparing economic analyses were implemented appropriately, consistently, and effectively. We recommended that the Secretary's office oversee and evaluate the services' efforts in carrying out DOD's economic analysis policy. In May 1977 DOD agreed that proposed military construction projects should be evaluated stringently before they are included in budget requests to the Congress, and said that the Assistant Secretary of Defense (Comptroller) would review economic analyses prepared by the services.

1/"Before Construction of Military Projects--More Economic Analyses Needed" (LCD-77-315, Mar. 28, 1977).

ESTIMATED SAVINGS MAY NOT BE ACHIEVED BECAUSE OF LACK OF BUILDING REPAIRS

Because of the unavailability of funds to repair building systems to which the Andrews and Bolling AFBs' EMCSs will be connected, savings used to justify the projects may not be realized.

The project A/E and the Air Force recognized that Andrews and Bolling AFBs needed to repair existing building systems in order for their EMCSs to operate properly. A concept report for the Andrews/Bolling EMCSs pointed out that numerous and varied mechanical equipment deficiencies existed in the bases' buildings. The project savings were computed based on the equipment working properly and included costs needed to repair the buildings. In November 1977, prior to contract award, Air Force headquarters informed the Chesapeake Division, Naval Facilities Engineering Command, that replacement/repair of defective existing equipment was required for a complete and usable EMCS. The Air Force approved use of construction funds, through contract modifications, to provide the repairs necessary.

In October 1979 the Chesapeake Division requested the Air Force Civil Engineers to increase the project's contingency funds by $113,000 to allow for repairs to 20 buildings, including 9 dormitories. (See p. 10.) The Civil Engineers responded that additional project construction funds were not available for the repairs and suggested using operation and maintenance funds.

In January 1980 the Military Airlift Command asked the Civil Engineers to reconsider using construction funds for repairs because of the lack of available operation and maintenance funds and the necessity of the repairs for achieving a usable EMCS. According to the Civil Engineers, Air Force headquarters had withdrawn reserve funds for the project and, therefore, it could not comply with the request. Subsequently, the command proposed deleting the nine dormitories because of limited savings and using any credits for deleted work to fund other necessary work. The command further suggested that Air Force headquarters should provide the necessary funds to complete the project. As of June 1980, this matter had not been settled.

To achieve savings used to justify projects, the services and installations must be committed to the successful completion and subsequent operation of their EMCSs. We

believe that when the services commit large amounts of money to install EMCSs justified on cost savings, they are also accepting the responsibility of insuring the systems and equipment they control are in an operating condition which will allow savings to be achieved.

CONCLUSIONS

In view of the inaccurate justifications used for recent EMCS projects, we believe that the need for stringent review of projects exists. Although DOD has issued instructions for justifying energy projects, including EMCSs, and for revalidating the projects prior to contract award, some project justifications are not accurate. We believe that more thorough project analyses and revalidations are needed to assure that installations are justifying EMCS projects adequately and that the services are making the best use of appropriated military construction funds.

RECOMMENDATIONS

We again recommend that the Secretary of Defense's office oversee and evaluate the services' efforts in carrying out DOD's economic analysis policy, and in particular, closely review projects, such as EMCSs, whose funding depends on such analyses. We further recommend that the Secretary of Defense require the services to establish management controls to insure that before EMCS projects are completed, needed building repairs have been made so that planned savings can be achieved.

DOD representatives agreed with our recommendations. However, they said their limited staff would prevent better review of EMCS projects. We believe that if additional staff resources are not provided to ensure that economic analyses are being made properly, the problems discussed in this report will continue.

CHAPTER 4

FURTHER DOD GUIDANCE ON CERTAIN ASPECTS OF THE EMCS PROGRAM WOULD BE HELPFUL

Because DOD has not provided adequate guidance to the services, the services have not fully considered the economies of EMCS joint use 1/ and the efficiencies of staffing EMCSs adequately and timely to provide effective utilization once the systems become operational.

LIMITED EFFORTS TO EXPLORE JOINT USE

Potential savings from the joint use of EMCSs have not been realized because DOD and the military services have not considered adequately such joint use. Although there has been some consideration on a limited basis, many opportunities may have been overlooked. In addition to potential savings in hardware and software, there are potential savings which could be realized on a recurring basis, such as operation and maintenance costs. Further, we believe that EMCSs could offer the services additional benefits as a management tool through centralized maintenance management of heating, ventilating, and air-conditioning equipment. There is no overall policy within DOD regarding joint use; as a result, differing policies and concepts have been developed within the military services.

