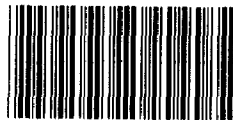




UNITED STATES GENERAL ACCOUNTING OFFICE
WASHINGTON, D.C. 20548

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RESOURCES, COMMUNITY,
AND ECONOMIC DEVELOPMENT
DIVISION



121355

MAY 11, 1983

B-211694

The Honorable John O. Marsh, Jr.
The Secretary of the Army

Dear Mr. Secretary:

Subject: Water Resource Construction Costs Could Be
Reduced if Value Engineering Were Applied to
More Designs and Applied Earlier in the
Design Process (GAO/RCED-83-127)

Since fiscal year 1965 the Army Corps of Engineers has used value engineering (VE) to reduce water resource construction costs by approximately \$565.7 million. Although these savings are noteworthy, potentially the Corps could achieve greater savings in water project construction costs by applying VE to more project designs and applying it earlier in the design process.

The Corps needs to give increased attention to its water project VE program if maximum savings are to be realized. Given current budgetary and personnel constraints, more effective use of existing resources is the best option for achieving greater VE savings.

The Corps defines VE as an organized effort directed at analyzing designs to achieve the project's authorized purposes at the lowest total cost consistent with performance, reliability, quality, maintainability, and safety.

VE may be applied to project designs (1) early in the design process--as soon as a concept or design is approved in the General Design Memorandum (GDM) or when the project's individual features are approved in the Feature Design Memorandum (FDM), (2) later in the design process as detailed plans and specifications are developed but prior to contract award, or (3) after a construction contract is awarded.

OBJECTIVE, SCOPE, AND METHODOLOGY

Our objective in this review was to evaluate the effectiveness of the Corps' in-house VE program and identify whether opportunities existed to increase VE savings on the construction of water projects. Specifically, we identified opportunities available to the Corps to increase savings by applying VE to

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more project designs and earlier in the design process. We did not attempt to validate other aspects of the program such as (1) managerial support, (2) procedures for selecting designs, (3) validity of savings claimed by the Corps, or (4) replication of cost saving ideas in subsequent designs.

Although the Corps' VE program consists of a civil works function and a military function, we limited our review to the civil works area--specifically, water resource projects--for fiscal year 1981, for which the most recent data was available at the time of our review.

We made our review at Corps headquarters in Washington, D.C., and at seven of its district offices in Mobile, Alabama; Sacramento, California; St. Paul, Minnesota; Kansas City and St. Louis, Missouri; New York, New York; and Tulsa, Oklahoma. We selected these districts for several reasons, including (1) large expenditures of funds during fiscal year 1981 for engineering and design, (2) diversity in the number of assigned staff and amount of staff time devoted to VE, and (3) geographic diversity.

At Corps headquarters we obtained and analyzed pertinent policies and regulations, appropriations for engineering and design, statistical data on the results of the VE program for water resource projects, and Engineer Inspector General reports pertaining to VE for the selected districts. In addition, we held discussions on the results of our review with the Corps' Chief Value Engineer, representatives from the Office of the Chief of Engineers, and the Deputy Assistant Secretary of the Army (Civil Works).

For the districts selected, we interviewed the district value engineers to obtain information about various alternatives for increasing the effectiveness of VE. We also obtained listings of all designs completed in sufficient detail to permit VE to be applied in fiscal year 1981. Information obtained on these designs included (1) the estimated cost of construction, (2) whether the design was reviewed for VE, (3) when in the design process the review occurred, and (4) construction cost savings identified during the review.

The St. Louis District could not identify which designs were reviewed for VE or when in the design process such reviews occurred. Consequently, we were unable to include data from the this district in our analysis. However, we did obtain comments from the district value engineers on their VE activities and alternatives for increasing VE effectiveness.

The review was performed in accordance with generally accepted government auditing standards.

INCREASED VALUE ENGINEERING
SAVINGS ARE POSSIBLE

The Corps has not realized the full potential of its VE program to reduce water resource construction costs. By reviewing more designs for value engineering and performing such reviews early in the design process, the Corps can potentially achieve greater cost reductions.

More designs should be reviewed

The Corps has no published criteria--such as project size or complexity--specifying which water resource project designs should be reviewed. However, Army Pamphlet 5-4-5 and the Office of the Chief Engineer's publication entitled "Value Engineering in Construction" state that proper selection of designs for VE review is vital to the program's success. Design selection is particularly important if maximum monetary savings are to be achieved, especially since VE resources are limited.

