IMPLEMENTING VALUE ENGINEERING ON A MAJOR PROJECT OF THE U. S. DEPARTMENT OF ENERGY

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ABSTRACT

This paper describes the role played by a viable value engineering program in relation to the goal of the Yucca Mountain Site Characterization Project Office (YMSCO) to evaluate site suitability for a potential nuclear waste repository. Problems encountered in embedding a value engineering culture within the project are identified along with suggested solutions. Lessons learned are useless unless they are applied. We anticipate that those charged with inaugurating similar programs will not make the same mistakes if the experiences of this project will help in their learning curve.

INTRODUCTION

Congress has mandated in public law 104-106 that all governmental agencies establish value engineering (VE) programs and employ them where appropriate, to reduce non-essential costs and improve productivity. In addition Department of Energy (DOE) Order 430.1 has a clause that requires that all projects in DOE must use a cost reduction tool such as VE on all projects.

Funds for YMP derive from utility taxes paid by all users of nuclear electric power generation throughout theU.S. All money circulates through congressional appropriation and budget mechanisms. VE program objectives are to satisfy all essential YMSCO needs while identifying and eliminating unnecessary cost.

The author is the DOE value engineering coordinator on the project and is responsible for all VE work done. This paper describes in some detail major hurdles encountered in developing the project VE program, identifies causes and suggests solutions that can be used in establishing a similar program. To have a successful VE program a value engineering "mind set" needs to be incorporated. Ways to help carry out that mindset are discussed.

DESCRIPTION OF THE FACILITY

Nuclear power plants have been required to store spent fuel on their sites, many of which are reaching their limit. When that occurs, they must close and the result could be turmoil and economic disaster for manufacturing and business in the immediate areas of the plants.

The Nuclear Waste Policy Act established the process for the selection of suitable locations for disposal of spent nuclear fuel within a geologic repository. The Yucca Mountain Site Characterization Project is in the process of constructing the Exploratory Studies Facility (ESF) which is required to explore the characteristics of the Yucca Mountain site to decide its suitability as the potential repository of high level nuclear waste. Determination whether the site is suitable is called site characterization. The objective is to access and evaluate the performance of the strata that will serve as the geological barrier of the proposed repository material. If the site is not found to be suitable during the characterization process the project may be canceled.

ESF consists of operational support equipment and structures and underground testing areas to characterize the proposed repository level. Figure 1 provides a conceptual view of the underground portion of the ESF project.