Army

In July 1978 the U.S. Army Facilities Engineering Support Agency issued its EMCS Report Update which stated that if an installation survey reveals that only a few buildings are acceptable candidates for central control, it may be economical to tie into an EMCS at another installation. This is the only statement of Army policy we were able to identify during our review. Army personnel advised us that joint-use systems (1) are feasible where several small bases in an area are under the same command and (2) may be unmanageable if several major installations are connected.

1/By joint use we mean the use of a single system by (1) two or more installations or (2) activities under different organizational commands on the same installation.

Fort Ord, California, and the Presidio of Monterey, California, provide an example of where both computer hardware costs and recurring operations costs will be saved through joint use. The two installations are located approximately 10 miles apart and are under the same commander at Fort Ord. Fort Ord is installing a basewide EMCS funded in fiscal year 1977. Soon after Fort Ord's project was underway, a system was designed for the Presidio of Monterey which would use Fort Ord's computer hardware and operating personnel. One computer console will be located at the Presidio of Monterey for monitoring information for facility maintenance. Consequently, Fort Ord will not need to staff or maintain a separate system at the Presidio of Monterey.

We also noted an instance where, although some consideration is being given to a joint-use system for installations under one command, none was given to a system under construction by a different command. The Army is considering a single system to serve Cameron Station and Fort Meyer, Virginia, and Fort McNair, Washington, D.C. According to the Army, this would be feasible since all are part of the Military District of Washington. The Army did not consider connecting these installations to a nearby system under construction at Fort Belvoir, Virginia, because Fort Belvoir is under a different command.

Navy

The Navy's concept of EMCS joint use envisions a group of systems at several bases or major entities which, while having stand-alone capability, would be tied to a central system. The central system will act as a recordkeeping activity, develop strategy, and function as a focal point to perform central heating, ventilating, and air-conditioning management. The Navy foresees centralized management of utilities as a benefit of such a system and cites load shedding as an advantage of a centralized system.

A Navy official said that efforts to serve several activities with a single EMCS are limited because commanders are reluctant to relinquish the responsibility of operating and maintaining installations used to carry out their military missions. The official also stated that political realities may prevent tying together individual systems as envisioned by the Navy unless bases are part of an organization, such as a public works center.

At the time of our review, the Navy had programed EMCSs at its Norfolk and Guam Public Works Centers and was studying the feasibility of installing systems at several other public works centers. Although the Navy has programed an EMCS for its Norfolk Public Works Center, it is also planning, designing, or constructing EMCSs at five other Navy installations in the Norfolk area. An official said that connecting these installations to a single EMCS would be impractical because the installations belong to different naval commands and have different chains of command. The official further said that such a system would be too large to be manageable and that industry has not yet developed equipment to make such a system workable.

Our discussion with an industry representative indicated that additional equipment is not necessary when connecting several installations and, in fact, less equipment may be required. The only additional requirement is for a connecting communication line among the installations, usually a leased telephone line.

Another example of inadequate consideration of joint use is on the west coast. The Naval Air Rework Facility, Alameda, is installing a system which is scheduled to begin operating in early 1980. The rework facility is a tenant activity of the Naval Air Station, Alameda. The station had considered procuring an EMCS in 1976, but could not economically justify the system. The station has several buildings, such as a commissary, base exchange, and several social clubs, which are likely candidates for EMCS control. Although the station had been offered the joint use of the rework facility's EMCS, at the time of our review, it had not taken any action to incorporate these buildings into a joint-use arrangement with the rework facility.

Air Force

Air Force officials agreed that joint use of EMCS is technically feasible. The only problem they foresee is the potential involvement of two commands or operating structures. However, they believe joint use should be considered in projects, where feasible, because it could result in hardware and operations savings. They stated it was time to issue policy or guidance on joint use.

A limited joint-use system is being considered at two AFBs in the Washington, D.C., area. In June 1977 DOD advised us that the Air Force was evaluating the possibility of using one EMCS to serve Andrews and Bolling AFBs, both part of the

Military Airlift Command. The Air Force originally planned for each base to have an EMCS with the Andrews system having the capability for monitoring, controlling, and performing an optimization program for each base and the Bolling system performing that function for that base only.

