

VALUE ENGINEERING**JGS 210-120-1-76E**

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1. SCOPE

This standard practice provides the basic procedure for Value Engineering (VE).

2. GENERAL**2.1 Principles**

The following are the principles of VE.

2.1.1 Concept

VE is a problem solution methodology, and is generally defined as below.

Value Engineering is an organized effort directed at analyzing the functions of products and services to achieve those necessary functions at the lowest life-cycle-cost.

VE has 4 notable aspects, which are:

- (1) Team effort
In order to generate alternatives of higher value, it is necessary to organize sufficient expertise and effort.
- (2) Function approach
The function of products and services is focused, and the alternatives which can achieve the required function will be sought.
- (3) From the viewpoint of client
Value means the client's satisfaction, and the results should be evaluated by the client.
- (4) The lowest life-cycle-cost (Refer to 2.1.3)
Cost shall be the lowest, taking not only investment cost but also operating cost and demolition cost, etc. into account.

2.1.2 Function and Value

Function is the intent or purpose of products and services.

Value is determined by comparing the function with the cost which is paid in order to obtain the function. Value is expressed in the following relationship.

$$\text{Value} = \frac{\text{Function}}{\text{Cost}}$$

There are 4 patterns of relationship between function and cost (life-cycle-cost) achieving an increase in value, as shown in the following table.

Pattern	1	2	3	4	Caution
Function	↑	→	↑	↑	↓
Cost	↓	↓	→	↑	↓

Pattern 1. Function goes up, Cost decreases
This is the ideal pattern.

Pattern 2. Function stays equal, Cost goes down
This is the most usual approach. Cost reduction is realized by, for example:

- Deletion of redundant functions
- Using alternatives with the same function

Pattern 3. Function goes up, Cost stays equal

Cost reduction is not the only purpose of VE. This pattern is important to achieve higher value within the budget.

Function increases when the following items are improved:

- Capacity
- Yield Rate
- Properties of Products
- Plant Availability (Rate of Operation), etc.

Pattern 4. Function goes up more than Cost goes up

In this pattern, exhaustive consideration is necessary, because this pattern means, from the viewpoint of the client, exceeding the initial budget. If the client does not agree the necessity of the improvement in the function, these alternatives should be withdrawn.

There is one other pattern. It is the case where Cost reduces more than Function (as per the "Caution" case above). This is not included as a solution under VE, because a required function is deleted.

It is possible that, through careful analysis, unnecessary functions would be found out among the functions that are believed to be necessary by the client. Removing those unnecessary function is a VE solution. However when this sort of alternative is proposed to the client, serious consideration shall be given to whether it can be accepted by the client.

Value is improved in order to satisfy the client. Therefore it should be borne in mind that the client, not JGC determines the value.

2.1.3. Life-cycle-cost

Life-cycle-cost is the cost of ownership.

The calculation method of life-cycle -cost is specified in para. 3.2.5.

The following costs over the life of products and services should be taken into account.

- Development, Design/Engineering
- Procurement, Production/Construction
- Sales, Administration
- Operation, Demolition

The following costs are main factors of life-cycle-cost.

(1) Capex (Capital Expenditure)

This is the initial investment amount. It means not only contractor's EPC cost but also the client's other initial costs.

(2) Opex (Operation Expenditure)

These are the expenses that occur when the plant is in operation. They comprise Fixed Cost and Variable Cost.

Variable Cost includes, for example, expenses for utilities, catalysts and chemicals, etc.

Fixed Cost includes, for example, expenses for labor, sundries, local/head office, service company, etc.

As the case may be, the Demolition (Disposal) cost which occurs when the plant is demolished, will also be calculated.

2.2 Application of VE

VE can be applied to any products and services which have a function.

To JGC, the following applications of VE are possible.

2.2.1 Internal VE

This application type of VE is conducted within JGC. Sometimes vendor/subcontractor is included as a team member.