During fiscal year 1981 the six Corps districts we contacted had completed 147 designs in sufficient detail to permit VE to be applied. These 147 designs had an estimated construction cost of \$416 million. While 32 of these designs (22 percent) with an estimated construction cost of about \$250 million were reviewed for VE savings, the remaining 115 designs (78 percent) with an estimated construction cost of about \$166 million were not. The following table summarizes the VE efforts of the six Corps district offices.

<u>District</u>	<u>Fiscal year 1981 designs</u>					
	<u>Completed</u>		<u>Not reviewed</u>			
	<u>Number</u>	<u>Cost</u>	<u>Number</u>	<u>Percent</u>	<u>Cost</u>	<u>Percent</u>
	<u>(millions)</u>				<u>(millions)</u>	
Mobile	55	\$239.7	45	82	\$ 85.2	36
Tulsa	52	31.3	49	94	19.6	63
Kansas City	19	9.1	10	53	2.3	25
Sacramento	8	12.0	4	50	4.4	37
St. Paul	8	28.7	6	75	18.9	66
New York	5	94.9	1	20	35.1	37
Total	<u>147</u>	<u>\$415.7</u>	<u>115</u>	78	<u>\$165.5</u>	40

On the 32 designs reviewed, the Corps realized savings of about \$8.6 million. While the Corps realized savings on projects costing as little as \$71,000, about 99 percent of the savings resulted from reviews of 19 designs estimated to cost over \$1 million each to construct. However, included in the 115 designs not reviewed were 14 estimated to cost over \$1 million each and totaling about \$141 million. Two of the 14 designs were estimated to cost over \$10 million each.

VE reviews should occur early
in the design process

VE can be applied during any phase of a project's design from conception to completion as well as after the construction contract is awarded. However, according to the Society of American Value Engineers, various Corps publications, and the Corps value engineers we interviewed, the greatest VE savings can be expected when reviews occur early in the design process. This is because (1) maximum savings usually result from changes made before contract award, (2) redesign and implementation costs are lower, and (3) there is less effect on the overall project schedule.

Some difference of opinion exists, however, among the value engineers regarding what early in the design process means. Six of the value engineers questioned whether sufficient detail exists at the approved GDM stage to allow for VE reviews, but all said that at the FDM stage there is usually sufficient detail to allow for VE reviews.

Typically, when the Corps district offices reviewed designs for VE, they did so at one or more of three points--early in the design process when GDM's and/or FDM's are approved, late in the design process but before contract award, or after contract award. Our analysis showed that the Corps district offices were not generally performing VE reviews as early in the design process as possible. Of the 32 designs reviewed for VE savings, only 6 were reviewed at the most opportune time--early in the design process, when GDM's and/or FDM's were approved.

On three of the six designs reviewed early in the design process, greater savings were achieved than those designs reviewed later in the review process. The average savings achieved for these three designs was about 13 percent of the estimated construction costs as compared with about 3.5 percent on the 26 designs reviewed later in the design process. The three remaining designs reviewed early resulted in realized savings of only about 2 percent because these designs were the last

in a series of similar designs and they had already benefited from VE improvements made on the earlier designs.

Staffing resources limit VE savings

The Corps value engineers told us that limited personnel resources assigned to VE activities was the primary reason that many designs were not reviewed and others were not reviewed at the most opportune time. During fiscal year 1982 only 18 of 50 Corps value engineers nationwide were engaged in VE activities on a full-time basis. The remaining 32 spent less than 100 percent of their time on such activities. For example, in the seven districts we contacted, three of the value engineers had multiple responsibilities and the amount of time they spent on VE activities ranged from less than 5 percent to 85 percent.

The Chief Value Engineer told us that he questions whether value engineers working less than full-time on VE activities can adequately accomplish the activities necessary to maintain a quality program. He said that the value engineers' other responsibilities preclude them from spending the time needed to apply VE to a greater number of designs and schedule the designs for early review, which is essential to achieving greater savings.

District value engineers having multiple responsibilities also question their effectiveness in maintaining a quality program. For example, before October 1, 1982, the St. Louis value engineer said that he spent only about 5 percent of his time on VE activities. The remainder of his time was devoted to fulfilling his responsibilities as the Assistant Chief of the Engineering Division. He said that his multiple responsibilities did not allow him sufficient time to fully address his VE responsibilities. Since October 1982 the value engineer has devoted approximately one-half of his time to VE activities.