In November 1979, about 2 years after the project's contract date, the contractor changed equipment suppliers. To meet the requirements of the contract specifications, the new supplier has proposed providing separate computers for each base which would not be connected. Remote operation of the Bolling EMCS from Andrews would still be accomplished; however, it would be done through a remote control panel. According to Andrews and Bolling officials, the systems will operate separately during normal working hours but during nonworking hours and weekends, Andrews operators will operate both systems. Andrews AFB plans to staff its system for continuous operations with a supervisor and five operators while Bolling will have one operator. A Bolling official said that a separate operator is necessary for that base because most of its maintenance problems occur during working hours. The Bolling operator would be familiar with the base's building systems and, thus, be able to diagnose and respond to problems quickly.

The Air Force did not consider joint use when it planned systems for two Florida locations, Eglin AFB and Hurlburt Field, which is on the Eglin reservation. The installations are approximately 10 miles apart, and Hurlburt Field is dependent on Eglin AFB for electrical power, but each installation will have its own EMCS. Eglin AFB plans to expand its system to two auxiliary fields that are a part of Eglin and are as far or farther away than Hurlburt Field. Although technically feasible, we were told joint use was not considered because Hurlburt Field is under the Tactical Air Command and Eglin is under the Air Force Systems Command.

The Air Force missed another opportunity for joint use at two installations near Sacramento, California. McClellan AFB, which has a system already operating and, according to base officials, functioning very well, was not formally contacted about joint use when Mather AFB was planning an EMCS. McClellan AFB, which is under the Air Force Logistics Command, is approximately 10 miles from Mather AFB, which is under the Strategic Air Command. According to the vendor for the McClellan AFB EMCS, joint use between the two was technically feasible and would have been substantially less costly than procuring and installing a separate EMCS at Mather AFB.

DOD

An official from the Office of the Deputy Assistant Secretary of Defense (Installations and Housing) said that DOD has not established a policy on the joint use of EMCSs and that he was unaware of any studies on such systems. The official further pointed out that:

--DOD's general position is that, because of the recent development of EMCSs and system complexities, systems should be installed and operational before attempting to tie several together.

--The services would have to overcome the problem of commanders' unwillingness to give up control over installations they are responsible to run before joint use could be accomplished.

--Since the tri-service guide specifications (see pp. 31 and 32) were introduced, system costs have been reduced and the economic advantage of joint-use systems may have decreased.

If systems had to be installed and operating before attempting joint use, expenditures for hardware and software would preclude any possible savings from redundancies in these costs and duplicate staffing. This position also appears to be contrary to Army and Air Force efforts as noted above.

We believe that commanders do not necessarily have to give up control over their installations. If control is important, commanders of each installation served by the EMCS could provide part of the staff required to operate the EMCS. Further, we believe that control over the energy consumption in facilities would not be lost under joint use, since an agreement between the installations involved could provide for control. Many interservice agreements, such as for aircraft maintenance, demonstrate that different commands can work together and still accomplish each command's mission objective.

Finally, system costs may have been reduced since the introduction of the tri-service guide specifications, but they can still run several million dollars and include both initial and recurring operating and maintenance costs. Unless cost/benefit analyses are made, the decrease in economic advantages (if any) remains unknown.

NEED FOR EMCS STAFFING GUIDANCE

EMCSs must have qualified and properly trained staff. Understaffing of EMCSs has resulted in limited system use because some installations have not been staffed adequately for EMCSs when systems became operational. The tri-service guide specifications require vendors to train system personnel before the system is tested. Only the Air Force has issued staffing guidance. Without staffing guidance, it will be difficult for the services to be assured that adequate qualified personnel are available for training once systems become operational.

EMCS staffing needs to be timely

EMCS staffing needs to be done early to afford managers and operations and other personnel the opportunity to observe the installation and to help install the control sensors.

The Air Force has recognized the need to staff early. As a result of its audit agency's finding, the Air Force issued a policy letter on August 20, 1979, which stated that early staffing would

--give key system personnel a good understanding of the system,

--permit system training before the system becomes operational,

--allow key personnel to be present during system testing and acceptance, and

--enable the EMCS to be operated at "peak efficiency" when accepted by the Government.