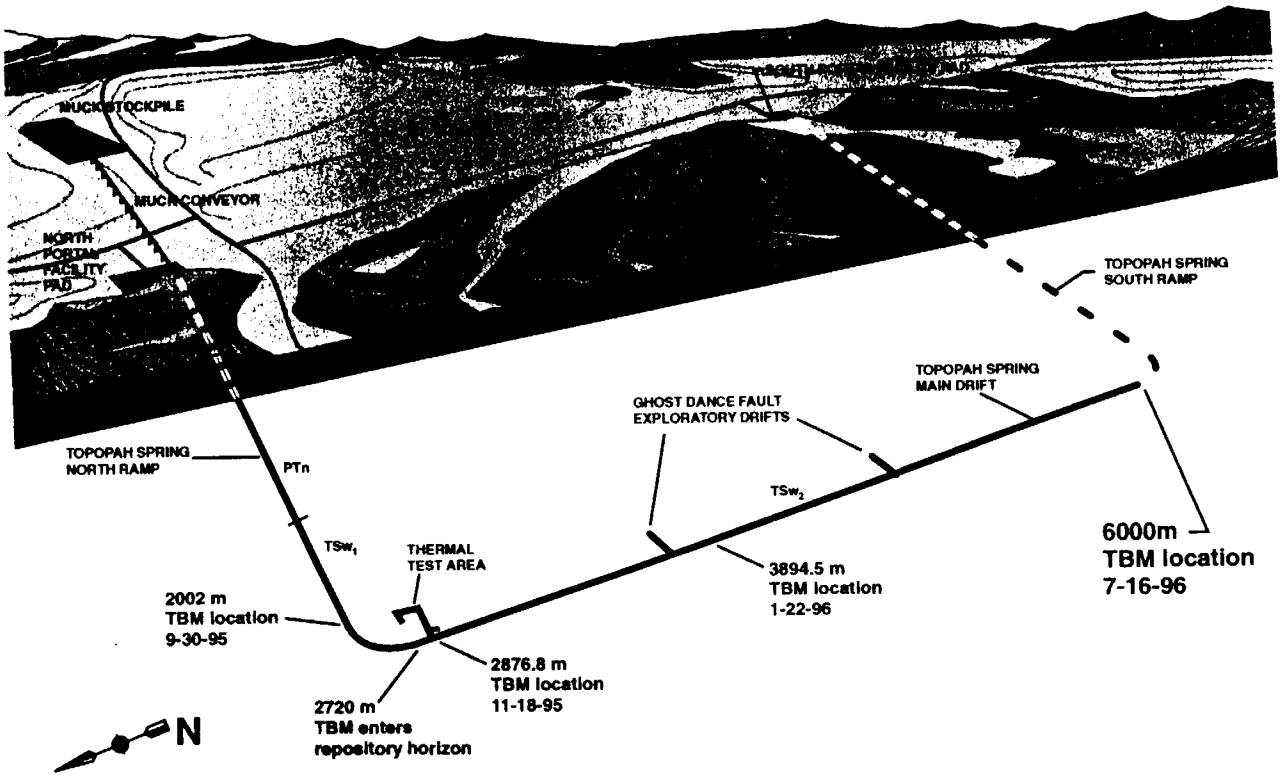

Figure 1

ESF Conceptual Arrangement

ESF surface facilities have been designed to support the construction and operation of the underground facilities and utilities. ESF subsurface facilities consist of a 28 ft. diameter main drift constructed through the long axis of the Topopah Springs level of the repository block. This main drift is connected to the surface at the north and south ends via 28 ft. diameter ramps.

Underground facilities consist of access tunnels, support facilities, and emplacement drifts in which the waste would be placed. Access to the underground is provided by shafts and ramps. The method of tunnel excavation will be primarily by tunnel boring machine. Drill-and-blast techniques may be used to a limited degree, primarily in non-emplacement areas of the proposed repository. Actual construction time is expected to be approximately seven years.

IMPLEMENTING THE VALUE ENGINEERING PROGRAM

The value engineering program is carried out to support the project by using an organized multi disciplinary team approach to implement project VE policies and procedures. This approach permits the creative development of appropriate alternatives that will satisfy the project functional requirements at the lowest life cycle cost. Use of value engineering also enhances the quality, value and schedule performance of YMSCO field operations and site characterization activities.

Launching a VE program requires a champion, or even better, several champions. It needs people in top management who have been exposed to and understand VE's potential to help management perform its duties. To gain that support it needs management to create expanding curiosity about VE, gained through education, application and advertising its successes.

VE reduces problems to a handful of the most meaningful ones. It constantly fights for simplicity in a more complicated world. The more simple our solutions,

the easier we guarantee quality. Complication multiplies and expands areas that beg for quality programs.

Significant tasks necessary to carry out a successful VE program include the following:

- *Develop a system to identify study areas.*
- *Prioritize potential studies and budget for them.*
- *Train a pool of VE team members.*
- *Develop support for VE studies.*
- *Perform VE studies on the project.*

The following benefits to the project derive from a well-run VE program:

- Builds management understanding and support of the VE process.
- Integrates with existing management process and design reviews
- Corrects areas of poor value.
- Encourages team building.
- Formalizes problem identification and solving skills.
- Provides experienced staff for study/training facilitation, and the opportunity to learn from experts.
- Dramatically shortens problem solution time, places emphasis on prompt decision making.
- Provides incentives to implement VE study results.

