AASHTO GUIDELINES
FOR
VALUE ENGINEERING
1987

Published by the

AMERICAN ASSOCIATION OF STATE HIGHWAY AND TRANSPORTATION OFFICIALS

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CONTENTS

EXECUTIVE SUMMARY

AASHTO recognizes the need for the prudent use of diminishing resources and revenues while providing a quality transportation program. Value engineering is a function-oriented technique that has proven to be an effective management tool for achieving improved design, construction, and cost-effectiveness in various transportation program elements. States that have successfully implemented a VE program have realized additional benefits beyond design and cost savings; for example, constant updating of standards and policies, accelerated incorporation of new materials and construction techniques; employee enthusiasm from participation in agency decisions; increased skills obtained from team participation.

This document provides guidelines for states to voluntarily establish their own value engineering (VE) programs. It is the intent of these guidelines to promote broad acceptance and use of VE, allowing maximum flexibility to each state. The following are important elements of a successful value engineering program:

- A firm commitment of resources and support by executive management are the most important elements for assuring the success of a VE program.
- All levels of management must understand and support value engineering.
- A state VE program requires development of a policy directive describing where, when, how, and to what specific areas of work the VE effort should be directed.
- It is essential to provide some degree of VE training or program familiarization at every level within the state organization.
- It is essential to establish a position of value engineering coordinator to administer and monitor the state's VE program. A person in this position may or may not have other duties.
- For optimum results in the project development phase, value engineering should be performed:

  —Early in the planning-design process to maximize potential product improvement and cost savings.
  —On high-cost and/or complex projects.
  —By a multi-discipline team of professionals trained in VE techniques.

- A Value Engineering Change Proposal (VECP) program to encourage contractors to develop VE proposals allows the state to benefit from a contractor's design and construction ingenuity, experience, and ability to work through or around restrictions. Some important elements of a successful, ongoing VECP program are:

—Processing of proposals must be kept simple and done quickly.
—Cost savings are shared with the contractor.
—Change proposals become the property of the state and the concept may be used on future projects.
—Change proposals should not compromise any essential design criteria or preliminary engineering commitments.
—Change proposals cannot be the basis for a contract claim.

- It is essential that all VE team recommendations and contractor proposals be fairly reviewed and expeditiously evaluated for implementation.
- VE techniques can also be used to improve productivity in other areas of a state's transportation program, including traffic operations, maintenance, procedures and operations, standard plans and specifications, and design criteria and guidelines.
- VE programs within the state organization should be closely monitored, evaluated, and modified to assure the program's effectiveness.

INTRODUCTION AND BACKGROUND

Value engineering evolved out of the necessity to find substitutions for manufacturing materials that became scarce during World War II.

In 1959, the Society of American Value Engineers (SAVE) was incorporated in Washington, D.C., to unite practitioners and promote the growth of value engineering. The Society officially defined value engineering as "the systematic application of recognized techniques which identify the function of a product or service, establish a value for that function, and provide the necessary function reliability at the least overall cost. In all instances, the required function should be achieved at the lowest possible life cycle cost consistent with requirements and/or performance, maintainability, safety, and aesthetics."

Escalating construction and maintenance costs, combined with reduced revenues, led to an increased interest in value engineering by state and federal transportation agencies. Congress became interested in VE applications to highway projects in the late 1960's. After a series of hearings, Congress included a provision in the 1970 Highway Act (later codified in Title 23, U.S.C. as Section 106(d)) that permitted the Secretary of Transportation to require value engineering, or other cost-reduction analyses, on any proposed federal-aid highway projects on any federal-aid system. In 1975, FHWA created an organizational unit to lead that agency's efforts to stimulate interest in value engineering. FHWA stated:

> It is our intent to provide a high level of support to those highway agencies that are willing to maintain a responsive Value Engineering program. We will continue to encourage those agencies not fully aware of the potential of Value Engineering and, through the National Highway Institute, we will continue to furnish opportunities for training in the technique.
>
> Our goal is to obtain recognition of the benefits to be derived from a Value Engineering program in each state highway or transportation agency and the development of a capability for its practice.