The letter also stated that the system engineer and console operator positions should be filled within 90 days after the award of the construction contract.

As of June 1980 the Army and Navy had no formal EMCS staffing policy. A Corps of Engineers official said that the corps informally encourages installations, through major commands, to make EMCS staff available shortly after systems are placed under contract. He further said that the Army is developing an EMCS staffing guide which will facilitate system staffing at the base level. Until the guide is available, installations will have to individually justify the personnel

required to operate their systems. A Navy official said that the Navy, through its engineering field divisions, informally encourages installations to staff EMCSs in a timely manner and that it also plans to develop staffing guidance.

Fort Eustis and the Naval Academy had their staffs available to work with the contractors during system installation. Officials at these installations felt that this had assured a knowledgeable staff to operate their systems and contributed to their successful operation. Andrews and Bolling AFBs and Fort Belvoir, whose systems were contracted for in December 1977 and September 1979, respectively, have planned or are planning to have staffs available to work with the contractors installing their systems. Although the tri-service guide specifications were used for these projects, Andrews AFB and Fort Belvoir officials said that their visits to the Naval Academy and Fort Eustis to observe those systems in operation greatly influenced their decision to staff their systems during installation.

Adequate staff are needed

In April 1978 the House Committee on Appropriations, Surveys and Investigations, staff reported that the services had not given sufficient emphasis to the management structure to operate and maintain EMCSs. DOD responded in February 1979 that EMCS training support and maintenance had been firmly established through the tri-service specifications and that vendors, as part of a system installation contract, will train EMCS operators. Training starts with DOD personnel studying and observing system installation and continues through start-up, initial operation, and follow-on training.

In July 1979, the Air Force Audit Agency reported on two systems which were not adequately staffed. These two systems did not operate 24 hours a day and did not have the use of all functions. We found a similar example in our review.

When the system at McClellan AFB became operational in November 1978, it had no operators, but it did have two system engineers who, along with their other EMCS duties, operated the system 40 hours a week. At the time of our review in July 1979, the system was still operating in this manner. The first operators were not hired until late August 1979, with the full complement of staff not arriving until early October 1979, or about 11 months after the system began operation.

At the time of our review, many functions were not being performed because of the lack of operators. For example, equipment runtime totalization used for maintenance management, a monitoring function, was not being used. Also, alarms went unanswered until the next workday due to the limited hours of system staffing. For instance, if an alarm occurred during nonstaffed hours, the system recorded the alarm but system engineers did not respond to it until the next workday.

Installation officials stated that once operators were hired, the system could be programed to perform additional functions, such as equipment runtime totalization and respond to alarms.

CONCLUSIONS

Although the services are installing or studying the feasibility of joint-use EMCSs on a limited basis, they are not taking advantage of all opportunities for joint-use systems. The services believe that joint-use systems would not be practical because commanders do not want to give up control over their installations. We do not believe control is sacrificed under joint use anymore than it is sacrificed in other areas of joint use, such as aircraft maintenance. Furthermore, EMCSs now offer the services a useful tool which could result in additional benefits from centralized maintenance management. For example, centralized EMCS management of two or more installations' heating, ventilating, and air-conditioning systems could be an initial step in centralizing the maintenance functions of those installations.

With the exception of the Air Force, the services also lack EMCS staffing guidance. Adequate staffing on a timely basis is necessary if an installation expects to achieve efficient and full use of its EMCS. The Army and Navy are developing staffing guidance; therefore, we have no recommendations at this time.

RECOMMENDATION

We recommend that the Secretary of Defense establish policy which will require the services to consider joint use when planning and evaluating systems.

While DOD representatives agreed with our recommendation, they said more experience is needed to determine efficient span of control of an EMCS, also interorganizational use, even within the same service, will pose problems. We believe that DOD can resolve organizational problems through joint agreement or reassignment of responsibilities as it has done in accomplishing other mission objectives.

CHAPTER 5

PROBLEMS IN USING THE TRI-SERVICE SPECIFICATIONS ON PROPRIETARY SYSTEM EXPANSIONS

When the tri-service guide specifications are used to expand an existing EMCS, competitive procurement may not be achievable, or if competitive procurement is achievable, the interchangeability of parts may be sacrificed and interfacing problems may result in a duplication of system hardware and software. We believe this is because many of the existing systems procured prior to the tri-service specifications are proprietary systems of major manufacturers. Often, for these systems, the Government does not have access to the system documentation to determine how the system works or what interface devices will be necessary to use other manufacturers' equipment.