(1) VE at proposal stage

In order to win the bid, higher value alternatives (mainly cost reduction) are considered.

General Manager of Project Systems Division will order VE on the important estimation jobs.

(2) VE for improvement of the particular unit/service

This application type of VE is possible to be performed both by JGC solely and by JGC with vendor/subcontractor who supplies the particular materials or service. Careful attention should be paid in selecting vendor/subcontractor as a VE team member (refer to 2.5.2) and in sharing the fruits of VE.

(3) Department VE (In-house VE)

VE which is conducted to resolve the problems of the department. Sometimes the staff of other departments will join as VE team members.

2.2.2 VE with Client**(1) VE at the planning stage or Feasibility Study stage of the project**

This VE is performed with the client from the planning stage or Feasibility Study stage of the project.

If the client and JGC enjoy a close relationship, like an "Alliance", there will be a high possibility that this type of VE is performed.

(2) VE at the execution stage of the project

VE is performed with client after award of the contract of the project.

2.3 Timing

VE can be conducted at all phases of the project. However, the earlier in the project VE is applied, the more benefit can be achieved. The appropriate time to apply VE is considered to be as follows.

(1) At the end of Feasibility Study Stage

At this stage, the following points are focused on.

- Technical design
- Removing redundancies
- Reducing life-cycle-cost
- Integration
- Line-ups
- Design temperature and pressures
- Equipment design
- Materials of construction
- Applied standard
- Project schedule, etc.

The target of benefit (mainly cost reduction) in NPV (Net Present Value) is between 10% and 50 %.

(2) At the end of FEED Stage

At this stage, the points primarily focused on are,

- The cost effectiveness of the chosen engineering solutions
- Removing redundancies, reducing life-cycle-cost, etc.

It is possible to propose alternatives which offer large scale changes, however the loss incurred by rework of design or re-planning of project schedule should be taken into account. Therefore, the alternatives are usually limited to the most appropriate design within the specified scope.

The target of benefit (mainly cost reduction) in NPV is between 5% and 25%.

2.4 Term

The term will vary with the following items.

- (1) Subject
 - Plant type (Refinery, Petrochemical, or other plants)
 - Plant capacity
 - Scope of work
- (2) Time limit
- (3) Target of benefit

For the evaluation phase and development phase of the job plan to be executed very roughly, it will take typically about one week.

2.5 Personnel Involved**2.5.1 Steering Committee**

The Steering Committee is the upper organization of the team members, and is management level. When VE is conducted by JGC with client or vendor, a person from client or vendor should join the Steering Committee.

The roles of the Steering Committee are as follows:

- (1) Decide that VE should be applied on the specified project.
- (2) Assign the team members.
- (3) Give the team members the target of benefit from VE.
- (4) Give the team members time limit and available M.H.
- (5) Evaluate the alternatives resulting from VE, and decide whether they are useful or not.

2.5.2 Team Members

Team members actually conduct the VE work. Usually the number of team members is from 5 to 8, including a team leader.

The relationship between the application type of VE and participants is shown in the next table.

Application Type of VE	Client	JGC	Vendor/ Subcontractor
Internal VE			
(1) VE proposal stage		◎	○
(2) VE for improvement of the particular unit/ service		◎	○
(3) Department VE		◎	
VE with client			
(1) VE at the planning or feasibility study stage -	◎	◎	○
(2) VE at the job execution stage	◎	◎	○

◎ Necessary

○ as the case demands

In the case of VE on a project, team members will be selected from the engineers of the following expertise, for example.

The necessary expertise will vary job by job, however members should have sufficient expertise to guarantee adequate investigation of all aspects.

- Project Coordination
- Cost Estimation
- Process
- Utility
- Civil & Architecture
- Piping
- Rotating Machinery
- Equipment
- Furnace
- Electricity
- Instrumentation
- Fire Protection
- Operation & Safety
- Procurement
- Construction
- Sales, Marketing
- R&D, etc.

