VOLUME II
PART B
VALUE ENGINEERING

VOLUME II

TECHNICAL, COST ESTIMATING AND VALUE ENGINEERING REQUIREMENTS

PART B - VALUE ENGINEERING

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VOLUME II

TECHNICAL, COST ESTIMATING, AND VALUE ENGINEERING REQUIREMENTS

PART B - VALUE ENGINEERING

1.1 **GENERAL**. Value Engineering is an organized study of functions to satisfy the user's needs with a quality product at the lowest life cycle cost through applied creativity. The intent of this section is to provide guidance on the execution of professional Value Engineering studies for the U.S. Army Corps of Engineers and ultimately present customers with improved project quality, best project value, satisfying customer needs and the reduction of project costs without the reduction of project quality.

1.2 **APPLICABLE PUBLICATIONS**.

AR 5-4 and OCE Supplement I	Department of the Army Productivity Improvement Program (DAMPIP)
AR 672-20	Incentive Awards
DR 1180-1-1	Construction Contract Modification
EP 11-1-3	Value Engineering Officer's Operational Guide
ER 5-1-11	USACE Business Process
ER 11-1-321	Army Programs, Value Engineering
ER 37-2-10	Accounting and Reporting - Civil Works Activities
ER 37-34-5-10	Accounting and Reporting - Military Activities
FAR Part 48	Federal Army Regulations, Value Engineering
FAR Part 52.248	Federal Army Regulation, Value Engineering

1.3 **PRECONCEPT SUBMITTAL REQUIREMENTS**. VE Studies will not be performed on preconcept submittals. Any studies of project criteria will be performed by the Savannah District VE Officer (VEO).

1.4 **CONCEPT/EARLY PRELIMINARY (35%) DESIGN SUBMITTAL REQUIREMENTS**. VE Studies for concept/early preliminary design submittals will be performed during the design review period. Results of the studies shall be received by the Savannah District at the same time that design review comments are received and coordinated. Once the VE suggestions to be adopted are approved by the User, the design A-E or the inhouse (IH) designers and Project Manager (PM) will determine if the approved items are outside the original scope for design

services. If so, a modification to the contract will be issued prior to the incorporation of the items with the final design. Start of final design will not necessarily have to wait on the processing of a modification if other nonrelated work can be started.

1.5 **SIXTY PERCENT (60%) SUBMITTAL REQUIREMENTS**. VE Studies will normally not be performed for a project with a requirement for a 60 percent submittal. .

1.6 **FINAL (100%) DESIGN SUBMITTAL REQUIREMENTS.** VE Studies will normally not be performed on final design submittals. If studies are made, they will be due to the project cost being over the budget or due to failure to perform VE Studies earlier or due to a reduction in the programmed amount during the final design phase. Remarks concerning concept/early preliminary design will be applicable to final design. If VE findings are small in scope, the necessary changes or additions may be incorporated during the corrected final period. If VE findings have a major impact on the design, then a contract modification to include a contract time extension will be necessary.

1.7 **CORRECTED FINAL DESIGN SUBMITTAL REQUIREMENTS.** VE Studies will normally be performed prior to the corrected final design submittal.

1.8 **VE STUDIES FOR REQUESTS FOR PROPOSAL (RFP)**. VE studies will be performed on Design-Build requests for proposals prior to advertisement as scheduled by the Project Manager. VE studies for RFP packages are in essence an in-depth technical review of the entire package which includes instructions, technical criteria and often a detailed site design. The same Value Methodology shall apply to VE studies performed on Requests for Proposal and shall result in full VE Study Reports No.1 and No.2.

1.9 **VE VERSUS DESIGN.** VE encompasses a "new look" by a SECOND TEAM approach which objectively analyzes a system and its functional purpose and its interface with other systems to achieve the required function at least cost commensurate with its useful life and time frame. The prime purpose of this analysis is not to find fault or tear down the original designers, but rather to determine if the function is actually worth the cost. A comprehensive functional analysis study to identify high cost-low worth or low value items and/or entire systems is essential to the organized VE team approach. The expected cost-benefit ratio of study cost to savings is generally 1 to 30 or greater. The subject of additional design fees to incorporate VE alternatives will be considered and negotiated on a case-by-case basis.

1.10 **BEFORE THE VE METHODOLOGY CAN BE APPLIED.** Items for the building, process and production equipment, site work, site utilities, and support features of potentially "high cost and low worth" must be isolated. As part of the VE process, a cost model to identify the component costs must be prepared and included in the VE report.