In 1974, FHWA assigned a VE Coordinator in Washington, D.C. to administer the VE program. Shortly thereafter, a workshop in "Value Engineering for Highways" was developed with funding provided by the National Highway Institute (NHI). The NHI has taught VE courses continuously since 1975. By January 1986, 125 NHI-sponsored courses had been presented in 45 states and more than 3500 highway professionals had been trained.

The United States General Accounting Office and the United States Congress have recommended that FHWA require greater use of value engineering by the states, to improve product quality and reduce product cost. In FHPM 6-1-1, Subsections 1 and 9, the FHWA strongly encourages state use of value

engineering. FHWA may also request that value engineering be performed on those features of federal-aid projects where its employment has high potential for public benefit.

In April 1985, California hosted the fourth national VE conference in San Diego to explore the state-of-the-art practice as VE relates to transportation systems. Representatives of 24 state highway agencies attended. Some of the major recommendations made in workshops during that conference included:

- AASHTO should formally recognize VE as an element in transportation engineering in the same way other elements have been recognized.
- AASHTO should be encouraged to take a major role to influence states in developing aggressive VE programs.
- AASHTO should take over the sponsorship of future national and/or regional VE conferences.
- Top highway management should be positively influenced to become familiar with and more involved in the VE program.
- A strong AASHTO stand on VE should be formulated and publicized. Value engineering should not be mandated by federal authority.

In October 1985, at the AASHTO meeting in Seattle, Washington, the Standing Committee on Highways established a value engineering task force to develop an AASHTO VE Guide for voluntary use by the states to effectively apply VE techniques to their highway project development, construction, and operations programs.

The material contained in this publication is intended to promote broad acceptance and use of the concept of value engineering. It is presented in the interest of providing uniformity among the states, while recognizing that the basic principles of VE are well-defined and flexible enough to enable each state to tailor a VE program to its own needs.

Numerous publications that address value engineering in its various forms and applications have been developed during the past few years. See Appendix 1 for a summary of some of these documents.

POSITION STATEMENT

AASHTO recognizes the need for the prudent use of diminished resources and revenues while providing a quality transportation program. AASHTO supports and encourages the development and implementation of an active VE program within each of its member organizations.

Value engineering (VE) is a proven effective tool for both product improvement and design enhancement. VE can substantially improve design and cost-effectiveness of projects, facilities, operations, procedures, and other areas of the transportation program. VE provides assurances to executive management and legislatures that cost-effective projects and productivity are being achieved, thus optimizing the allocation of limited funds without reducing function. In order to improve design excellence and achieve efficient cost and quality control, it is AASHTO's position that:

- Each member state should consider establishing an ongoing VE program.
- The challenges of rising costs and diminished resources be addressed through the application of VE principles and practices in project development, construction, traffic operation, maintenance, and other appropriate areas.
- Guidelines be provided to member organizations to promote and assist in broad acceptance and use of VE with the provision of flexibility to adapt to individual needs within the states.

ELEMENTS OF A STATE VE PROGRAM

I. GENERAL

For a state to have an effective value engineering program, it is important to have management support, a policy directive, and a VE coordinator. Failure in any one of these areas reduces the state's effectiveness in obtaining maximum results.

It should be pointed out that the elements of an effective VE program essentially apply whether a state trains its own personnel to perform VE studies or employs an outside VE consultant.

A. MANAGEMENT SUPPORT

The understanding and support of value engineering by top management is the most important factor of a successful VE program. This support is needed initially to assure adequate funding for training of personnel and establishment of the program. Once the VE program is established, the continuing active involvement of top management creates and maintains the positive attitudes that are necessary to implement cost-effective changes.