2.5.3 Facilitator

Facilitator will arrange and facilitate the meetings.

2.6 Evaluation

At the last stage, the investment efficiency of VE activities should be evaluated. The efficiency is calculated using the following formula.

$$Efficiency = \frac{A}{B}$$

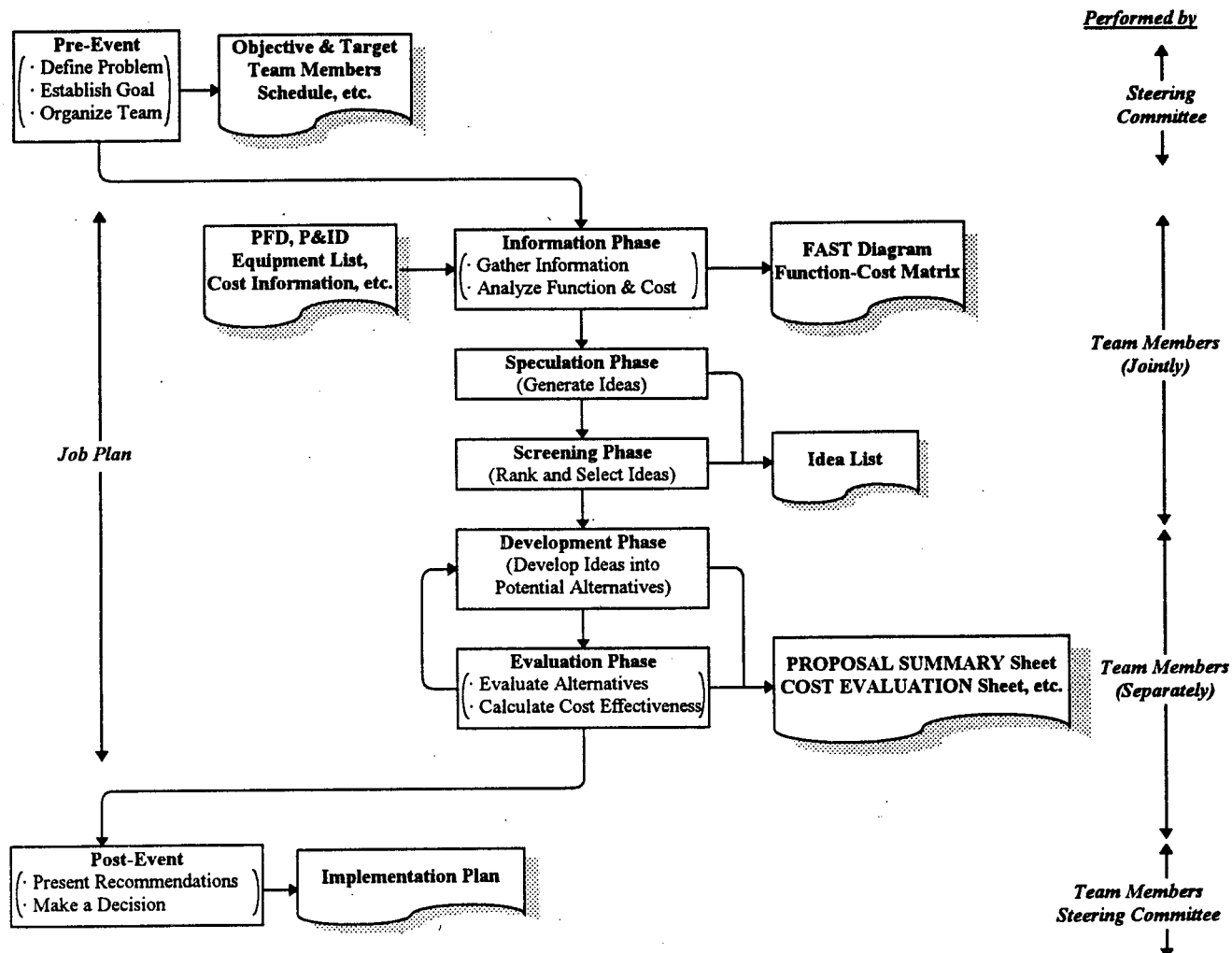
A: Cost Effectiveness (Net Present Value)