In another example, the St. Paul value engineer, who spends approximately one-half of his time on VE activities, said that the district could benefit if he worked full-time on VE. He said that he would be able to devote more time to conducting and monitoring VE reviews and developing VE training programs.

Similarly, the Engineer Inspector General has questioned the effectiveness of part-time value engineers. In his fiscal year 1982 report on the St. Louis District, the Inspector General explained that a full-time value engineer had been displaced and the activity had been relegated as a part-time function with the Assistant Chief of the Engineering Division.

Furthermore, the report pointed out that this individual was probably one of the busiest people in the district and that his ability to give adequate attention to VE was questionable. In addition, the report indicated that "experience has shown that in those districts with a full-time value engineer, engineering design activities were more cost effective * * *."

In response to the concerns raised by the Inspector General, the St. Louis District, beginning October 1, 1982, transferred the VE responsibilities from the Assistant Chief of the Engineering Division to another individual to increase the amount of time and effort spent on VE activities. The newly assigned value engineer now spends approximately one-half of his time on VE activities.

OPTIONS AVAILABLE FOR ACHIEVING GREATER SAVINGS

The Corps value engineers told us that achieving greater VE savings in water resource construction will not be easy given the Corps' limited personnel resources assigned to VE activities. However, the value engineers provided suggestions on how the Corps could more effectively use available resources but pointed out that Corps district management determines the level of effort to be devoted to the VE program. The suggestions were as follows:

- Reassign existing staff to conduct VE reviews.
- Increase reliance on contracting with private consulting firms for VE reviews.
- Expand the use of VE workshops by (1) encouraging Corps districts to sponsor workshops for conducting VE reviews and (2) utilizing workshops conducted by organizations other than the Corps and submitting Corps project designs to such workshops to be reviewed as case studies.
- Identify Corps districts having VE expertise and make that expertise available, when possible, to other districts needing VE assistance.

Reassigning existing staff

The Corps value engineers told us that because the VE program is understaffed the program's maximum effectiveness cannot be realized. Reviewing more designs for VE would provide the Corps opportunities to potentially achieve greater savings in

water project construction costs. While assigning additional staff to VE reviews would allow more designs to be reviewed, Corps district management must decide whether the benefits derived from assigning more staff to the VE program outweighs the benefits derived from assigning these staff to other district activities. We did not evaluate the impact of reassigning staff from other Corps activities to the VE program; however, the Chief Value Engineer told us that the Corps could double its VE savings with additional staff.

Contracting

The Corps value engineers we interviewed told us that increasing reliance on contracting with architect/engineer firms was a feasible approach to increasing VE efforts when staff limitations prevent a district from conducting VE reviews or conducting them early in the design process.

The Chief Value Engineer told us that at least one Corps district had contracted with architect/engineer firms for VE reviews on water resource projects. However, none of the districts included in our review had done so. The Corps value engineers in Mobile, New York, and Sacramento, however, told us that they had contracted for VE reviews of military designs with favorable results. Since fiscal year 1979 the Sacramento District has spent about \$118,000 on contracts for VE reviews of military designs and has realized savings of about \$3.7 million--a return of about \$31 in realized savings for every dollar spent. Similarly, the Mobile and New York Districts have realized savings of \$400,000 and \$300,000, respectively, on expenditures of \$25,000 and \$17,600. The Chief Value Engineer told us that other Corps districts had achieved similar savings on VE reviews of military designs.

VE workshops

The Office of the Chief Engineer annually sponsors workshops to train its engineers in applying VE methodology to project designs. The value engineers we interviewed said that these workshops are valuable not only for training Corps staff, but also in reviewing Corps designs that may not have otherwise been reviewed, thus increasing the potential for reducing construction costs. The Chief Value Engineer said that participants in a recent workshop reviewed five designs and identified proposed savings of about \$1.6 million.

In addition to the above workshops, Corps districts can conduct their own workshops. For example, the Mobile District

has conducted workshops when a large project is being developed and a number of designs are available. The Mobile District value engineer told us that he may use personnel from sources other than his own district, such as representatives from construction contractors, architect/engineer firms, and other Corps districts. He also said that this approach enables the district to (1) accomplish several VE reviews at one time, (2) enhance the potential for VE savings, and (3) commit minimal personnel resources. Design changes resulting from one of these workshops totaled about \$3.5 million in savings on one project.

