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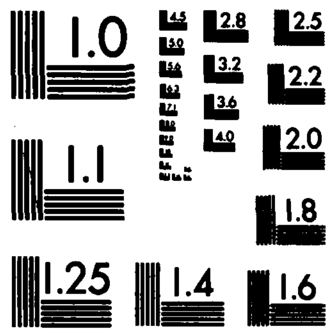

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NAVAL POSTGRADUATE SCHOOL
Monterey, California

THESIS

PREPARATION COSTS OF STEP TWO
SPECIAL PROJECT SUBMISSIONS
AT NAVY PUBLIC WORKS CENTERS

by

Kenneth W. Dressel

December 1984

Thesis Advisors: P. M. Carrick
W. R. Talutis

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This thesis compares the cost to the government of contracting out Special Project Step Two submissions versus the cost of preparing Step Two submissions with in-house government employees. Data from 80 Step Twos prepared at two Navy Public Works Centers was collected and analyzed. The results indicate conclusively that Step Two preparation by in-house employees is much less costly than contracting out Step Two preparation. In

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Preparation Costs of Step Two Special Project Submissions at Navy Public Works Centers

by

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Lieutenant, Civil Engineer Corps, United States Navy
BCE, Georgia Institute of Technology, 1979

Submitted in partial fulfillment of the
requirements for the degree of

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ABSTRACT

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I. INTRODUCTION

A. PURPOSE

The primary purpose of this thesis research is to compare the cost to the government of preparing Step Two Special Project submissions by two different methods. The first method is the use of in-house government employees to do the Special Project preparation work. The second method is to contract out the Special Project preparation work to an architectural and engineer (A&E) firm. A secondary purpose for this research is to develop a predictive model for the time and cost required to prepare a Step Two Special Project submission. The research was conducted on 80 Step Two submissions prepared at two Navy Public Works Centers during 1984. The remainder of this chapter will introduce and briefly explain relevant terminology, and will describe the organization of the thesis.

B. NAVAL SHORE FACILITIES

Naval Shore activities are involved in a wide variety of operations and functions, ranging from administrative support commands to Naval Air Stations to complete industrial facilities such as Naval Shipyards. Despite this diversity, all shore activities have in common the function of supporting in one way or another the operating forces of the Navy. To be able to carry out their missions properly all shore activities must establish and maintain the proper amount and type of physical plant and public works facilities. Typically, the maintenance, repair, and construction of real property facilities and land occupies a major portion of an activity's budget, and the adequacy of such facilities has a direct impact on the ability of the shore activity to perform its mission. Thus, close attention tc facilities planning, construction, maintenance, and repair is a requirement for a successful shore activity. The responsible management of scarce resources is also a necessity to enable each activity to stretch each available facilities dollar to the maximum extent possible. Only through such management can the often aged and obsolete facilities that exist throughout the Navy be best utilized to support the fleet.

The responsibility for the real property facilities of a shore activity rests with the activity Commanding Officer, and is normally delegated by the Commanding Officer to the Public Works personnel on his staff. Operations and Maintenance, Navy (O&M,N) funds are provided to each activity via its major claimant on an annual basis. Major claimants are commands senior to shore activities in the chain of command, through whom the shore activity receives operating funds. The O&M,N money provided is used by the activity to maintain and repair its facilities. A small amount of O&M,N funding is also provided for the modification of existing facilities or the construction of new facilities. In general, a shore activity has complete control over how the O&M,N facilities money is spent. There are, however, limits on the amount of money that Commanding Officers are allowed to spend on individual, specific projects. Projects of either a repair or construction nature that exceed the Commanding Officer's funding authority must be referred to higher authority for approval and funding.

The Special Project program has been developed for those maintenance, repair, and construction projects that exceed a shore activity's Commanding Officer's funding authority. The Special Project program enables shore activities to request that their major claimants fund projects that exceed their own funding authority. Very large projects require Assistant Secretary of the Navy (ASN) approval, but the vast majority of Special Projects are approved and funded at the major claimant level.

Large projects of a construction nature are funded directly by Congress through the Military Construction (MILCON) program. This is accomplished through a separate annual appropriation passed each year which specifically identifies the projects to be funded.

Despite not being able to fund their own large projects, individual shore activities must take the responsibility and action of identifying and initiating projects to be submitted to higher authority for approval. This facility planning function is normally accomplished by those personnel at the activity responsible for carrying out the public works function. Once an activity has identified a necessary facilities project that exceeds its own funding authority, the activity must then prepare the proper project documentation and funding request for submission to higher authority. Specific guidelines for the preparation of project documentation packages required for different types of Special and MILCON projects are provided in OPNAVINST 11010.20D "Facilities Projects Manual."

Shore activities face a choice in the method of preparation of project documentation. The activity may use its own personnel, if these personnel have the expertise and time available to prepare the project submission. As an alternative, if the activity has the authority to contract for services, the activity may enter into a contract with a local architectural and engineering (A&E) firm to prepare the project. Another alternative, for activities that are supported by a Navy Public Works Center (PWC), is to request that the PWC do the project preparation work. PWCs are separate commands responsible for providing public works services on a centralized basis to shore activities in a given geographical area. PWCs also have the option of using their in-house Civil Service engineers or to use an A&E contract to do the actual work.

Whether a project documentation package is prepared by government employees or by A&E contract, significant cost is incurred to produce the final package. In the case of work performed by government employees, all of the expenses associated with the employees effort including fringe benefits, overhead, and work environment costs must be included to achieve a true picture of the total cost. In the case of work performed by an A&E firm, the government incurs administrative and other costs beyond the amount of money paid to the firm. Government engineers and other personnel are still active in the contracted project preparation process, preparing and administering the contract, working with the A&E to ensure that the work is being done properly, and reviewing the final product for adequacy.

C. GOVERNMENT CONTRACTING VERSUS IN-HOUSE PERFORMANCE

It is the stated policy of the government to rely upon the private enterprise system to supply its needs, except where it is in the national interest for the government to directly provide the products and services it uses. This policy stems from the reasoning that in the process of governing, the government should not compete with its citizens, and that the competitive system is the primary source of national economic strength. This national policy was initiated through Bureau of the Budget Bulletins in the 1950's and has been perpetuated through the now well known

Office of Management and Budget Circular No. A-76. This circular was first issued in 1966, and was last revised in 1983.

The basic requirement of Circular No. A-76 is that government agencies identify those commercial activities that can be performed by contract as well as by government employees. Once these activities are identified, agencies must regularly conduct cost comparisons to determine the most cost effective method of performing the work. Only if the cost comparison shows that the function can be performed at less cost by in-house personnel will the function be retained in-house.

According to the Circular, certain functions performed by the government are inherently governmental in nature, being so intimately related to the public interest as to mandate performance only by government employees. These functions are not considered to be in competition with the commercial sector, and are thus exempt from the requirements of A-76. Generally, these functions include those activities which require either the exercise of discretion in applying government authority or the use of value judgement in making decisions for the government. The preparation of Special Project submissions falls into this category of function, and has thus been exempt from cost comparison studies.

Despite this exemption much Special Project preparation work is performed by A&E contract at PWCs. The ability to contract this work enables the Navy to bring outside expertise into the facility planning process when necessary. The use of A&E contracts also plays a significant role in expanding the amount of work that can be accomplished by the PWC engineering organizations.

D. RESEARCH

It is the purpose of this thesis to investigate the costs associated with the preparation of Special Project documentation, and to compare the cost of in-house preparation versus A&E contract preparation. Special Project documentation is prepared in two sequential phases, the Step One Submission and the Step Two Submission. Both steps are submitted from an activity to its major claimant. Step Ones are general in nature, providing a brief description of the project and a rough cost estimate. Step Twos provide more specific information about the project and a more detailed cost estimate. Step Twos are normally requested by an activity's major claimant when funding of the project is planned. This thesis will focus only on the costs associated with the preparation of Special Project Step Twos, as a limited amount of Step One preparation data was available. Because of travel constraints, the research was limited to Step Twos prepared at Navy Public Works Center, San Francisco Bay, and Navy Public Works Center, San Diego.

The intent of the research was to compare the costs to the government of the preparation of Step Twos by in-house personnel versus the cost to the government of contracting for the preparation of Step Twos. Two PWCs were chosen for the research because of the availability of a large amount of projects data, and because of the relatively sophisticated cost accounting system utilized at PWCs. The costing system is designed to provide service rates that very closely track the actual "full" cost to the government of performing any in-house work.

In conjunction with the cost comparison, an attempt was also made to develop a model that could be utilized to predict the costs that might accrue to any particular Step Two preparation job. This predictive model was based on certain pertinent characteristics of the Special Project itself. Additionally, the data was analyzed to determine if it would be possible to predict the type of Special Project that would be the most cost effective to contract out rather than do in-house.

E. METHODOLOGY

The research was conducted by travelling to the two PWCs involved, and collecting actual data from completed Step Two Special Project work requests. Data was collected on 80 Step Twos prepared during 1984. After the data collection, the information collected was analyzed for the purposes of the cost comparison and model formulation. Standard statistical techniques were employed for the analysis of the data collected and the interpretation of the results obtained.

F. THESIS ORGANIZATION

Chapter II provides a background discussion of the Special Project program, the Naval Facilities Engineering Command, Public Works Centers, and their organization. The chapter also includes a description of the cost accounting system in use at PWCs and discussion pertaining to the cost comparison.

Chapter III describes the methodology of the thesis research. Specifically, the development and description of the database, the analytical computations and statistical techniques performed, and the formulation of cost models are explained.

Chapter IV presents the findings and discusses the significance of the results. Additionally, alternatives are discussed with regard to both in-house and contract work performance.

Chapter V concludes the thesis with a summary of the background discussion, objectives of the research, and results.

II. BACKGROUND

A. SPECIAL PROJECT

1. Background

Navy policy provides for an activity to administer the maintenance and repair of its real property. The activity, through its Public Works staff, determines the work that must be done, assigns priorities for the work, and arranges for the performance of the work in any one of a variety of ways, depending on the organization. However, there are limits on the amount of funds that an activity Commanding Officer can spend on a particular project. Projects that exceed a Commanding Officer's funding authority are submitted to the activity's major claimant for approval and funding. A project is a single planned undertaking of construction, repair, maintenance, or equipment installation work, either separately or in combination, necessary to satisfy a finite requirement. [Ref. 1: p. 7-1]

2. Project Approval

A chart showing project approval authorities, obtained from the Civil Engineer Corps Officers School textbook 'Special Projects Seminar' [Ref. 2: p. 1243-2], is provided as Figure 1. The relevant funding authority dividing line for Special Projects is that between an activity Commanding Officer and the Major Claimant of the activity.

APPROVAL AND FUNDING OF WORK ON FACILITIES 09-13-83

PROGRAM	CATEGORY OF WORK	FUND RANGE	PROJECT APPROVAL	APPROPRIATION
ANNUAL MAINTENANCE & OPERATION	MAINTENANCE	UNLIMITED	COMMANDING OFFICER	O&MN (LOCAL)
	REPAIRS	< $75,000		
	CONSTRUCTION	< $25,000		
	EQUIPMENT INSTALLATION *	< $15,000		
SPECIAL PROJECTS	MAINTENANCE **	> $75,000	SPONSOR	O&MN (MAJOR CLAIMANT)
	REPAIRS	$75,000 - 500,000	SPONSOR	O&MN (MAJOR CLAIMANT)
	EQUIPMENT INSTALLATION *	> $15,000	SPONSOR	O&MN (SPONSOR)
	MINOR CONSTRUCTION	$25,000 - 200,000	SPONSOR	O&MN (MAJOR CLAIMANT)
	REPAIRS	> $500,000 > $100,000 & 50% of replacement value	ASN (S+L)	O&MN
UNFUNDED MILITARY CONSTRUCTION	EMERGENCY CONSTRUCTION (TOA $30 Million)	> $ 1 Million	ASN (S+L) & CONGRESS	MCN
	RESTORATION OF DAMAGED FACILITIES	> $ 1 Million	ASN (S+L) & CONGRESS	MCN
	CONTINGENCY CONSTRUCTION	≥ $ 1 Million	DASD (I+H) & CONGRESS	MCN
FUNDED MILITARY CONSTRUCTION	UNSPECIFIED MINOR CONSTRUCTION (UMC)	$200,000 - 500,000 $500,000 - 1 Million	CNO ASN (S+L) & CONGRESS	MCN (UMC)
	MINOR MILITARY CONSTRUCTION	$200,000 - 1 Million	CONGRESS	MCN (VARLOCS)
	PLANNING AND DESIGN	> $300,000	ASN (S+L) & CONGRESS	
	MILITARY CONSTRUCTION PROJECTS	> $ 1 Million	CONGRESS	MCN
	REAL PROPERTY ACQUISITION	> $100,000	CONGRESS	MCN

* Installation/expense costs only; does not include procurement of equipment.
** Applies to SPECIFIC maintenance, no limit on continuous maintenance.

FIGURE 1

A Commanding Officer may approve and fund specific maintenance and repair projects costing less than $75,000 each, construction projects costing less than $25,000 each, and equipment installation projects costing less than $15,000 each. The only limit on the activity, other than those stated above, is that the total dollar amount spent on such projects may not exceed the activity's budget. Projects costing in excess of these amounts must be approved and funded by the activity's Major Claimant.

3. Special Project Preparation and Submission

Special Projects must be submitted to major claimants in two steps. The first step submission is for the purpose of identifying the requirement and providing an approximate estimate of cost. The second step submission, made when project funding appears probable, includes the engineering and cost data necessary to define and justify work to be done.

4. Special Project Summary List

An activity annually submits a listing of currently required Step One and Step Two unfunded Special Projects to its major claimant. This report is called the Special Project Summary List. In actuality, three separate lists are required to be submitted; one for construction/alteration projects, one for maintenance and repair projects, and one for equipment installation projects. Projects are listed in the priority order that the activity has determined is most appropriate. The Special Project Summary List is the activity's formal method of informing its major claimant of the special projects the activity would most like to see funded. The Special Project Summary List must be submitted by 15 April each year. [Ref. 2: p. 4730-1]

5. Project Preparation

When a facilities project requirement becomes known to an activity, the activity is required to prepare the Step One Special Project request form, NAVFAC 11014/64A, shown in Figure 2 [Ref. 1: p. D-13]. For those activities that are served by a PWC, the PWC is responsible for providing the project preparation work. The shore activity also must identify the project on its Special Project Summary List as long as the project remains valid. Once the submission is prepared, the activity submits the project request Step One to its major claimant.

The major claimant then reviews the project and makes a determination regarding when the project might be funded. This decision is heavily influenced by the activity's own prioritization of the project on the Special Project Summary List. When funding is programmed the major claimant advises the activity to submit a Step Two Special Project request.

When advised by the major claimant that funding of the project is planned, the shore activity is required to prepare the Step Two Special Project request form NAVFAC

SPECIAL PROJECT REQUEST (INTERIM)

STEP ONE SUBMISSION

PART I – SUBMISSION

Naval Construction Battalion Center, Gulfport, MS 39501 | 62604

Naval Facilities Engineering Command, Alexandria, VA 22332 Via: Southern Division

R11-81 | Repair Roof Covering Building 60

[X] MAINT./REPAIR [ ] MINOR CONSTRUCTION/ALTERATION [ ] AIR CONDITIONING [ ] EQUIPMENT INSTALLATION

Building 60 is a two-story, pre-engineered, metal roofed, masonry sided, slab on grade structure which houses this Center's headquarters, Civilian Personnel Officer, Public Affairs Officer, Legal Office, and Personnel Activity Support Office.

2-00785

610-10

60

[ ] [X] [ ] [ ] [ ] [ ]

$ 31,800

$ 1,800

The present roof on Building 60 consists of metal panels and despite all efforts to seal panel joints, the roof continues to leak. It is proposed to over lay the present roof with a plywood, built-up, asphalt, aggregate-surfaced roof.

[ ] YES [XX] NO

N. R. MARTIN, LCDR, CEC, USN	PUBLIC WORKS OFFICER	17 MARCH 1981

PART II – MAJOR CLAIMANT ACTION

a. [ ] APPROVED FOR SECOND STEP SUBMISSION AND CONSIDERATION. FOR FUNDING IN FY ______ OR FY ______

b. [ ] DEFERRED PENDING FURTHER STUDY. RECOMMEND UPDATE AND RESUBMISSION IN ______ MONTHS.

c. [ ] OTHER: ____________________

SIGNATURE OF APPROVING OFFICIAL	TITLE	DATE

FIGURE 2

11014/64 and a Cost Estimating Form, NAVFAC 11013/7. [Ref. 1: p. D14-15] Appendix A shows a sample of a Step Two submission. The activity Public Works Officer or other cognizant person as designated by the activity must provide certification in Block 28 of the request form that the project meets all of the criteria set forth in OPNAVINST 11010.20D.

6. Navy Industrial Fund (NIF) Activity Projects

Costs of maintenance and repair of the plant at a NIF activity are considered as overhead in the case of buildings and equipment, or as direct cost in the case of utility distribution systems or facilities used in direct support of production. For continuous maintenance there are usually no dollar limits, and these costs must be recovered from NIF customers as overhead in the rate structure. All maintenance and repair projects costing over $75,000 that are to be funded as an overhead expense must be approved by the cognizant senior command. In the case of PWCs the senior command is NAVFAC headquarters in Washington.

7. Classification of Projects

The procedures for Special Project submittal, administration, and funding depend upon the type of work involved in the project. The Special Project classification is derived from the work involved; the four classifications of projects are: construction, repair, maintenance, and equipment installation. These classes are defined as follows:

Construction: Construction is the erection, installation, or assembly of a new real property facility; the addition, expansion, extension, alteration, conversion, or replacement of an existing real property facility; or the relocation of a real property facility from one installation to another. Construction includes equipment installed in and made a part of such facilities, and related site preparation, excavation, filling and landscaping, or other land improvements. [Ref. 1: p. 3-1]

Repair: Repair is the restoration of a real property facility to such condition that it may be effectively utilized for its designated purposes by overhaul, reprocessing, or replacement of constituent parts or materials that have deteriorated by action of the elements or usage and have not been corrected by maintenance. [Ref. 1: p. 4-1]

Examples of repair projects are: replacement of broken piling, deck or structural elements of a pier or wharf; roof repair by replacement; and replacing broken pavement or overlaying worn or deteriorated pavement.

Maintenance: The recurring day-to-day, periodic, or scheduled work required to preserve or restore a real property facility to such a condition that it may be effectively utilized for its designated purpose is defined as "maintenance." The term includes work undertaken to prevent damage to a facility that otherwise would be more costly to restore. [Ref. 1: p. 5-1]

A clear line cannot always be drawn between maintenance and repair; judgement must be exercised in differentiating between these categories of work. As a general rule, maintenance differs from repair in that maintenance does not involve the replacement of parts of a facility, but constitutes the work done on the parts to prevent or correct wear and tear and therefore forestall replacement.

There are two broad types of maintenance effort; one type readily lends itself to the Special Projects program while the other does not. Specific maintenance is the maintenance of a facility on a specific job order basis. This type of work recurs over a given cycle, but is not of a continuous nature on a particular facility. The exterior painting of a building is an example of specific maintenance work. The other type, continual maintenance, is maintenance performed on a standing job order or maintenance service contract basis. This work is highly repetitive on a portion of the facility, and extends throughout the year or season (an example would be a maintenance contract on an air conditioning system in a building). Specific maintenance is the type which can be accomplished by Special Project.

