



**US Army Corps  
of Engineers®**

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ARCHITECTURAL AND ENGINEERING INSTRUCTIONS

FOR

COST CONTROL DURING DESIGN  
(DESIGN-TO-COST)

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19 December 1996

Headquarters  
U.S. Army Corps of Engineers  
Directorate of Military Programs  
Engineering Division  
Washington, D.C. 20314-1000

FOREWORD

We must relentlessly pursue high quality design and accurate estimate through the many tools we have available to us. Cost Control During Design (Design-To-Cost) is a process that has been around for many years and is an effective method in controlling costs of project designs. It is our obligation to be cost conscious in our design to ensure that the design remains within cost targets. We must be responsive to the needs of our customers without compromising the integrity of our design and cost estimate. We are making good progress in these areas. Please send me your comments and your lessons learned using this new procedure. With your permission, I plan to share your experiences with other folks in the Corps. Essayons.

This Architectural and Engineering Instructions (AEI) applies to Major Subordinate Commands (MSC), district commands and technical centers, and other USACE field offices having military construction responsibilities. This AEI is intended to be used by the USACE design offices for Air Force projects, as appropriate, when new design directives are released.

FOR THE DIRECTOR OF MILITARY PROGRAMS:

KISUK CHEUNG, P.E.  
Chief, Engineering Division  
Directorate of Military Programs

ARCHITECTURAL AND ENGINEERING INSTRUCTIONS  
FOR  
COST CONTROL DURING DESIGN

1. GENERAL.

a. Purpose. The purpose of this Architectural and Engineering Instructions (AEI) is to provide design and estimating policy and technical guidance to the design districts or divisions of the U.S. Army Corps of Engineers (USACE) for all Air Force projects. Cost Control During Design is established to place more emphasis on accurate definition of project requirements, preparation of a parametric cost estimate to establish cost targets based on those requirements and monitoring during the design. This AEI should be used in conjunction with the Code 3 process to establish cost targets in enough detail to assure execution of project designs within available funds.

b. Applicability. This AEI is effective immediately and applies to Major Subordinate Commands (MSC), district commands and technical centers, and other USACE field offices having MILCON responsibilities, herein referred to as the design agency.

c. Reproduction. Local reproduction of this AEI, or any subsequent editions, is authorized.

d. Proponent Office. This AEI is a living document and will be periodically reviewed, updated, republished, and redistributed. The proponent office having responsibility for maintaining and publishing this AEI is the Cost Engineering and Program Formulation Branch, Engineering Division, Directorate of Military Programs, HQUSACE. The point of contact for this AEI is Mr. Ronald Hatwell (202) 761-1240, FAX (202) 761-0999, E-MAIL Ronald.J.Hatwell@USACE.ARMY.MIL. Recommended changes, with the rationale for the changes, should be sent to HQUSACE, ATTN: CEMP-EC, 20 Massachusetts Ave., NW, Washington, D.C. 20314-1000.

2. BACKGROUND.

a. Project Requirements and Cost Control. During a partnering conference between the Corps and Air Force major command civil engineering representatives, the Air Force expressed general concerns on project designs exceeding available funds and the accuracy of construction cost estimates. The attendees at the partnering conference identified major areas affecting the accuracy of cost estimate during the design process and recommended establishing a process to

manage costs during design. As a result, the Director of Engineering, Office of the Civil Engineer, Department of the Air Force requested the Corps to institute cost control during design on all Air Force projects.

3. REFERENCES. The following references should be used with this AEI:

- a. Project DD Form 1391, Military Construction Project Data.
- b. Architectural and Engineering Instructions (AEI), Project Engineering with Parametric Estimating.
- c. Local Installation Design Guide, if available.
- d. Department of the Air Force standard design packages, when applicable.
- e. Architectural and Engineering Instructions (AEI), Design Criteria, latest edition, and the criteria documents referenced therein.
- f. Corps of Engineers Guide Specifications (CEGS).
- g. Corps of Engineers Cost Engineering Regulations and Manuals.
- i. Title 10 U.S.C. Sec. 2087(b), Architectural and Engineering Services and Construction Design.
- j. Defense Federal Acquisition Regulation Supplement 236.601.

4. COST CONTROL DURING DESIGN

a. Cost control during design is a process of identifying the full scope of a project and establishing cost targets before design start to affect cost control throughout the course of design. This scope must be identified and verified with the user's major command. Finally cost targets are identified using a system level workbreakdown structure for every system (for both primary/buildings and support facilities) being designed into the project. These system level cost targets are estimated using parametric cost estimating systems (and other detail methods for unique work) and adjusted where necessary so that the full scope is included in the total cost..