Although top management support is essential, it is unlikely that a VE program will succeed if managers directly responsible for project decisions do not understand, accept, and support it as well. Obtaining their support requires that:

- They are aware that top management understands and supports the program.
- They are familiar with VE methodology and techniques.
- They are convinced that VE can be a powerful tool when used properly.

Support from all levels must be active rather than passive, as the effectiveness of the value engineering program is proportional to the emphasis given to it by management.

B. DEVELOPMENT OF STATE POLICY DIRECTIVE

The success of a value engineering program depends as much on initial program planning and direction as on the procedures and techniques of the process itself. To be effective, a VE program must be based on a policy of where, when, how, and to what specific areas of work the VE effort should be directed. A state's policy directive, manual, or procedural guide should:

- Explain the philosophy of value engineering, including a definition of VE.
- Explain the purpose and objectives of a VE program.

- Provide guidelines for VE activities specific to each program.
- Outline the organization's methods and procedures for administering and evaluating the program.

C. VE COORDINATOR

Implementation of a value engineering program may vary from state to state in terms of approach, scope, and organization. Ideally, an effective value engineering program should be directed and coordinated by an assigned individual, commonly called a value engineering coordinator.

For best results, the VE coordinator should not be responsible for both the VE program and production delivery of the state's projects. Typically, the value engineering coordinator administers the program by establishing VE procedures, providing appropriate training and orientation, monitoring the progress of VE studies or proposals, and assuring that VE recommendations are fully and fairly evaluated and that those accepted are implemented. The VE coordinator may or may not have other duties within the organization, but it is important that the individual selected to fill this position be fully trained and firmly committed to value improvement and be clearly identified within the organization.

II. PRECONSTRUCTION VE GENERAL PRINCIPLES AND GUIDELINES

A. ADMINISTRATION AND TRAINING

VE Coordinator

The VE coordinator has the essential role in making the state's VE program work. In most cases, the VE coordinator should develop and monitor the state's program. The VE coordinator must be trained in VE principles and committed to value improvement.

Training

Orientation and training in value engineering should be provided in varying degrees at nearly every level within the organization. Executive management must be oriented to understand and support the fundamentals and principles of VE for the program to be successful. VE coordinators, team leaders, and team members need basic and subsequent training to ensure the success of the VE process and the ultimate implementation of recommendations. An overview of the procedures and the benefits of value engineering should be provided to staff not directly involved in VE, to encourage understanding and support of the value engineering process.

Training in value engineering is available from a variety of sources, including NHI training courses. Consultants with expertise in value engineering can provide training and assistance in VE planning, implementation, and management. There are also many publications available that offer VE instruction.

Training should be a combination of VE theory and hands-on experience. Trained personnel become increasingly effective in performing VE analysis. The more widespread the VE concept becomes within an organization, the easier it becomes to have study results accepted and implemented. Overall organizational understanding also facilitates information gathering and reduces some of the resistance to change, which in turn increases the capability and effectiveness of the VE program.

B. PROJECT SELECTION AND OTHER VE CONSIDERATIONS

It is important to select projects that provide the maximum opportunity to improve the public investment by quality enhancement or life-cycle cost savings. A generally accepted and useful approach for selecting both projects and items to be studied within a project is based on Pareto's curve, or law of distribution, shown in Figure 1. The curve is based on the principle that a small number of elements—about 20 percent—account for about 80 percent