These factors are integrated into the project VE plan at both the program and study levels.

VALUE ENGINEERING STUDIES

Value Engineering on the YMP follows a job plan that applies specific techniques to analyze the item being studied. Then, convert it to VE language, prioritize the functions to scope the study, generate alternatives, analyze them, develop the best, present the results in person and generate implementation effects. The concept of "function" and "function analysis" is at the heart of the VE methodology. Function analysis during the VE study begins with defining the functions that must be accomplished in the system studied. The six step VE study plan is used to accomplish each study and is shown in Table 1.

Table 1

Format for a Value Engineering Study

1. Information Phase	Gather all pertinent information. Clarify assumptions. Convert concept to functions and a FAST diagram. Perform Cost/Worth analysis to rank functions.
2. Speculative/Creative Phase	Apply brainstorming to generate a quantity of alternatives for each function selected in order of its savings potential.
3. Analysis Phase	Evaluate all ideas developed during the creative phase. Compare and rank them quantitatively with each other. Attach costs to rank them by potential savings.
4. Development Phase	Develop the two or three best alternatives from the Analysis Phase, and compare them to the baseline. Determine total impact of all proposed changes and prepare an implementation plan.
5. Presentation Phase	Present VE improvement recommendations, with their anticipated financial and non-financial impacts to YMP management for approval. Prepare a preliminary VE study report as a handout.
6. Implementation Phase	Monitor and track the progress of implementation. Prepare a final VE study report, documenting the implementation results.

Twelve VE studies have been completed at this time on the Yucca Mountain Project. Subjects of these studies are listed in Table 2 with the estimated cost savings for each study. Study #1 and #4 have been implemented, and represents actual savings or cost avoidance of about 18 Million Dollars. The rest of the studies listed have not been implemented, so the savings are estimated.

Table 2

Value Engineering Study Status Table

STUDY	VE STUDY RECOMMENDED SAVINGS (ESTIMATED %)	VE STUDY BASELINE
1. TBM STARTER TUNNEL[1]	20%	$ 2,655,000
2. STANDBY POWER GENERATION[2]	67%	$ 2,821,000
3. NORTH PORTAL BOX CUT CONCEPTS[2]	61%	$ 1,040,000
4. INTEGRATED DATA AND CONTROL SYSTEM[1]	46%	$ 37,568,000
5. ESF SUBSURFACE SENSORS[2]	50%	$ 3,188,000
6. CANYON POWER DISTRIBUTION[2]	54%	$ 13,000,000
7. NORTH/SOUTH PORTAL POWER DISTRIBUTION[2]	59%	$ 12,193,000
8. ELECTRICAL NICHES & WALK WAYS[2]	97%	$ 14,195,000
9. COMMUNICATION SYSTEM[3]	37%	$ 3,800,000
10. PROCUREMENT SYSTEM STUDY[4]	66%	45 WORKING DAYS PER PROCUREMENT
11. REQUIREMENTS RELEVANCY & REDUCTION[5]	14%*	122 DOCUMENTS
12. SIMPLIFICATION OF PACS DESCRIPTION DOCUMENT[6]	98%	APPROX 110 PAGES

[1] VE study implement - cost avoidance realized
[2] Implementation deferred due to budget cuts.
[3] Temporary construction communication system now in use due to budget cuts. Temporary system being evaluated against VE study recommendations.
[4] Contract/contractor changes will require a reevaluation of these savings.
[5] Partially Implemented - remainder deferred due to budget cuts
[6] VE Study recommendation in review

* - Two orders determined to be not applicable.
- 8 orders identified for possible exemption.
- 13 orders identified for possible combining.