Equipment Installation: Equipment installation refers to both installed equipment and personal property.

Installed equipment, sometimes called built-in equipment, is accessory equipment and furnishings that are required for operation and are affixed as a part of the real property facility. The equipment is engineered and built into the facility as an integral part of the final design and as an essential part thereof. Equipment of this type is considered part of the real property.

Personal property, sometimes called plant equipment, or equipment in place, is defined as accessory equipment and furnishings that are movable in nature and not affixed as an integral part of the real property facility. This equipment includes all types of production, processing, technical, training, servicing, and RDT&E equipment. [Ref. 1: p. 6-1]

8. Policy

Incrementation: No project may be subdivided in order to reduce the cost for purposes of circumventing programming and approval requirements. Each project must result in a complete and usable real property facility or improvement thereto. The planned acquisition of, or improvement to a real property facility through a series of minor construction projects is prohibited. All construction requirements in support of a single specific project at an activity must be grouped into a single project. Multiple minor construction projects for facilities with different category codes in support of the same specific purpose at the same activity are not allowed.

Repair Project Policy: In general, repair projects should be accomplished using material similar to the original. However, if a direct replacement is not available or if improved materials are available, and if justified by an economic analysis, substitutions may be made. Also, during the course of a project constituent parts (such as utility services) may be increased in size to meet current demand.

When the scope of a repair project exceeds 50 percent of the replacement value of the facility and the cost exceeds $100,000, the project must be approved by ASN (M,RA&L). The facility replacement value is determined from the property record for that facility.

9. Special Project Chronology

An activity may submit Step One special project requests to its major claimant at any time of the year, and in general activities submit projects upon the identification of a specific facility deficiency. The project will then be added to the activity's special project summary list for its next submission to the major claimant. The major claimant collects the special project requests from all of the activities under its cognizance, and based upon its own priorities and the expected level of funding, develops a special project execution plan. Each activity is notified of the projects it can expect to have funded, and is requested to provide the Step Two submissions at this time. Once the Step Two is completed the geographic EFD is authorized to proceed with project design. The Step Two serves as the definitive statement of the project scope of work, enabling the design agent to award an A&E design contract.

In practice, through informal contact with the major claimant and past experience, many activities are able to predict which special projects will be included on the execution plan. They are thus able to have their Step Two submissions ready, or already submitted when the execution plan is promulgated. Also, many activities will skip the Step One submission phase for projects of a critical nature, going directly to the Step Two. This is done because the activity plans to assign the project a very high priority on its summary list and funding is thus relatively certain. On the other hand, some projects may be chosen for funding by the major claimant on short notice, in the event extra money becomes available. In this event, activities must expedite Step Two preparation so that formal project approval and funding can take place prior to the expiration of project funds.

Step Two special project submissions normally are retained by the major claimant, unless forwarding to ASN for approval is required. In the review process, claimants are generally concerned with the necessity of the project, a well defined project scope of work, and the accuracy of the cost estimate. A well defined scope of work and a good cost estimate are important in reducing the occurrence of future program problems due to scope changes and cost overruns.

B. NAVFAC

1. General

The Naval Facilities Engineering Command (NAVFAC), one of the systems commands which reports to the Chief of Naval Material, is responsible for and authorized to perform the design, planning, development, procurement, construction, alteration, repair and maintenance at shore activities of the Naval establishment for public works and public utilities; and to procure construction, transportation, and weight handling equipment. The Command exercises technical control in connection with alteration, repair and maintenance of public works and public utilities, and establishes operating standards and procedures pertaining thereto.

Specifically related to the action of an activity's Public Works Department or to a Public Works Center, NAVFAC provides advice and assistance regarding maintenance of public works, establishes standards and procedures for administrative and technical functions, provides professional and technical advice, and performs technical functions.

NAVFAC's role is one of providing advice and assistance to activities, and of being the superior command to which Public Works Centers report. However, this has not always been the case. During the 1950's each independent bureau and office pursued facilities management according to its own habits and customs, and there was no centrally coordinated program. Partly as a result of the deteriorated condition of Naval shore facilities, in 1963 the Secretary of the Navy designated the Bureau of Yards and Docks (soon to become NAVFAC) as the single executive for the maintenance of real property with full responsibility for the program, including funding. With the advent of Project PRIME in 1967, CNO assumed the functions of the single executive, with NAVFAC providing expert advice and assistance in facility matters. Funding and management for facilities now follow the same lines as command, with funds provided in a single operations and maintenance budget. [Ref. 3: p. 66]

2. Engineering Field Divisions

The Engineering Field Divisions (EFDs) carry out the NAVFAC mission in the field, with each EFD given responsibility for a specific geographic area. The EFDs are tasked to respond to the requests of individual activities on facilities matters, and they also provide the same assistance to PWCs. In the NAVFAC chain of command EFDs fall between NAVFAC Headquarters in Washington and the individual Public Works Centers in their geographical region. There are six EFDs:

EFD	LOCATION	AREA
Pacific Division	Honolulu, HI	Pacific Ocean area, Alaska, Hawaii
Atlantic Division	Norfolk, VA	Eastern U.S., Europe, Atlantic and Caribbean
Northern Division	Philadelphia, PA	Northeastern and Central U.S.
Southern Division	Charleston, SC	Southeastern U.S.
Western Division	San Bruno, CA	Western U.S.
Chesapeake Division	Washington, D.C.	Naval District Washington

The EFDs are directed by a Civil Engineer Corps (CEC) Rear Admiral or Commodore as Commander, or a CEC Captain as Commanding Officer. The staff consists of a small number of CEC officers in key management positions and several hundred civilian engineers, technicians, and administrative personnel. EFDs become involved in the Special Project program by reviewing project submissions when requested to do so by either activities or major claimants. They also provide guidance and assistance to the PWCs under their cognizance.

3. Public Works Centers

On a Navy shore activity, the Public Works Department is responsible for all facilities management functions. These matters normally include:

- Facilities planning and programming
- Real estate management
- Facility design and construction
- Facilities maintenance, repair, minor construction, alteration, and equipment installation
- Utility system operation and maintenance
- Facility disposal

-Transportation fleet management, operation and maintenance
-Housing administration
-Environmental protection program management.

Where several activities are located in close proximity, one activity may be designated as a Public Works Lead Activity (PWLA) to provide facilities management services to all activities in that area. The PWLA remains a component of one of the activities. However, where a larger number of major activities are concentrated in one area, a Public Works Center (PWC) may be established under the command of the Naval Facilities Engineering Command (NAVFAC). The minimum criteria for establishment of a PWC are: three or more customer commands, at least 1000 civilian employees, and a total annual budget of $30 million.

The PWC provides to its customers the same types of services as those normally provided by an activity's own Public Works Department; facilities maintenance, utilities, and transportation services; at the request of the customer commands. The mission of the PWCs, as stated in NAVFAC Instruction 5450.82 [Ref. 4: p. 2] is "... to provide public works, public utilities, public housing, transportation support, engineering services, shore facility planning support, and all other logistic support of a public works nature incident thereto, required by the operating forces, dependent activities, and other commands served by the PWC." Except for facilities planning, family housing, inspection services, and some engineering services, these functions are performed on a cost reimbursable basis. Commanding Officers of customer activities retain financial responsibility for public works matters. Although PWCs are not tasked to provide financial management support it has been NAVFAC policy to encourage PWC personnel to become involved in the facilities management budget process of customer commands.

At present there are nine PWCs, located at:

San Diego, CA
Oakland, CA
Pensacola, FL
Great Lakes, IL
Norfolk, VA
Pearl Harbor, HI
Guam
Subic Bay, Philippines
Yokasuka, Japan

4. PWC Organization

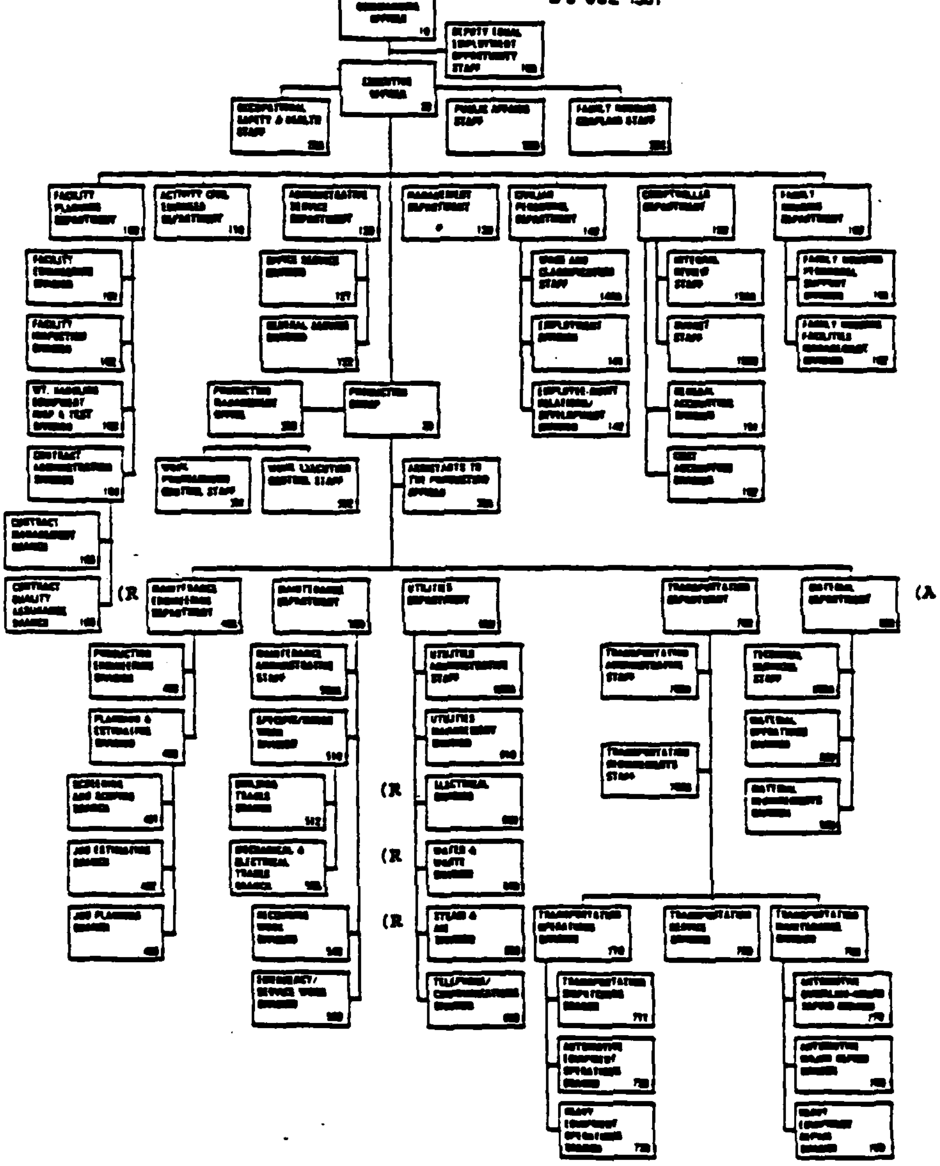
The Commanding Officer of a Public Works Center, normally a CEC Captain, reports to the Naval Facilities Engineering Command via the appropriate EFD. The PWC's relationship with its customers is that of a service organization. In general, the PWC is not in the same chain of command with its customers. Most PWC customers have no in-house facilities maintenance capability of their own, and are required to obtain their public works services through the PWC. Large customer commands have full time CEC officers assigned to their staffs to coordinate the work requested, while smaller commands are assigned a part time CEC officer representative, who works for the PWC and coordinates the work of several smaller commands.

To ensure uniformity and promote efficiency NAVFAC has promulgated NAVFACINST 5450.21C, "Public Works Center Standard Organization and Functions." This instruction sets forth a standard organization to which all PWCs are expected and encouraged to adhere. This standard organization is shown as Figure 3. [Ref. 5: enclosure (1)]

The department involved with the preparation of Special Project documentation is the Facility Planning Department, Code 100. The Facility Engineering Division, Code 101, does the actual project preparation work. Code 101 is divided into several branches, based upon engineering discipline. At PWC SDIEGO, Code 101 is responsible for all aspects of the A&E contracting of work, as well as any in-house work required. At PWC SFB, a new division, "A&E Professional Services," Code 30A2, was established early in 1984 under the supervision of the Production Officer to perform many aspects of the A&E contracting process on a centralized Center-wide basis. This division was formed to consolidate the A&E contracting effort of the various PWC divisions that make use of A&E contractors. All of the A&E contracts used in the accomplishment of jobs covered in this study were awarded prior to the formation of Code 30A2. The primary functions of Code 101 are as follows: [Ref. 5: p. 6]

1. Prepares documentation for Special and Military Construction Projects including preliminary environmental assessments, cost estimates and economic analyses for customers.

2. Conducts engineering investigations and studies.



PUBLIC WORKS CENTER
STANDARD ORGANIZATION

FIGURE 3

3. Prepares plans and specifications for maintenance service contracts.

4. Conducts special studies of a planning nature such as Basic Facility Requirements (BFRs) and space utilization studies. BFRs are planning documents submitted from activities to major claimants that justify an activity's facility requirements based upon the activity mission.

5. Provides input to WESTNAVFACENGCOM regarding development of the regional master plan and activity master plans.

6. Jointly with the Work Programming Control Division (Code 351) determines facilities planning work that will be accomplished via A&E contracts.

Code 101 thus does much more than prepare Special Project Step Two submissions. At PWC SDIEGO in FY 84, 143 of 405 total work requests received were for Special Project preparation. No formal records are kept on Step One versus Step Two requests, but according to the supervisory engineer at Code 101, very few requests for Step Ones are received. [Ref. 6] He attributes this to two factors; first, due to the relatively simple nature of Step Ones, many activities are able to do their own, and second, many times activities skip the Step One phase of a project submission. Of the remaining 262 requests received by Code 101, 166 were for engineering investigations, 72 were for MILCON project preparation, 21 were for service contract plans and specifications, and 3 were for preparing activity BFRs. A breakdown of work requests by type was not available from PWC SFB but the estimated levels from the Code 101 FY 85 budget submission are 152 special projects, 82 engineering investigations and planning related requests, 25 MILCON projects, and 37 maintenance service contract plans and specifications. [Ref. 7] The PWC SFB Code 101 FY 85 budget estimates that 27,700 in-house and 26,200 A&E manhours will be spent on these work requests. The estimated total dollar value of the Special and MILCON projects to be prepared is approximately $400 million. The figures for PWC SDIEGO manhours and project value are approximately one third greater than those for PWC SFB.

5. PWC Work Flow

Work is requested by customer commands through the use of standardized request forms. All work requests go first to the Production Management Office (Code 350) for entry into the PWC Production Management system before being routed to the appropriate division for work accomplishment. The purpose of the Production Management system is to provide a uniform methodology for screening, estimating, planning, and processing all of the work performed by the PWC. The system also produces a variety of different reports related to the operations of the PWC and its various departments. Code 350 is responsible for the maintenance of the Production Management system, and is responsible for providing a single, centralized point of contact to PWC customers for job status inquiries.

Once Code 350 has created a job file, a request for Special Project preparation is sent to Code 101. Upon a job's arrival in Code 101, the division's supervisory engineer assigns it to the appropriate branch, based upon the predominant discipline involved, and then the branch head assigns the job to one of the engineers in the branch. The engineer to whom the job is assigned is known as the Engineer in Charge, or EIC, and is responsible for all aspects of the completion of the job. If the job is to be done in-house the EIC does it, and if the job is to be done by A&E the EIC does all of the work required in awarding the contract, working with the A&E, and reviewing the A&E's work.

The decision as to whether or not to contract out a particular job is made at the EIC level, unless special instructions have been given to him. For example, several months ago PWC SFB adopted a policy of doing all Special Project preparation work in-house and PWC SDIEGO has instituted a policy that all EICs must have at least one job outstanding that they are doing themselves. In cases other than these, the EIC bases the contracting decision on his own workload at the time, as well as any pertinent factors in the job itself. Certain jobs may require expertise not available among the in-house employees, although this problem is relatively rare. The greatest factor in the contracting decision is the workload, in that the amount of work requested of Code 101 exceeds the manpower available to accomplish the work. Since contracting requires the use of fewer in-house manhours than doing the work in-house, contracting is used as a method to increase work output.

Other than the above mentioned policies that have been implemented, specific guidelines concerning the contracting decision are not utilized on a regular basis at either PWC SFB or PWC SDIEGO. Similarly, there are no specific guidelines concerning acceptable job completion times.

Despite the fact that a job is to be done by an A&E firm, there still is much work that must be done by the EIC in support of the effort. This includes: [Ref. 8]

1. Writing a scope of work to define the work desired from the A&E.

2. Preparing the government estimate for the work.

3. Negotiating the contract modification with the A&E firm.

4. Writing the Board Report concerning the contract modification.

5. Assisting the A&E with any problems related to the successful accomplishment of the work. This includes such matters as gaining access to project sites, obtaining facility engineering drawings, and acting as liaison between the A&E firm and the customer activity.

6. Reviewing the A&E firm's submittals and certifying the firms invoices for payment.

Once a job has been completed, it is reviewed by the branch head, the Code 101 supervisor, and the Facility Planning Officer. The customer activity is also given the opportunity to review and comment on the project prior to its final preparation. After the reviews have been completed and the necessary changes made, the final submittal is sent to the requesting activity. The job folder is then returned to Code 350, along with a copy of the Step Two, and the job is closed out of the system. Job order files are retained at Code 350 for record purposes.

C. THE NEGOTIATED ARCHITECT AND ENGINEER CONTRACT PROCESS

The Officer in Charge of Construction (OICC), Navy Public Works Center, San Francisco Bay and the OICC, Navy Public Works Center, San Diego are delegated contractual authority by Western Division, Naval Facilities Engineering Command (WESTNAVFACENGCOM) for A&E contracts. This authority includes specific A&E contracts not to exceed $100,000 and open-end multi-service contracts not to exceed $200,000.

In accordance with Public Law 92-582, all A&E selections which are expected to result in a fee in excess of $10,000 must be synopsized in the Commerce Business Daily. [Ref. 9: p. 5.3.3] A&E selections of lesser amount are to be publicized through appropriate notices at the contracting office and other places where they will give reasonable notice to A&Es in the area of the project. Each such synopsis or other publicizing must set forth the significant specific evaluation factors to be applied in making the selection decision. The following items are examples of A&E selection evaluation criteria: [Ref. 9: p. 5.3.3]

1. Specialized experience of the firm in the type of work required with a listing of specific skills required for the project;

2. Professional capacity of the firm to accomplish the contemplated work within the required time limits;

3. Professional qualifications of staff to be assigned to the project;

4. Innovative design capability;

5. Adequacy and qualification of subcontractors and consultants;

6. Past experience, if any, of the firm with respect to performance on Department of Defense contracts;

7. Cost control effectiveness;

8. Present workload;

9. Location of the firm in the general geographical area of the project, provided that there is an appropriate number of qualified firms therein for consideration;

10. Volume of work previously awarded to the firm by the Department of Defense.

At least 14 days must be allowed after publication of a synopsis in the Commerce Business Daily to permit any firms wishing to be considered for selection to indicate that fact and file any necessary forms. The following wording must be utilized to conclude each synopsis issued:

> "A&E firms which meet the requirements described in this announcement are invited to submit completed Standard Forms 254 (unless already on file) and 255, U.S. Government Architect-Engineer Qualifications, to the office shown below. Firms responding to this announcement by (date) will be considered, and firms having a current SF 254 on file with this office can also be considered." [Ref. 9: p. 5.3.8]

Standard Form 254s are kept on file and updated periodically in contracting offices by A&E firms which wish to be considered for selections by that office. The Standard Form is a general resume of the firm's experience. A firm which does not have a Standard Form 254 on file but wishes to be considered for a particular procurement may file that form along with the Standard Form 255 and/or other indication of interest.