Another variation of the workshop involves submitting Corps designs for use as case studies in workshops conducted by private organizations, such as architect/engineer firms or universities. For example, in 1982, the Sacramento District submitted Corps designs for use in a workshop conducted by a value engineering firm. The workshop team identified potential savings of about \$500,000 on this project. The only cost to the Corps associated with this VE review was approximately \$30,000 for in-house redesign work.

Interdistrict reviews

While none of the districts in our review had requested another district to review designs for VE, the value engineers we interviewed said that requesting assistance from another district was a feasible approach for getting designs reviewed that otherwise may not have been reviewed. Four of these value engineers said that since their districts had in the past successfully arranged to do design work for other districts or have had other districts do design work for them, they believed that the VE workload could at times be similarly handled.

CONCLUSIONS

Value engineering is a valid means of reducing construction costs while maintaining project quality. However, which designs are selected to be reviewed for VE savings and when they are reviewed is vital to the success of a VE program. Because many of the water project designs at the six Corps offices were not reviewed for VE savings while substantial savings were identified by the Corps on designs so reviewed, we believe that VE should be applied to more designs. Also, we believe that designs should be reviewed early in the design process to optimize the potential for savings.

The Corps needs to give increased attention to its VE program if maximum savings are to be realized. Given current budgetary and personnel constraints, more effective use of existing staff is the best alternative for achieving greater VE savings. Given the existing staff assigned to the VE program, the Corps could (1) review only those projects estimated to cost \$1 million or more to construct, (2) apply VE staff earlier in the design process (after GDM's and/or FDM's are approved), (3) reassign existing staff to do VE reviews, and (4) have districts with VE expertise review designs for other districts when workload permits. In addition, other options are available to do more reviews that have proven to be cost effective, but these options require that more resources be available for the VE effort. The options include contracting with architect/engineer firms for VE reviews and increasing the use of VE workshops.

RECOMMENDATIONS TO THE SECRETARY OF THE ARMY

Because of the potential savings that could be derived from a more comprehensive VE program, we recommend that the Secretary of the Army direct the Chief of Engineers to require that (1) only water project designs with estimated construction costs exceeding \$1 million be considered for VE review unless district management determines that resources are available to review designs of lower cost projects, or in their opinion, circumstances warrant the expenditure of resources for such reviews and (2) such reviews be done early in the design process--when GDM's and/or FDM's are approved. Also, we recommend that the Secretary direct the Chief of Engineers to provide guidance to field offices on how they can more effectively use resources to review designs for VE savings. The guidance should provide field offices alternatives which, taken either singly or in combination, could result in VE being applied to more designs. Alternatives that should be considered for inclusion in the guidance are reassigning existing staff to do VE reviews, contracting for VE reviews, increasing use of VE workshops, and identifying and using VE expertise in other districts when workload permits.

AGENCY COMMENTS AND OUR EVALUATION

In its April 28, 1983, comments, the Department of the Army concurred with the report findings, conclusions, and recommendations. However, the Department pointed out that one suggestion in the draft report should be clarified to avoid the inference that all water project designs with estimated construction costs exceeding \$1 million be required to be reviewed for VE savings.

Our aim was not to suggest that all water project designs estimated to cost more than \$1 million be required to be reviewed for VE savings, but rather that only such designs be considered for review since designs estimated to cost less than \$1 million that we reviewed accounted for only 1 percent of the savings realized by the Corps. Accordingly, we have revised this suggestion in the final report to clarify this matter.

The Department also commented that the following actions will be taken to enhance the Corps' VE program.


- Specific criteria relating to selecting project designs for VE review will be developed and distributed to commanders to ensure that targets of opportunity are not overlooked. Guidance will be developed stressing the need to concentrate on high dollar projects with potentially significant savings. The guidance will also address contracting for VE reviews and increasing the use of VE workshops.
- The need for early application of VE to designs will be reemphasized.
- Assignments to designated VE personnel will be reviewed with the objective of "freeing-up" additional time for VE activities.

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

Copies of this report are being sent to the Director, Office of Management and Budget, and to appropriate congressional committees.

Sincerely yours,


for J. Dexter Peach
Director