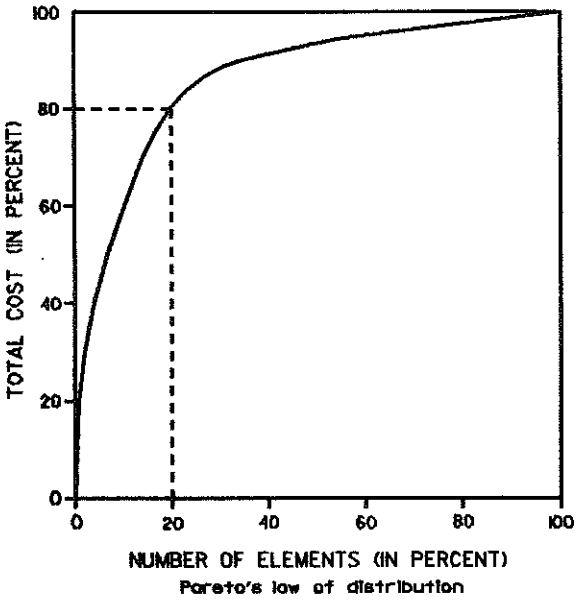

Figure 1

of the costs. It follows that these few elements generally contain the greatest potential for value improvement. Based on this, not all of a state's projects will be candidates for a successful VE study.

Some typical characteristics of potential VE projects are:

- Projects that substantially exceed initial cost estimates.
- Complex or multi-part items or processes that provide unique but costly functions.
- Items using critical or high-cost materials.
- Items requiring difficult construction or fabrication procedures.
- Items that perform a questionable function.
- Items that simply appear too costly to build, operate, or maintain.
- Projects that have grown complex, possibly by development over a long period of time.
- Major structures.
- Projects with complicated or costly traffic control or detours.

Value engineering techniques can be used to improve productivity or the "benefit to cost ratio" in nearly every aspect of a state's transportation program, including preliminary engineering, traffic operations, maintenance, standard plans and specifications, and design criteria and guidelines.

C. TEAM STRUCTURE AND VE STUDY

Team Structure

A value engineering team of five to seven persons with diverse backgrounds usually produces the best results. A team of less than five tends to limit the amount and variety of creative input, and a team of more than seven can be unwieldy. Teams should be structured so there is appropriate expertise to evaluate the major problem areas anticipated within the project, e.g., traffic, right of way, structures, soils, paving, etc. Including general expertise from the areas of design, construction, right of way, maintenance, or traffic operations makes for a good team balance.

Representatives from disciplines other than engineering can also provide greater objectivity to a team effort. Expertise from outside the state organization (e.g., local agency, USFS, FHWA, etc.) may be appropriate on certain projects.

Opinions are varied as to whether members of the original planning or design team should be included on the VE team. Previous involvement on the study project may inhibit the objectivity that is required to analyze the project. On the other hand, the original designers can explain the problems involved and the reasons for particular design elements. In any case, the original designer is an excellent resource individual for the team to consult.

Specific training in the concepts, application, and techniques of value engineering is highly desirable for those working as VE team members. Occasionally, a team may include one or two members who are untrained in VE but highly skilled in disciplines that are vital to the study.

Team Leader

One individual should be appointed as team leader to guide the team in its efforts and be responsible for its actions during the study. The team leader should be an individual who is very knowledgeable of and proficient in the VE process and able to direct the team's activities toward its goal. Additional training in motivation and leadership techniques may be warranted for team leaders.

Timing

Design recommendations can be more readily incorporated into the project if the VE study is done as soon as possible after basic design elements are available. By proper timing and planning, the VE Coordinator can usually ensure the specific VE studies can be accomplished without conflicting with the project schedule. In fact, the earlier VE is applied, the greater the potential for savings. This principle is illustrated in Figure 2, which shows that