The parametric cost estimates when approved by the design team will then become the basis for establishing cost targets for the discipline designers responsible for those system designs.

The accuracy and reasonableness of the project (parametric) estimate is highly dependent on the input of the designer team and its customers. Therefore, it should be developed based on a complete requirements definition or project definition obtained in a "Squatters Session" or "Charrette" with the designer, user/customer, and Major Command (MAJCOM). A critical milestone is for the estimate to be discussed and then carefully reviewed by the design team to ensure that each system cost target is reasonable and that all the systems included within the estimate will accomplish all design requirements of the project.

The key elements in this process are the partnered integration of the MAJCOM Project Manager (AF-PM) in the design and review process and the empowerment of cost engineering to be a focus for ensuring design-to-cost. Designers must communicate constantly with the cost engineer/estimator and inform the cost engineer/estimator of all design decisions/changes effecting the cost. The cost engineer/estimator must maintain the estimate up-to-date to ensure that it stays current with the design. If the current estimate deviates from the target by greater than 5%, the cost engineer/estimator must raise a flag and immediately advise the designer(s) about the cost variations. With this process the designers will have more awareness of the cost impacts of their decisions and will make them better, more cost conscious designers. Key cost review milestones are identified during the process to ensure that the design proceeds on (cost, schedule, and design) target. This process also establishes a process change that involves both the design team (includes Architect Engineer and Design Agent) and the customer on cost control as a critical responsibility.

## 5. COST CONTROL DURING DESIGN PROCESS

### **Requirement Definition (RD) Phase**

The Base Civil Engineer (BCE) and/or AF-PM defines the requirements for the project. Required items for RD are found in Table 1.

The RD phase can be accomplished by BCE and/or AF-PM using in-house capability, Architect Engineer (A-E) and/or Design Agent (DA).

The RD phase requires the preparation of a parametric estimate using either of the two Department of Defense (DOD) systems, the Air Force Parametric Cost Engineering System (PACES) or Tri-Services Automated Cost Engineering System (TRACES) Parametric Building Models for Windows (PBMW). Estimate must be prepared to the systems level as shown in Appendix A.

### **Project Definition (PD) Phase**

During the definition phase the AF-PM provides the results of the RD including estimate to its Design Agent, who then proceeds to prepare PD phase requirements using Corps of Engineers Code 3 process. The PD phase requirements must be prepared using a “Charrette” process involving the full design team, including the Cost Engineer, the customer, AF-PM, and anyone else involved in the design of the project.

The DA must then match PD and the RD phase requirements and their cost estimates to ensure that there is clear agreement and understanding on scope and a commitment on the cost targets. If the scope and cost targets between the PD and RD do not match, all conflicts must be resolved prior to proceeding with the design. This must be a design milestone occurring not later than 10% design accomplishment. Once conflicts have been resolved, the DA will provide the AF-PM with a scope and cost buy-in memorandum.

### **Design Phase**

During the design phase the DA awards the design contract to 90% design. At 60% design completion the DA is required to conduct an on-board review and formal verification of the cost estimate using design targets as the baseline for review.

If cost targets are being met, design continues to final (90%).

When the cost target at any systems level is exceeded, the DA must identify the reasons for the overrun. If design changes that impact cost must be made, the DA must advise the AF-PM of

these changes, their construction costs, design costs, and schedule impacts. The DA must also identify and recommend options to the proposed design changes that would mitigate cost and schedule impacts. All decisions at this point must be based on a consensus between the AF-PM and the DA partnership.

At 90% design review, a cost estimate review must be made prior to proceeding to final design and all conflicts resolved in the same manner as at the 60% review.

Once cost and design issues have been resolved, the design will proceed to final design. The Government estimate (GE) is prepared and the project advertised. The estimate is expected to be complete at this stage except for quotation, bid period discoveries, and amendment impacts.

### **Contract Award Phase**

If the low bidder is within +/- 10% of GE the contract is awarded and award data is submitted by the DA to HQUSACE (CEMP-EC) for incorporation in the DOD historical cost data base.