PROBLEMS ENCOUNTERED IN BUILDING THE VALUE ENGINEERING PROGRAM

A number of problems have surfaced in the establishment of the VE program. They have been identified, analyzed and recommendations to correct the problems have been noted. This paper addresses the following questions related to the Yucca Mountain value engineering program:

- How is management acceptance of Value Engineering obtained?
- How should potential VE study areas be selected?
- How should the right disciplines for the team be selected?
- How is acceptance gained for superior solutions costing less?
- How can the decision-making process be speeded up?

Each of these VE program problem areas is discussed in a Problem, Cause, Corrective Action format as follows:

- Define the problem.
- Identify the cause of the problem.
- Provide recommendations for corrective action on the Yucca Mountain Program that translates to other value engineering programs.

How Is Management Acceptance of Value Engineering Obtained?

Problem: At the inception of the VE program, management did not understand nor support the program This resulted in a low level of funding and slow implementation of value engineering.

Cause: This problem is symptomatic of engineering and design professionals who constantly assert "we always do value engineering in our everyday work and we don't need to do any additional value engineering studies in our area of work." Lack of management support is illustrated by management's lack of faith in the team's abilities when they override the VE system to pre-ordain their solution. Thus, they prevent the study team from accomplishing their objective of finding new alternatives to the original design.

Corrective Action: Several training sessions for management personnel in both the Department of Energy and the Management and Operating contractor have been carried out on the project. This has resulted in management being more aware of the value engineering process and the potential value of VE. Due to funding cuts on the project, plans to make VE training of personnel mandatory have been shelved at this time.

Methods of performing VE studies have been modified to prevent management personnel from interceding during the course of the study except for the briefing on the first day. Results of studies are being advertised throughout the project and plans are being made to acknowledge outstanding effort on VE studies by the staff.

How Should Potential VE Study Areas Be Selected?

Problem: Identification of potential VE study areas has been very slow and time consuming for the VE coordinator. Many potential areas for study exist on the project. However, potential study areas are not being suggested. This problem is illustrated by the fact that there is no backlog of potential study material and efforts to get information on study material are met by indifference by the engineering, design and management staff. Studies are not suggested by the project personnel because they are not aware of the potential benefit from VE to help them.

Cause: Management has been slow to encourage the staff to identify opportunities in the design or processes on the project that might be resolved through a VE study. One area, the electrical design team has requested six of the twelve studies done on the project so far. Thus, about one half of all the studies are being suggested from one design team area. There is no formal avenue to identify and submit candidate studies.

Corrective Action: The Management & Operating contractor (M&O) VE coordinator has developed a list of potential studies on the project and is actively pursuing information on material that may be used to add to the potential study list. Further effort is planned by the VE coordinator to get other project design team leaders more interested in VE and what it can do for them.

Procedures to obtain study candidates have been outlined in the VE plan. Items over one million dollar value are required to be reviewed for potential VE studies. Activities have been initiated on the project to seek additional champions for VE through training and advertising of study results. A formal method to identify and submit candidate studies is being developed.

How Should the Right Disciplines for the Team Be Selected?

Problem: Problems occurred in performing one of the studies objectively without any bias from members of the study team. The team gathered to do the study was organized from the project except for the team leader.

The design group that performed the original design was represented on the VE team by two members. Those original design group members attempted to bias the study results to show that the original design was the top alternative. A related problem to this occurs when obtaining needed information to do the study without getting lobby influence by those affected.

Cause: Two VE team members were from the design group that did the original design. At the start of the study the manager from the original design group said "remember that this is our bread and butter that you are studying." Team members on the VE study from his group tended to favor options that did not change the original design. These options favored the original concept and they attempted to skew the study results toward the original concept as the number one alternative.

Corrective Action: Since the study in question was performed, more care has been taken to choose the team members carefully to avoid selection of multiple team members from the original design group. It is preferable to not have any VE team members from the original design group. However that may not be possible on this project since the people that have the knowledge required to be able to perform a study and contribute to the study team are from the design group.