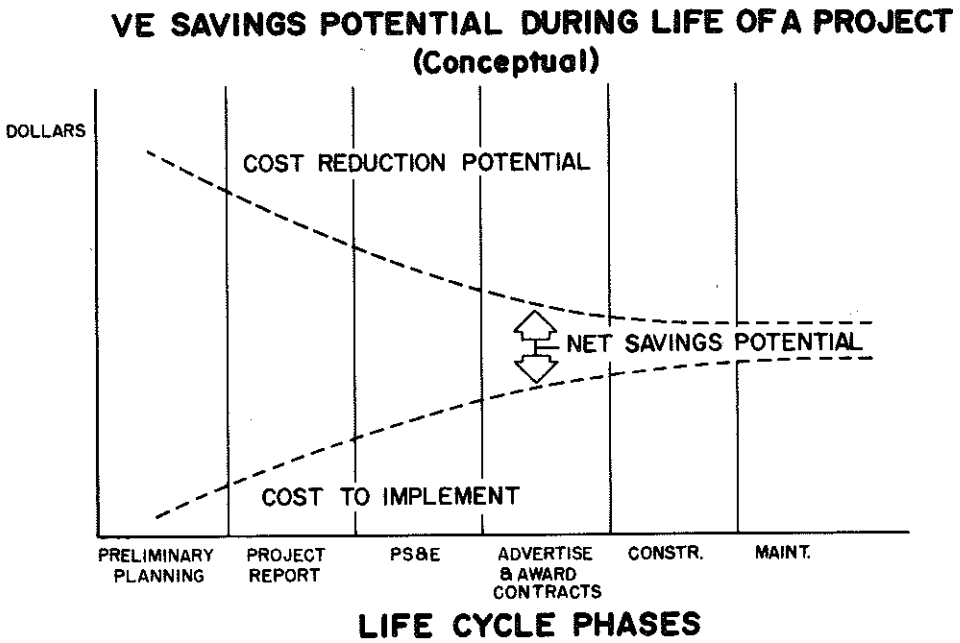

Figure 2

decisions made in the early stages of project development have considerably more influence on life-cycle costs than those made later in the PS&E, construction, and maintenance phases.

Location and Site of Team Effort

It is of great benefit to a value engineering team to be able to conduct its study somewhere near the actual project location. The opportunity to visit the project site provides valuable insight into the field conditions that must be considered during the VE study. At any rate, it should be conducted where the most pertinent information is easily obtainable.

Basic Design Data

For optimum results, value engineering should be applied as early as possible after basic design elements and preliminary cost information have been developed. It is essential that this basic information be available and organized before a VE study is begun.

For studies where gathering this information is part of the VE team activity, team members may determine what additional data they require. Where

the design office supplies the VE team with study data, the VE coordinator should establish a checklist of items that would be essential and/or beneficial for the team study.

Length of Study

The time required for a value engineering study may vary considerably, consistent with the diversity of VE approaches. When a VE team is assembled to work exclusively on a VE study of a specific project, and where all necessary information is assembled in advance, the time required may be as little as three days. When a VE team works intermittently on a VE study, the study may require several weeks to complete. Breaks in the study will often allow time to compile or search out additional useful information. It is important to establish a definite time for completion.

Team Study Record

A Value Engineering Study Record or other organized format is compiled during the VE study as a step-by-step record of the VE analysis. The record should be complete and understandable, as it becomes an essential part of the final product of the VE team. It serves as documentation to support the team's recommendations, tracks the team's deliberations and considerations, and aids in implementation of the recommendations.

VE Team Presentation

When a VE team study takes several weeks to complete, the team leader should brief the involved managers periodically during the progress of the study. The completion of a study by a VE team consists of a formal presentation of their recommendations to the state's management and appropriate staff who must evaluate and implement the findings. This presentation should be brief, with time allocated for management or staff to question the team on any concerns they may have. This presentation and discussion period helps to establish the viability of the team's recommendations.

D. IMPLEMENTATION AND REVIEW

It is important that all recommendations receive serious consideration; however, it may not be possible to implement all recommendations. Obviously, conducting a VE study is only part of a VE program. Full and fair evaluation of all proposals and implementation of those determined to be viable is also a major part of the value engineering program.

Later, as study recommendations are implemented and savings are actually

realized, this information should be publicized throughout the organization. This keeps employees aware of the value engineering accomplishments and results and serves to promote VE as a team effort of the entire organization.