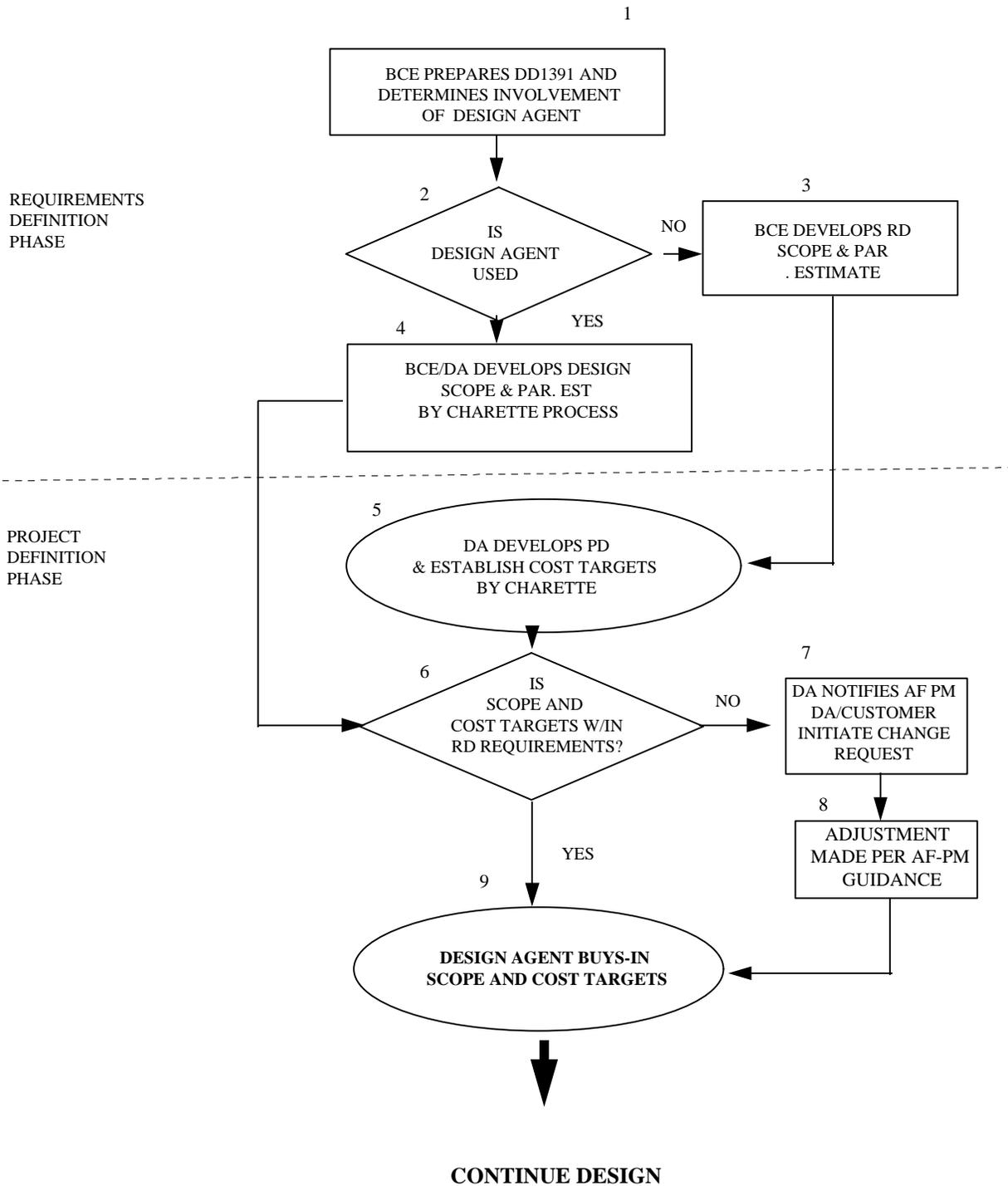
If the low bidder is not within +/- 10% of GE, the DA must conduct a formal bid analysis to identify areas of disparity and reasons for the difference. Copies of bid analysis must be provided to AF-PM and to HQUSACE (CEMP-EC) along with the contract award data for incorporation to the DOD historical cost database.

