VALUE ENGINEERING IN HAZARDOUS WASTE AND CONTAMINANT REMEDIATION

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by

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ABSTRACT: Value Engineering is a formal procedure for examining a design or project to identify alternative details or procedures that, when adopted, yield better value (i.e., reduced cost) without affecting the function or success of a design or project. This paper briefly describes the steps involved in Value Engineering workshops. Next, the paper describes the successful use of Value Engineering in two Superfund projects and the U.S. Department of Energy's Uranium Mill Tailings Remedial Action Project.

INTRODUCTION

Value Engineering (VE) is a formal procedure and approach that can be used to ensure that hazardous waste remedial actions are accomplished in a cost-effective manner. VE has been demonstrated to be successful in reducing costs and improving value in major construction projects. In recent years, government agencies have employed VE techniques to evaluate the function, cost, and necessity of major elements of remedial actions involving uranium mill tailings, hazardous wastes, and contaminated groundwater.

This paper describes briefly the process of VE and presents two case histories where VE has been used to reduce the cost of hazardous waste remediation.

THE VALUE ENGINEERING PROCESS

VE is a means of evaluating the function, cost, and objectives of a design or construction project with the purpose of improving the value of the design or its components, or of reducing the project cost.

A team of technical specialists is assembled to conduct a VE review session over a period of several days. The team usually consists of engineers, scientists, and a cost estimator, most of whom are independent of the design team. A typical VE session is conducted in the following phases:

- o Information Phase.
- o Function Analysis Phase.
- o Speculation Phase.
- o Analysis Phase.
- o Concept Development Phase.
- o Presentation/Implementation Phase.

A VE coordinator or facilitator organizes the VE team, establishes the ground rules, and ensures that the group does not lose sight of its mission.

Information

The information phase involves presentation of the design for the construction or remedial action that has been proposed. A member of the design team usually makes a presentation to explain the main concepts of the design, including project objectives, design constraints, drawings, specifications, and special conditions that are integral to the project. The estimated cost and contingency cost of the project are also described.

Function Analysis

In the function analysis phase, the major project components are identified, their functions are determined, and the estimated cost for each component is assigned. A Function Analysis System Technique (FAST) diagram is prepared to help team members visualize the need for and the role of each major component. An example FAST diagram for a uranium tailings remedial action project is shown in Figure 1. In general, the components are listed in functional order proceeding from what the design will do, on the left side of the diagram, to how the objectives will be met, on the right side. Project components that are found to make little or no contribution to the overall project objective will become subjects for further investigation in the subsequent VE phases. Similarly, project components with a high cost are also subjects for subsequent VE evaluation.

Speculation

During the speculation phase, the VE team considers each major design component and suggests alternative means of accomplishing the function of that particular component. In this phase, team members are not allowed to criticize any suggestions for alternative design components or approaches. This promotes creative thinking in the group.

For example, a remedial design may propose a wastewater treatment plant that would be constructed in a permanent building. A VE team member may suggest that the wastewater treatment plant be assembled from modular units and housed in a temporary building, so that the salvage value or resale of the treatment plant would be higher, and the project would achieve a lower net cost.