The Standard Form 255 is a statement by a firm of its qualifications for a particular project for which selection is about to be made. The synopsis or other publicizing may require the submittal of a Standard Form 255 if the estimated fee of the A&E contract is under $25,000, but the synopsis must require the submittal of a Standard Form 255 by interested firms if the estimated fee is in excess of that amount. In the case of Special Project Step Two preparation, the contracts are generally grouped on open-end contracts, and are therefore expected to exceed the limit, thus requiring the Standard Form 255.

The awarding of an A&E contract requires three major actions or phases to be completed. These are pre-selection, selection, and negotiation and award.

1. <u>Pre-Selection</u>

The first step in the awarding of an A&E contract is the convening of a Pre-Selection Board for the purpose of compiling a slate of qualified firms for the work. The members of the committee are engineers selected from among the employees of the PWC on the basis of experience. The Pre-Selection Board is made up of a chairperson and at least two other members. The Pre-Selection Board is provided with the proposed scope of work, government cost estimate, SF-254s and 255s, and responses to the Commerce Business Daily announcement. The slate of qualified firms is not to be prepared from personal records of individual committee members. The Pre-Selection Board also considers any experience data that is on file with the EFD, supporting data and information that may be obtained from other EFDs, the Army Corps of Engineers, other government agencies, and supplemental information that may be requested from and submitted by prospective contractors.

The Pre-Selection Board evaluates each firm in light of the criteria set forth in the synopsis. Substantial efforts should be made to bring new A&E firms (those who have never been awarded an A&E contract or have not recently been awarded an A&E contract) into the selection process. Each Pre-Selection Board must assure that new firms are given every opportunity to participate on a fair and equitable basis in the A&E program. It is firm DOD and NAVFAC policy that A&E contract selections shall be spread among all qualified firms including small and minority firms. Although primary consideration should be given to experience and satisfactory performance, effort shall be made to spread the work and give consideration to new firms. Firms having awards of $100,000 or more in the current or preceding year normally will be excluded if other firms are available.

The Pre-Selection Board submits a written Board Report to the OICC, stating that the recommendations contained therein are based on an examination of contractor's brochures, performance records, and indicating the criteria used in making the slate selection. The Pre-Selection Board recommends several firms for consideration by the Selection Board, with the exact number depending on the size of the project. At least three firms must be chosen for all projects, with more firms recommended for larger and more complex projects.

The OICC may approve the slate as submitted, or, if not satisfied with the report of the Pre-Selection Board, may return the slate to that committee or to a new Pre-Selection Board with instructions to restudy and prepare a new slate. An OICC may not add firms to or delete firms from a slate. Once the slate is approved it is considered that every firm on the slate is basically qualified to perform the work in question.

2. Selection

The approved slate is then forwarded to the Selection Board, together with all of the information on the firms available. The Selection Board has the same number of members as the Pre-Selection Board and is also made up of PWC engineers and architects. No person may serve on both the Pre-Selection Board and the Selection Board. The Board interviews the recommended firms with regard to establishing their technical qualifications, experience, organization, capacity, current workload, immediate availability, key individuals who will be doing the work, and other relevant factors. There is no discussion, at the time of the interview, of the price to be paid for the services. However, the general magnitude of the work may be indicated for the purpose of avoiding misunderstandings. The Selection Board may not add firms to, or delete firms from, the slate.

If the Government estimate for the contract is less than $10,000, the selection may be based on prior interviews or the data on file, subject to telephone verification of the firms interest in the project. Since most Special Project Step Two preparations are accomplished as amendments to open end contracts of greater than $10,000, this method is not appropriate.

If the Government estimate exceeds $10,000 or if the project is of more than routine difficulty, the selection must be based on oral or written communication with the recommended firms. Discussion may be carried out by telephone unless the contract is expected to exceed $50,000, in which case personal interviews are required with at least three Board members present.

As soon as possible after the interviews, the Board shall, in private session, discuss the qualifications of the firms interviewed. The Board members shall, by secret written ballot, select the firm they consider best qualified to perform the project under consideration. The Board also selects a second and third firm in order of preference. It is within the discretion of the Board to decide, before a ballot is taken, whether a simple majority or some greater percentage is required for selection.

A Board Report, in the form of a written recommendation to the OICC shall include an explanation of the reasoning on which the Board recommends the particular firm, but shall not indicate how individual members of the Board voted. The OICC shall specify in writing his approval or disapproval of the firm selected.

The contractor who is selected shall be advised by letter that the OICC wishes to receive a price proposal for the services in question with a view toward entering into a contract if a satisfactory price agreement can be reached. It should be clearly stated that this notice is not an award or a commitment by the Government. Suggestion that the contractor visit activities or incur other costs in preparation for the price discussions is desirable. However, it should be stated that the suggestion is made for the contractor's benefit and that any decision as to whether to comply is at his own discretion. The Government will not be responsible for any such costs incurred.

3. Negotiation and Award

After receipt of the price proposal from the selected A&E firm, the Negotiation Board reviews and compares it with the government estimate in order to determine whether or not there are any significant differences. The Negotiation Board is made up of the same members as the Selection Board. If the contractor's proposal is equal to or less than the government estimate, the amount involved is $10,000 or less, all elements of the proposal are in line with the estimate, and the negotiation board is fully satisfied that the contractor has a complete and full understanding of the work to be performed, award may be made without further negotiation.

If any element of the price proposal varies significantly with the government estimate, even though the total amount may be in accord with the government estimate, or if the amount involved is over $10,000, the negotiation board must meet with the contractor for the purpose of negotiating the contract price. Normally such negotiations will first involve a discussion of the work to be performed in order to assure that there is no misunderstanding between the government and the contractor as to the nature and extent of the work.

Once the discussion of the scope of work is complete the parties conduct a review of the various price elements to determine the reason and basis for the difference between the proposal and the government estimate.

In accordance with the NAVFAC P-68, 'Contracting Manual' [Ref. 9: p. 5.3.13], negotiated procurements are not allowed to be awarded in amounts in excess of the government estimate. If, during the course of negotiations, it is determined that the government estimate is in error, it may be changed as appropriate. Such change from the original estimate must be mentioned in the board report. In the jobs researched for this study, the government estimates were in general very close to the A&E fee proposal. Any differences consisted of slight variations in the amount of A&E manhours required for a particular item of the work.

After a fee has been agreed upon, a board report or memorandum of negotiation must be prepared. This report must include, as a minimum, the justification for the recommended price including any differences between the contractor's proposal and the government estimate and the method of resolution thereof and justification for any negotiations concerning time. In the event that a fee cannot be agreed upon, negotiations with the selected firm are terminated and the second most desirable firm is invited to make a proposal.

4. Open Ended Architect & Engineer Contracts

The term "open-end contract" refers to a special category of A&E contract wherein a firm is contracted with to perform one or more specific items of work, with the stipulation that the firm will then be provided additional projects to do during the course of the year, up to a maximum total contract fee. These additional items of work are considered to be amendments or modifications to the original contract, and thus do not entail the requirement to go through the selection process again. The advantage of this type of contract lies in the ability to award small project work in a relatively short time frame.

To permit the greatest flexibility in obtaining engineering work whenever and however needed, many different open-end contracts are in effect at both PWC SFB and PWC SDIEGO. This enables the PWC engineer in charge of a project to choose from among several A&E firms the one best qualified for the particular project. All of the contracted Special Project preparation work that was accomplished for the jobs selected for this research was done using open-end contracts.

In accordance with NAVFAC P-68 OICCs are authorized to assemble A&E projects required to be performed within a six month to one year period and synopsize these projects in a single synopsis in the Commerce Business Daily, with selection and award subject to: [Ref. 9: p. 5.3.8]

1. No contract shall exceed $200,000 in total A&E compensation.

2. No single project shall exceed $99,000 in total compensation.

3. A specific project or projects must be in existence at the time of synopsizing, with other projects of a similar nature which will require the same professional skills known to be required within the next twelve months.

4. Selection must be based upon personal interviews of firms by the selection board.

5. An A&E contract is to be awarded for an initial specific project or projects, with other projects to be added by negotiated, fixed-price, lump-sum change orders during the life of the contract.

6. The selection board interviews and report shall specify the initial work, describe the nature of the additional work contemplated, the maximum total fee that may (not will) be paid for the contract and the fields of professional expertise for which the contractor was selected.

7. Care must be taken to spread the A&E work so that several contractors are selected for work at any particular activity.

8. Not authorized is contracting for personal services, engineering on an hourly basis, or the hiring of engineers in contravention of other prohibitions. All work under open-end contracts shall be negotiated on the basis of a specific written statement of work and performed for a fixed price.

5. <u>Cost Estimation of A&E Contracts</u>

NAVFAC P-68 states that it is the policy of the government that a government estimate must be prepared in as much detail as if the government were going to bid on doing the job. [Ref. 9: p. 5.3.6] To that end PWC engineers must prepare a cost estimate for every Step Two preparation contract modification. This is accomplished by performing an analysis of the types of work required in the project preparation, the amount of time that will be required, and the cost of the work.

6. <u>Components of the Estimate</u>

The estimate for an A&E contract consists of three separate parts or components. Figure 4 shows the forms used by both the government and the A&E firm in developing estimates. The three components are (1) Design--Section A, (2) Engineering Services--Section B, and (3) Construction Contract Support Services (CCSS)--Section C.

(1) Design--Section A. The design effort is presented in Section A. This effort is what is normally required for the production and delivery of designs, plans, drawings, and

A E FEE ITEMIZATION
12ND WESTDIV 11012/1 (REV 6-78)

See Instructions on Reverse

DATE OF SCOPE OR MODIFICATION	4 October, 1983
DATE OF ESTIMATE	10/17/83
PROJECT TITLE	A/E Services Step II Special Projects
CONTRACT NO	N62474 82 C ~~6178~~ 4396
EST CONSTRUCTION COST	N/A
LOCATION	NAS ALA, Repair Parking Apron Near Bldg. 166, NPWC, SF Bay, Oakland, CA
A-E FIRM	LOWRY & ASSOCIATES

SECTION A ~~DESIGN~~ Engineering Services

ITEM	NO. OF DWGS	PROFESSIONAL MANHOURS	PROFESSIONAL RATE	PROFESSIONAL COST	SUB PROFESSIONAL MANHOURS	SUB PROFESSIONAL RATE	SUB PROFESSIONAL COST
1 PROJECT ENGINEER		6	24	144			
2 ARCHITECTURAL							
3 STRUCTURAL							
4 MECHANICAL							
5 ELECTRICAL							
6 CIVIL							
7 LANDSCAPE							
8 SPEC/REPORT WRITERS		31	19	589	4	17	68
9 TYPIST					8	9.50	76
10 COST ESTIMATOR		12	19	228			
11 TOTALS		49		961	12		144

12 TOTAL DIRECT LABOR (Professional and Sub-Professional)	1105
13 OVERHEAD 120 % x $ 1105 (Line 12)	1326
14 TOTAL DIRECT LABOR AND OVERHEAD (Lines 12+13)	2431
15 PROFIT 10 % x $ ~~1326~~ 2431 (Line 14)	243
16 TOTAL FEE FOR DESIGN SERVICES (Lines 14+15)	2674

SECTION B ENGR SVCS, REPRO & TRAVEL

1 SUBSURFACE INVESTIGATION (Itemized on supplement sheet)	
2 TOPOGRAPHIC SURVEY (Itemized on supplement sheet)	
3 FIELD INVESTIGATION (Itemized on supplement sheet)	184
4 REPRODUCTION (Itemized on supplement sheet)	50
5 OTHER SPECIAL COSTS (Identified on supplement sheet)	
6 TRAVEL - REIMBURSABLE (Itemized on supplement sheet)	
7 TOTAL FEE FOR ENGINEERING SERVICES REPRODUCTION AND TRAVEL	234

SECTION C CONSTR. CONTRACT SUPPORT SVCES

ITEM	PROFESSIONAL MANHOURS	PROFESSIONAL RATE	PROFESSIONAL COST	SUB PROFESSIONAL MANHOURS	SUB PROFESSIONAL RATE	SUB PROFESSIONAL COST
1 SHOP DRAWING REVIEW & OFFICE CONSULTATION						
2 AS-BUILT DRAWING PREPARATION						

3 TOTAL DIRECT LABOR (Lines 1 and 2, Professional and Sub-Professional)	
4 OVERHEAD % x $ (Line 3)	
5 TOTAL DIRECT LABOR AND OVERHEAD (Lines 3+4)	
6 PROFIT % x $ (Line 5)	
7 TOTAL FEE FOR CONSTRUCTION CONTRACT SUPPORT SERVICES	
GRAND TOTAL FEE DESIGN ENGINEERING SERVICES TRAVEL AND CCSS	2908

A-E SIGNATURE	TIC SIGNATURE	CODE	PHONE	DATE OF APPROVAL
[signature]				

FIGURE 4

FIGURE 4 (continued)

SUPPLEMENT TO A-E FEE ITEMIZATION - ENGINEERING SERVICES
[illegible]

Contract No. N62474- 82-C- ~~[illegible]~~ 4396 48 | Date of Report 4 October, 1983

Note: *Items 1 and 2 are to include all direct costs, overhead, profit, travel and standard equipment. Items 3, 4, 6 and 7 are to include direct labor cost, overhead and profit.*

1. Sub-Surface Investigation: *Enter total on line 1, Section B of A-E Fee Itemization*

Description	Quantity	Unit Cost	Amount
Mobilization/Demobilization	______	______	$ ______
Borings: Depth ______	______	______	$ ______
Mechanical Analysis	______	______	$ ______
Atterberg Limits	______	______	$ ______
Unconfined Compression	______	______	$ ______
Consolidation Tests	______	______	$ ______
Triaxial Compression	______	______	$ ______
Other	______	______	$ ______
Report	______	______	$ ______
Sub-Total			$ ______
Profit, ______ %			$ ______
Total		Lump Sum	$ ______

2. Topographic Survey: *Enter total on Line 2, Section B of A-E Fee Itemization*

Description	Amount
Survey Party, ______ Man. ______ days $ ______ per day	$ ______
Survey Party, ______ Man. ______ days $ ______ per day	$ ______
Computer Time, ______ hrs. $ ______ per hour	$ ______
Engineering, ______ hrs. $ ______ per hour	$ ______
Draftsman, ______ hrs. $ ______ per hour	$ ______
Other, specify	$ ______
Sub-Total	$ ______
Profit, ______ %	$ ______
Total Lump Sum	$ ______

3. Field Investigation: *Enter total on Line 3, Section B of A-E Fee Itemization*

1/2 days $ 368 per day. Lump Sum $ 184

4. Reproduction: *Enter total on Line 4, Section B of A-E Fee Itemization*

Drawings: ______ sheets or SF/set, ______ submittals, $ ______ per sheet or SF $ ______

Specifications: 2 submittal $ 25 per submittal $ 50

5. Other Special Costs: *Enter total amount on Line 5, Section B, A-E Fee Itemization*

Description	Amount	Description	Amount
Cathodic Soils Testing	$ ______	Feasibility Study	$ ______
Aerial Plan Survey	$ ______	Concept Study	$ ______
Color Renderings	$ ______	Interior Design Package	$ ______
Solar Energy Study	$ ______	Project Engr'ng Documentation	$ ______
Energy Conservation Study	$ ______	Maintenance/Operations Manual	$ ______
Environmental Prot. Plan	$ ______	Other	$ ______
Acoustical Study	$ ______	Lump Sum	______

6. Travel and Subsistence (Reimbursable, in accordance with Government Travel Regulations): *Enter total estimate on Line 6, Section B of A-E Fee Itemization*

Air $ ______ Auto $ ______ Taxi or Car Rental $ ______

Subsistence, Mandays ______ $ ______ per day $ ______

Total Estimated Travel Expense $ ______

7. Options: Field Consultation During Construction, Field Verification Prior to Construction and Value Engineering. *Option to Government, do not enter on A-E Fee Itemization*

Consultation: $ ______ per manday. Verification: $ ______ per manday. VE: $ ______ per manhour.

specifications for a construction project. Actually, in the case of Special Project preparation, this section is renamed Engineering Services as it more properly describes the type of work performed. The effort required is estimated by determining the direct labor man-hours required for each discipline (project engineering, architectural, structural, mechanical, electrical, civil, landscape, specification/ report writer, cost estimator, and typist) separated by professional and sub-professional capabilities. These separate man-hour requirements are then extended by the appropriate labor rate and totaled to arrive at the "total direct labor" (line 12). For open-end contracts the labor rates for each type of skill is set upon the initial award, and remain the same for the entire period of the contract. The indirect costs of the A&E firm are represented in the overhead rate. The overhead rate is applied to the total direct labor to compute the amount of overhead. An average overhead rate of approximately 105% was experienced in the projects looked at in this study, and is considered to be approximately the industry wide average. The amount for profit is then added to the total of overhead and direct labor to determine the "total fee for design services" (line 16).

(2) Engineering Services--Section B. Engineering services in this portion of the estimate are those items

required to develop the Step Two for the project, but are not included in Section A. As shown on the form utilized, these items can include subsurface investigation, topographic survey, field investigation, reproduction, other special costs, and travel. Fees for these items are negotiated as a lump sum to include direct cost, overhead, and profit.

The only engineering services used by contractors in the Step Two preparation jobs reviewed were for field investigation and reproduction. The other services are more likely to be required only during an actual project design phase rather than the Step Two phase.

The fee for field investigations is designed to cover the effort necessary to determine existing conditions. Work items included are evaluations of the adequacy of existing utility systems, structural condition of existing facilities, verification of existing as-built drawings, etc. Field investigation is negotiated in terms of man-days with an appropriate rate to include overhead and profit.

Reproduction costs are for the reproduction of the finished product in quantities as specified by the scope of work.

(3) Construction Contract Support Services--Section C. Construction Contract Support Services (CCSS) are negotiated as an option to the government available for a period of time following the final design submittal. The services available include (1) shop drawing review and office

consultation and (2) as-built drawing preparation. Due to their nature these services are only required in conjunction with actual design effort, and not for engineering services such as Step Two special project documentation. None of the projects reviewed contained any costs in this category.

D. PROJECT COST COMPUTATION

As Navy Industrial Fund commands, PWCs generally perform work for customer commands on a cost reimbursable basis, that is, the customer pays the PWC for any services performed. In the case of most engineering services (including Step Two preparation), however, PWCs do not charge most customers for the work performed. For this type of work, PWCs are provided with appropriated funds through the NAVFAC chain of command. These funds are known as 'mission management' funds, and are used to provide facilities engineering, planning, and inspection services and other engineering support to customers. NAVFAC INSTRUCTION 7040.4C [Ref. 10] provides guidance concerning charging of these services to customers of PWCs. In general, O&M,N funded Navy activities are not charged, while all other customers are.