TABLE 1.0  
COMPARISON OF RD AND PD REQUIREMENTS

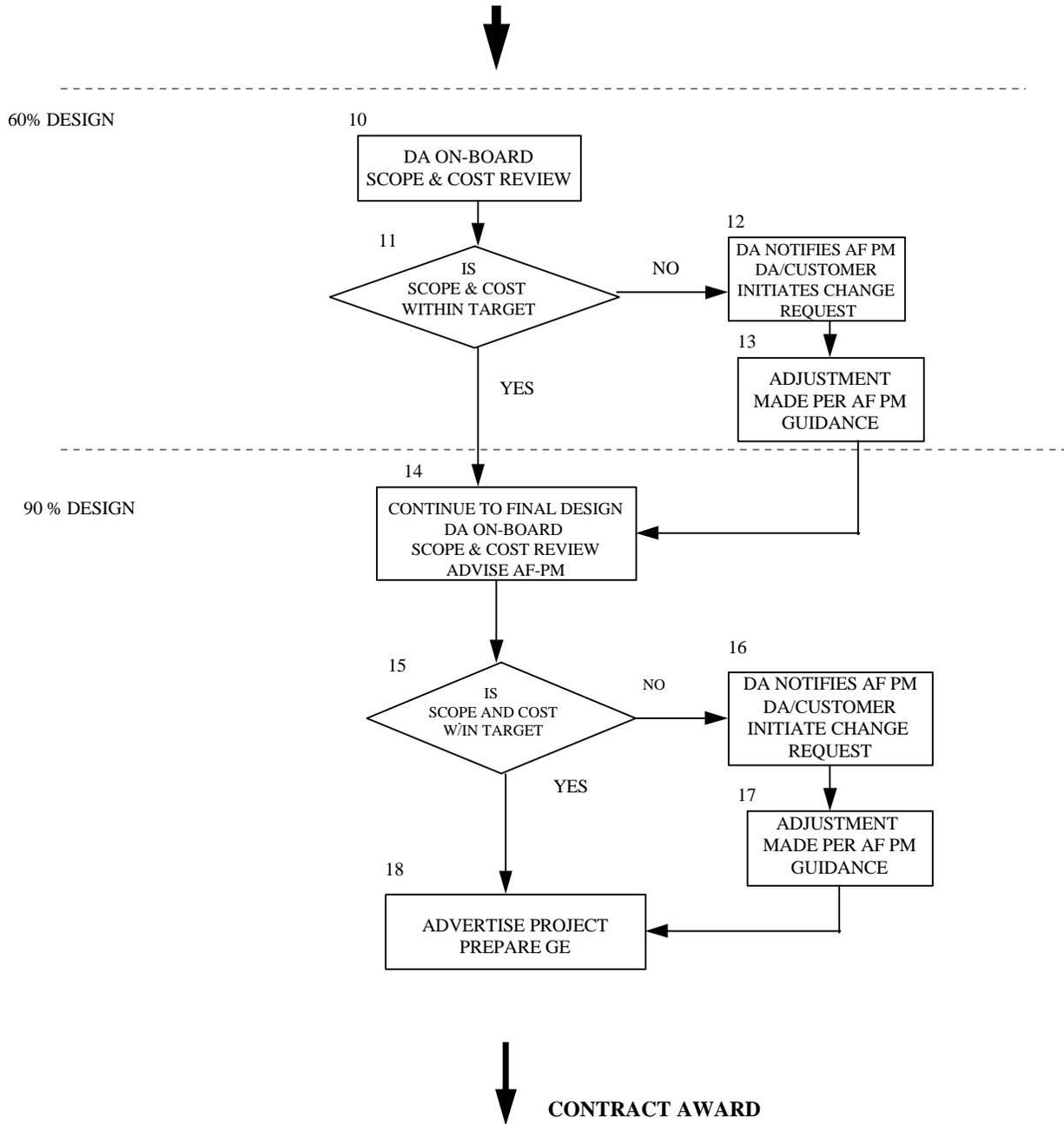
ITEM	RD*	PD
SITE PLAN FUNCTIONAL LAYOUT CHARRETTE	X Recommended Recommended	X (Validate) X (May be same) X
PRELIMINARY SITE INVESTIGATION SOIL BORING UTILITY LAYOUTS, SIZES & CONNECTIONS	X Optional Preliminary Sizes and Connections Recommended	X X X
ENVIRONMENTAL INVESTIGATION ARCHITECTURAL COMPATIBILITY	X X	X X (Same)
ELECTRICAL/MECHANICAL/STRUCTURAL SYSTEM NARRATIVES & CALCULATIONS	Narrative and PACES or TRACES parameters	X
UNIQUE DESIGN FEATURES (Identify unusual foundations, security, demolition, communications, lead based paint, environmental remediation, etc.)	Narrative	X
IDENTIFY FLOOR AND ROOF STRUCTURE AND OTHER SPECIAL REQUIREMENTS	Narrative	X
WRITTEN REPORT - DESIGN ASSUMPTIONS	Narrative	X
PARAMETRIC COST ESTIMATE	X	X
CUSTOMER BUY-IN	X	X