B: Spent M.H × Unit Cost of M.H (Input)

3. WORK PROCEDURE

In this standard practice, a job plan for internal VE at the estimation stage is described, as follows.
Reference is made to Fig. 1. (Value Engineering Procedure)

Fig. 1 Value Engineering Procedure



3.1 Pre-Event (Planning)

- (1) Deputy General Manager of Project Systems Division, who is on the Steering Committee, decides whether to apply VE or not to the estimation of a project, at a meeting to define the estimation policy.
- (2) Engineering Manager sets the target benefit and obtains the approval of the Deputy General Manager.
- (3) At the stage of defining the detailed policy for estimation, Engineering Manager and key persons from each discipline decide the following items.
 - Categories to be subject to VE
 - If several categories are chosen, fix each category's target benefit
 - Team members (usually 5 to 8 members for every category)
 - Schedule (Time limit and M.H)

3.2 Job Plan

From this stage, actions are executed by team members. The actions are structured sequentially, and the phases form the "Job Plan"

3.2.1 Information Phase

The main activities of Information Phase are (1) gathering all information on the project and (2) analyzing the function and cost.

(1) Gathering Information

Studying ITB intensively forms the most substantial part of this work.

(2) Analyzing the function and cost

This activity is performed through the following 3 steps.

(a) Identify the function of the components. Function is defined by using two words, a verb and a noun.

(b) Make a functional diagram which shows the functional relationship of the components.

(c) Allocate cost to the functions.

(3) The purposes of these 3 steps are;

(a) It enables the depth of all team members' understanding of the subject to approach the same level, and the viewpoint to change from components to functions.

(b) The function identification and cost allocation highlight VE team's focal function areas. (The functions of lower value become focal function areas in general.)

Function Analysis System Technique (FAST) is one of the main methodologies of analyzing the function and cost. (The steps in Function Analysis System Technique are given in A.1)

3.2.2 Speculation Phase

In the information phase, the functions were identified and the focal functions were selected.

The main activity of the speculation phase is to generate ideas which can achieve the selected functions. Team is required to generate as many ideas as possible, not solutions.

In order to generate ideas, the brainstorming method is usually adopted. The 4 rules of brainstorming are;

(1) No criticism is allowed. (Judgment is suspended until subsequent step.)

(2) Freewheeling is welcomed. (The wilder, the better.)

(3) Quantity, not quality. (The greater the number of ideas, the more the likelihood of success.)

(4) Build on others' ideas. (Combination and improvement are sought.)

All ideas are immediately recorded. In order to record them, a blank form sheet (Refer to A.2) can be used.

3.2.3 Screening Phase

The speculation phase, if successful, will have resulted in a great number and variety of ideas. Once all ideas are aired, team members will execute rough screening.

(There are various kinds of screening technique; one method known as the GFI Method is described in A.3)

The purpose of the screening is to select ideas which should be sent on to the next phase. The ideas should be evaluated from the viewpoint that they can achieve both technical and economic expectations.

3.2.4 Development Phase

The ideas which survive the screening phase are developed into attractive and realizable alternatives. The ideas will be refined to alternatives of higher value through the following steps.

(1) Combine ideas

The ideas themselves are incomplete and fragmentary. By combining ideas, they can form concrete alternatives to some extent.

(2) Identify advantages and disadvantages of ideas**(3) Overcome disadvantages**

It is usual that an alternative at this stage has some disadvantages. Means of overcoming all disadvantages should be sought.

If information from outside of the team is necessary to overcome disadvantages, team members will gather it immediately.