TRI-SERVICE GUIDE SPECIFICATIONS

Until recently only a limited number of firms made and installed EMCSs. Often, due to the proprietary nature of these systems, DOD was prevented from expanding or modifying earlier systems without using the original manufacturer. Also, according to DOD, these manufacturers were not offering current technology which had been rapidly becoming more sophisicated in recent years. To provide for increased competition, off-the-shelf, technologically superior hardware, and greater system flexibility, DOD developed and adopted tri-service guide specifications. To assure competition in future expansions, the specifications require the manufacturer to provide full documentation of the system's software, hardware, and diagnostic routines to the Government.

The Air Force and the Navy developed the tri-service guide specifications for use by all of the military services. The specifications were first published in July 1977 and have been revised periodically since then. They are performance specifications which provide EMCS equipment options consistent with state-of-the-art development. Using the specifications as a guide, EMCS designers can select those items applicable to a specific project as long as equipment performance, standardized hardware, and other requirements, such as system documentation, are met to provide competitive procurement on future system expansions. All of the services use the

specifications for new systems, but differing service policies exist for using the specifications on system expansions.

Proprietary system expansions

The Air Force has issued a policy which does not require that existing systems be expanded using the tri-service guide specifications and competitive procurement. This policy was issued to prevent the possible installation of more than one operator console. The Army recognizes in some cases it may not be feasible to use the tri-service specifications and competitive procurement when expanding proprietary systems. The Navy requires use of the tri-service specifications when expanding even proprietary systems which may require interface devices at additional cost, effectively allowing the original equipment manufacturer a competitive advantage.

Army

In February and again in September 1978 the Army provided its engineering divisions copies of the EMCS guide specifications and stated that they could be used for preparing specifications for EMCS projects until official Corps of Engineers guide specifications were published. A Headquarters, Corps of Engineers, official said that the Army requires use of the specifications for new systems; however, when expanding existing proprietary systems without system documentation, it may not be practical to use the specifications and it may be necessary to negotiate expansions with the sole-source vendor. The Army had four EMCS projects under design or in construction which are not using the specifications: three are projects to expand existing proprietary systems and one is a project being held in abeyance because of the uncertain status of the installation involved.

Fort Eustis, Virginia, acquired an EMCS in fiscal year 1976 which it expanded in fiscal year 1977. Although the tri-service specifications were not available, the 1976 project was a competitive procurement of a proprietary system. The 1977 expansion was also a competitive procurement, but the contractor for the fiscal year 1976 project was sole bidder for the fiscal year 1977 project. An internal memorandum stated that the hardware for the fiscal year 1977 project, which represents about 70 percent of the costs, must be procured from the original contractor. Fort Eustis has programed a further expansion in fiscal year 1980.

A Norfolk District Corps of Engineers official said that the District did not formally evaluate the options of using the tri-service guide specifications as compared to negotiating the expansion because two thirds of the existing system is proprietary and the Army does not have system documentation. The official felt that even if the tri-service specifications would have been available and used on earlier projects and the Army had system documentation, the contractor for the 1976 and 1977 projects would still have a competitive advantage of bidding on a system expansion. A Headquarters, Corps of Engineers, official said the tri-service specifications would not be required on the 1980 project.

On the Fort Eustis project, the Norfolk District asked for authority to negotiate the fiscal year 1980 expansion with the original project contractor because that contractor had a competitive advantage and was the sole bidder on the fiscal year 1977 project. The North Atlantic Division rejected the request. Subsequently, when the project went out for bid, a firm filed a protest because the project's specifications called for expanding the existing system and did not allow for replacing the central control system which restricted competition to those firms installing equipment of the original contractor. The District stopped the bidding and again requested authority to negotiate with the original manufacturer. The North Atlantic Division then rejected the request. Norfolk is attempting to get the North Atlantic Division to reverse its decision. A Headquarters, Corps of Engineers, official said that competitive procurement would be in the best interest of the Government and would be required on the Fort Eustis system.