NOTES: \* - RD format based on USACE Code 3 PD Format  
X - Required

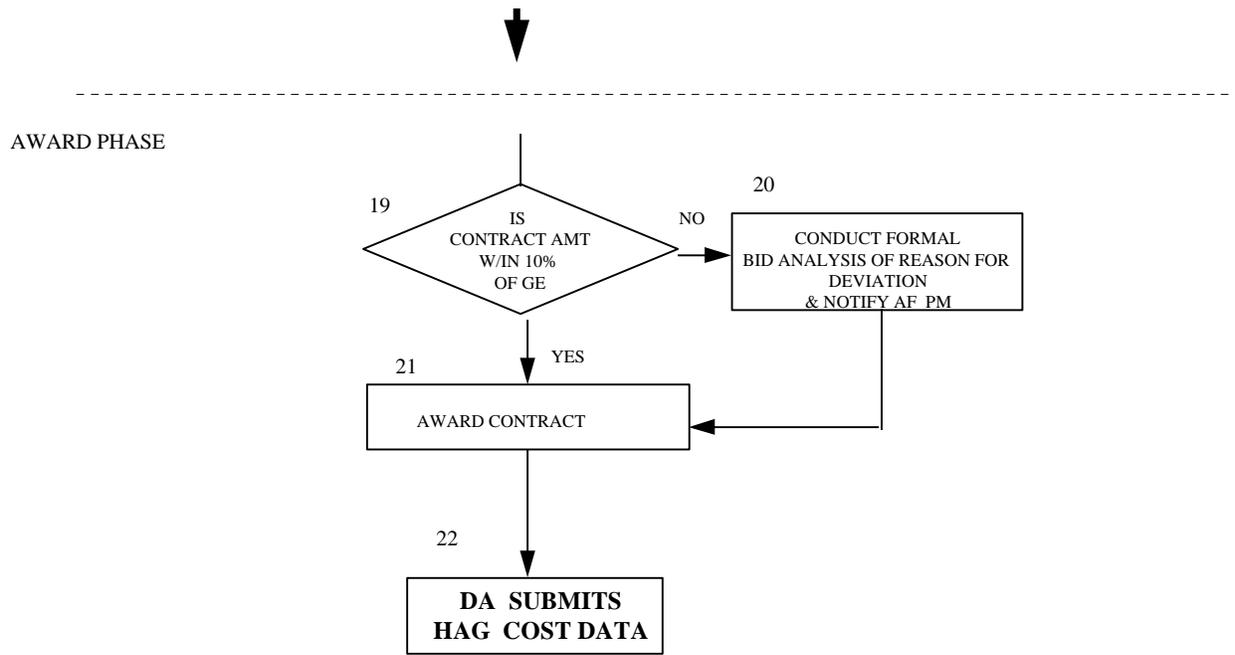
### COST CONTROL DURING DESIGN



### COST CONTROL DURING DESIGN



**COST CONTROL DURING DESIGN**



**KEY TO COST CONTROL DURING DESIGN**

1. DD1391 Preparation.
  - User/Customer identifies requirement.
  - Base Civil Engineer (BCE) collects data for use in development of scope and cost.
  
2. Design Agent Support .
  - BCE evaluates and analyzes project requirements.
  - BCE determines in-house capability.
  - BCE determines completeness of scope definition.
  - BCE requests assistance from Design Agent (DA) to firm up scope and cost.
  
3. Development of Requirements Definition (RD) Scope and Cost (w/out DA assistance)
  - BCE conducts “squatter session” with user/customer.
  - BCE prepares construction cost estimate using 1178 cost generator or parametric estimating system. BCE establishes cost targets using Work Breakdown Structure (WBS) format to systems level (if applicable). (See Appendix A)
  
4. Development of RD Scope and Cost (w/ DA assistance).
  - DA forms design team (to include a cost engineer).
  - DA performs site visit.
  - DA conducts a “charrette” with user/customer, BCE, MAJCOM Project Manager (AF-PM).
  - DA prepares a parametric cost estimate based on WBS format to assembly category level . Ensures the cost estimate is prepared using the appropriate database for material , labor, and equipment rates.
  - DA establishes design schedule.
  - DA identifies cost targets using WBS format to systems level.
  - **DA gets user/customer and AF PM buy-in.**
  
5. Development of Project Definition (PD) Scope and Cost.
  - DA firms up RD scope and cost
  - DA forms design team (use same team members involved in RD).
  - DA conducts site visit.
  - DA conducts a “charrette” with user/customer, BCE, AF-PM.
  - DA performs sub-surface investigation
  - DA uses USACE “Code 3” format to develop PD.
  - DA prepares a parametric cost estimate to assembly category level based on “Code 3” design data. Ensures the cost estimate is prepared using the appropriate database for material, labor, and equipment rates.
  - **DA establishes design scope and cost targets based on WBS format to systems level**
  
6. RD versus PD Validation

- DA compares RD and PD scope and cost.
- DA identifies scope or cost variations

#### 7. MAJCOM Overview

- DA notifies AF PM of scope or cost differences.
- DA identifies cost and schedule changes (design and construction)
- DA identifies cost reduction options.
- AF PM reviews PD scope and compares with RD
- AF PM determines merit of scope and cost changes. Resolves issues and provides guidance.
- AF-PM buys-in to PD scope and cost. Uses PD as benchmark.