Five common barriers to implementation of VE study recommendations are:

- *Poor documentation or insufficient supporting data.* If the support for and rationale behind study recommendations are inadequate or incomplete, the VE study report probably will not be convincing, in which case recommendations are not likely to be implemented.
- *Imbalance of priorities.* If the state generally gives a much higher priority to "getting out the program" than to achieving a balanced, cost-effective design through implementing viable VE recommendations, the VE effort will suffer.
- *Inadequate appreciation, understanding, and acceptance of VE potential.* This barrier may present itself in circumstances where there is little incentive to do a cost-effect project. It may also surface on routine projects that are perceived as "standard designs."
- *Resistance to change.* Where management support is uncertain, or statewide VE training and orientation is inadequate, the review of final value engineering study recommendations may result in the defense of an original design rather than a fair appraisal of the validity of the VE recommendations.
- *Study completed too late.* If a VE study is scheduled too late in the project development process, opportunities for implementing the recommendations are usually lost due to tight project schedules.

Progress should be reviewed periodically to ensure that any roadblocks that arise are overcome promptly.

In addition to evaluating the success of VE implementation on individual projects, an annual review of the state's VE program is recommended. This summary of statewide VE activity provides an overview of the strengths and weaknesses of the VE program, and identifies policies or procedures that need improvement in order to upgrade the program for future value engineering efforts.

III. CONSTRUCTION VE GUIDELINES

A. VALUE ENGINEERING PROPOSALS BY CONTRACTORS

Value engineering change proposals (VECP) programs differ from other VE programs in that the recommendation is developed by the construction contractor, who chooses whether or not to participate. The state's role becomes one of creating and managing a program that will be attractive to the contractors. This program is called by different names in the various states; for example, Value Engineering Incentive Provision (VEIP), Value Engineering Incentive Clause (VEIC) and Cost Reduction Incentive Proposal (CRIP).

A contractor's participation in a VECP program involves a certain amount of risk. It costs money to search for realistic savings that will be shared by the state, and the contractor cannot expect that all proposals will be accepted. However, the program offers an opportunity to the contractors to demonstrate ingenuity and construction excellence and receive financial benefit.

Care should be taken to ensure that a VECP does not compromise any essential design criteria or any preliminary engineering commitments such as environmental mitigation measures. Certain construction elements may be excluded from consideration for a VECP.

B. BENEFITS

The VECP program offers benefits to the state in instances where a change proposal (without impairing essential functions and characteristics of the items or of any other part of the project including but not limited to service life, reliability, economy of operation, ease of maintenance, desired aesthetics, and safety) offers one or more of the following:

- Enhances the design at reduced cost to the state.
- Results in a net savings over the contract cost.
- Advances the project completion date.

The program offers a low-cost opportunity to use the experience and creative talents of the contractor. Contractors participating in the VECP program take pride in contributing actively in the final development and construction of the project.

C. VALUE ENGINEERING INCENTIVE CLAUSE (VEIC)

To invite VECP's from the contractors, the state includes in the contract document a Value Engineering Incentive Clause (VEIC) specifically defining the basic requirements and evaluation criteria of the program. Before initiating a VECP program, a state may want to secure an interpretation from the attorney general or other appropriate source as to the legality of their VEIC

provisions. VEIC specifications and requirements are described in Section 104.07 of the AASHTO Guide Specifications for Highway Construction dated May 23, 1984 and are not further discussed in this document.

D. SECURING AND MAINTAINING CONTRACTOR PARTICIPATION

The first step in securing adequate contractor participation is to be certain that the VEIC encourages, rather than discourages, such participation. For instance, the sharing percentage must be equitable, the VEIC requirements, policies, and procedures should not be so legalistic, stringent, or cumbersome as to discourage contractors from participating, and there should be flexibility to meet changing conditions.