Thus, from the point of view of most of a PWC's customers, the preparation of Step Twos is a free service provided by the PWC. Despite the fact that most customer commands are not charged for the engineering services provided by Code 101, a rate is established each year for the work performed by

Code 101. This rate is used for charging the Code 101 time that is cost-reimbursable for customers and for charging against the available mission management funds, and provides the basis for cost figures used in this study.

The rates established by a PWC to charge its customers are designed to reflect as closely as possible the actual operating cost to the government of providing the service. Rates are established on an annual basis, and remain in effect for the full fiscal year, to provide stability in the budgeting process of customer commands. The goal of the PWC is to perform financially on a break-even basis, with 'revenues' from appropriated funds and customer charges equalling the expenses incurred by the PWC in the course of its operations. This is a difficult task in practice, as rates must be estimated eighteen months prior to and established seven to nine months prior to the start of the fiscal year in which they take effect. This is required so that customer commands and their major claimants may prepare budget submissions.

The rates established by PWCs for charging their customers consist of four main elements. These are direct labor, labor acceleration, shop overhead, and general and administrative overhead. Separate rates are established for each of the various PWC work centers.

The first element of the rate, the direct labor, is determined by taking an average direct labor cost for a work center's productive personnel. The hourly direct salaries of all of the Code 101 productive personnel are added together and divided by the number of such personnel. The resulting figure forms the first part of the work center rate.

The second element of the rate, labor acceleration, is designed to account and charge for the value of fringe benefits received by government employees. Such items as paid leave, Social Security taxes, and retirement are determined, added together, and applied on a percentage basis to the direct labor cost. This figure for labor acceleration is then added to the direct labor amount previously calculated. The percentage used in calculating labor acceleration is determined locally by each NIF activity, and in FY 84 was 30.8 percent at PWC SFB and 31.0 percent at PWC SDIEGO.

The third element of the rate, shop overhead, is designed to cover the costs associated with the work center overhead. As such, it covers the costs of support personnel salaries, office or shop material and supplies, maintenance and repairs to the facilities used, and depreciation on capital equipment. These costs are added together, divided by the estimated number of productive labor hours to be worked by the work center, and this hourly figure is added to the two elements previously calculated.

The final element of the rate, general and administrative overhead, is designed to cover the PWC expenses that must be distributed over all of the work centers. Costs covered include the PWC Comptroller, Management Office, Civilian Personnel Office, and the Administrative Service Office. These costs are added together, divided by the estimated number of productive hours to be worked by all of the PWC work centers, and this hourly figure is added to the rate.

The stabilized rates that result from the above process account for most, but not all, of the expense to the government of operating the PWC. There are two items of expense that are not funded through the NIF rates that are expenses to the government. These costs are those of military personnel at the PWC and most of the cost of Civil Service retirement.

Military personnel costs do not make up a large percentage of the cost of operating a PWC. Generally, a PWC, depending upon its size, will have between 10 and 15 CEC officers and one to five Navy enlisted personnel assigned. These numbers compare to at least 1000 civilian personnel. Thus the cost of the military personnel, when spread over the total number of annual productive hours, is very small, and for the purpose of this research will be estimated as a one percent addition to the stabilized customer rates. More specific figures were not readily available from PWC SFB and PWC SDIEGO and would not materially affect the results of the cost comparison.

While a portion of the Civil Service retirement cost is recovered by the NIF activity through the stabilized customer rates, most of the cost is not funded through the NIF. This cost is established at 13.4 percent of the direct labor cost by NAVCOMPT INSTRUCTION 7600.27. [Ref. 11: p. 8] This percentage has been applied to the direct labor segment of the stabilized rate, and added to the rate for use in the cost comparison.

Since all of the PWC jobs used in this research were accomplished during FY 84, the stabilized rates for that year were used in this study. Those rates, plus the adjustments for military personnel and retirement, are shown below:

	PWC SFB Code 101	PWC SDIEGO Code 101
Direct labor	14.20	15.44
Labor Acceleration	4.37	4.79
Shop Overhead	10.32	7.48
G&A Overhead	2.13	1.99
	-----	-----
Stabilized Rate	31.02	29.70
Military Personnel	0.31	0.30
Retirement	1.90	2.07
	-----	-----
Total Cost Rate	33.23	32.07

The cost of the A&E contracts used in the preparation of Step Twos was relatively simple to determine. The total fee paid by the government to the A&E firm was the figure used as the total cost to the government. Thus to determine the total cost of a Step Two it was necessary to add the contract cost to the in-house contract support cost, as determined by multiplying the number of in-house hours times the hourly rate established above. For jobs done in-house, only the number of hours used multiplied times the hourly rate was required to determine the cost of the Step Two.

III. METHODOLOGY

A. GENERAL

The purpose of this thesis research is to investigate the costs associated with the preparation of Special Project Step Two submissions, and to compare the cost of in-house preparation versus A&E contract preparation. To accomplish this, data on Step Two preparation jobs was obtained through research conducted at the Navy Public Works Center, San Francisco Bay (PWC SFB) during August 1984, and at the Navy Public Works Center, San Diego (PWC SDIEGO) during October 1984. Information was obtained on 80 Step Two preparation jobs performed by the two PWCs during FY 84.

Jobs selected for research were limited to those jobs completed by the PWCs in FY 84. This was for two reasons. At PWC SFB historical data on in-house manhours expended was available only for FY 84 jobs. At PWC SDIEGO information was available for jobs completed prior to FY 84, but insufficient time was available to gather the necessary data for years other than FY 84.

The jobs selected for research represent approximately one fourth of the Step Two output of PWC SDIEGO and one third of the Step Two output of PWC SFB for FY 84. The jobs selected were those for which all the data required for each job was available. The original intent was to take a random sample of the jobs completed during the year, to avoid any bias in the selection process. However, the total number of jobs for which complete data was available was rather small, so the random sample plan was dropped. Due to the predominance of contracting out at both PWCs during FY 84 more data on contract jobs was available than on in-house jobs. The number of jobs used in the study are:

	A&E	In-House
PWC SFB	24	13
PWC SDIEGO	31	12
	---	-----
TOTAL	55	25

Several reasons accounted for the inability to use all of the Step Two preparation jobs completed during the year. The most frequent problem was the inability to locate Step Two preparation job files at the Facility Engineering Division. The missing files were either misfiled, lost, or in use. Time did not allow for a thorough search to be made for missing files. In most of the other cases some needed piece of information was unavailable even if the file was available.

B. DATA COLLECTION

The purpose of the data collection effort was to extract that information on completed Step Two preparation jobs that would enable a valid cost comparison to be conducted. Information on the costs incurred in the preparation of each Step Two was collected. In addition, descriptive characteristics of each Step Two were collected.

The data collection effort began with the Step Two job files at Code 101. Each file contained a copy of the Step Two that had been completed. From the Step Two file the following information was obtained:

1. The estimated construction cost (ECC) of the Special Project itself.

2. The number of different engineering disciplines involved with the project work.

3. Whether or not prior project documentation, in the form of a Step One submission, Navy Occupational Safety and Health Control Report (OCR), or some portion of project design, was available to the preparer of the Step Two.

4. For Step Two submissions accomplished by contract, the name of the A&E firm.

The next step in the data collection process was to obtain the number of in-house manhours used on the job. This information is available on report 3P32B, "Customer Request Reference List-Engineering." A sample and description of the 3P32B report are shown as Figure 5. [Ref. 12: pp. 6-142, 143] This report is generated by the Production Management Office on a weekly basis. The information on the report is generated by Code 101 employees themselves through their time

REPORT NO. 3P32B | CUSTOMER REQUEST REFERENCE LIST-ENGINEERING | DATE 80-11-01 | PAGE 98

ASSIGNED WORK CENTER: 420

REF NO	JOB ORD	PAC	DT OPN	DT CLS	AGF	W/C	TR	EST	TRN DT	W/C	EMPLOYEE	TR	ACT HR	STOCK NMBR	PRI	ST	REC NMBR	DAY	EDD	COST
										/-----	------LABOR	------/								
A81137	1422013		790906		422	101	QC	40	790906	101	077241731	QF	8.0							123.71
									790910	101	077241731	QF	4.0							61.86
									790911	101	077241731	QF	2.0							30.93
									790912	101	077241731	QF	8.0							123.71
									790917	101	077241731	QF	8.0							123.71
									790918	101	077241731	QF	8.0							123.71
									790919	101	077241731	QF	3.0							46.39
									790925	101	077241731	QF	8.0							123.71
									791108	101	384012053	QF	4.0							69.65
									800111	101	077241731	QF	8.0							139.23
									800116	101	077241731	QF	2.0							34.81
									800117	101	077241731	QF	2.0							34.81
									800118	101	077241731	QF	2.0							34.81
									800124	101	077241731	QF	2.0							34.81
									800129	101	077241731	QF	2.0							34.81
									800130	101	077241731	QF	4.0							69.62
									800208	101	545055853	QH	4.0							69.62
									800212	101	077241731	QF	1.0							17.40
									800404	101	077241731	QF	5.0							87.02
									800903	101	349129571	QA	2.0							34.81
									800905	101	077241731	QF	4.0							69.62
									800905	101	349129571	QA	2.0							34.81
									800908	101	349129571	QA	1.0							17.40
									800911	420	077241731	QF	8.0							139.42
									800912	420	077241731	QF	2.0							34.86
									800923	420	349129571	QA	1.0							21.43
				TOTAL				40					105.0							1776.64
A81219	1812219		801001		32	420	QC	80	801030	420	559277458	QC	4.0							97.58
									801031	420	559277458	QC	6.0							146.38
				TOTAL				80					10.0							243.96
A81644	2060003		800206		270	101	QA	60	800211	101	545763837	QH	4.0							69.62
									800212	101	545763837	QH	8.0							139.23
									800213	101	545763837	QH	4.0							69.62
									800215	101	532788229	QH	4.0							69.62
									800221	101	532788229	QH	4.0							69.62
									800311	101	545763837	QH	4.0							69.62
									800314	101	545763837	QH	3.0							52.21
									800717	101	545763837	QH	4.0							69.62
									801001	101	545763837	QH	4.0							86.21
									801016	101	545763837	QH	8.0							172.42
									801029	101	545763837	QH	8.0							172.42
				TOTAL				60					55.0							1040.21
A81743	2060000		800814	801023	66	420	QP	60	800917	420	212401705	QP	8.0							171.42
									800918	420	212401705	QP	6.0							128.57
									800919	420	212401705	QP	6.0							128.57
									800922	420	212401705	QP	6.0							128.57
									801001	420	212401705	QP	6.0							146.38
									801002	420	212401705	QP	6.0							146.38
									801003	420	569337767	QP	1.0							24.40
									801015	420	212401705	QP	2.0							48.79
				TOTAL				60					41.0							923.08
A81945	1132595		800922		41	101	QA	0												
				TOTAL				0												
A82027	6401867		800722		103	420	QE	160	800828	420	077241731	QF	3.0							81.78
									800923	420	457746555	QF	1.0							22.64
									800923	420	556361155	QF	1.0							27.62
									800924	420	077241731	QF	8.0							218.02
									801009	420	077241731	QF	8.0							240.20
									801016	420	077241731	QF	2.0							60.05
									801016	420	511320645	QC	1.0							29.45
									801017	420	077241731	QF	2.0							60.05
									801021	420	077241731	QF	4.0							120.10
									801023	420	077241731	QF	8.0							240.20
									801027	101	327364910	QH	8.0							207.26
				TOTAL				160					46.0							1306.98

FIGURE 6-40
REPORT NO. 3P32B, CUSTOMER REQUEST
REFERENCE LIST -- ENGINEERING

FIGURE 5

FIGURE 5 (continued)

6. Report No. 3P32B, Customer Request Reference List - Engineering (Figure 6-40), Report No. 3P32C, Customer Request Reference List - Estimating (Figure 6-41), and Report No. 3P32D, Customer Request Reference List - Planning (Figure 6-42). The following data appears on reports numbered 3P32B, 3P32C, 3P32D.

a.	REF NO	ABC Reference Number.
b.	JOB ORD	Job Order Number.
c.	FAC	Facility Number.
d.	DT OPN	Date opened.
e.	DT CLS	Date closed. If blank, then the ABC Reference Number is still open.
f.	AGE	The number of days an ABC Reference Number has been open or the number of days between the open and close dates.
g.	W/C	Estimated Work Center.
h.	TR	Trade Code.
i.	EST	Estimated hours.
j.	TRN DT	Transaction date for labor (the muster date).
k.	W/C	Performing Work Center.
l.	LABOR	
	(1) EMPLOYEE	The employee numbers of workers who worked on the ABC Reference Number.
	(2) TR	Trade Code of worker who worked on the ABC Reference Number.
	(3) ACT HR	Actual hours which the employees worked on the ABC Reference Number.
m.	COST	The dollar cost of each labor transaction for the ABC Reference Number.

cards. On a daily basis each employee records on his time card how much time he spent on the various jobs he worked on that day. The hourly figures thus generated show up on the 3P32B report, as well as the cost of these hours, based on the stabilized rates of Code 101. The 3P32B report is designed to list all of the time spent on a job by each employee (designated by Social Security number). In this manner it was hoped to be able to identify the skills required on each job as well as the manhours. However, in many cases engineers are required to handle work not in their specialty (a civil engineer might have to prepare a predominately electrical engineering Step Two) so it was impossible to determine the number of disciplines involved in a project solely from the 3P32B report.

The accuracy and reliability of the data collected from the 3P32B was questioned during the data collection effort. A few jobs were found that were closed out, or completed, with only two or three hours charged to them. Code 101 personnel explained [Refs. 6 and 8] that sometimes errors are made or circumstances exist that compromise the accuracy of the report. For example, PWC SDIEGO experienced a shortage of mission management funds in the last two months of FY 84 so no hours could be charged to the types of jobs that use mission management funds. Work done on projects was charged to other cost codes. Thus it was necessary to discard some jobs from this study that did not appear to have had manhours charged correctly to them. Despite this effort to use only jobs which appear to have had accurately charged hours, it is probable that some inaccuracy exists in the data.

The information on the negotiated fees arranged with A&E firms for the performance of work by contract was obtained from the contract files maintained by PWC Code 30A2 at PWC SFB and by Code 101 at PWC SDIEGO. The data available was broken down as specified by the A&E itemization fee sheet that is required to be prepared both by the government and the A&E for purposes of negotiation. That is, the number of total manhours utilized was divided into professional, subprofessional, and typist. However, since the same information was not available for the in-house prepared Step Twos, the only information used in the cost comparison was the total number of manhours and the total cost.

C. DATA ANALYSIS

Once the data was collected the data analysis phase of the research began. In this phase the cost information and descriptive factors of the Step Twos themselves were tabulated and standard statistical techniques were used for the purpose of determining significant relationships. The data from PWC SFB and PWC SDIEGO were analyzed separately.

The basic goal of this research was to compare the costs to the government of contracting out versus performing in-house, the work of preparing Step Two Special Project submissions. In so doing, it was necessary to ensure that the comparison was valid and not subject to bias. For example, it is possible that only the more difficult jobs are contracted out, while the more simple Step Twos are prepared in-house. If this were the case then simply looking at the average costs would be an unfair comparison. To combat this problem, the descriptive factors of the jobs were collected.

The first descriptive factor chosen was the estimated construction cost (ECC) of the Special Project itself. This characteristic was chosen to determine if larger jobs, as defined by their cost, would require more time to document via a Step Two. The ECC value was taken from the Step Two cost estimate, and was adjusted to 1984 dollars if the Step Two estimate was for a different fiscal year.

The second descriptive factor chosen was the number of engineering disciplines involved in the project. As with the ECC, as disciplines are added it is possible that the project becomes that much more difficult to describe and estimate. Possible disciplines were architectural, structural, mechanical, electrical, and civil.

The third factor chosen was the availability of prior project documentation, in the form of a Step One submission, OCR, or some portion of project design. This was only a binary variable; yes if prior documentation was found in the project file and no if none was found. No difference was attributed to projects for which more than one type of documentation was available. This factor was chosen to observe if the existence of prior documentation would assist the Step Two preparer in his work and thus reduce the Step Two preparation time required.

The three factors were chosen for the potential impact they would have on the cost of a Step Two, as well as for simplicity in using them. A secondary goal of this research was to develop a predictive model for Step Two preparation time and cost, so ease of use of the factors was desirable. The ECC used in this study is not available prior to Step Two preparation, so for estimating use prior to Step Two preparation, at least a rough cost estimate would be required from some other source.

The primary statistical tool used in the analysis of the data gathered from the two PWCs was regression analysis. Regression analysis is used in an attempt to predict or estimate the value of an unknown dependent variable on the basis of the known value of one or more independent variables. In the case of the Step Two project preparation data, the dependent variable used was the cost of the preparation work. The three independent variables were the ECC of the Special Project, the number of disciplines involved, and whether or not prior project documentation was available.

Regression analysis normally is unable to predict without error the value of the dependent variable in question. There are factors other than those chosen as independent variables that may cause variations in the dependent variable. Thus the goal of regression analysis is to provide the most accurate average relationship between the dependent variable and the independent variables. Any difference between the actual value of the dependent variable and the predicted value from the regression equation is regarded as an error and may be treated as a random deviation.

In assessing the quality or validity of a regression equation it is necessary to use a measure of the goodness of fit between the actual and predicted data points. The standard error of the estimate (SEE) is the standard deviation of the dependent variable. The measure is based on the difference between the observed value of the dependent variable and the predicted value provided by the regression equation. In the best possible case the SEE would be zero, indicating a perfect relationship between the dependent and independent variables.

Another measure of the goodness of fit or reliability of the regression equation as a predictive tool is the coefficient of determination, or r^2. Possible values of r^2 range from 0 to 1, with a value of 1 indicating a perfect fit and a value of 0 indicating that there is no relation between the independent and dependent variables. The coefficient of determination may be expressed in percentage terms. For example if $r^2=.49$ it means that 49 percent of the variation in the dependent variable can be explained by the change in the independent variables. This also means that 51 percent of the variation in the dependent variable can not be explained by the regression model.

A third test of the regression equation is known as the t-test, which is used to determine if a coefficient from the equation is significantly different from zero. The test statistic is developed by comparing the coefficient to its own standard deviation. The higher the t-value the more unlikely it is that the coefficient is merely a random deviation from zero. In other words a high t-value indicates that the independent variable is important in explaining the value of the dependent variable. Generally, t-values of higher than two indicate significance.

One critical assumption for the use of regression analysis is that there is a linear relationship between the dependent and independent variables. The output equation of a regression analysis is in linear form, so if a curvilinear relationship exists the regression equation will suffer from high error terms. To help alleviate this problem it is often necessary to transform the raw data to more closely approximate a straight line relationship and thus obtain a better fitting regression equation. This allows the development of regression equations if the original variables are not linearly related, but the transformed variables are linearly related.

For this study data transformation was used to develop the most accurate regression equation possible given the data available. Since it was not possible to know in advance which transformation would be the best, the dependent and independent variables were each transformed in five commonly used ways. For each variable the square root, square, inverse, logarithm, and natural logarithm were used in addition to the original data point. Then step-wise regression was used to determine which combination of dependent and independent variable forms would best describe the relationship.

Step-wise regression is a method of variable selection that employs a series of r^2 tests to check on the significance of independent variables added to the regression function. In addition the significance of variables already in the model is reexamined once new variables have been added. If they are not significant they are deleted from the regression function. Once all of the variables have been considered the most significant regression equation possible from the variables available is provided.