#### 8. Adjustments Made

- AF PM revises DD 1391 scope and cost.

#### 9. Design Agent Buy-in

- Uses RD requirements as basis for design.
- Establishes cost targets for use in cost control during design process.
- Continues PD to 90% design

#### 10. 60% Design Review Requirements (when applicable)

- AF PM determines based on complexity of project.
- DA evaluates and makes recommendation
- DA submits design to user/customer and MAJCOM.
- DA conducts in-progress-review (IPR)
- DA prepares quantity take-off (QTO) cost estimate or updates the parametric cost estimate by updating the quantities for those items that are cost drivers to validate requirements and construction costs for consistency with PD cost parameters and targets.

#### 11. PD versus Midpoint Design Validation

- DA compares PD and midpoint design scope and cost
- DA identifies scope or cost variation.
- DA identifies cost and schedule changes (design and construction)
- DA identifies cost reduction options

#### 12. MAJCOM Overview

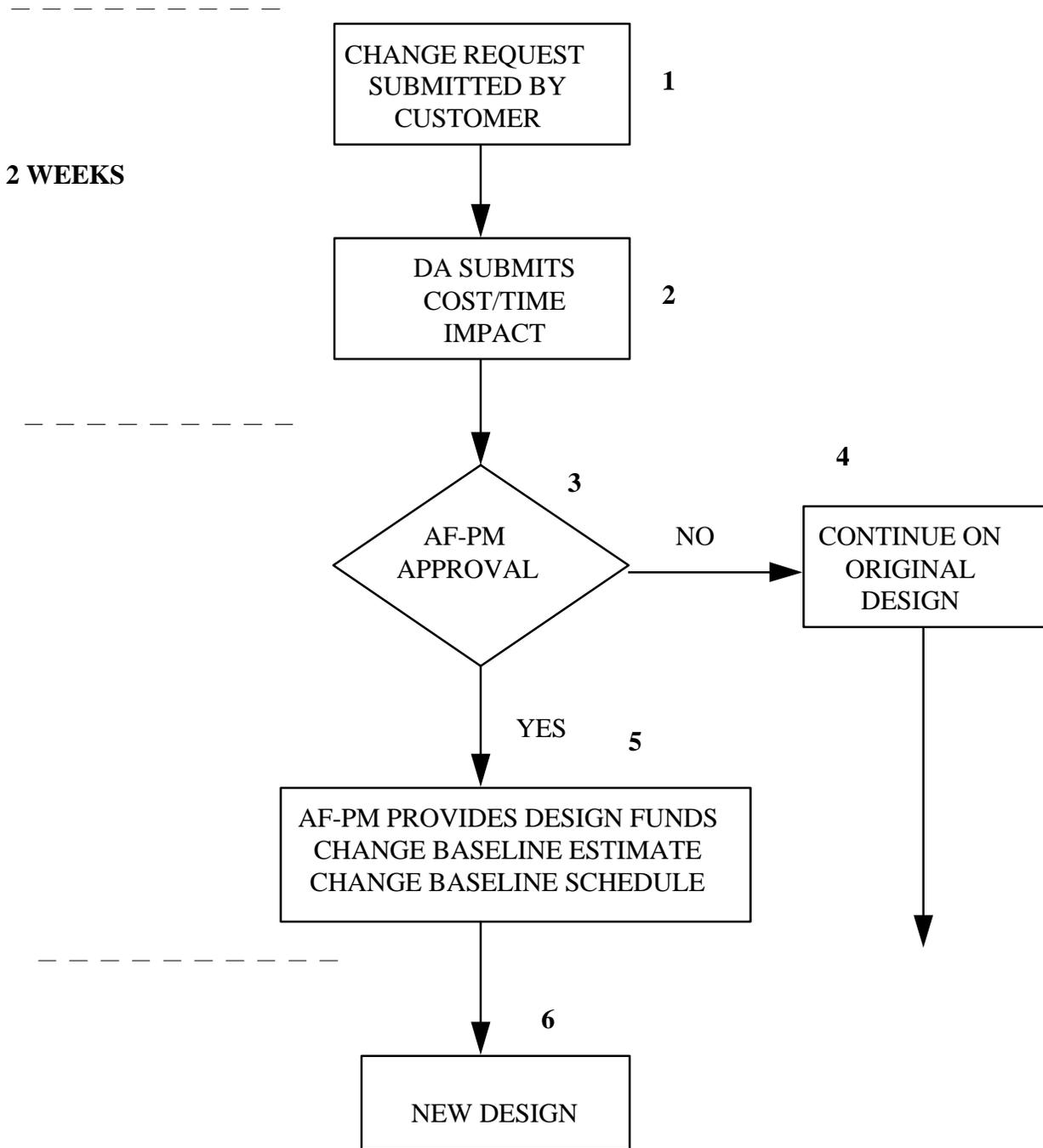
- See item 7 above

#### 13. MAJCOM Overview

- See item 8 above.