Past experience indicates that contractors need to be oriented to the VECP program and educated about VE methodology and procedures. A state initiating a VECP program should do what is necessary to ensure that an effective contractor orientation and education program is developed and conducted. Otherwise, many contractors will probably be reluctant to participate. Some suggested approaches to contractor orientation and education are:

- The state should work closely with contractor organizations during the whole of the VECP program planning process. It is important that contractors have the opportunity to review all elements of the program, and provide input. The payoffs from this kind of a joint effort, in terms of contractor support and participation, can be considerable.
- The state should encourage contractors to develop and conduct VE training courses. Where the state is conducting VE training for its own personnel, contractor personnel also could attend such programs.
- The contractor orientation, education, and promotion program should be a continuing one. Continuing efforts could include regular and periodic distribution of VE information and discussion of VE during preconstruction conferences.

Most of these approaches are obvious, and certainly many others could be developed to fit particular conditions. What is important to emphasize is that a well-planned, aggressive, and imaginative contractor VE orientation, education, and promotion program will greatly enhance the probability of the success of the VECP effort.

Even though initial contractor participation is secured through this type of promotion, the VECP program will not be successful unless a high level of participation is maintained. Three considerations are necessary for maintaining contractor participation:

- The state must ensure adequate opportunities for participation by providing a broad incentive clause in their standard specifications.
- Contractors must be assured of a fair and objective evaluation of their

proposals. This requires that the state take all reasonable measures to create positive attitudes toward contractor change proposals. It may be beneficial to involve the VE coordinator in the day-to-day VECPs.

- Contractors must be assured of timely processing of change proposals. To satisfy this requirement the state should allocate adequate resources to the program.

IV. OTHER BENEFITS OF A VE PROGRAM

In addition to the obvious benefits received from a value engineering program, there are a number of positive influences. Some recognized side benefits are:

- Design, construction, and maintenance standards are constantly being reviewed through VE team activities.
- The structured, functional approach using a job plan provides trained employees with a new method of approaching all problems.
- Value engineering team members develop an appreciation for the concerns and issues of other functional areas or disciplines and communications are often improved.
- Team work skills and team dynamics are enhanced in the design process.
- Designers improve or develop their skills in preparing and delivering to management logical, organized presentations supporting their views.
- After receiving VE experience, many designers find it comparatively easy to apply the principles in the regular design process.
- Implementing a VECP program has a potential for improving state/contractor relations through more cooperative processing of change proposals.
- Proven VE designs or techniques and VECP accepted changes often have application on numerous future projects or contracts, thereby providing continuing savings and other benefits.

APPENDIX I

Value Engineering Publications

VALUE ENGINEERING PUBLICATIONS

The publications listed below provide useful information on establishing and conducting VE programs.

Value Engineering in Preconstruction and Construction, NCHRP Synthesis of Highway Practice 78, by O. D. Turner and Robert T. Reark, September 1981. This report includes a broad description of the fundamental concepts of value engineering and the key elements of VE methodology, to show how VE is different from traditional cost reduction approaches. It also covers implementation guidelines and value engineering incentive clause programs.

Guidelines for Value Engineering (VE), prepared by Task Force #19, Subcommittee on New Highway Materials, AASHTO-AGC-ARTBA Joint Cooperative Committee. Reprinted by FHWA February 1983. A concise overview of how to establish a value engineering program for highway projects, how to select appropriate projects, and how to effectively conduct a VE study.

Value Engineering for Highways, by Kempter-Rossman International for FHWA. 1980. Revised October 1983. A comprehensive text on VE development and history, fundamentals, principles, and the steps of a VE study from project selection through the audit phase. Includes a chapter on human relations and an appendix of sample VE projects.

AASHTO Guide Specifications for Highway Construction, Copyright 1985. Section 104.07 gives detailed specifications for VE proposals by contractors. This document provides guidance for a Value Engineering Incentive Clause for a VECP program.

Value Engineering Contract Provisions on Federal-Aid Highway Construction Projects, FHWA Report No. FHWA-TS-84-216, by Kempter-Rossman International, December 1984. This study was conducted to determine if the Federal-aid Highway Program was receiving the maximum benefits from the use of value engineering contract provisions in Federal-aid construction contracts. The report is based on data from 19 states and is a good representation of VE incentive clause programs, problems, benefits, and recommendations.

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