In addition to regression analysis, use was made of averages, standard deviations, and confidence intervals in analyzing the data. A confidence interval is an estimate that covers a range of values distributed on both sides, plus and minus, of a mean or average. With a predetermined level of confidence the interval can be constructed based on an average plus or minus the standard deviation. For the purposes of this analysis a confidence level of 95 percent was used. Accordingly, with the sample size, average, and standard deviation, a confidence interval can be constructed such that 95 percent of the population values for a given computation will fall within the range of values covered by that interval. Confidence intervals are also used to test the hypothesis that the mean value of two samples are the same.

The statistical work performed in this study was accomplished using the MINITAB program available on the IBM computer at the Naval Postgraduate School.

D. RESULTS

The data for the two PWCs was analyzed separately rather than on a combined basis. This was done to provide a comparison between the two organizations and to highlight any unusual data or results that might be obscured in a combination analysis.

1. PWC SFB

Data was gathered on 24 Step Twos prepared by A&E firms and 13 Step Twos prepared by in-house personnel at PWC SFB during FY 84. This represents approximately one third of the total number of Step Twos prepared during the year.

The first step in the data analysis was to determine the characteristics of the Step Twos that were done by A&E firms as compared to the Step Twos that were done by in-house personnel for the A&E jobs.

Number of jobs sampled	24
Average Special Project ECC	$228,847
Standard Deviation of ECC	$221,431
95 Percent Confidence Interval for the Average ECC	$135,323 to $322,372

A normal distribution of ECCs was assumed in these calculations, and those that follow. The confidence interval obtained can be interpreted to mean that if 100 samples of this size were taken, the true mean would lie in the computed confidence interval of 95 of the samples. Confidence intervals are a function of the sample standard deviation and sample size, growing larger as standard deviation increases and sample size decreases. For the in-house jobs:

Number of jobs sampled	13
Average Special Project ECC	$198,759
Standard Deviation of ECC	$130,899
95 Percent Confidence Interval for the Average ECC	$119,637 to 277,881

Thus the ECCs of the Special Project preparation jobs done by contract are about 15 percent larger, on the average, than the ECCs of the jobs done in-house. The test of the hypothesis that the averages are equal indicated that the confidence interval for the difference in the averages ranges from -$87,757 to $147,934. Since zero is within this range it is not possible to reject the hypothesis that the averages of the two groups are equal. Another indicator of this result is the fact that the two confidence intervals of the ECCs overlap each other. This means that the actual averages may be equal, so it is not possible to reject the hypothesis that they are equal.

Also calculated were the average number of disciplines involved in each project preparation:

	A&E jobs	In-house jobs
Average Number of Disciplines	1.625	1.769
Standard Deviation	0.770	0.599
95 Percent Confidence Interval for Average Number of Disciplines	1.30 to 1.95	1.41 to 2.13

As with the ECC calculation, there is a difference in the indicated average but it is not possible to reject the hypothesis that they are equal.

As a final computation related to the characteristics of the jobs, the percentage of jobs for which prior documentation was available was calculated:

	A&E jobs	In-house jobs
Prior documentation jobs/total jobs	14/24	8/13
Percentage	58	62

This difference is also not significant. Overall, the sample data indicates that there is some small degree of difference between the types of jobs that are contracted and those that are done in-house, in the three characteristics chosen for study. The predictive model to be developed, based upon the regression analysis conducted, will enable these differences to be taken into account when comparing the costs of the two methods of work performance.

The next set of calculations conducted were concerned with the average costs of the Step Two preparation jobs. This portion of the analysis does not consider the differences in the characteristics of the types of jobs done by each method. For A&E jobs, separate calculations were made of the A&E contract portion of the work and the in-house administration portion of the work. These two subtotals were then totalled to arrive at the total cost. For the jobs done in-house only one figure, the cost of in-house work, was required:

	A&E jobs	In-house jobs
Average A&E Contract Cost	$2786	
Standard Deviation	$650	
95 Percent Confidence Interval for Average A&E Contract Cost	$2511 to $3061	
Average In-house Hours	44.7	57.3
Average In-house Cost	$1486	$1904
Standard Deviation	$913	$827

95 Percent Confidence Interval for Average In-House Cost	$1100 to 1872	$1404 to 2404
Average Total Cost for Job	$4272	$1904
Standard Deviation	$1054	$827
95 Percent Confidence Interval for Total Cost	$3827 to 4717	$1404 to 2404

This result presents the key figures for the cost comparison of the A&E contracting out of jobs versus performing the work in-house. There is a very significant difference in the average total cost between the two methods, as indicated by the fact that the confidence intervals fail to overlap by a wide margin. Another significant result is that the average A&E contract cost alone exceeds the cost of doing the work in-house. Even with no in-house contract administration costs A&E contracting appears to be more expensive than doing the work in-house.

The in-house cost of administering A&E contracts is obviously a large proportion of the total job cost when Special Project preparation work is contracted out. This proportion was quantified and an attempt was made to determine if a particular size of job would be most cost effective to contract out. The calculation made compared in-house cost to A&E cost for each job. The result for PWC SFB was that on the average in-house costs equalled 57.5 percent of the A&E cost. This figure differs slightly from the 53.3 percent indicated above, $1486 divided by $2786, due to the relative size differential between jobs.

The percentages obtained by this calculation were then divided into two groups, one for those jobs whose ECC was greater than the sample median and one for those jobs whose ECC was less than the sample median. The average percentage of in-house cost to A&E cost for the low ECC group was 56.3 percent, while the percentage for the high ECC group was 58.8 percent. This difference is relatively insignificant, indicating that while the total cost of in-house effort rises with job size, the percentage of in-house cost required to support A&E effort is unaffected by job size.

The final area of analysis consisted of the regression analysis of the cost data. The primary function of this portion of the study was to ensure that any differences in the types of jobs done by each method of work accomplishment were taken into account in the cost comparison. The first part of the analysis involved determining the most appropriate regression equation to predict job cost behavior. For A&E jobs separate equations were used for A&E cost and in-house cost, then added together to predict a job's total cost. For in-house jobs only in-house hours were predicted, then multiplied by the PWC SFB hourly cost rate of $33.23 to determine job cost. The hourly rate is made up of wages, fringe benefits, and overhead as was detailed at the end of Chapter II.

The purpose of the regression portion of the analysis was to obtain the regression equation that best described the relationship of job cost to the independent variables.

As it turned out for all of the samples looked at, the best equation used only one of the independent variables or variable forms, and discarded the rest as they did not improve the accuracy of the regression equation. Because the purpose of this study was to develop the most accurate regression equation, equations using multiple independent variables were not used. Each of the three independent variables had the effect on job cost that would be intuitively expected. That is, those jobs with larger ECCs, a greater number of disciplines involved, and no prior documentation did cost more than jobs with the opposite characteristics.

The data transformation was useful, as all but one of the most accurate regression equations obtained used transformed states of the variables rather than the original raw data. The r^2 values obtained ranged from 28 to 55 percent, as compared to values of r^2 ranging from only 2 to 43 percent for the same equations using the untransformed data. Thus the predictive ability of the regressions was greatly enhanced through the use of data transformation.

It was found that different equations were the most accurate for different sets of data. Four of the six equations obtained used the Special Project ECC as the independent variable, one used the number of disciplines, and one used the existence of prior documentation. Even among the equations using ECC as the independent variable, different transformations were used to provide the most accurate equation. Each different equation was used, rather than developing one equation for all of the data sets. This was done to provide the most accurate predictive equation possible given the data collected.

For the PWC SFB A&E jobs the equation that best served to describe the A&E cost function was:

$(\text{A\&E cost})^2 = 7{,}268{,}691 + 0.000009046\ (\text{ECC})^2$

$r^2 = 28.5$ percent

t-ratio of $(\text{ECC})^2$ coefficient = 2.96

SEE = 3,000,080

In this case the stepwise regression program chose these two variables from among the various transformations formed from the raw data. The r^2 value is relatively low, indicating that only 28.5 percent of the variation in the A&E cost can be explained by a change in the Special Project ECC. Nevertheless, A&E cost for preparing Step Twos may be expected to rise as the Special Project ECC rises. This is in keeping with what may be intuitively expected; larger Special Projects take longer to document than smaller ones. In using the equation to predict cost it is of course necessary to transform the dependent variable back to its original form, by taking the square root of the equation value.

For the PWC SFB A&E jobs the equation that best described the in-house manhours used was:

(1 / in-house manhours used) = 0.017826 + 0.0201 (Prior Documentation)

(1 / in-house manhours used) = the reciprocal of in-house manhours

R^2 = 55.8 percent

t-ratio = 5.27

SEE = 0.009235

This result again uses only one independent variable in predicting the value of the dependent variable, however, it is a different variable than was used in the A&E cost equation. This indicates that for this set of sample data the existence of prior documentation reduces the amount of in-house time required to be spent on A&E jobs. Furthermore, this variable is the best predictor of manhours required among the three available.

For PWC SFB in-house jobs the regression equation that best described the manhours used was:

(1 / in-house manhours used) = 0.014456 + 815.7 (1 / ECC)

(1 / ECC) = the reciprocal of the ECC

r^2 = 34.9 percent

t-ratio = 2.43

SEE = 0.009244

As with the A&E cost on A&E jobs equation this equation uses the Special Project ECC as the independent variable. However, in this case the inverse of the variables was used rather than the square. This equation makes economic sense; as ECC grows larger the number of in-house manhours required for the Step Two preparation increases.

Once the most appropriate equation was established for each category of cost, it was possible to use the equations to predict Step Two preparation costs if a Special Project's characteristics were known. The actual costs of the 24 A&E jobs was compared to the predicted costs of doing the same jobs in-house. Similarly, the actual costs of the 13 in-house jobs were compared to the predicted costs of doing the same jobs by A&E contract. By doing the comparison in this manner it is possible to take into account the differences in the characteristics of the Special Projects themselves.

The results of this calculation were as follows:

	Total	Avg per job
Actual Cost of 13 In-house Jobs	$24,757	$1904
Predicted Total Cost of Same 13 Jobs if Done by A&E Contract	$52,533	$4041
Actual Cost of 24 A&E Jobs	$102,531	$4272
Predicted Cost of Same 24 Jobs if Done In-house	$38,234	$1593

These results are generally in line with what would be expected from the prior calculations, with the exception of the predicted cost of the A&E jobs if done in-house. The average value of $1593 is about 16 percent less than the average cost of the actual in-house jobs, despite the fact that the average ECC of the actual A&E jobs is higher than the average ECC of the actual in-house jobs. Given the positive relationship between ECC and in-house cost in the best regression equation, the predicted average cost should have been higher, not lower than the actual average cost. However, the predictive equation is such that low ECC values have a much greater effect on the predicted cost than do high ECC values. An ECC of only $1,000 leads to an in-house cost prediction of $40 while an infinite ECC value leads to a prediction of only $2299. The actual average ECC of jobs done by A&E contract was $228,847; using this value results in a predicted in-house cost of $1844 per job or $44,256 for the 24 jobs.

As a further test of the regression equation it was used to predict the cost of the 13 jobs whose costs were known. The result was a prediction of $21,380, or $1644 per job, versus actual costs of $24,757, or $1904 per job. The difference of 14 percent is similar to that obtained above. The same test was applied to the A&E predictive equation set and the predicted cost of $99,164 was quite close to the actual cost of $102,531 experienced for the 24 jobs.

2. PWC SDIEGO

Data was gathered on 31 Step Twos prepared by A&E firms and 12 Step Twos prepared by in-house personnel at PWC SDIEGO during FY 1984. This total represents approximately one third of the total number of Step Twos prepared during the year. The same calculations that were made on the PWC SFB data were made on this data.

For the PWC SDIEGO A&E jobs:

Number of jobs sampled	31
Average Special Project ECC	$190,729
Standard Deviation of ECC	$244,535
95 Percent Confidence Interval	$101,012 to 280,446

For the in-house jobs:

Number of jobs sampled	12
Average Special Project ECC	$168,615
Standard Deviation	$114,862
95 Percent Confidence Interval	$95,616 to 241,614

The ECCs of Special Projects done by contract are about 13 percent larger than the ECCs of jobs done in-house. This is similar to the 15 percent differential at PWC SFB, and similarly, the hypothesis that the averages are equal can not be rejected.

Also calculated were the average number of disciplines involved in each project preparation

	A&E Jobs	In-house Jobs
Average Number of Disciplines	1.61	1.50
Standard Deviation	0.80	0.67
95 Percent Confidence Interval	1.32 to 1.91	1.07 to 1.93

The percentage of jobs for which prior documentation was available was calculated:

	A&E Jobs	In-house Jobs
Prior documentation jobs/total jobs	6/31	2/12
Percentage	19	17

As with the PWC SFB jobs there was no significant differences in the characteristics of jobs done by contract as compared to jobs done in-house. The percentage of prior documentation jobs was much lower at PWC SDIEGO, reflecting the small amount of Step Ones that are done there. As Step Ones are the primary form of prior documentation available, the lack of Step Ones at PWC SDIEGO resulted in the small percentage of jobs with prior documentation.

The average job cost information on the PWC SDIEGO job is as follows:

	A&E Jobs	In-house Jobs
Average A&E contract cost	\$2853	
Standard Deviation	\$1547	
95 Percent Confidence Interval for Average A&E Contract Cost	\$2286 to 3421	
Average in-house hours	42.0	52.5
Average in-house cost	\$1346	\$1684
Standard Deviation	\$578	\$938
95 Percent Confidence Interval for Average In-House Cost	\$1134 to 1558	\$1087 to 2280

Average total cost for job	\$4199	\$1684
Standard Deviation	\$1567	\$938
95 Percent Confidence Interval for Total Cost	\$3624 to 4774	\$1087 to 2280

As with the results from PWC SFB there is a wide difference in cost between the two methods of work accomplishment. The confidence intervals are not close to each other. Of interest here also is the similarity of all of the data to what was experienced at PWC SFB.

The calculation of in-house cost to A&E cost for A&E jobs was made next. On the average in-house costs at PWC SDIEGO were 61.4 percent of the A&E cost. The average percentage for the low ECC group was 52.9 percent while the percentage for the high ECC group was 70.0 percent. This finding was surprising, as a normal expectation would be to see the percentage of in-house support grow smaller as the job grew larger. The result here was the opposite, indicating that proportionately more in-house effort is required for larger jobs. This finding differs from PWC SFB, where there was no difference in the percentage based on job size.

The regression analysis came next. For the PWC SDIEGO A&E jobs the equation that best served to describe the cost function was:

A&E cost = 1198.6 + 1026.0 (Number of Disciplines Involved)

r^2 = 28.4 percent

t-ratio = 3.39

SEE = 1332

One of the variables not used in the PWC SFB equations, the number of disciplines, was used in this equation. A&E cost is positively related to the number of disciplines, although the r^2 is only 28.4 percent.

For the PWC SDIEGO A&E jobs the equation that best described the in-house manhours used was:

$$(\text{in-house manhours})^2 = 1725.6 + (3.72 \times 10^{-09})(\text{ECC})^2$$

r^2 = 45.6

t-ratio = 4.93

SEE = 1419

The t-ratio is quite high in this case, despite the fact that the coefficient is a very small number. The standard deviation of the coefficient is only 7.5×10^{-10}.

For the PWC SDIEGO in-house jobs the regression equation that best described the manhours used was:

$$(1 / \text{in-house manhours used}) = 0.018561 + 550.9 (1 / \text{ECC})$$

r^2 = 43.1

t-ratio = 2.75

SEE = 0.01231

This case was the only one in which the equation used the same variables, in the same form, at both PWCs. All three variables were used at one time or another for a particular equation, but ECC was the variable used the most, in 4 of the 6 regression equations. In no case did the addition of a second variable lead to a better regression equation.

The results of the calculations leading to the predicted costs are as follows:

	Total	Avg Per Job
Actual cost of 12 in-house jobs	\$20,204	\$1684
Predicted total cost of same 12 jobs if done by A&E contract	\$49,502	\$4125
Actual cost of 31 A&E jobs	\$130,179	\$4199
Predicted cost of same 31 jobs if done in-house	\$40,828	\$1317

The same problem appears here as appeared in the predictive equation for in-house job manhours for PWC SFB. The equation underestimates the number of manhours, and therefor the cost, required because below average ECC jobs have more of an influence than above average ECC jobs. This result is not surprising because the predictive equation was the same for both PWCs. For the A&E job average ECC of \$190,729 the predicted in-house cost is \$1495 per job, or \$46,350 for the 31 jobs.

The regression equations were further tested against the actual known costs. For the in-house jobs the equation predicted a cost of \$16,351, or \$1363 per job, versus actual costs of \$20,204, or \$1684 per job. For the A&E jobs the predictive equations did much better, predicting a total cost of $132,766, or $4283 per job, versus actual costs of $130,179, or $4199 per job.

E. OBSERVATIONS

The cost data from the two PWCs was compared in two slightly different ways. The first means was using a simple average, the second means was regression analysis to account for any differences in the types of jobs done by each method. Either way the significance of the results is quite clear. The cost of having a Step Two Special Project submission prepared by A&E contract is very much greater than having the submission prepared by in-house personnel.

In comparing just the A&E contract portion of the total A&E contract job cost to the total in-house preparation cost the question arises as to the cause of the cost difference. A calculation of the average hourly fee paid to the A&E firms in this study by the two PWCs revealed that PWC SFB paid $48.52 per hour and PWC SDIEGO paid 43.52 per hour These figures are the result of dividing the total A&E fee by the number of hours negotiated in Section A of the fee. Thus they are not directly comparable to an hour of PWC time since the A&E cost per hour includes cost, but no hours, for field investigation. This item is covered in the PWC hourly rate. To even out the comparison of hourly rates approximately a 10 percent reduction in the A&E hourly rate would be required.

This adjustment in the A&E hourly rates leaves A&E cost in the $40-44 per hour range, as compared to the $32 and $33 rates for the PWCs. Thus A&E firms would have to be able to do Step Twos in roughly 75 percent of the time required by PWC personnel to be cost competitive. Based on the calculations of the previous section this is clearly not occurring. The average contract fee paid to an A&E firm for a Step Two for both of the PWCs was very close to $2800 meaning that about 70 hours of total A&E time are involved. This compares to a 57 hour average at PWC SFB and a 53 hour average at PWC SDIEGO. This indicates that the cost advantage of preparing Step Twos in-house is made up partly of lower costs per hour and partly of lower hours required for the work.

Another finding of the data analysis work was that the equations developed to predict time and cost required for a Step Two were poor. The r^2 values of the equations ranged from 28 to 55 percent, too low to achieve highly reliable predictive ability. Another undesirable characteristic is that the equations use a transformed state of the data, making their field use more difficult. Finally, while statistically it may be the most valid predictor, it is difficult to envision a supervisor estimating time required on a job simply by whether or not a Step One or other prior documentation exists. Such a yes/no criteria leads to only two possible cost values and is unusable in a realistic situation.

Obviously there are factors other than the three characteristics of Special Projects tested in this study that impact upon the time and cost required to prepare a Step Two. Discussion with Code 101 personnel at both PWCs [Refs. 6 and 8] revealed three major factors that were not included here and that probably affect Step Two preparation time.

The first factor is the behavior of the customer command as related to the preparation process. If the customer is cooperative and has a good idea in advance of what is desired in the project, time required should be reduced. On the other hand, if the customer is difficult to work with and changes its mind on the project scope quite often the time required to finish the Step Two is likely to increase. A&E firms may request additional payment if the changes are significant in relation to what was negotiated for, although this is rare. Generally, the EIC in-house time is increased when changes occur, as the EIC works with the customer to avoid incurring additional A&E charges.