14. Final Design
  - DA uses PD (or 60% design) requirements.
  - DA conducts on-board reviews.
  - DA updates QTO cost estimate or updates the parametric cost estimate by updating the quantities for those items that are cost drivers. Evaluates bidding climate.
  - DA performs biddability and constructibility reviews.
15. PD (or Midpoint design) versus Final Design Validation
  - See item 11 above
16. MAJCOM Overview
  - See item 7 above
17. MAJCOM Overview
  - See item 8 above
18. Advertise Project
  - DA obtains authorization
  - DA prepares Government Estimate (GE)
19. Bid Opening and Review
  - DA compares contractors bids to GE.
20. Bid Analysis
  - DA performs bid analysis
  - DA interviews bidders
21. Award Contract
  - DA obtains funds for award.
22. Award Cost Data
  - DA submits award cost data to AF PM and HQUSACE (CEMP-EC).

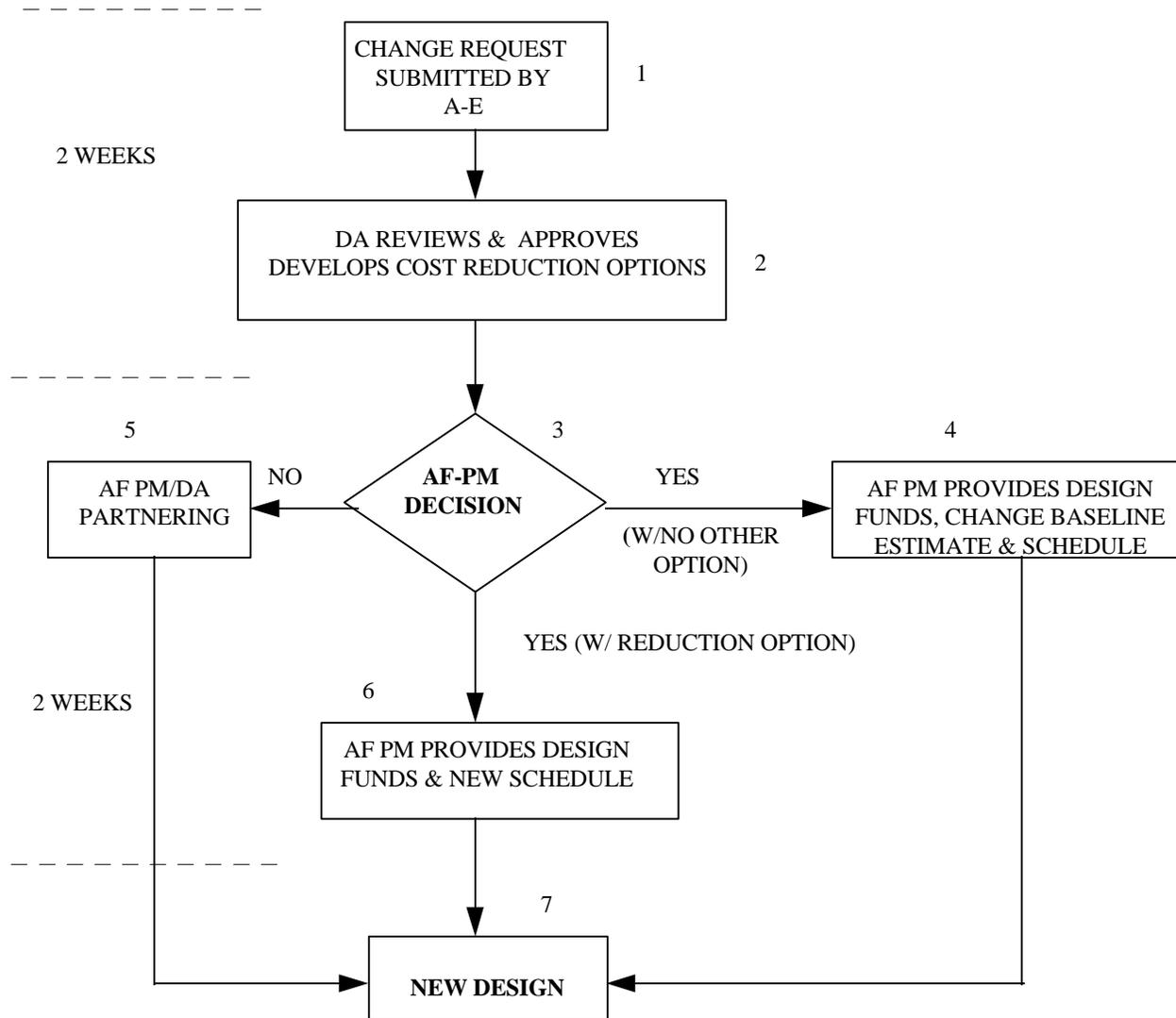
### CUSTOMER CHANGE REQUEST PROCESS



**KEY TO CUSTOMER CHANGE REQUESTS**

1. Customer Submits Change Request
  - Must be reviewed and approved by AF-PM prior to DA review
2. DA Reviews Change Request
  - Assesses construction and design cost impacts.
  - Assesses schedule impacts
  - Submits recommendation to AF-PM
3. AF-PM Decision Point
  - Assesses project cost and schedule impact
4. AF-PM Approves
  - AF-PM provides design funds
  - AF-PM adjusts project funds (PA)
  - DA proceeds with re-design
  - DA adjusts schedule
5. AF-PM Disapproves
  - DA continues on original design and schedule.

### ENGINEERING CHANGE REQUEST PROCESS



**KEY TO ENGINEERING CHANGE REQUESTS**

1. Change request by the designer (A-E).
2. DA reviews proposal and approves.
  - DA recommends cost reduction options (two at least) to stay within the program amount (PA).
  - DA provides time and cost changes (design and construction).
  - DA submits change request to the AF PM.
3. AF PM Decision
  - AF PM assesses project cost and schedule impact
4. AF PM Approval - **With no other option**