1.11 **SCOPE OF WORK.** VE service shall include a VE analysis of the entire design package. The Value Engineering Study (VES) shall consist of a minimum of one 40-hour team study by a multi-discipline team of professionals. The study group will follow the five-step job plan (see paragraph 1.17) as recognized by the Society of American Value Engineers (SAVE). A VES Report No. 1 shall encompass the recommendations of the VES team with detailed "BEFORE" (as designed) and "AFTER" (VE alternative) cost estimated life-cycle cost considerations with calculations, sketches, and isometrics as necessary. A VES Report No. 2 will be a summation of those items that were accepted by the Government and which shall be incorporated into the final design package. A formal oral presentation to the design A-E or the IH design team and to

the Government will be required as delineated under paragraph 1.16 and 1.19 of these instructions.

1.12 **VALUE ENGINEERING STUDY SERVICES.** Services shall be performed in accordance with the schedules set forth in paragraph 1.19 of these instructions.

1.13 **ESTABLISHMENT AND APPROVAL OF THE VE TEAM.** VE analysis necessitates that the VE effort be performed by a separate or independent firm or group of experienced professional designers not associated with or in the regular employment in the same firm or firms performing the original design or proposals. These VE services should be performed by a qualified firm or persons having Certified Value Specialist (CVS) credentials or minimum Associate Value Specialist (AVS)that qualify them to perform such services. In all situations, the team leader shall be responsible for and shall select his own team members to meet the foregoing requirements and qualifications.

1.13.1 *Members*. The VE team size shall be as required to provide VE expertise in all design disciplines included in the original design. However, in instances where a discipline has little impact on the total project cost and/or contributes an insignificant design portion of the overall project, a waiver may be granted only by the VEO. Although the VE team members shall not be the same personnel that are involved in the original design or proposal, is not to be construed or interpreted to rule out consultation and partnership between the design A-E and VE disciplines which are mandatory and vital to achieve a well-balanced and cost effective workshop.

1.13.2 *VE Experience*. All members of the team shall be completely knowledgeable of VE methodology. The VE Team Leader will be CVS or AVS certified by the Society of American Value Engineers or as a minimum with the approval of the VEO, a person who has completed the Corps of Engineers 40-hour VE Workshop or equivalent certified training approved by the Society of American Value Engineers with demonstrated professional leadership, experience, and qualifications. Practical experience is considered to have been gained primarily by being actively engaged as a consultant and leader in VE activities. All members of the VES team shall have prior VE experience and training, thereby making the 40-hour team study or workshop effective and accomplished within the shortest time frame.

1.14 **VE AND A-E FIRM REQUIREMENTS.**

1.14.1 *Typical VES Team Requirements (Subcontracted VES)*:

a. Qualified Architect or Engineer/CVS/AVS Leader.

b. Structural Engineer.

c. Mechanical Engineer.

d. Electrical Engineer.

e. Civil Engineer.

f. On a case-by-case situation, Cost Estimating/Life Cycle Analysis and Drafting technician.

g. Obtain overview of original design from design A-E.

h. Site visitation (on a case-by-case basis).

i. At the termination of the VE Workshop, the VE Team Leader will make a formal presentation to the design A-E or the IH designers, the User and the Government.

j. The VE Team Formal Presentation to the Government, design A-E, User, and others will be held at the project site, unless otherwise specified. It is anticipated that a maximum of two disciplines may be required. See paragraph 1.15.2 of this guide.

k. Preparing Report No. 1, including the following mandatory enclosure:

Executive Report format with summary of initial cost savings attached. The savings must be checked off as "proposed" in Report No. 1.

l. Other Requirements for VES:

(1) The specific level of effort will be developed for the VES team based on the scope and nature of the specific project and should consider other factors such as geographical location.

(2) The PM shall coordinate the VE workshop with the VEO, the User, the IH designers, the design A-E and the VE firm as far in advance as possible. The PM shall notify all participants by phone and in writing 2 weeks or more in advance of the workshop dates to allow for adequate scheduling.

(3) The Savannah District VE Officer shall be put on "Copy to" list of review conference minutes and any correspondence relating to VE.

1.14.2 *Typical Design A-E Effort for VE Briefing and Review Response of the VE Study*. The specific level of effort for support of the VES, review of the study results, participation in the Report No. 1 presentation, and preparation of Report No. 2, which will be prepared by the VE A-E or the IH VE team, shall be based on the scope and nature of the specific project and should consider factors such as geographic location. The level of effort will be determined by negotiations.

1.14.2.1 First day of the VE Team Workshop - VE Team meets in geographical location of the design, where the designers and the user present an overview of the original design to VES team. The design team includes only design A-E or IH disciplines, ie, Project Engineer Manager, Architectural, Structural, Mechanical, Electrical, and Civil, as appropriate.