Secondly, the availability of record drawings of the affected buildings or areas of the customers base can have an effect on job time. If drawings and other information of a technical nature are readily available the engineers job is greatly simplified, while the lack of such information is a major hindrance and will add to the time required to finish the Step Two. The availability of such technical information is known to an A&E firm prior to the A&E fee negotiation.

Finally, the experience and skill of both the EIC and the A&E firm working on Step Twos is a factor. Those with a great deal of experience should tend to take less time to prepare a Step Two, as a learning curve effect should be realized. Those lacking experience must become familiar with the requirements for a Step Two, as well as become familiar with the military installations in the area and the PWC itself. Although this learning curve effect was not covered in this study, it would be possible to compare preparation costs as a function of experience to quantify this factor.

One item disregarded in this data analysis section of the study is the question of the quality of the output. There exists at present no convenient way to measure the quality of a Step Two submission. Possible methods might include comparing the final project cost with the Step Two estimate, or calculating a major claimant rejection rate. According to personnel at both PWCs the rework required on Step Twos due to dissatisfied customers is almost nonexistent. Comparing the project estimate with the final project cost would be a useful measure of Step Two quality. However, any design or construction contract change orders would have to be taken into account for a valid comparison. Lacking such a measure of quality, in this study, the assumption was made that since all Step Twos must be reviewed by Code 101 and Code 100, they are of equal, acceptable quality when finished by PWC.

Chapter 4 will discuss the implications of the results presented in this chapter as related to those persons involved with Special Project Step Twos, and will consider what alternatives, if any, are available and desirable to pursue.

IV. DISCUSSION

A. GENERAL

The results of the data analysis process carried out in Chapter III have many implications for those in management positions related to the Special Project program. This chapter will discuss some of the ramifications of the findings and potential alternatives available.

The first topic to be addressed is the role of the Step Two submission in the Special Project process. The Step Two performs a specific function in the process, and due to the high cost of Step Twos, it is important that Step Twos properly serve the function for which they are intended. As major claimants are the end users of Special Project submissions, it is important that major claimants are able to efficiently use them. Alternatives to the present two step Special Project submission process are discussed.

The second topic to be discussed is the contracting out decision. PWC managers have the alternative of having work done by in-house PWC personnel or by A&E contract. Cost is only one of the factors that enter into the decision. Among other factors entering into the decision are the workload and abilities of in-house personnel. The cost efficient use of resources requires that managers develop a system by which the managers can be sure that work completion requirements are being met at the least possible total cost.

The third topic discussed is the A&E contracting process. Alternatives to the current methods used are discussed and the advantages and disadvantages of each are presented. The goal of the alternatives discussion is to develop contracting methods that will result in less expensive A&E fees, and require less in-house contract administrative and support effort.

The fourth section of the chapter discusses PWC customer considerations and how the customer's needs might better be met. Specifically, the possible effect of a pricing system for PWC engineering work on customers is addressed. The chapter concludes with a summary of the areas of discussion.

B. SPECIAL PROJECT PROCESS

As was demonstrated in Chapter III, the preparation of a Special Project Step Two submission is an expensive process. Doing the work with in-house personnel serves as one way of keeping the cost down, but even when prepared in-house, a completed Step Two costs at least $1500. In addition to a Step Two, all Special Projects require the submission of a Step One, and after funding the actual project design work must be accomplished. Thus much planning work is required before any actual Special Project repair or construction work can be accomplished.

Despite the significant role that NAVFAC plays in the facilities planning and Special Project process, the ultimate responsibility for an activity's actions rest in the activity's chain of command rather than with NAVFAC. Therefore, major claimants must have the opportunity to review what the shore activities under their cognizance are planning regarding the shore activity's facilities.

The responsibility of major claimants for an activity's facilities has led to the Special Project submission and approval process that was described in Chapter II. An interview was conducted with the Commander in Chief, U.S. Pacific Fleet (CINCPACFLT) Special Project coordinator [Ref. 13] for the purpose of determining the viewpoint of a large major claimant regarding the Special Project program.

In the interview it was indicated that the two step process for Special Project submission is necessary to enable a major claimant to properly manage the program. The Step One submission lets the major claimant know that a facilities deficiency of Special Project magnitude exists and that funds will be required to correct the deficiency. However, the Step One is often not sufficiently detailed or accurately cost estimated to allow the major claimant to ascertain the desirability of funding the project. In addition the Step Ones are not sufficiently detailed to enable a proper comparison between competing projects from several different shore activities. Finally, the Step One is not detailed adequately to serve as the basis for the award of a contract for actual project design. The project design contract is

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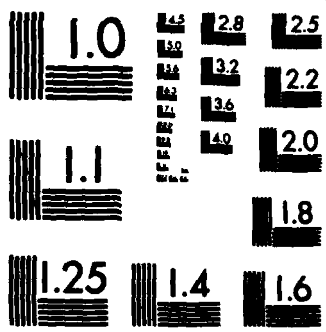

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generally awarded by the geographic EFD using funds provided by the major claimant. The Step Two is the major claimant's official statement to the EFD of the project scope.

The Step Two does meet the requirement for sufficiency in the areas discussed above, and thus meets the needs of the major claimant for reviewing projects for funding. The CINCPACFLT Special Project coordinator indicated that trying to save money by combining the two steps into one would, in his opinion, be inefficient. Not all Special Project requests are funded, and to spend the money for a Step Two quality submission would be wasteful were a project not to be funded. Also, the decision to develop the Step Two quality submission would rest with the activity rather than with the major claimant, who is in a better position than the activity to know when projects will be funded. In addition, many projects are funded several years after their initial submission, and an outdated submission has to be updated. On the other hand, it was indicated that CINCPACFLT does let activities know if a project will be placed very high on the activity's Summary List, or if the project is of an urgent nature, that they may skip the Step One submission, as funding is virtually assured.

Another possibility to streamline the process is to do away with the requirement for the Step Two submission and to authorize a partial project design instead. The "35 percent design" is commonly recognized in the A&E profession as a partial completion point at which to halt the design and let the customer review the work for necessary changes. This partial design could be used in place of a Step Two. It could of course then contribute to the remainder of the design. The Special Project coordinator indicated that in his opinion, this would be impractical for two reasons. First of all, the Step One is an inadequate document upon which to award a design contract, and secondly, the 35 percent design would be too cumbersome for the major claimant to review. Thus the Step Two is looked upon as detailed enough for the major claimant's purposes but not so detailed as to preclude efficient review.

The two step Special Project process as it exists effectively serves the purpose of the end users of the process, the shore activity major claimants. The Step Two submission is a necessary and useful part of the process that begins with the identification of a shore facility deficiency and ends with a completed project.

C. IN-HOUSE VERSUS A&E WORK ACCOMPLISHMENT

The results of the research conducted in this study indicate quite conclusively that Step Two Special Project submission can be prepared by PWC in-house personnel at a great cost saving to the government as compared to having the same work done by an A&E firm. The cost differential is quite large, and can have a significant impact on the ability of Code 101 to perform its work on a limited amount of mission management funding. The estimated cost difference between in-house and A&E contracting work performance is over $2000 per job. For the 143 Step Two requests done by PWC SDIEGO in FY 84 the annual savings from doing all of the Step Twos in-house, rather than by contract, would be over $286,000. For PWC SFB the annual savings would be over $200,000 based upon an estimated output of 100 Step Twos a year. These amounts are significant when compared to the entire Code 101 mission management budget for FY 84 of $1.1 million at PWC SFB and $1.6 million at PWC SDIEGO.

Despite the cost differential, a great deal of the facilities engineering work at both PWC SFB and PWC SDIEGO is done by A&E contract. At PWC SFB less than one third of all Code 101 work requests in FY 84 work were done by in-house personnel, while at PWC SDIEGO only 22 percent of the Code 101 work requests in FY 84 were done by in-house personnel. The seemingly simple and obvious solution to the problem of expensive A&E prepared Step Twos is to have them all done with in-house personnel. While attractive from a cost standpoint there are practical problems with this solution. The most significant of these problems is the lack of enough in-house engineers to keep up with the Code 101 workload. Under current conditions, using A&E firms quite extensively, the turnaround time for Code 101 work requests is between six and twelve months on the average. This is often unsatisfactory for the customer command facing the need to get the Step Two to its major claimant as quickly as possible to enable a project to get started.

The hiring of more in-house personnel would therefore appear to be a possible solution to the problem of increasing work output at the least cost. Costs would be reduced, as compared to doing the work by contract, and the additional manpower would enable more in-house manhours to be devoted to work accomplishment. This in turn would increase work output and reduce work request turnaround time. PWCs have no civilian personnel ceiling point constraints, so they can hire as many people as necessary to keep up with the workload. The problem with this solution is that the PWCs are unable to attract enough qualified engineers to work for them at current Civil Service pay scales. The average engineer at PWC SDIEGO was paid $15.44 per hour in FY 84. Due to differences in seniority levels the average engineer at PWC SFB was paid $14.20 per hour. In the A&E jobs studied, the average engineer's salary, obtained from the negotiation records, was $18 per hour. Both PWC SFB and PWC SDIEGO are continuously advertising open positions for Code 101 engineers, but the rate of new hires is barely able to keep up with the attrition rate. The raising of the in-house salaries to a competitive level would increase the cost of in-house work performance, but the cost of in-house work would probably still be much below the cost of having the work done by contract.

Another problem for Code 101 in hiring new engineers is that many engineers are not interested in performing the facilities planning type of work that is done in Code 101. They would rather be working as actual project design engineers than simply doing the planning work. Since Code 101 engineering is restricted to facilities planning and engineering studies, there is no project design work for the in-house engineers to be involved with.

Unfortunately, the two causes of the hiring and retention problem; uncompetitive pay and the lack of project design work, are beyond the direct control of Code 101 to solve. Civil Service job grade levels are set by a centralized civilian personnel office. The working level engineers in Code 101 are classified as GS-11s and the only way to significantly raise the average engineers pay would be to raise the grade level. Civil Service General Schedule (GS) employees salaries are set on a nationwide basis, with no adjustment for high cost of living areas such as San Francisco and San Diego. Both PWC SFB and PWC SDIEGO have requested their local personnel offices to raise the grade levels of their engineers to make them competitive in the local market, but the requests have been denied by the personnel offices because job grade levels are set by nationwide job content standards and not by local conditions.

The problem of job content for the Code 101 engineers could be addressed by the PWCs as an organization. Project design work is done at PWCs in Code 420, the Production Engineering Division. A job rotation plan could be implemented in which engineers might rotate back and forth between Code 101 and Code 420 every few months. This sort of plan would enable the Code 101 engineers to get the project design experience that they desire without the engineers having to permanently leave Code 101. Both new employee hiring and retention could be positively affected by such a job rotation plan.

Despite the fact that an A&E contractor does all of the productive work when Step Twos are contracted out, the number of manhours saved by A&E contracting is not as great as might be expected. As was demonstrated in Chapter III, between 40 and 45 in-house manhours can be expected to be spent in the A&E contracting process, while on the average only about 55 manhours is required to do the whole job by in-house personnel. Although an EIC can have several A&E jobs in progress at one time, each A&E job still takes up 75 percent as many manhours as the EIC would in doing the work himself. Therefore a reasonable expectation is that total A&E contracting as compared to total in-house work performance leads to approximately a one third increase in the output of Step Twos by Code 101. An alternative way of looking at the situation, and perhaps a more relevant way from the point of view of customer commands, is that the use of A&E contracting would tend to shorten the time required for a

PWC to complete a work request and return the Step Two to the customer.

The time requirements of customer commands for the completion of Step Twos varies depending upon the particular circumstances of a project. While there is no time deadline for major claimants to release Special Project execution plans, the CINCPACFLT Special Project coordinator indicated that CINCPACFLT wanted to get the plan out as far in advance of the execution year as possible to avoid confusion and problems in the execution year. For the FY 86 Special Project program CINCPACFLT published the execution plan in July 1984, 15 months prior to the start of the execution year. The promulgation of the execution plan at this time means that there are 27 months until the end of the execution year, which is the deadline for award of the actual project construction contract. Within those 27 months the Step Two must be completed and submitted, the detailed project design must be completed, and the construction contract must be advertised and awarded. Naturally, activities would rather have the construction contract awarded at the beginning of the execution year rather than at the end, so it is the activity's interest to submit a Step Two to the major claimant as soon as possible. In the event of an urgent project that the major claimant is willing to fund immediately, an activity has an even greater need to submit the Step Two rapidly. On the other hand, activities may request a Step

Two before the execution plan is published. This is done if the activity believes that a project will be on the execution plan and the activity wants to stay ahead of the game by requesting PWC to prepare the Step Two early.

Because of the variety of situations that can occur in the Special Project process it is impossible to state a normal, or average time in which PWC customer activities require the completion of their Step Twos. However, for each specific Step Two activities do know when the Step Two is required to meet a funding deadline. Activities are able, on their work requests, to let the PWC know when they must have a Step Two completed to meet a funding deadline. In general, however, activities desire the completion of their Step Twos as quickly as possible. The penalty for slow work on Step Twos can be the delay or cancellation of Special Project funding. Both PWC SFB and PWC SDIEGO have received complaints from customer commands regarding the length of time it takes for engineering work to be completed. While it is impossible to state a definitive average requirement for work turnaround time, Code 101 managers must be aware of the needs of the customer commands regarding the completion of specific work requests, and so structure the mix of in-house and A&E work as to meet these needs.

The two PWC Code 101s visited in this study did not make use of any overall definitive criteria for deciding when to contract out work performance. PWC SFB did stop contracting out Step Twos a few months ago, based on the Facility Planning Officers non-quantified observation that Step Two contracting is not cost effective. [Ref. 7] Insufficient time has passed since the institution of this policy to determine the effects on work backlog and overall Code 101 costs. PWC SDIEGO has also instituted a similar policy; each EIC must be doing at least one of his assigned jobs by himself rather than by contract. This policy is designed to keep the EIC skilled in actual work performance, as well as, secondarily, to save some money over contracting out all work requests. [Ref. 14] The lack of an overall criterion for the A&E contracting decision applied to Step Twos as well as the other types of work done by Code 101. The other types of work done by Code 101 (engineering investigations, MILCON project documentation, facility planning, and service contract plans and specifications) are also able to be done by A&E contract as well a by in-house personnel. The establishment of a system for work backlog management would be useful in minimizing the amount of work that must be contracted to meet customer schedule requirements.

In developing such a system data similar to that collected for this study would need to be collected for all of the types of work done by Code 101. This data could then be analyzed to determine the type of job or work request that requires the least amount of in-house time per hour of A&E time worked. It was seen in Chapter III that for Step

Twos about 40 to 45 manhours are used in the A&E contract process to avoid having to use 55 manhours to do the work in-house. In the case of Step Twos the payoff from contracting is not great; on the average only 15 manhours per work request. One of the other types of Code 101 work, such as engineering investigations or MILCON project preparation, may be more efficient to contract out from the point of view of in-house manhours saved per manhour contracted. Once the data has been analyzed, only those types of work that are the most cost efficient to contract out should be done by contract. The types of work that are the least efficient to contract out should be done in-house if at all possible.

Another necessary aspect of a work management system would be the comparison of existing backlogs for different types of work with the customer command's requirements for a given work request's completion. If, by using in-house personnel, the work can be completed in a satisfactory time frame, the work should be done in-house for economy reasons. If, on the other hand, customers are dissatisfied with the time required for work completion then more of the work might have to be contracted to get the job turnaround time down to acceptable levels. This is a difficult problem to solve, given the variability in the required time for each work request, but close contact with the customer commands would serve to help the system work.

One requirement of such a work management system or the development of criteria for the A&E contracting decision is the availability of accurate manhour data. It appears that Code 101 manhour reporting on the 3P32B report is prone to error. Code 101 branch heads should carefully check the future accuracy of manhour data before management decisions in any great detail are made.

D. A&E CONTRACTING BY CODE 101

Despite any successes achieved in the aforementioned work management strategy, under current personnel conditions Code 101 will continue to have to contract out a great deal of work. Even though a one third increase in output may seem to be a small gain from the expensive process of contracting out, it is still very helpful in meeting the requirements of customer commands. If PWCs are able to eventually increase the Code 101 in-house staffing to be able to do the majority of work in-house the need to hire A&E firms for certain jobs will still exist. Some jobs will require expertise that is not available among the in-house staff. Also, fully staffing Code 101 to meet peak customer demand might lead to seasonal periods with insufficient work for the in-house personnel. Seasonality of work request demand was not covered in this study, but Code 101 personnel at both PWCs indicated that they felt a certain degree of seasonal demand variance was experienced. In times of peak demand A&E conracting could be used in the management system to keep the work backload manageable until demand slowed again.

Since it is probable that A&E contracting will, at least to some extent, always be required in the work of Code 101, it is important to ensure that the contracting is done in the most cost effective manner. There are alternatives to the current method of contracting, using different types of contracts and procedures. Even using existing contract procedures it may still be possible to reduce the cost of contracting significantly.

The results of Chapter III indicated that the average cost of the A&E contract for Step Two preparation is greater than the average cost of preparing a Step Two with in-house personnel. When the cost of in-house effort is added to the contract cost the difference between in-house and A&E work performance is even greater. The higher cost of the A&E contracts can be attributed to both a greater number of manhours and to much higher hourly rates than for in-house work. As described in Chapter II, the A&E procurement process involves negotiated rates and fees rather than competitive bidding with contract award to the lowest bidder. One alternative available to the government might be to use competitive bidding in the A&E contract process as a way of trying to reduce A&E costs.

The lack of fee consideration in the selection of A&E firms has been highly controversial and the subject of much debate over the years. The General Accounting Office (GAO) issued a report to Congress in 1967 stating that it felt the

Department of Defense (DOD), by not including price as a factor in the A&E selection process, was not in compliance with existing law. GAO recommended that compliance with competitive negotiation requirements could be accomplished by a two part procurement process. The first part would be the solicitation of unpriced technical proposals, while the second part would require those submitting acceptable proposals to submit a price on their technical proposals. Award would be made to the firm submitting the most advantageous proposal, after considering not only price, but also the technical merits of the proposals.

DOD replied to the GAO report by saying that the technical and professional measures in use were the only types of competition appropriate for the type of service purchased from A&E firms. DOD also said that there was nothing in the legislative history indicating an intent on the part of Congress to require price comparisons for A&E services. Since this initial exchange, the argument over price competition has continued to the present, but as it stands now, price is not a factor in the A&E selection process.

The major arguments in favor of instituting price competition in the selection of A&E firms are as follows:

1. The A&E industry can operate a price fixing system for contracts.

2. Favoritism and corruption can be exercised with the current selection process.

3. There is no incentive for offering lower prices on the part of the A&E industry.

4. Price comparisons of different proposals is precluded, resulting in higher cost to the government.

The major arguments in favor of the existing procedure are:

1. The qualifications of the selected A&E are perceived to be more important than the price.

2. The consideration of fee would otherwise dominate the negotiation discussions.

3. A&Es will be forced to cut corners on the design effort to remain competitive, and as a result the quality of design, innovation, and creativity will be reduced. Such actions will lead to greater overall facility construction and operating costs.

4. The detailed development of fee proposals by all interested A&E firms will increase overall design costs and delay project completions.