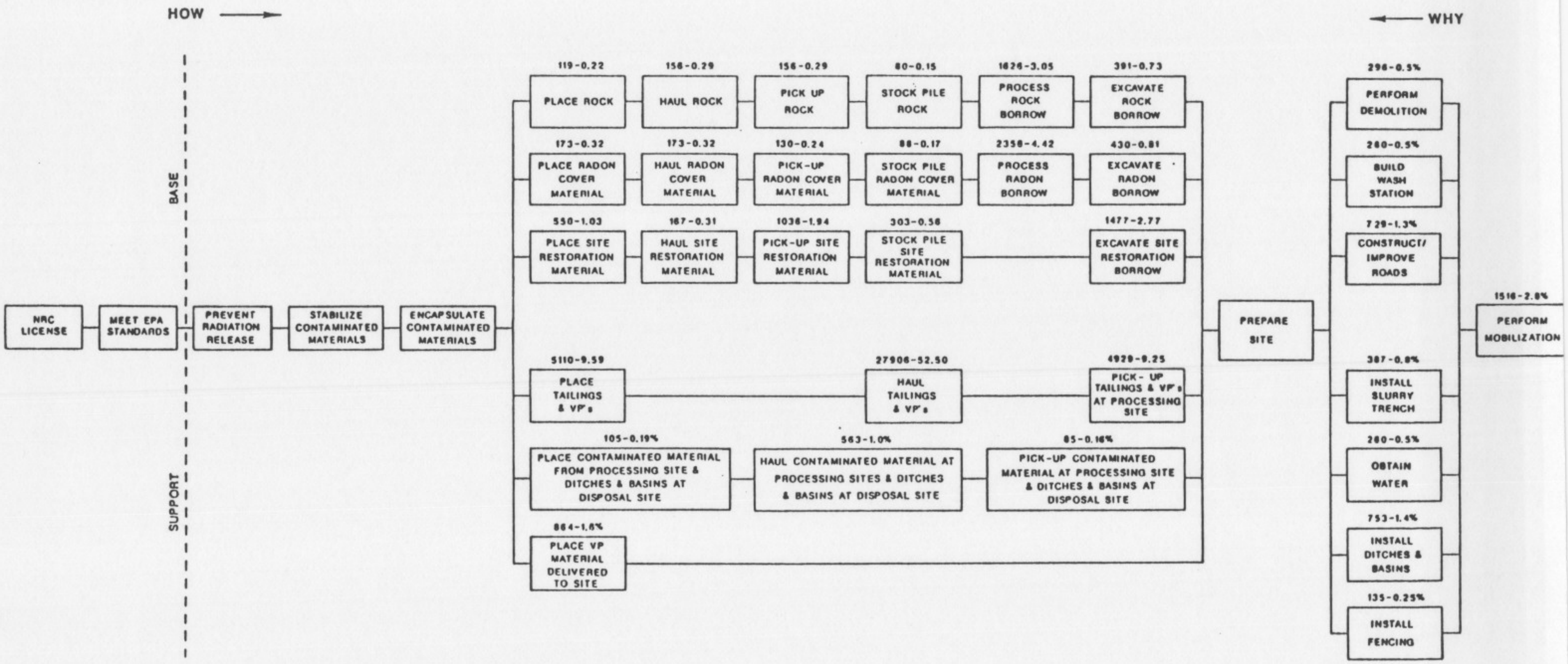
Analysis

The analysis phase focuses on sorting out the ideas that were suggested in the speculation phase and developing the ideas that seem to have merit for improving value and reducing cost. The cost estimator prepares rough costs for the new concepts and these costs are compared with those of the original design. The alternatives are compared among themselves, and then with the component in the original design, to decide which ideas have the greatest potential and should become recommendations to the owner (or to the government).

Concept Development

During the concept development phase, the concepts selected by the VE team are organized and refined before presentation to the owner. Sketches are prepared, a narrative is written, and cost estimates are fine-tuned.

FUNCTION ANALYSIS SYSTEM TECHNIQUE (FAST) DIAGRAM-GRAND JUNCTION, COLORADO



TOTAL - $53,329,000

FIGURE 1

decides whether the VE recommendations should be incorporated into the remedial action, and directs the designer or construction manager to implement the changes.

CASE STUDIES

Superfund Sites

The authors have conducted VE sessions for two Superfund sites. At both, contaminated groundwater is to be pumped from the aquifer, treated, and re-injected into the groundwater or discharged. Contaminant cleanup at both sites also includes demolition and removal of contaminated buildings. At one site, contaminated soils and sludges are to be excavated and incinerated. Water treatment options under consideration include carbon adsorption and electrochemical treatment.

For each site, a three-day VE session was held at a location away from the team members' normal office demands. The groups included Chemical and Process Engineers, Civil Engineers, Groundwater Hydrologists, Health Physicists, and Cost Engineers. The groups proceeded in an orderly way through the phases of VE described above. Final reports were prepared in the week following the VE session.

In Superfund remediation at the stage of the 30 percent design, as was done for the two case histories described here, the VE team is constrained by the technical approach selected and designated in the Record of Decision (ROD). The team must ensure also that any recommended changes:

- Protect human health and the environment,
- Meet or exceed performance, quality, and safety requirements, and
- Lead to a reduced construction, operating, or maintenance cost.

Because Superfund projects are, as it were, in the public domain, the VE team may seek alternative methods which reduce costs not only to the party paying for the remedial work, but also for prospective bidders, the contractor, and society in general. This approach results from the VE requirement to consider "life-cycle" costs as well as initial costs.

Pursuant to the objective of cost-effectiveness for all stages and parties involved in the Superfund remediation project, the VE team considered the following aspects of the planned work:

- The form and details of the contract,
- Bid procedures,
- The definition and breakdown of pay items,
- Contract termination procedures, and
- Design details, including surface water control, excavation procedures, waste-disposal planning, and decontamination procedures.
- Aquifer restoration plans, including pumping, water treatment, and clean water discharge.

Presentation/Implementation

In the presentation/implementation phase, the VE recommendations are presented to the owner or government entity who is sponsoring the project. The owner or government representative decides whether the VE recommendations should be incorporated into the remedial action, and directs the designer or construction manager to implement the changes.

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At the stage of a 30 percent design for a remediation project, certain aspects may be difficult, if not impossible, to Value Engineer effectively. For example, if the ROD calls for incineration, the 30 percent design may simply include specifications for a contractor-supplied incinerator. The specifications may state only the waste feed rate and characteristics, and the end-product requirements. As the practice is usually to bring in a transportable incinerator, VE cannot be undertaken productively on the nuts and bolts aspects of a unit process. Rather, the VE team must concentrate its efforts on the timing of installation of the incinerator, methods of paying for the operation of the equipment, and unduly restrictive specification requirements regarding operating rates or procedures.