1.14.2.2 At termination of the VE Workshop or upon completion of VE Report No. 1, the VE Team Leader makes a formal presentation of VE proposals to the designers, User, and PM. The designer then joins and interacts in partnership with the VE firm by phone to supplement the VE effort in preparation for the VE Study Report No. 1 presentation. The design A-E or IH design team and the user shall review each VE change proposed by the VE Team Study and reach an agreement on acceptability. If the proposal, however, is totally unacceptable, it shall be included in the report as having been considered by the VE Team and the rejection shall be accompanied by specific technical reasons for the rejection. Upon a mutually agreeable understanding between the design A-E or the IH design team and the VE firm, the proposal may be indicated as "void" within Report No. 1 and then discussed at the oral presentation.

Inasmuch as the designers may wish to include their response during the minutes covering the VE formal presentation, his response need not be in writing prior to the presentation.

1.14.2.3 The designers, VEO, PM, User and VE team shall meet at the Savannah District or other designated geographical location for the VE Study Report No. 1 review conference where the formal oral presentation is made by the VE Team Leader. Resolution of VE proposals and concurrence or nonconcurrence is achieved at this scheduled meeting.

1.14.2.4 At the conclusion of the VE presentation of Report No. 1, the VE A-E or the IH VE team shall prepare Report No. 2 which shall reflect the final decision of the Government's management team. Report No. 2 shall include the VE Proposal Summary Listing with summary of initial costs savings with those proposals indicated as “Accepted”. The Return on Investment (ROI) is to be completed by the Government VE Officer.

1.15 **STUDY GROUP REQUIREMENTS AND ENVIRONMENT.**

1.15.1 *Information Required*. Prior to commencing a VE Study, the design A-E or the in-house design team will make available, as far in advance as possible, the following information to the VES Team:

a. Four sets of full size drawings or Request for Proposals.

b. Two sets of detailed cost estimates for full designs for parametric cost estimates for RFPs.

c. Two sets of specifications for full designs.

d. DD Form 1391 and PDB or other project justifications and description of project pertinent to criteria as appropriate.

e. Basis of design.

f. Pertinent technical requirements including technical portions of design manuals that may constrain achieving needed function at lowest overall cost consistent with desired performance.

g. Design calculations (Mechanical, Electrical, etc.)

h. Boring logs and soil reports.

i. Life cycle cost calculations and energy studies based on 25-year life cycle and 10 percent annual discount rate unless otherwise directed.

j. Other project information such as catalog cuts, photographs of the site, design and criteria manuals, etc., that will be useful to the VES team during the study period.

1.15.2 *Environment*. The VES Team shall be assembled and isolated away from their normal work station in order to avoid daily interruptions such as phone calls, quick questions, brief meetings, etc., which are very disruptive. If circumstances require it, an appropriate meeting room, motel room, etc., should be rented for the workshop to provide the following:

a. Room size to accommodate all VE study participants and preferably isolated from normal environment.

b. Adequate lighting for prolonged reading, writing, etc.

c. Tables large enough to accommodate full size drawings and chairs for all VE study participants.

d. Proximity and access to telephones and duplicating machines.

e. Blackboard and/or flip chart.

f. Projectors and screens.

g. Current estimating books, at least three-holed punch, scissors, scales, tracing paper, multi-color felt tip pens, loose-leaf notebooks, etc.

1.16 **BASIC REQUIREMENTS FOR VE.** VE studies shall be accomplished using a functional analysis approach. It should be noted that cost reduction actions cannot be labelled "Value Engineering" unless the action includes identifying the function, brainstorming and selecting the alternative that will perform the required function at the lowest total cost considering performance, reliability, quality, and maintainability. The five-phase VE Job Plan shall be used and is as follows:

a. Information. For information gathering and identification of high cost - low worth functions. Define and analyze design, evaluate function, and establish worth. Note: Original design team is required to present the VE Team with an overview of original current design. The design team, VE Team and PM shall attend.

b. Creative (Speculative) Phase. For brainstorming the generation of alternative ideas by means of creative thinking atmosphere and the withholding of judgment during this phase. The design team, VE Team and PM shall attend.

c. Analysis (Judgment/Judicial) Phase. For evaluating and judging each alternative idea for merit and separating needs from desires. List basic advantages/disadvantages, compare, evaluate, refine, and select best alternative ideas for development of firm proposals. The design team, VE Team and PM shall attend.

d. Development Phase. Fully develop and summarize best alternative ideas using accurate and realistic costs. Develop "before" and "after" cost comparisons with net savings. Discard alternatives that prove to be not cost effective or of low value. Only the VE team shall attend.

e. Presentation Phase. Prepare a formal presentation report in sufficient detail for the fully developed viable alternatives including view-graphs, savings, and recommendations needed to implement each specific VE proposal. The report must be in sufficient detail to permit a technical review to evaluate the merits of each proposal. The design team, VEO or VE Team Leader, User and PM shall attend.