The Navy and NAVFAC fully support the present A&E selection and contract award method and are opposed to the introduction of price competition into the process. As might be expected, the A&E profession has supported the current system as well. Prior to 1972 the industry, in its Code of Ethics, forbade its members from submitting prices with their submittals. An anti-trust complaint by the Justice Department resulted in the removal of the offending clause from the Code but the industry's position is clear.

The preparation of Special Project Step Twos is a service purchased by the government from the A&E industry and as a result, price competition does not take place in the A&E selection process. However, Step Twos are a much less complex and less technical product than actual project design work. While the arguments against price competition are valid for project design contracts they appear less valid in the case of Step Two preparation.

Step Two submissions consist of a brief project description and cost estimate. The preparer must in many cases devise a solution to a problem or determine the most appropriate solution to meet a facility's needs. The development of a solution or the comparison of many alternative solutions is not always required, as a Step One or other preliminary work on the project may be available to the preparer. Many Step Twos cover projects of a relatively routine nature, such as street repairs, the painting of buildings, or roof repairs or replacement. These projects do not require a great deal of creativity or originality in developing a solution to the problem. Other projects, such as those involving environmental health or energy conservation, are of a more complex nature and do require originality, creativity, and the ability to compare many alternative methods of solving the problem.

For those projects that require high levels of analysis by the Step Two preparer the existing contractor selection method may be appropriate. It is important that all potential solutions to a problem be explored and that the most cost effective is chosen. An A&E facing a low bid fixed price fee may be tempted to cut corners on a Step Two and choose an inappropriate solution as a result. While the project design process might correct the problem and develop a better solution this is not assured, nor expected. In addition, any changes required in the project in the design phase may delay the work, and any cost changes disrupt major claimant funding plans.

On the other hand, the competitive pricing of A&E work on those Step Twos of a routine nature would be likely to provide a product meeting the needs of the government at a reduced cost. Step Twos could be packaged together as a group and a single contract could be awarded, thus reducing contract administrative costs for each Step Two. The two step contracting method might be appropriate for this procurement. All qualified firms, as selected by the Pre-Selection Board, could be invited to provide cost data for the work in question and the best combination of technical competency and price would be selected. As an alternative, all of the firms which have open-end contracts and are qualified to do the particular Step Two could be invited to submit prices for the work. Once the selection decision is made, an amendment to the open end contract would be made. It is difficult to predict the outcome of such a procedure on cost as well as Step Two quality, but a small scale test of the method could be made with little difficulty.

Another possible alternative for reducing the cost of A&E work on Step Twos is for PWCs to contract out only the cost estimate portion of the work. Under current procedures the A&E firm does both the project description write up and the cost estimate. The suggested alternative would leave the write up of the project to the in-house engineer and would reduce the amount of the A&E fee required. Utilizing this alternative would not even require the use of A&E firms exclusively, as only a cost estimate would be contracted for Opening the work up to an expanded group of suppliers should also help to reduce prices. This alternative might also work well for those jobs that are of a routine nature not requiring detailed analysis of alternative solutions. The PWC in-house engineers are more familiar than A&E firm engineers with the Navy's facilities and requirements and the sort of project description that is necessary for a Step Two. Using the in-house engineers for project write up, while contracting out the cost estiamte, would make the best use of the in-house talent, while still contracting out a significant portion of the work. As with the first alternative a test of this process could be carried out with little difficulty, enabling management to compare the cost with the current method of contracting out the entire Step Two.

A third potential cost reducing alternative for A&E contracting is to have only one or two A&E firms do all of the Step Twos that must be contracted. Using this alternative would take advantage of any learning curve or experience effects that may be available in Step Two preparation. Research for this study did not include gathering data that could be used to determine if such a learning curve exists, but engineers at both PWC SFB and PWC SDIEGO [Refs. 6 and 8] indicated that in general it was their professional opinion that A&E firms doing Step Twos for the first time required more in-house support than firms that had done many Step Twos already. By having A&E firms specialize in this manner it should be possible to reduce the in-house time spent working with A&Es inexperienced in preparing Step Twos. It may also be possible to negotiate more favorable fees from a firm that knows it can expect a certain amount of essentially similar work fromthe Navy over the course of a year. The NAVFAC policy of spreading the work equitably among all qualified A&E firms could still be adhered to; only the types of jobs that each firm received would be altered. Another alternative related to this one might be to award A&E contracts based upon the customer activity. In this manner an A&E firm sould become familiar with one activity and its facilities, and possibly become more efficient in that activity's project preparation.

This learning curve effect also applies to the work that is done in-house by PWC personnel. Specialization to some degree should reduce the amount of time required for Step Two preparation as individuals become more experienced. There are, however, limits to this practice, as certain persons or firms other than those normally used may be more appropriate for specific jobs. Code 101 could even try hiring cost estimators rather than only engineers, thus allowing the engineers to develop the solutions and the cost estimators to cost them out. The specialization alternative would be relatively simple to implement, and the resulting cost data analyzed to determine the effectiveness of the process.

It was shown in Chapter III that at PWC SFB the in-house contract administration and support cost as a percentage of A&E cost was relatively constant, regardless of the size of the A&E contract. At PWC SDIEGO the in-house cost as a percentage of the A&E cost actually was higher for larger jobs than for smaller jobs. These findings indicate that the in-house work cost required to support A&E contracting is not a fixed cost, but the dollar amount varies with the size of the job. This finding is somewhat surprising considering that the mechanics of contract award are essentially the same in any case. Larger jobs should require somewhat more time for the review process and the government estimate preparation, but overall the percentage of in-house cost should fall as job size and A&E cost increases. The fact that this is not occurring at PWC SFB, and the opposite is happening at PWC SDIEGO, indicates that perhaps excessive government time is spent on larger jobs in supporting the effort of A&E firms. Care must be taken to ensure that excessive time is not spent supporting an A&E firm that has been contracted for and paid to do the work by itself.

In summary, under the current A&E selection and contracting procedures the contracting out of Step Two submissions is very inefficient compared with work accomplishment by in-house personnel. The amount of effort contracted for, averaging only $2800 per Step Two in FY 84, is simply too small to make contracting cost effective when the level of in-house effort required is so large. The alternatives described above might serve to help the situation to some extent by reducing the cost of either the A&E contract or the in-house effort.

E. CUSTOMER CONSIDERATIONS

Both PWC SFB and PWC SDIEGO are aware that some of their customer commands are preparing some or all of their own Step Two submissions using their own personnel. [Refs. 7 and 14] This capability varies with the type of staff personnel assigned at each customer activity. Normally activities serviced by a PWC will not be manned to perform their own facilities planning work, so any work done on Step Twos comes at the expense of an activity's other work responsibilities. The main reason given to the PWCs by activities that do their own Step Twos is that the activities can have the Step Twos sooner if they do them themselves. A secondary reason is that the activity has more control over the content of the Step Two than if the Step Two is done by the PWC.

The fact that customer commands commit their own resources to the preparation of Step Twos is significant, considering that the customer has the option of getting free Step Twos from PWC. If Step Twos were to be charged for by PWCs it is likely that even more Step Twos would be prepared by the customer commands without using the PWC. This occurrence would be likely to improve the overall efficiency of Step Two preparations, as activities would decide to do their own Step Twos whenever they could do so for less than the PWC price. The reduction of demand for Step Twos from the PWCs would then enable the PWCs to reduce turnaround time for customer requests, and reduce reliance on the expensive alternative of A&E contracting. Thus a certain equilibrium situation could be reached with Step Twos in the aggregate being prepared in the most cost effective manner.

While the institution of a price system for Step Two preparation and other engineering services would lead to the most economically correct solution, of solutions available within the existing system, to the cost problem, there are other factors to be considered. Many activities, facing personnel ceilings, are unable to, or would be unable to do such work themselves. Facing tight budgets, they may choose to do their own work rather than to pay PWC, but do the work poorly, leading to problems with projects. Or they might defer or cancel necessary facility planning work to conserve funds, which would lead to even greater facilities problems in the future. These sorts of problems are not inevitable. PWC customer activities are responsible for, and pay for, other aspects of facilities maintenance and could do the same for facility planning work. Were a charging system to be implemented it would be necessary to monitor closely the effect it would have on both cost and the quality of facility planning.

F. SUMMARY

The present method of contracting out Step Two submissions is not cost effective as compared to doing the work with in-house personnel. Presently, the most cost effective solution to the problem of high priced A&E prepared Step Twos would be to do all Step Twos with in-house personnel only. This solution is difficult to implement, as the in-house work force is not large enough to do all the work in-house without increasing the backlog of work and the length of time customers must wait for work completion. The hiring of additional in-house personnel is desirable, but difficult due to uncompetitive pay scales.

As the cost differential between in-house and A&E work accomplishment has a significant effect on the Code 101 budget, Code 101 should develop a work management plan to minimize the need for using A&E contractors. Such a system would ensure that contracting out is done only when absolutely necessary, and that only the types of jobs that are the most cost effective to contract out are contracted out.

Faced with the need to contract out a great deal of work, despite the high cost of contracting, PWCs should consider how to more efficiently use contracting. Such alternatives as fixed price contracting, contracting out only the cost estimate portion of the work, and having certain A&Es specialize in certain types of work or certain customer activities might not make A&E contracting competitive with in-house work accomplishment but should reduce the contracting costs. Tests of these alternatives should be conducted and the results analyzed to determine if they are cost effective.

Chapter V will give a brief summary of the background discussion, objectives of the research, and the results.

V. CONCLUSION

A. RESULTS

The primary purpose of this thesis was to investigate the costs associated with the preparation of Special Project documentation, and to compare the cost of in-house preparation versus A&E contract preparation. This was done through collecting and analyzing data from the Navy Public Works Centers San Francisco Bay and San Diego. The result was a conclusive finding that a large cost differential exists between the two methods of work accomplishment. The cost of contract work accomplishment, including the negotiated A&E fee and in-house contract administrative and support costs, can be expected to be at least twice as high as the cost of in-house work accomplishment. This finding was fully supported from data collected from both of the PWCs.

A secondary purpose of the research was to try to develop a Step Two preparation cost prediction model. Such a model was required in the data analysis portion of the research to compare A&E versus in-house costs on jobs having different key characteristics. The key job characteristics used were the estimated construction cost of the project, the number of engineering disciplines involved in the project, and whether or not prior job documentation was available. The results of this phase of the research indicated that only a relatively small portion of the variation in Step Two preparation cost could be attributed to the three characteristics chosen for study. This finding means that there are other factors than those studied that affect Step Two preparation cost. Probable significant factors are the quality of cooperation from the customer command and the ready availability of record drawings and other technical data. Due to their nature, these two factors would be quite difficult to quantify in a study of completed jobs.

As a result of the poor predictive ability of the equations developed from the job data the cost prediction models are of limited use for management personnel. However, the results do provide some information as to the factors affecting Step Two preparation cost.

The final objective of the research was to attempt to determine if the size of the job had an effect on the cost effectiveness of contracting out. Inconclusive results were obtained in this area; at PWC SFB in-house cost as a percentage of A&E cost was constant for both large and small jobs, while at PWC SDIEGO the percentage was higher for larger jobs. This finding is of some practical help in determining whether large or small Step Twos are more efficient to contract out. It does indicate that the in-house cost involved with contracting work is not a fixed cost, but varies with the magnitude of the job being done.

B. CONCLUSIONS AND RECOMMENDATIONS

The major significant finding of the study is that the cost of contracting out Step Twos is much greater than the cost of doing them in-house. This condition exists for two reasons. First, the cost of A&E contracts for Step Two preparation is greater than the cost of doing the work in-house. Secondly, in addition to the A&E contract cost, a great amount of in-house time is required for contract administration and support effort. The obvious recommendation is that as many Step Twos as possible should be done in-house. There are problems with implementing this solution, as civilian engineering personnel are difficult to hire and retain. With an insufficient number of in-house employees the backlog of work would grow larger than it already is, resulting in increased customer dissatisfaction.

A number of alternatives to the current methods of contracting and doing the work in-house were provided and some advantages and disadvantages of each were discussed. Although contracting will likely always be a more expensive alternative to in-house work accomplishment, there are ways to reduce the cost of contracting that should be attempted. These include competitive bidding, contracting out only the cost estimate portion of the work, and having contractors specialize by type of work or by customer activity. The key to reducing the costs of the Step Two preparation function, as well as the overall cost of the facility planning function, is management awareness of the cost of the various types of work that are done in Code 101. Recommended is an analysis of all Code 101 functions that may be contracted out, for the purpose of being able to quantify the costs involved. Once the comparative costs between A&E contracting and in-house work performance are known for the different types of work, decisions can be made regarding the most effective use of resources to accomplish the Code 101 mission. A work management system could be established to ensure that only the most cost effective use is made of A&E contracting. The goal of such a system should be to meet the needs of the customer commands while minimizing the cost of work performance.

APPENDIX A

STEP TWO SUBMISSION

SPECIAL PROJECT REQUEST

STEP TWO SUBMISSION

N00228	NAVAL SUPPLY CENTER, OAKLAND, CALIFORNIA	August 1983
C20-83	REMODEL SPACES AND HEADS, BUILDING 422	

[ ] MAINT./REPAIR [X] MINOR CONSTRUCTION/ALTERATION [ ] AIR CONDITIONING [ ] EQUIPMENT INSTALLATION

Bldg. 422 is a one-story, steel-framed/metal skin building 600 ft. long x 200 ft. wide, with mezzanines. The building is used as a warehouse. It houses the NISTAR's system which is a computer-controlled storage and recovery system for the automated handling of supplies at NSC,Oakland.

200574

441-10

422

The mission of NSC, Oakland, is to provide supply and support services to fleet units and shore activities as assigned, and perform such other functions as may be assigned by Commander, Naval Supply Systems Command. This project is required to update the present facility and will prevent interruptions and delays in the flow of vital supplies and materials to defense forces.

$ 86,000	$ 86,000	$ 5,000	$ 91,000	$10,607,000

1941 [X] YES [ ] NO

[X] YES [ ] NO [ ] N.A.

Repair and upgrade existing heads and office, convert existing space to men's and women's locker rooms. Repair, replace and paint existing interior walls ceilings and floor finishes. Install new doors, walls, light fixtures, heating and ventilating system, plumbing fixtures, and fire sprinklers.

The proposed solutions were considered the best at least cost to the Government. No alternative solutions of lesser cost to the Government are available.

[X] YES [ ] NO An outside A/E firm has reviewed this project. Recommendations regarding current quantities of work and updated unit prices have been incorporated into this request.

HAS EFD DESIGN DIVISION REVIEWED SOLUTION? [ ] YES [X] NO

CAN ANOTHER FACILITY BE ECONOMICALLY ADAPTED FOR THIS FUNCTION? [ ] YES [X] NO

[ ] YES [X] NO

[ ] INADEQUATE MAINTENANCE [X] FACILITY AGE [ ] DEFICIENT CONSTR. [ ] DEFICIENT DESIGN [ ] OTHER:

[ ] YES [X] NO

HOW LONG WILL PROPOSED CORRECTIVE ACTION LAST? 20 + YEARS

a. [ ] YES b. [X] NO

a. [X] YES b. [ ] NO

a. [ ] STATION LABOR b. [X] CONTRACT

a. [ ] YES b. [X] NO

$ 4,400	$ Minimal	$ Minimal

A savings of 5.1% of estimated construction costs due to inflation is possible if project is not deferred for 1 year. | 20

a. [X] NO b. [ ] YES

Possible interruption to the operation, and possible additional costs in labor.

YEARS BEFORE SERIOUS DAMAGE OCCURS 1½

Inefficient circulation and no provision for personnel lockers may result in increased labor costs, which can cause impairment to essential operations.

a. [X] YES b. [ ] NO BY HOW MUCH? <5%

This facility is an important new link in the supply chain. Its inefficient utilization affects the whole supply system.

a. [X] MORALE b. [X] HEALTH c. [ ] PUBLIC RELATIONS d. [X] SAFETY e. [X] FIRE PROTECTION f. [ ] SECURITY g. [ ] OTHER

Morale: Remodeling will provide locker space for both men and women.
Health & Safety: New plumbing fixtures will be handicap accessible.
Fire Protection: New fire sprinklers will bring spaces up to code.

CERTIFICATION BY RESPONSIBLE OFFICER AT ACTIVITY: I am personally cognizant of the need for, the economy of, and the proposed method of accomplishment of this project and certify that the above information is correct, and that this project meets all criteria contained in OPNAVINST 11010.20 and subsequent changes thereto.

SIGNATURE	TITLE	DATE

EFD TECHNICAL VALIDATION

SIGNATURE	TITLE	DATE

ENCLOSURES

a. [X] ENGINEERING EST. (NAVFAC 11013/7) b. [X] LOCATION PLAN(S) PWC SKT. No. 0990 c. [ ] DRAWINGS d. [ ] PHOTOGRAPHS

*NOT applicable to Minor Construction, Alterations, or Equipment Installation

NAVFAC 11013/7 (1-78) Supersedes NAVDOCKS 2417 and 2417A	COST ESTIMATE	DATE PREPARED August 1983	SHEET 1 OF 8

ACTIVITY AND LOCATION
NAVAL SUPPLY CENTER
OAKLAND, CALIFORNIA

CONSTRUCTION CONTRACT NO: N/A

IDENTIFICATION NUMBER: C20-83

ESTIMATED BY: Amcotech; reviewed by Gordon H. Chong + Assoc.Inc. & M. Gallagher, EIC

CATEGORY CODE NUMBER: 441-10

PROJECT TITLE
REMODEL SPACES AND HEADS
BUILDING 422

STATUS OF DESIGN: [ ] PED [ ] 35% [ ] 100% [ ] FINAL [X] Other (Specify) Budget

JOB ORDER NUMBER: CR# 06270

ITEM DESCRIPTION	QUANTITY NUMBER	QUANTITY UNIT	MATERIAL COST UNIT COST	MATERIAL COST TOTAL	LABOR COST UNIT COST	LABOR COST TOTAL	ENGINEERING ESTIMATE UNIT COST	ENGINEERING ESTIMATE TOTAL
ARCHITECTURAL WORK								
DIVISION 2 - SITEWORK								
Section 02050 - Demolition & Removal								
-Removal of doors, windows, plaster								
ceiling, plumbing fixtures & accessories		LS				4,675.00		4,675.00
DIVISION 5 - METAL STRUCTURES & MISC.								
Section 05120 - Structural Steel	1,584	LBS	.77	1,220.00	.28	444.00	1.05	1,664.00
Section 05501 - Miscellaneous Metal								
Bolts & Angle Clips		LS				385.00		385.00
DIVISION 6 - CARPENTRY								
Section 06100 - Rough Carpentry								
-Girt, Floor joist & Ceiling joist	1.24	MBF	550.00	682.00	946.00	1,173.00	1,496.00	1,855.00
3/4" Plywood floor over floor joist	1,728	SF	.44	760.00		570.00	.77	1,330.00

S/N 0105-LF-000-1195

NAVFAC 11013/7 (1-78)
Supersedes NAVDOCKS 2417 and 2417A

COST ESTIMATE

DATE PREPARED: August 1983 | SHEET 2 OF 8

ACTIVITY AND LOCATION: NAVAL SUPPLY CENTER, OAKLAND, CALIFORNIA

CONSTRUCTION CONTRACT NO: N/A

IDENTIFICATION NUMBER: C20-83

ESTIMATED BY: Amcotech; reviewed by Gordon H. Chong + Assoc.Inc. & M. Gallagher, EIC