  - AF PM approves the engineering change.
  - AF PM provides design funds for changes (if needed).
  - AF PM adjusts baseline estimate (PA) and schedule.
  - DA proceeds with new design.
5. AF PM Approval - **With reduction option**
  - AF PM approves the engineering change.
  - AF PM provides design funds for changes (if needed).
  - AF PM adjusts baseline estimate (PA) and schedule
  - DA proceeds with new design
6. AF PM Disapproval
  - AF PM and DA meet to assess project execution impact
  - AF PM and DA hammers-out compromise.
  - AF PM provides design funds, adjusts PA and schedule.
  - DA proceeds with new design

**APPENDIX A**

PARAMETRIC COST ESTIMATE

DATE: 11/26/1996

TIME: 08:21:38

PROJECT: CC1996

PROJECT DESCRIPTION: General Purpose Administration Building

PROJECT COMMENT: This is a parametric cost estimate for cost control during design.

BUILDING TOTAL GROSS FLOOR AREA: 25,000 SF

GEOLOCATION: ANDREWS AFB

ESTIMATED BY: USACE

ESTIMATE DATE: 11/20/1996

REPORT FILE: psyscc96.wpd

COST DATABASE: NAT95A

ESCALATION MODIFIER: Mid-Point of Construction

PARAMETRIC COST ESTIMATE  
WBS SYSTEM CONSTRUCTION COST REPORT

SYSTEM DESCRIPTION	TOTAL	% TOTAL
<b>PRIMARY FACILITY:</b>		
ADMIN BUILDING		
01 SUBSTRUCTURE	87,171	3.2%
02 SUPERSTRUCTURE	298,952	11.0%
03 EXTERIOR CLOSURE	386,357	14.2%
04 ROOFING	63,617	2.3%
05 INTERIOR CONSTRUCTION	142,450	5.3%
06 INTERIOR FINISHES	185,137	6.8%
07 CONVEYING SYSTEMS	105,339	3.9%
08 PLUMBING	84,539	3.1%
09 H.V.A.C	528,012	19.5%
10 FIRE PROTECTION SYSTEMS	44,176	1.6%
11 ELECTRIC POWER & LIGHTING	308,260	11.4%
12 ELECTRICAL SYSTEMS	107,720	4.0%
14 FURNISHINGS	370,552	13.7%
FACILITY TOTAL	\$2,712,289	100.0%
<b>SUPPORT FACILITIES:</b>		
17 SITE PREPARATION	75,046	19.6%
18 SITE IMPROVEMENTS	54,918	14.3%
19 SITE CIVIL/MECHANICAL UTILITIES	185,845	48.4%
20 SITE ELECTRICAL UTILITIES	68,023	17.7%
SUPPORT FACILITY TOTAL	\$383,833	100.0%
<b>TOTAL CONSTRUCTION COST</b>	<b>\$3,096,122</b>	<b>100.0%</b>