1.17 **REPORTS AND MINIMUM DOCUMENTATION REQUIREMENTS FOR VE.** The results of each VE Study performed on the project shall be documented as follows:

a. Reports and Minimum Documentation in final 8-1/2 x 11 format for both Study Report No. 1 and Study Report No. 2:

(1) Executive Report and contents page with summary of initial cost savings for both Report No. 1 and Summary Report No. 2.

(2) VE Study proposal summary listing with summary of initial cost savings. ROI to be completed by the Government VE Officer. Serves as a "Record of Decisions" and is mandatory for Report No. 2.

(3) Brief description of total project to include a site plan and current Project Amounts (PA).

(4) Brief summary of VE recommendations including initial and life cycle cost savings (provide "use" experience where material alternates are recommended).

(5) Each VE proposal will be described "Before and After VE" listing advantages and disadvantages. Sketches and isometrics will be provided as necessary to clearly depict VE proposals. Footnote new material and recommendations to change criteria.

(6) Each proposal will be accompanied with a detailed realistic cost estimate of savings. Life cycle cost analysis for energy proposals and other proposals, as appropriate, all in accordance with acceptable guidance

(7) Value Engineering Comments other than specific proposals will be included after last proposal.

(8) Appendices to include Contact Directory, Speculation List, VE cost model(s) of project plus bar graphs of subsystems, Functional Analysis Systems Technique (FAST) Diagram, DD Form 1391 and any other supporting documentation.

b. VE Report No. 1. This preliminary report shall be prepared by the VE Study Team and shall document the "VE Job Plan" and the results of the Value Engineering Study and services performed. The VE Team shall not be limited by the technical requirements and the design data, but shall challenge it except for the construction cost limitation which shall not be exceeded. Savings generated by criteria challenges and/or waivers to criteria shall be footnoted. All proposals and their respective original and proposed detailed estimates shall be documented in this report. Where clarification is deemed appropriate, the proposal shall be supported by rough-hand sketches, isometrics, drawings, descriptions, interface systems, specifications, and life-cycle cost to permit a thorough evaluation by the design A-E, the IH design team, VEO, PM and User. The report shall be concise, yet informative in all respects. If the VE study results in no recommended changes to the design, a detailed report indicating the effort and areas considered shall be submitted.

c. The Second and Final Report No. 2. This report will be prepared by the VES team and is a summation of those items that were accepted by the design A-E, the IH design team, VEO, PM and User. Report No. 2 shall be complete and final in all respects with all proposals resolved unless specifically reserved by the Government. Accordingly, Report No. 2 shall not list any items "Held in Abeyance" unless so directed. Description and summation of proposals shall include initial and life cycle savings for all proposals. Minutes of VE presentations shall be the responsibility of the Project Manager. A copy of the minutes shall be included in Report No. 2. The accepted proposals enumerated in Report No. 2 shall constitute a "Record of Decisions" on VE recommendations to be implemented if so directed by a separate order. Also, certain proposals that have been accepted in past VE studies will be accepted in future projects unless ruled otherwise by the Government.

1.18 **VE REPORT FORMAT.** Report No. 1 and Summary Report No. 2 (and other reports that may be called for in the scope of work) must be systematically assembled and must be short and concise, yet informative. VE reports shall be prepared and submitted for final reproduction on 8-1/2 x 11 paper. Pages must be sequentially numbered in the lower right-hand corner to facilitate assembly. Report No. 1 shall be referenced by Report No. 2. The reports shall be computer generated in accordance with the latest guidance.

1.18.1 *Numbering System*. If responding is necessary, the design A-E or the IH design team shall refer to the VE report using the same numbering system as in the VE report and in the same sequence as in the report submitted by the VE team. This will facilitate an orderly final review by all concerned parties.

1.18.2 *Alternatives*. All alternatives which are unacceptable to the design A-E, the IH design team, the User and the reviewers must be supported by reason for rejection, including technical, cost, codes, etc. All of the designers' calculations, both cost and technical calculations, should be included in an appendix. Also, all alternatives presented in the VE report, identified as Other Areas of Potential Savings, must be responded to in the same manner. Where possible, savings associated with these other areas should be included even though the savings are not shown by the VE Team in the VE Study.

1.19 **VE REPORT SUBMISSION SCHEDULES FOR ORAL PRESENTATION.** VE studies shall be submitted in accordance with the schedules as set forth in the Project Management Plan (PMP) and required number of submittals set forth at the predesign or prestudy conference.