Navy

In November 1978 the Navy required all new EMCSs or system expansions to conform to the tri-service guide specifications. A Navy official said that all systems acquired since that time have used the specifications with the exception of small one or two building systems. For example, in September 1978 Camp Pendleton, California, requested authority to use proprietary specifications to expand its EMCS. The Western Division, Naval Facilities Engineering Command, responded that the expansion was of such a magnitude that competition was required. The official said the competitive procurement would require use of the

tri-service guide specifications in lieu of proprietary specifications. Camp Pendleton wanted to use proprietary specifications because it wished to

--avoid the duplication of system hardware,

--avoid hardware interface problems,

--avoid software interface problems,

--avoid maintenance service contract problems,

--avoid the compounding of the above four problems with subsequent system expansions, and

--allow for the complete interchangeability of parts.

According to a Camp Pendleton official, the specifications for the system expansion recognized that interface devices would be required for expansions provided by other than the vendor of the original system. Although Navy engineers included specifications for the interface devices in the invitation for bids, only one bid was received for the system expansion. That bid came from a firm which was backed by the only vendor who did not need to provide the interfacing devices--the vendor of the original system--even though other potential bidders reviewed the specifications. The interfacing requirements represented an additional cost to other vendors. This effectively allowed the vendor of the original system a competitive advantage, since it would not need interfacing devices for its own system expansion.

The U.S. Naval Academy requested authority to negotiate a sole-source contract for a fiscal year 1976 expansion with the vendor of the existing system. The Navy used the following reasons for justifying sole-source negotiation.

--At that time, 90 percent of the existing hardware would have had to be replaced, if supplied by other than the original vendor.

--A Navy study had indicated that a manufacturer of installed equipment had a distinct economic and competitive advantage due to interfacing problems.

--The time required to design a sole-source contract versus a competitive bid contract would be substantially less. Specifications and plans for a competitive bid package would be 6 to 7 times larger than those for a sole-source negotiation.

The Academy is planning a $5.6 million project to rehabilitate and expand its utility system which includes about $1 million to extend its EMCS. An Academy official said that a sole-source contract with the contractor who installed the 1976 expansion project would be appropriate because:

--The Academy does not have system documentation without which there would not be competition.

--Use of the tri-service guide specifications could result in installing two separate systems or replacing the existing system which works well, is saving energy, and does not need to be replaced.

A Naval Facilities Engineering Command official said that the Academy would be required to use the tri-service guide specifications and competitive procurement to expand its EMCS.

Air Force

The Air Force used the tri-service guide specifications on all new system procurements for fiscal year 1978 and later projects. In April 1977 the Air Force issued guidance on the applicability of the tri-service guide specifications for the expansion of existing systems. The guidance does not require that existing systems be expanded using the tri-service guide specifications. The guidance does permit proprietary expansion and does encourage the type of expansion which will result in a system capable of operating from one console.

The Air Force attempted to expand an existing system using the tri-service guide specifications at Robins AFB, Georgia. The existing system was not designed under the tri-service guide specifications, and the A/E estimated that the cost to update the existing system to accommodate the expansion under the specifications would be $2.1 million. This amount excludes system expansion costs. The Air Force decided not to expand the existing system but to put in a second independent system at a cost of $1.7 million.

In an August 1978 letter, the Corps of Engineers stated the following concerning the Robins AFB system:

> "This system was not designed to meet the Tri-Service EMCS Guide Specifications and cannot be brought into compliance without major modifications. It is not possible to use Tri-Service Guide Specifications for the subject project without either modifying the existing system or making it a completely separate system."

According to the corps, a substantial amount of the existing hardware would require replacement or reconfiguration--but the sensors and cable would be usable.

Tri-service systems

There may also be problems with hardware compatibility on systems procured using the tri-service guide specifications as illustrated by the following system expansion at Fort Ord. The Corps of Engineers acquired a nonproprietary EMCS in fiscal year 1977 which used the tri-service guide specifications. A fiscal year 1979 expansion project extended the system to control the facilities at the Presidio of Monterey. The expansion, which also used the tri-service specifications, was awarded recently to another prime contractor. According to the prime contractor at Fort Ord, even under the tri-service guide specifications, the Presidio of Monterey prime contractor must use the same field interface devices or must incur extra costs for interfacing devices with Fort Ord's EMCS hardware which will enable field interface devices to communicate with the computer.