A typical team consists of members from engineering, scientific development, procurement, line operations, field management, and the team facilitator. A team is chosen so that no more than one member is from the original design group. In the case where a member of the original design group is a member of the VE team, that person should be made aware that they should attempt to perform the study without any bias in favor of the original design. Controlling the input at the briefing for the study also helps reduce undue influence.

How Is Acceptance Gained For Superior Solutions Costing Less?

Problem: Project management does not accept the VE study results and will not approve recommendations resulting from the study.

Cause: When one of the project VE studies was completed, the manager in charge of carrying out the design did not accept the study results. The cost estimate was not correct as far as he was concerned. He also thought the study was flawed because we did not look at several items that he wanted in the study. Therefore the manager predetermined that the study was not acceptable and he did not approve the study results on the first go around. .

Corrective Action: Meetings were held with the engineering manager to explain the results of the study and go over the cost estimates in detail to find out what the objections were. The VE coordinator must be knowledgeable of the study results and be able to have experts that can discuss the alternatives on the study to the satisfaction of the engineering manager. In the study in question, additional cost estimates were required to provide more detail on the preferred alternative.

Care must be taken to prepare the highest alternative on the study as completely as possible and be prepared to answer all possible questions from the engineering managers. A reporting system needs to be established to disseminate the results of the VE studies so that managers are more aware of the VE process and the potential benefits of doing studies.

How Can the Decision-Making Process Be Speeded Up?

Problem: Project management is slow to decide or will not make a decision on the results of the value engineering study when it is completed. As a result VE study recommendations are slow to be implemented or may never be implemented.

Cause: One of the requirements in the VE plan is to send the results to the cognizant engineering manager and that manager must make a decision on the alternatives and decide whether to accept the recommendations of the VE team. The problem arises that the cognizant engineering managers have made up their minds before the study starts, that the original design is the preferred alternative. It is difficult to get them to make a decision on the study recommendations because they have a preconceived notion of what the results should be.

Corrective Action: Buy off of the VE recommendations by the responsible manager needs to be obtained as soon as possible after the conclusion of the study. The VE plan requires that the cognizant engineering manager that is responsible for the study results must provide written answers with the reasons for not accepting the VE study results.

This must be provided to the Value engineering team and allow them to respond to the problem brought up by the engineering manager. The value engineering team may have the option to do additional work on the study if that is necessary or to accept the conclusions of the engineering management.

It is planned to hold an implementation meeting with the responsible management as soon as possible after the conclusion of the study. Buy off of an implementation plan is the desired result. A review board consisting of the VE team and managers representatives will be formulated to resolve management problems with studies.

CONCLUSIONS

A number of problems have surfaced during the development and application of value engineering on the Yucca Mountain Site Characterization Project. These problems are discussed in this paper and recommendations made concerning the organization and implementation of a value engineering program.

Results of the value engineering program thus far have been highly successful in satisfying the project's essential needs while identifying and eliminating unnecessary cost. Analyses of problems in implementing VE and the resulting recommended corrective actions have shown that:

- The Value Engineering Program has evolved successfully.
- Significant cost savings have been realized through performance of VE studies.
- Applications of lessons learned from corrective action recommendations have improved the VE program.
- VE training is an important part of the project and should be actively promoted.

To prevent problems from recurring, the VE program is being revised to reflect the lessons learned. The following recommendations are the result:

- Seek and cultivate champions for VE throughout management.
- Establish a broad base of trained people to perform VE studies.
- Establish procedures to obtain study candidates, team members and support.
- Establish a review board to pass on recommendations.
- Obtain buy off of the implementation plan by all responsible parties to the VE study.
- Establish a reporting system for the VE study results.
- Advertise results and acknowledge outstanding efforts.

We expect that future VE studies performed on the project will profit from these recommendations. The VE program will continue to add value to the project through identifying and eliminating functions that increase cost but do not add value, and then replacing them with better alternatives using the VE process. Lessons learned during the application of value engineering on this project can be applied to the building of any VE program.