1.19.1 *Working Relationships*. Copies of Report No. 1 shall be sent out (either electronically or hard copies) in time to be received and reviewed by the Government at least 2 weeks prior to the formal VE oral presentation. Report No. 1 shall receive concurrent review by the design A-E or the IH design team and the Government to include the Using Agency. The design A-E or the IH design team shall consult with the VES Team as necessary during the review time to identify problem areas or questionable VE proposals. It is envisioned that with a good harmonious relationship and the proper spirit of cooperation prior to the formal oral VE presentation to the Government, differences will have been resolved and agreement and concurrence will have been reached between the design A-E or the IH design team and the VE team regarding acceptable cost effective VE proposals or alternative proposals. Accordingly, the Government will have to rule only on those proposals involving criteria changes and those few proposals where agreement is in doubt.

1.19.2 *Presentation and Report*. In all cases, the VE Team will be required to make a formal oral VE presentation (using aids such as lap top computers with projectors, flip-charts, sketches, isometrics, or other acceptable methods) to the Government, the design A-E, and the User within a 2-week period (unless indicated otherwise) immediately following the submittal of VE Report No. 1. Prime A-E representatives shall attend the VE presentation unless otherwise scheduled. Copies of VE Report No. 2 will be prepared by the VES team and submitted following the oral presentation to the Government. It is particularly important that other cost effective suggestions that may evolve from attendees during the VE presentation to the Government be incorporated by the VES team in the VE Report No. 2.

1.20 **APPROVAL AND IMPLEMENTATION OF PROPOSED VE CHANGES.** The Contracting Officer may approve or reject in whole or in part any VE change and reasons for

rejection shall be included in the minutes of the formal VE presentation and Report No. 2. The implementation of approved VE changes shall be the incorporation of the approved changes into the final design of the project only as directed by the PM and the Contracting Officer under the changes clause of the contract.

1.21 **SPECIFIC INSTRUCTIONS.** The VE proposals and ideas become the property of the Government and may be used on future contracts or designs without additional compensation to the A-E.

APPENDIX

Format for complete Value Engineering Study Report

Contact the District Value Engineering Officer (VEO) for the current working electronic format of this document

DOD SERVICE:USACE
CONTROL NO:
VALUE ENGINEERING OFFICER:

Value Engineering Study on the

TITLE

SUB-TITLE

LOCATION

DATE

U.S. Army Engineer District, _____

VALUE ENGINEERING FIRM NAME:
ADDRESS: 100 W. Oglethorpe Ave
Savannah, Georgia 31401
PHONE: (912) 652-XXXX

VALUE ENGINEERING STUDY TEAM LEADER: _____

VALUE ENGINEERING STUDY TEAM MEMBERS

VALUE ENGINEERING TEAM STUDY

TABLE OF CONTENTS

VALUE ENGINEERING TEAM STUDY

PROJECT DESCRIPTION AND BACKGROUND

PROJECT TITLE:
PROJECT LOCATION:

Include location Map

VALUE ENGINEERING TEAM STUDY
EXECUTIVE SUMMARY

Value Engineering is a process used to study the functions a project is to provide. As a result, it takes a critical look at how these functions are met and develops alternative ways to achieve the same function while increasing the value of the project. In the end, it is hoped that the project will realize a reduction in cost, but adding value over reducing cost is the focus of VE.

The Value Engineering Study was initiated during the VE workshop/conference conducted in the _____ during _____. The study was based on the District□s _____, dated _____. A site tour was conducted with _____ and VE Team Members on _____.

The project was studied using the Corps of Engineers standard Value Engineering (VE) methodology, consisting of five phases:

Information Phase: The Team studied drawings, figures, descriptions of project work, and cost estimates to fully understand the work to be performed and the functions to be achieved. Cost Models (see Appendix C) were compared to determine areas of relative high cost to ensure that the team focused on those parts of the project which offered the most potential for cost savings.

Speculation Phase: The Team speculated by conducting brainstorming sessions to generate ideas for alternative designs. All team members contributed ideas and critical analysis of the ideas was discouraged (see Appendix B).

Analysis Phase: Evaluation, testing and critical analysis of all ideas generated during speculation was performed to determine potential for savings and possibilities for risk. Ideas were ranked by priority for development. Ideas which did not survive critical analysis were deleted.

Development Phase: The priority ideas were developed into written proposals by VE team members during an intensive technical development session. Proposal descriptions, along with sketches, technical support documentation, and cost estimates were prepared to support implementation of ideas. Additional VE Team Comments were included for items of interest which were not developed as proposals, and these comments follow the study proposals.