CONCLUSIONS

The principal reason for using the tri-service guide specifications appears to be to foster competitive procurement. The specifications require system documentation which is supposed to allow for future competitive procurement on existing systems. The Navy believes that the tri-service guide specifications, if used properly, can be an effective tool to obtain competition on new systems. However, recent efforts to expand proprietary systems indicate competitive procurement might not be practical. Subsequent bidders may be locked into using the original vendor's equipment due to interfacing problems, therefore, expansions may be more

costly because of this and duplicative system hardware and software costs. We believe that DOD procurement officials should be aware of the problems of using the tri-service specification on proprietary system expansions and should be alert to those instances where it may be more cost effective to use negotiated procurement.

CHAPTER 6

SCOPE AND METHODOLOGY

Our review covered the planning, justification, expansion, and use of energy monitoring and control systems by DOD. We visited 14 installations which had installed, planned, and/or operating systems to observe their operation, to review plans and justifications, and to discuss the systems with managing and operating personnel. We reviewed 16 of 131 projects which had been funded under DOD's Energy Conservation Investment Program. We selected these installations because they (1) were in geographical locations within the continental United States where DOD is installing a number of these systems and (2) had projects which covered various phases of project acquisition. Because these projects were not selected using statistical methods, our findings may not be representative of the 131 projects. The following is a list of installations we visited:

Army

Fort Belvoir, Virginia
Fort Benning, Georgia
Fort Eustis, Virginia
Fort Ord, California
Presidio of Monterey, California

Navy

U.S. Naval Academy, Annapolis, Maryland
Naval Weapons Center, China Lake, California
Naval Air Rework Facility/Naval Air Station,
Alameda, California

Air Force

Andrews AFB, Maryland
Bolling AFB, Washington, D.C.
Eglin AFB, Florida
Hurlburt Field, Florida
McClellan AFB, California
Robins AFB, Georgia

We also discussed an expansion project with an official at the U.S. Marine Corps base, Camp Pendleton, California.

We held discussions with and obtained documentation from cognizant officials at the Headquarters, Departments of Defense, the Army, the Navy, and the Air Force, as well as responsible DOD construction agencies and various commands at the field level. We also met with, and obtained information from, personnel at Headquarters, NASA.

On May 29, 1980, we met with representatives of the Departments of Defense, the Army, the Navy, and the Air Force to discuss this report.

EMCS FUNDING AS A PERCENTAGE OF DOD'S ENERGY CONSERVATION INVESTMENT PROGRAM

Fiscal year	Amounts funded: ECIP (note a)	Amounts funded: EMCS	Percentage
	(000 omitted)		
Army			
1976	$30,400	$ 885	2.9
1977	b/60,092	15,570	25.9
1978	15,567	2,905	18.7
1979	51,607	21,888	42.4
1980	c/41,450	c/5,500	13.3
Navy			
1976	28,828	1,993	6.9
1977	b/52,536	4,467	8.5
1978	26.139	2,485	9.5
1979	43,090	19,795	45.9
1980	c/42,790	c/7,220	16.9
Air Force			
1976	44,000	7,650	17.4
1977	b/29,741	10,781	36.2
1978	31,560	14,348	45.5
1979	35,026	21,996	62.8
1980	c/17,840	c/6,367	35.7

a/Energy Conversation Investment Program.

b/Includes supplemental appropriation.

c/Amounts requested.

SUMMARY OF EMCSs FUNDED UNDER THE ENERGY CONSERVATION INVESTMENT PROGRAM

	Amount (000) omitted	Project status: In design	Under contract	Construction	Complete	Total
Army (notes a and b)						
1976	$ 885	-	-	-	2	2
1977	15,570	-	-	7	4	11
1978	2,905	-	1	1	-	2
1979	b/21,888	3	4	4	-	11
1980	5,500	3	-	-	-	3
	$46,748	6	5	12	6	29
Navy (note a)						
1976	$ 1,993	-	-	-	5	5
1977	4,467	-	-	1	5	6
1978	2,485	-	-	2	1	3
1979	19,795	6	6	3	-	15
1980	7,220	4	-	-	-	4
	$35,960	10	6	6	11	33
Air Force (note c)						
1976	d/$ 7,650	-	-	5	8	13
1977	10,781	-	-	12	5	17
1978	14,348	1	-	17	-	18
1979	21,996	9	-	6	-	15
1980	6,367	6	-	-	-	6
	$61,142	16	-	40	13	69

a/As of October 1979.

b/Two projects valued at $4.7 million are pending because of the uncertain status of the installation.

c/As of December 1979.

d/According to the Air Force, one project valued at $1.4 million includes funds from fiscal years 1975 through 1977.