CATEGORY CODE NUMBER: 441-10

PROJECT TITLE: REMODEL SPACES AND HEADS BUILDING 422

STATUS OF DESIGN: [ ] PED [ ] 35% [ ] 100% [ ] FINAL [X] Other (Specify) Budget

JOB ORDER NUMBER: CR# 06270

ITEM DESCRIPTION	QUANTITY NUMBER	QUANTITY UNIT	MATERIAL COST UNIT COST	MATERIAL COST TOTAL	LABOR COST UNIT COST	LABOR COST TOTAL	ENGINEERING ESTIMATE UNIT COST	ENGINEERING ESTIMATE TOTAL
DIVISION 7 - MOISTURE PROTECTION								
Section 07250 - Sprayed Fire Protection	241	SF	5.34	1,287.00	4.62	1,113.00	9.96	2,400.00
DIVISION 8 - DOOR, WINDOWS & GLASS								
Section 08110 - Hollow Metal Door & Frames	5	EA	213.95	1,070.00	106.15	531.00	320.10	1,601.00
Section 08201 - Wood Doors & Frames	4	EA	88.00	352.00	86.24	345.00	174.24	697.00
Section 08710 - Finish Hardware								
-Locksets	10	EA	9.63	96.00	11.61	116.00	21.24	212.00
-Deadlocks	6	EA	17.88	107.00	21.18	127.00	39.06	234.00
-Pull Plates	5	EA	15.40	77.00	7.37	37.00	22.77	114.00
DIVISION 9 - FINISHES								
Section 09250 - Gypsum Wallboard								
-5/8" Panelling & Ceiling	3,768	SF	.33	1,243.00	.50	1,884.00	.83	3,127.00
Section 09310 - Ceramic Tiles	4	SF	2.64	11.00	3.85	15.40	6.49	26.00
Section 09650 - Resilient Flooring								
-1/8" Vinyl Asbestos Tiles	862	SF	.77	664.00	.44	379.00	1.21	1,043.00

S/N 0105-LF-000-1395

NAVFAC 11013/7 (1-78)

COST ESTIMATE

DATE PREPARED	August 1983
SHEET	3 of 8
ACTIVITY AND LOCATION	NAVAL SUPPLY CENTER OAKLAND, CALIFORNIA
CONSTRUCTION CONTRACT NO	N/A
IDENTIFICATION NUMBER	C20-83
PROJECT TITLE	REMODEL SPACES AND HEADS BUILDING 422
ESTIMATED BY	Amcotech; reviewed by Gordon H. Chong + Assoc. Inc. & M. Gallagher, EIC
CATEGORY CODE NUMBER	441-10
STATUS OF DESIGN	Other: Budget
JOB ORDER NUMBER	CR# 06270

ITEM DESCRIPTION	QUANTITY NUMBER	QUANTITY UNIT	MATERIAL COST UNIT COST	MATERIAL COST TOTAL	LABOR COST UNIT COST	LABOR COST TOTAL	ENGINEERING ESTIMATE UNIT COST	ENGINEERING ESTIMATE TOTAL
Section 09910 - Painting of Building								
Interior walls, Panellings & Ceiling	8,406	SF	.17	1,429.00	1.60	13,450.00	1.77	14,879.00
Metal & Wood Doors & Trim	14	EA	16.50	231.00	27.50	385.00	44.00	616.00
SUBTOTAL - ARCHITECTURAL								
DIVISION 16 - ELECTRICAL WORK								
Section 16510 - Interior Lighting								
1. Fluorescent Fixtures w/Lens (no lamps)	29	EA	82.62	2,396.00	82.62	2,396.00	165.24	4,792.00
2. Incandescent Lamp, Surface Standard	1	EA	48.03	48.00	30.98	31.00	79.01	79.00
Section 16402 - Interior Wiring								
1. Outlets, Duplex, Specs grade	31	EA	5.03	156.00	24.94	773.00	29.97	929.00
2. Boxes, Pull Box	10	EA	2.53	25.00	16.15	162.00	18.68	187.00
3. Switches	10	EA	187.00	187.00	23.20	232.00	41.90	419.00
4. Wires/Conduits	1,217	LF	.570	694.00	2.35	2,857.00	2.92	3,551.00

S/N 0105-LF-000-1135

NAVFAC 11013/7 (1-78)

COST ESTIMATE

Date prepared: August 1983 | Sheet 4 of 8

Activity and location: NAVAL SUPPLY CENTER, OAKLAND, CALIFORNIA

Construction contract no.: N/A

Identification number: C20-83

Estimated by: Amcotech; reviewed by Gordon H. Chong + Assoc. Inc. & M. Gallagher, EIC

Category code number: 441-10

Project title: REMODEL SPACES AND HEADS BUILDING 422

Status of design: [ ] PED [ ] 35% [ ] 100% [ ] Final [X] Other (Specify) Budget

Job order number: CRI 06270

Item Description	Quantity Number	Quantity Unit	Material Cost Unit Cost	Material Cost Total	Labor Cost Unit Cost	Labor Cost Total	Engineering Estimate Unit Cost	Engineering Estimate Total
5. Miscellaneous								
a. Remove old fire junction box								
and install new	1	EA	2.53	3.00	32.30	32.00	34.83	35.00
b. Remove phone box and								
unused conduits	1	EA	--	--	77.00	77.00	77.00	77.00
c. Disconnect Switch Mounting								
(locate exhaust fan on rooftop)	1	EA	5.50	6.00	22.00	22.00	28.00	28.00
6. Additional Material/Work								
a. Panelboard, 3 Ø, 208Y/ 120V								
100 MLO, 12 CKTS, Bolted	1	EA	214.21	214.00	172.11	172.00	386.32	386.00
b. CB for Panelboard								
Up to 20A, 1P, 10KAIC	5	EA	8.95	45.00	5.49	27.00	14.44	72.00
Up to 30A, 3P, 10KAIC	2	EA	40.69	81.00	16.50	33.00	57.19	114.00
SUBTOTAL - ELECTRICAL								$10,669.00

S/N 0105-LF-000-1195

NAVFAC 11013/7 (1-78) Supersedes NAVDOCKS 2417 and 2417A

COST ESTIMATE

DATE PREPARED: August 1983 | SHEET 5 OF 8

ACTIVITY AND LOCATION: NAVAL SUPPLY CENTER OAKLAND, CALIFORNIA

CONSTRUCTION CONTRACT NO: N/A

IDENTIFICATION NUMBER: C20-83

ESTIMATED BY: Amcotech; reviewed by Gordon H. Chong + Assoc. Inc. & M. Gallagher, EIC

CATEGORY CODE NUMBER: 441-10

PROJECT TITLE: REMODEL SPACES AND HEADS BUILDING 422

STATUS OF DESIGN: [ ] PED [ ] 35% [ ] 100% [ ] FINAL [X] Other (Specify) Budget

JOB ORDER NUMBER: CR# 06270

ITEM DESCRIPTION	QUANTITY NUMBER	QUANTITY UNIT	MATERIAL COST UNIT COST	MATERIAL COST TOTAL	LABOR COST UNIT COST	LABOR COST TOTAL	ENGINEERING ESTIMATE UNIT COST	ENGINEERING ESTIMATE TOTAL
MECHANICAL WORK								
Section 15820								
1. Furnace, Forced Air, Gas Fired w/flue valving & thermostat, horizontal flow 100 MBTU, stainless steel heat exchange	1	EA	605.00	605.00	253.00	253.00	858.00	858.00
2. Air Handler, 2200 CFM including Vibration Mounts	1	EA	1,882.00	1,882.00	275.00	275.00	2,157.00	2,157.00
3. Mixing Box, 2200 CFM w/Filter Frames/Dampers	1	EA	828.00	828.00	171.00	171.00	999.00	999.00
4. Damper Motor	1	EA	66.00	66.00	17.00	17.00	83.00	83.00
5. Exhaust Fan Utility Set w/Vibration Mounts 1550 CFM, 3/4"SP	1	EA	1,008.00	1,008.00	198.00	198.00	1,206.00	1,206.00
6. Volume Damper, 18 x 12	1	EA	53.00	53.00	28.00	28.00	81.00	81.00
7. Volume Damper, 16 x 12	1	EA	53.00	53.00	28.00	28.00	81.00	81.00
Section 15250								
1. Duct Insulation, 1" w/Vapor Barrier	1120	SFCA	1.12	1,254.00	1.35	1,512.00	2.47	2,766.00

S/N 0105-LF 010 1175

NAVFAC 11013/7 (1-78) Supersedes NAVDOCKS 2417 and 2417A

COST ESTIMATE

DATE PREPARED: August 198?

SHEET 6 OF 8

ACTIVITY AND LOCATION: NAVAL SUPPLY CENTER OAKLAND, CALIFORNIA

CONSTRUCTION CONTRACT NO: N/A

IDENTIFICATION NUMBER: C20-83

PROJECT TITLE: REMODEL SPACES AND HEADS BUILDING 422

ESTIMATED BY: Amcotech; reviewed by Gordon H. Chong + Assoc.Inc. & M. Gallagher, EIC

CATEGORY CODE NUMBER: 441-10

STATUS OF DESIGN: [ ] PED [ ] 35% [ ] 100% [ ] FINAL [X] Other (Specify) Budget

JOB ORDER NUMBER: CR8 06270

ITEM DESCRIPTION	QUANTITY NUMBER	QUANTITY UNIT	MATERIAL COST UNIT COST	MATERIAL COST TOTAL	LABOR COST UNIT COST	LABOR COST TOTAL	ENGINEERING ESTIMATE UNIT COST	ENGINEERING ESTIMATE TOTAL
Section 15904								
1. Mixed Air Thermostat	3	EA	139.33	418.00	25.66	77.00	165.00	495.00
2. Controls System		LS	--	110.00	--	33.00	--	143.00
3. Testing & Balancing		LS	--	--	--	165.00	--	165.00
Section 15840								
1. Ductwork, G.I. Sheets w/Supports & Acc.	1300	LB	2.22	2,886.00	2.71	3,523.00	4.93	6,409.00
2. Air Intake Louver w/Bird Screen, 30"x30"	1	EA	88.00	88.00	11.00	11.00	99.00	99.00
3. Ceiling Diffusers	7	EA	33.00	231.00	35.43	248.00	68.43	479.00
4. Return/Exhaust Registers	8	EA	31.38	251.00	31.38	251.00	62.75	502.00
5. Motorized Relief Damper	2	EA	77.00	154.00	27.50	56.00	104.50	210.00
6. Fire Damper	2	EA	85.25	170.50	85.25	170.50	170.50	341.00
7. Miscellaneous Work								
a. Removal of Misc. Piping	12	MH	--	--	16.50	199.00	16.50	199.00
b. Rerouting of Sprinkler System	30	FT	1.10	33.00	2.75	83.00	3.85	116.00

S/N 0105-LF-000-1535

NAVFAC 11013/7 (1-78) Supersedes NAVDOCKS 2417 and 2417A

COST ESTIMATE

DATE PREPARED: August 1983 | SHEET 7 OF 8

ACTIVITY AND LOCATION: NAVAL SUPPLY CENTER OAKLAND, CALIFORNIA

CONSTRUCTION CONTRACT NO: N/A

IDENTIFICATION NUMBER: C20-83

ESTIMATED BY: Amcotech; reviewed by Gordon H. Chong + Assoc.Inc. & M. Gallagher, EIC

CATEGORY CODE NUMBER: 441-10

PROJECT TITLE: REMODEL SPACES AND HEADS BUILDING 422

STATUS OF DESIGN: [ ] PED [ ] 35% [ ] 100% [ ] FINAL [X] Other (Specify) Budget

JOB ORDER NUMBER: CR# 06270

ITEM DESCRIPTION	QUANTITY NUMBER	QUANTITY UNIT	MATERIAL COST UNIT COST	MATERIAL COST TOTAL	LABOR COST UNIT COST	LABOR COST TOTAL	ENGINEERING ESTIMATE UNIT COST	ENGINEERING ESTIMATE TOTAL
Section 15401 - Plumbing								
1. Replacement of Fixtures								
(R) - Water Closet	4	EA	220.00	880.00	33.00	132.00	253.00	1,012.00
(R) - Lavatory (incl. 2 new fixtures)	8	EA	110.00	880.00	16.50	132.00	126.50	1,012.00
(R) - Urinal	2	EA	165.00	330.00	22.00	44.00	187.00	374.00
(R) - Service Sink incl. relocation,								
excavation, backfill, floor finish	1	EA	275.00	275.00	110.00	110.00	385.00	385.00
(R) - Extension of HW & CW Pipings								
to New Lavatory		LS		66.00		33.00		99.00
Section 15501 - Fire Protection								
1. Installation of Sprinkler Heads	10	EA	66.00	66.00	44.00	440.00	110.00	1,100.00
SUBTOTAL - MECHANICAL								$21,371.00
(R) indicates repair items								

S/N 0105-LF-000-1195

NAVFAC 11013/7 (1-78)
Supersedes NAVDOCKS 2417 and 2417A

COST ESTIMATE

DATE PREPARED: August 1983
SHEET 8 OF 8

ACTIVITY AND LOCATION: NAVAL SUPPLY CENTER, OAKLAND, CALIFORNIA

CONSTRUCTION CONTRACT NO.: N/A

IDENTIFICATION NUMBER: C20-83

PROJECT TITLE: REMODEL SPACES AND HEADS, BUILDING 422

ESTIMATED BY: Amcotech; reviewed by Gordon H. Chong + Assoc. Inc. & M. Gallagher, EIC

CATEGORY CODE NUMBER: 441-10

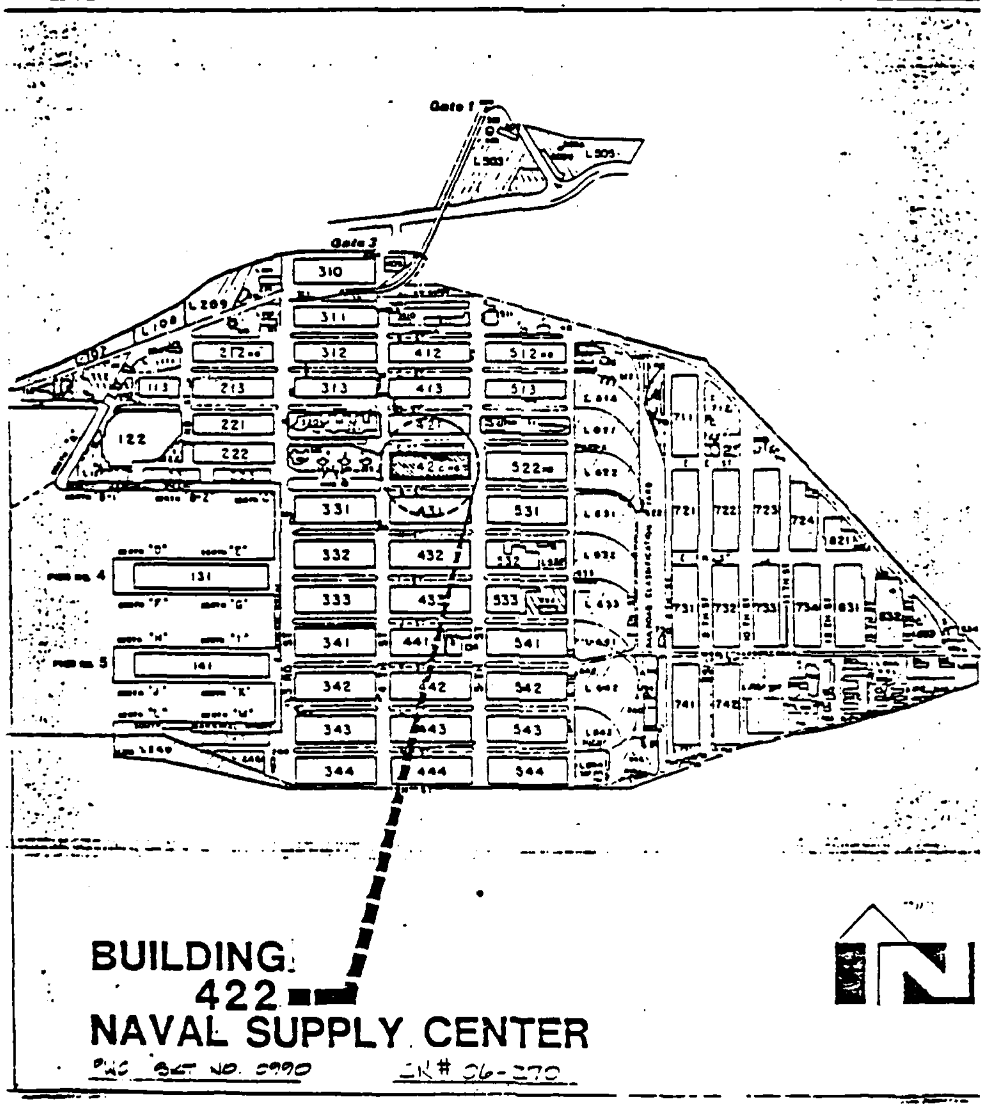
STATUS OF DESIGN: [ ] PED [ ] 35% [ ] 100% [ ] FINAL [X] Other (Specify) Budget

JOB ORDER NUMBER: CR8 06270

ITEM DESCRIPTION	QUANTITY NUMBER	QUANTITY UNIT	MATERIAL COST UNIT COST	MATERIAL COST TOTAL	LABOR COST UNIT COST	LABOR COST TOTAL	ENGINEERING ESTIMATE UNIT COST	ENGINEERING ESTIMATE TOTAL
SUMMARY OF ESTIMATE								
ARCHITECTURAL								$34,858.
ELECTRICAL								10,669.
MECHANICAL								21,371.
ESTIMATED CONSTRUCTION COST								$66,898.
CONTRACTOR'S OVERHEAD & PROFIT (25%)								16,725.
SUBTOTAL								$83,623.
CONSTRUCTION COST ESCALATED to end of FY 83 83,623 x [1 + (4/12 x .073)]								85,658.
TOTAL CONSTRUCTION COST (ROUNDED)								$86,000.
PLANNING (6%)								5,000.
TOTAL FUNDS REQUESTED								$91,000.
This cost estimate is valid thru								
FY 83. The following is included								
in the unit cost: contingency @ 10%.								
Area Cost Factor of 1.17 is also included.								

S/N 0105-LF-060-1115

LOCATION MAP



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4. Commander, Naval Facilities Engineering Command, Navy Public Works Centers; Promulgation of Functions and Tasks, NAVFAC Instruction 5450.82, 2 June 1981.

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6. Personal interview with Mr. John Bruce, Code 101, Navy Public Works Center, San Diego, California.

7. Personal interview with J.M. Rigoulot, LCDR, CEC, USN, Facility Planning Officer, Navy Public Works Center, San Francisco, California.

8. Personal interview with Mr. A. Regal, Code 101, Navy Public Works Center, San Francisco, California.

9. Commander, Naval Facilities Engineering Command, Contracting Manual, FAVFAC P-68, 1979. Technical Report.

10. Commander, Naval Facilities Engineering Command, Charging for Facilities Engineering and Facilities Inspection Services and other Engineering Support Performed by Public Works Centers (PWCs), NAVFAC Instruction 7040.4C, 2 January 1981.

11. Comptroller of the Navy, Capital Investment Program for Industrial Fund Activities, NAVCOMPT Instruction 7600.27, 4 August 1982.

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14. Personal interview with F.W. Smith, LT, CEC, USN, Facility Planning Officer, Navy Public Works Center, San Diego, California.

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