Presentation Phase: Presentation is a two-step process. First, the published VE Study Report is distributed for review by project supporters and decision makers. The formal, oral presentation of the VE Study Proposals will be coordinated through the District on _____.

VALUE ENGINEERING TEAM STUDY
SUMMARY OF PROPOSALS

____ ideas for ways to improve the project or reduce costs were generated during the Speculation Phase of this study. The Analysis Phase of the study reduced the number of ideas to ___ for development of which ___ ideas were designated as design comments and are included in this report.

Of all the ideas from the Analysis and Development Phases, __ ideas became proposals which, when accepted, can result in maximum possible cumulative savings of **$**_____ for this $____ project.

Proposal No.	PROPOSALS	PROPOSED SAVINGS	ACCEPTED OR REJECTED

VALUE ENGINEERING PROPOSAL

PROPOSAL NO: PAGE NO: 1 OF 4
DESCRIPTION:

ORIGINAL DESIGN:

PROPOSED DESIGN:

ADVANTAGES:

1.
2.
3.

DISADVANTAGES:

.

JUSTIFICATION:

DRAWING NO. 1

Existing Condition

DRAWING NO. 2

Proposed Condition

VALUE ENGINEERING PROPOSAL

PROPOSAL NO: 1 **PAGE NO: 4 OF 4**

	COST ESTIMATE WORKSHEET				
	PROPOSAL NO.				
		DELETIONS			
	ITEM	UNITS	QUANTITY	UNIT COST	TOTAL
	None required				$0
					$0
					$0
					$0
					$0
					$0
					$0
					$0
					$0
					$0
					$0
			Total Deletions		$0
		ADDITIONS			
	ITEM	UNITS	QUANTITY	UNIT COST	TOTAL
					$0
					$0
					$0
					$0
					$0
					$0
					$0
					$0
					$0
					$0
					$0
			Total Additions		$0
		Net Cost Decrease/Increase			$0
	*	Mark-ups	22.20%		$0
		Total Potential Net Income			$0