APPENDIX II

APPENDIX III

ASSISTANT SECRETARY OF DEFENSE

WASHINGTON D.C. 20301

MANPOWER
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AND LOGISTICS

23 JUN 1980

Mr. James G. Mitchell
Associate Director
Logistics & Communications Division
U.S. General Accounting Office
Washington, D. C. 20548

Dear Mr. Mitchell:

This is in reply to your letter to the Secretary of Defense dated May 15, 1980 regarding your draft report on "Better Planning and Guidance Needed in DoD's Acquisition of Energy Monitoring and Control Systems" (Code 945363), OSD Case #5437.

In general, the report is factual and its recommendations are reasonable. I note, however, two reservations. The first relates to the field of Energy Monitoring and Control Systems (EMCS). Here in the short span of about ten years, we have moved through three generations of equipment. By issuing a tri-service specification, the DoD has been a major influence on industry in the development of the third generation equipment. Nonetheless, the rapid advancement in the state-of-the-art, has caused the Department difficulties in planning, cost estimating, establishing compatibility between systems, and designing for future expansion. In some cases a decision had to be made as to whether a less than ideal system providing immediate savings was a better choice than waiting for a better system in the future. We agree that some of our systems could have been better but the significant fact remains that these installed systems do have good economic benefit to cost ratios and do have good energy savings to cost ratios. This situation also holds in cases where scope had to be reduced to meet the funds appropriated. Even at the reduced scope we believe these are good projects. We feel that your report would be stronger and fairer if it gave more consideration to the difficulties of working in so rapidly developing a field.

Our second concern arises from your recommendation to prepare master plans. The comments of the GAO representatives at a meeting in this office on May 29 suggest that by master plans you mean detailed feasibility studies. Such studies must be coordinated by consulting engineers and are quite costly. The DoD is generally short of planning and design funds which must be used for feasibility studies. Further the Congress has been

APPENDIX III

critical of "design breakage" in the DoD. "Design breakage" occurs when planning and design funds are expended for projects which are not funded for construction. Hence we are reluctant to contract for feasibility studies on a broad basis when the possibility for "design breakage" could be significant. Our concept of a master plan is a broader, less detailed plan developed by experienced in-house engineers applying good judgment. We believe it to be more cost effective to require the consulting engineer designing the EMCS to investigate specific buildings and to tell us when a building, or even a group of buildings, is not suitable for inclusion in an EMCS project.

With regard to the criticism that the services used inaccurate cost estimates of EMCS projects, it should be noted that almost all EMCS projects consist of retrofit work in existing buildings. Estimating costs for retrofit projects is more difficult than for new construction because of the many unknowns that cannot be identified until the work is actually accomplished. The additional criticism relating to the unavailability of funds to repair building systems to which EMCSs are to be connected may be justified in some cases. In other cases this criticism overlooks a unique situation which has been discovered only after an EMCS is on-line. This unique situation occurs when controls are thought to be satisfactory but the EMCS indicates to the contrary. We have learned that it takes an EMCS to identify some types of inappropriate controls or control systems. This situation has resulted in a few cases where funds to modify these controls or control systems have not been available since the problem was unforeseen and not known until the EMCS came on-line. We would expect to make the necessary funds available in the next fiscal year.

Your report recommends that this office oversee and evaluate the services' efforts in carrying out DoD's economic analysis policy and that it closely review energy systems projects. Efforts will be made to meet this recommendation within the capability of the very limited engineering staff. The other two recommendations in the draft report were discussed at the May 29 meeting with your representatives and further consideration will be given by this office to these recommendations.

On balance we believe our efforts in the EMCS area have been good and are resulting in energy and cost savings. We also believe we have been responsive to the direction of the Congress to demonstrate leadership in energy conservation and to be innovative in energy conservation work.

Sincerely,

Richard Danzig

Richard Danzig
Principal Deputy Assistant
Secretary of Defense (MRA&L)

(945363)

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