During the remediation VE sessions for the two Superfund sites, significant cost savings were identified. The areas were many and site-specific, but included proper contract formats, appropriate pay items, provision for at least one detailed design on which bidders could propose, opportunities and incentives in the contract for implementing cost-saving improvements, and proposals for use of existing site facilities rather than construction of new ones.

The cost savings identified by the VE sessions were at least 10 percent of project costs, and possibly more. The cost of the VE sessions was about 10 percent of the potential minimum savings. Those contemplating a VE session may wish to use this 10/10 rule as a guide in deciding to undertake VE; i.e., the cost of the VE session should be no more than 10 percent of potential savings, which should be at least 10 percent of estimated project costs.

Uranium Mill Tailings Remedial Action Projects

VE has been used many times over the past several years by the U.S. Department of Energy (DOE) during remedial activities planning for uranium mill tailings. The DOE was authorized by Public Law 95-604 to plan and implement the cleanup of 24 inactive uranium mill tailings sites in the program known as the Uranium Mill Tailings Remedial Action (UMTRA) Project. Cleanup at one of the tailings sites typically involves:

- o Site preparation (fencing, decontamination pads, and runoff water containment/treatment facilities).

- o Excavation of tailings and contaminated soils.

- o Transportation and placement of tailings and contaminated material in a disposal cell, either on the site or at an alternate location.

- o Placement of a compacted soil barrier to limit radon gas emanation and infiltration of precipitation.

- o Covering of the radon/infiltration barrier with rock and/or soil layers to protect the disposal cell from erosion.

- o Restoration of disturbed lands.

The relationship between these segments and the estimated cost of each segment is depicted in Figure 1.

The Durango VE Session

During the information phase, the VE team for the Durango, Colorado, tailings site remedial action identified that restoration (clean soil backfill, final grading, and revegetation) was estimated to cost $2.7 million and represented 12 percent of the total cost. The plan was to totally backfill the areas that had been excavated. A suggestion was made during the speculation phase that total backfill may not be needed to support the proposed future land use (a water intake structure for an off-channel dam), and that a cost savings could be achieved by using a smaller quantity of fill. The concept was expanded and refined, and became a $2.2 million cost savings for the project. When combined with other recommendations, the total estimated cost savings was $4.6 million. VE evaluations for other tailings cleanup designs resulted in comparable or modest savings by proceeding through a similar logic process.

A summary of the VE results for some of the UMTRA Project sites is included in Table 1. The cost savings for these sites ranged from five to 16 percent. The value of the waste cleanup is improved by implementing solutions that are more cost-effective yet still accomplish the project objectives.

SUMMARY AND CONCLUSIONS

VE has been used beneficially to reduce the cost of hazardous waste remedial action projects. Through the VE process, the value to the government or owner has been improved by ensuring that the design specifications provide a cost-effective site cleanup that has been selected in the ROD or that is governed by applicable regulations. Cost savings or cost avoidance in the range of ten to fifteen percent have been common for the projects that have been Value Engineered through the authors direction. The DOE has integrated the VE program with the Cost Reduction/Productivity Improvement Program.

ACKNOWLEDGEMENTS

The authors wish to thank their many colleagues and to acknowledge the vital roles they have played in participating in and contributing to productive and successful VE sessions. Without the many individual contributions and new ideas, the successes described in this paper would not have been possible. Also, we would like to acknowledge the role of our clients, the U.S. Department of Energy and the U.S. Environmental Protection Agency, both of whom have wisely incorporated VE into appropriate remedial action planning.

TABLE 1
VALUE ENGINEERING SUMMARY OF SELECTED UMTRA PROJECT SITES

URANIUM TAILINGS SITE	FUNCTIONS COMPONENT	COST SAVINGS	PERCENT REDUCTION IN PROJECT COST ESTIMATE
Durango, CO	Transport tailings	$2.3m	14%
	Restore land	2.2m	
	Control runoff	0.1m	
	Total:	$4.6m	
Grand Junction, CO	Redesign groundwater cutoff	0.4m	5%
	Decontaminate subpile gravels	0.7m	
	Haul vicinity property contaminated soil directly to disposal site	0.2m	
	Remove lift thickness specification	1.2m	
	Alternate debris disposal	0.1m	
	Increase highway load limits	0.3m	
	Total:	$2.9m	
Belfield and Bowman, ND	Improve road	0.3m	14%
	Transport contaminated soil	0.1m	
	Total:	$0.4m	
Green River, UT	Decontaminate buildings instead of demolition	0.1m	16%
	Protect disposal cell from erosion	0.5m	
	Total:	$0.6m	