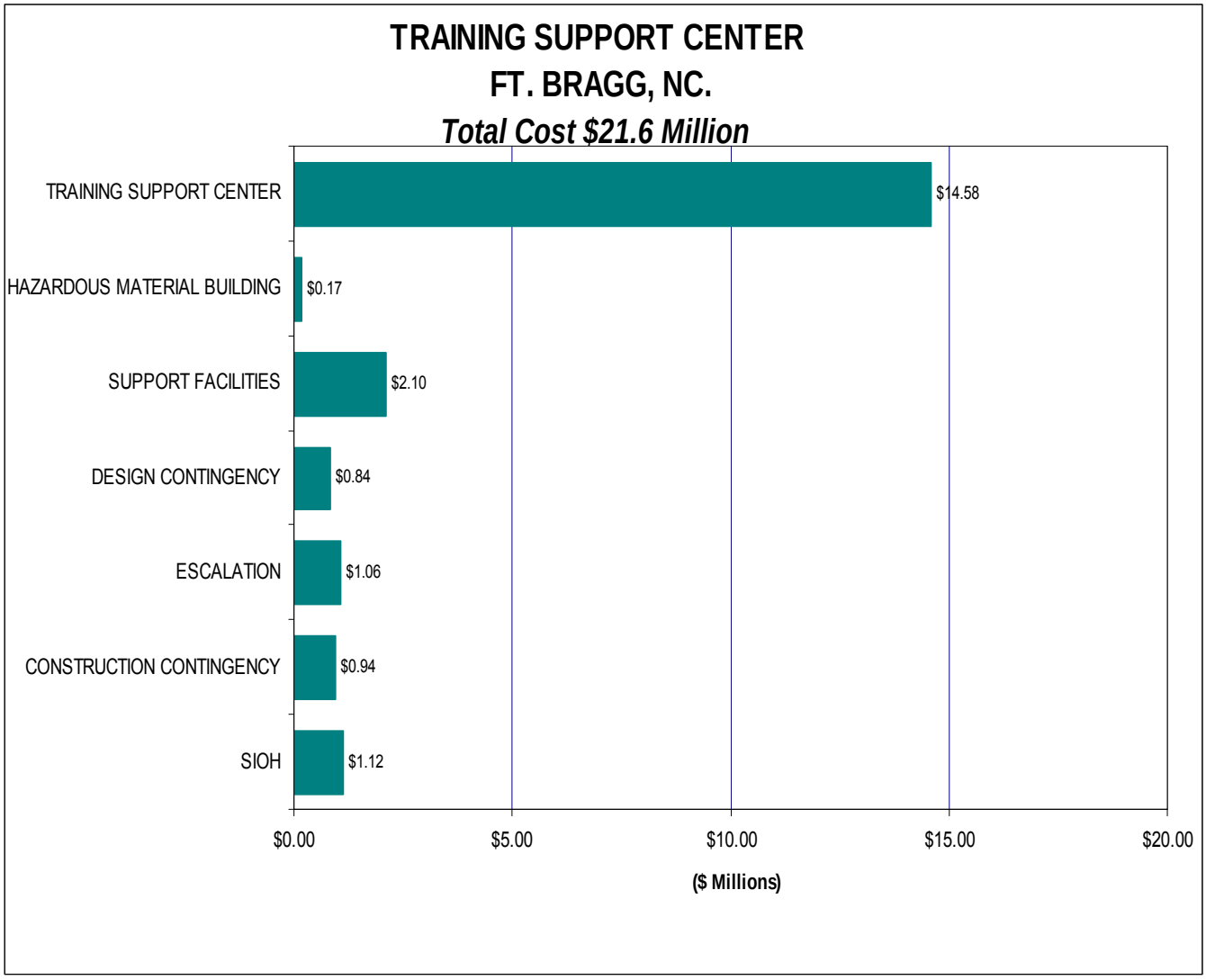
APPENDIX A: CONTACT DIRECTORY

NAME	ORGANIZATION	TELEPHONE/FAX

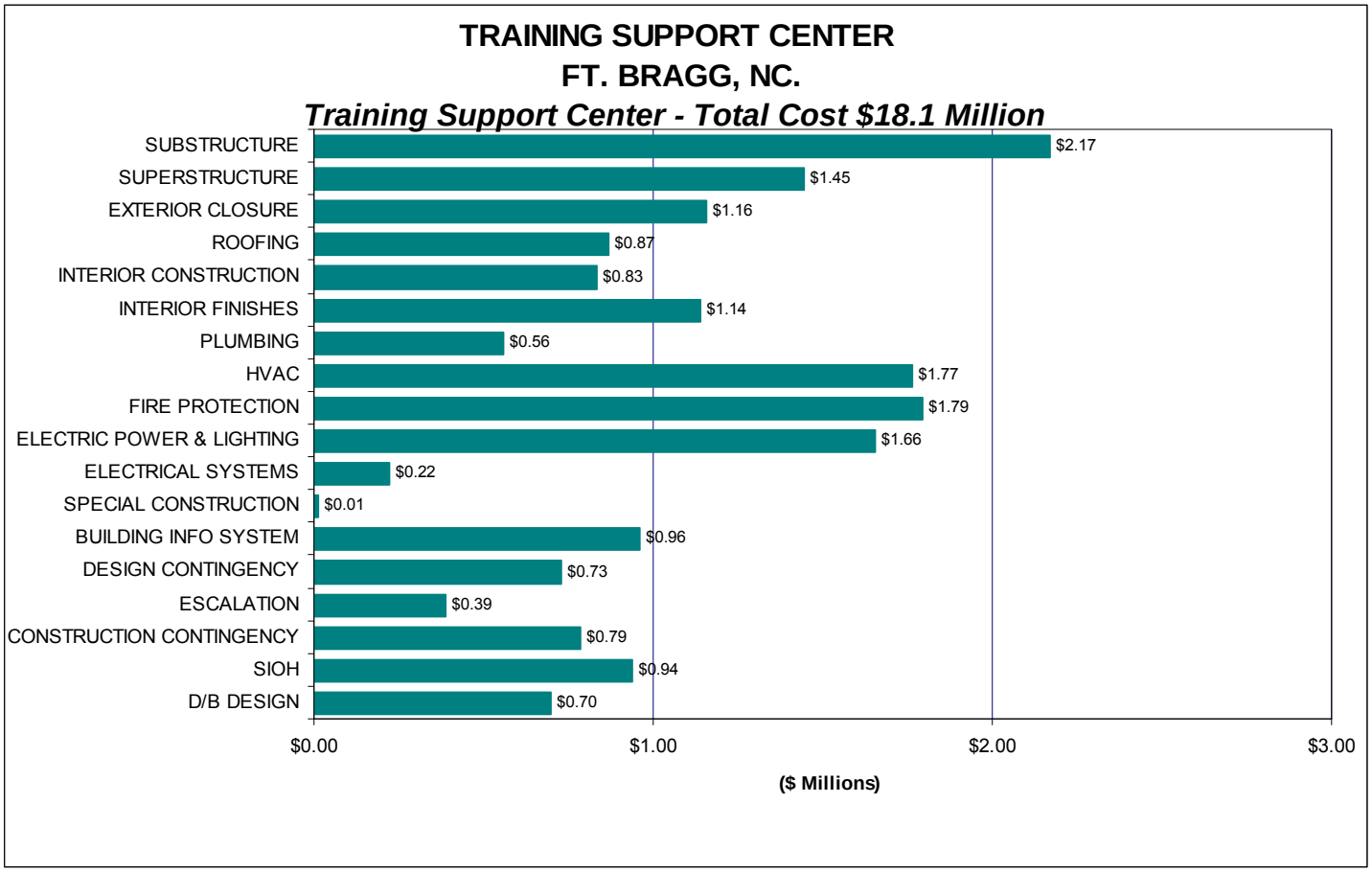
APPENDIX B: SPECULATION LIST

Y, N, C, BD	Proposal No.	PROPOSALS

APPENDIX C: COST MODEL

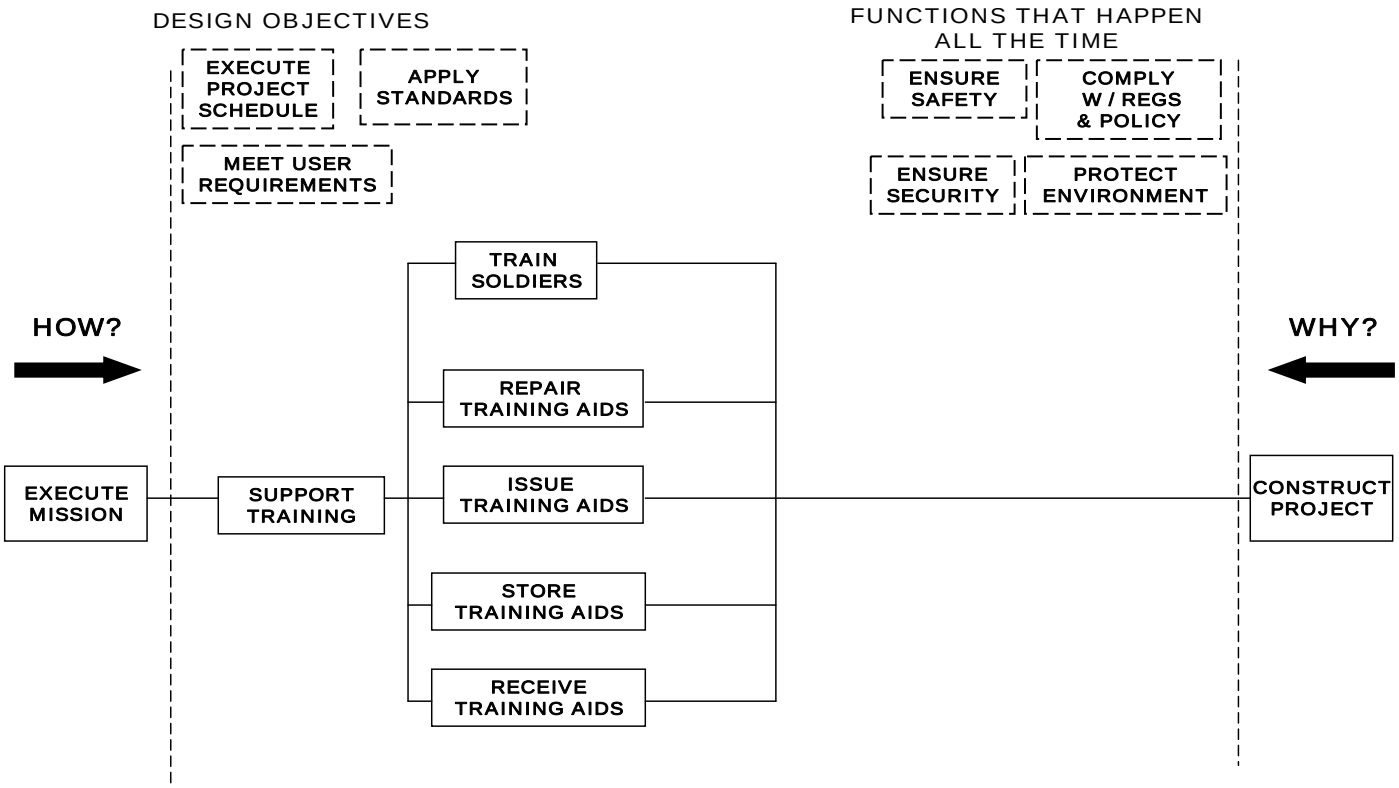


APPENDIX C: COST MODEL



APPENDIX D: FAST DIAGRAM

TRAINING SUPPORT CENTER, FT. BRAGG, N.C.



FUNCTION ANALYSIS SYSTEM TECHNIQUE (FAST) DIAGRAM