

CHAPTER 25

GUIDELINES FOR ENGINEERING, DESIGN, AND INSPECTION COSTS

1. INTRODUCTION

Engineering, design, and inspection (ED&I) activities begin with the preliminary design (Title I). Pre-Title I activities are not considered part of ED&I activities. ED&I activities include the engineering and design activities in Title I & II and the inspection activities associated with Title III. A more detailed description of the Title I, II, and III activities can be found in Chapter 3 of this volume.

Architectural/Engineering (A/E) activities are part of the ED&I activities. A/E activities are services that are an integral part of the production and delivery of the design plans, specifications, and drawings. Federal statutes limit the A/E costs to a percent of total construction cost, and these statutes have specific definitions of what activities are included in A/E costs. Activities that are not an integral part of the production of the design plans, specifications, or drawings may still be ED&I activities but are not A/E activities.

This chapter defines ED&I and A/E activities and discusses how to estimate and track them.

2. ED&I ACTIVITIES

To estimate ED&I costs, the estimator must understand what activities are included in ED&I.

Following is a list of ED&I activities:

- Preliminary and final design calculations and analyses
- Preliminary and definitive plans and drawings
- Outline specifications
- Construction cost estimates
- Computer-aided Drafting (CAD) and computer services
- A/E internal design coordination
- Design cost and schedule analyses and control
- Design progress reporting

- Regulatory/code overview by A/E
- Procurement and construction specifications
- Surveys (surveying), topographic services, core borings, soil analyses, etc., to support design
- Travel to support design
- Reproduction during design
- Design kickoff meeting
- Constructability reviews
- Safety reviews by A/E
- Value engineering
- Identification of long lead procurements
- Design studies not included in Pre-Title I
- Preliminary safety analysis report if not included in the Conceptual Design Report
- Design change control
- Modification of existing safety analysis report
- Design reviews (not third party)
- Acceptance procedures
- Certified engineering reports
- Bid package preparation
- Bid evaluation/opening/award
- Inspection planning
- Inspection services
- Review shop drawings
- Preparation of as-built drawings

3. WAYS TO ESTIMATE ENGINEERING, DESIGN, AND INSPECTION COSTS

Different methods may be used to estimate ED&I costs. Some common methods are: count drawings and specifications, full time equivalents (FTEs), and percentage.

A. Count Drawings and Specifications Method

When using this method, the estimator calculates the number of drawings and specifications representing a specific project. The more complex a project is, the more drawings and specifications it will require, and, therefore, more ED&I Costs will be associated with it.

B. Full Time Equivalent Method

The FTE method utilizes the number of individuals that are anticipated to perform the ED&I functions of a project. The manhour quantity is calculated and multiplied by the cost per labor hour and the duration of the project to arrive at the cost.

C. Percentage Method

When using this method, the estimator simply calculates a certain percentage of the direct costs and assigns this amount to ED&I. Federal statutes limit the A/E portions of ED&I costs to 6 percent of construction costs. Total ED&I percentages are usually from 15 to 25 percent.

D. Documenting Engineering, Design, and Inspection Costs

DOE Headquarters developed the A/E Cost Standard Form as a tool to be used for estimating and compiling actual costs on all conventional construction projects and the conventional portions of nonconventional projects. The DOE ad hoc working group refined a U. S. Navy form to develop this standard for estimating A/E services. The form, definitions, and instructions for the A/E Cost Standard Form have been published and distributed and are included as Attachment 25-1 to this chapter. The following conditions apply to the use of the cost standard or form.

1. All conventional line-item construction projects will use the standard. General plant projects are excluded.
2. Conventional construction projects include such things as warehouses, laboratories, office buildings, non-process related utilities, sewage and water treatment facilities, parking lots, roof repair, roads, etc. Conventional construction does not mean the projects are necessarily simple, nonsophisticated, or standard, but that simply from a design point of view, prior industry experience exists. Nonconventional projects include projects that are first of a kind and the level of effort is not easily predictable.
3. In calculating the design/construction cost percentage ratio, equipment, equipment installation, and other nonconstruction costs will be excluded from the construction cost estimate. Therefore, construction costs included in the calculation will be limited to those construction items for which the A/E contractor has design responsibility. This method is used for determining contract performance. Additional costs for other design, drawings, and specifications (either in-house or outside source) will be documented and included in the total design/construction cost ratio, thereby measuring project performance.
4. The cost standard will be used in the construction of budget estimates and all subsequent estimates and in the management of the cost baselines.
5. A/E contracts will be structured in accordance with the cost standard to segregate design, drawings, and specification costs from the other A/E costs, so that tracking and analyzing actual costs can be accomplished by categories.

6. Any site overhead allocated to construction projects will be identified and documented separately from all other components of project costs so that DOE cost analyses will be comparable to those of other Federal agencies and commercial organizations.
7. The cost standard should be used on all new projects. Project managers will not be required to restructure already completed projects into the format. However, they are encouraged to restructure cost data on completed projects whose cost components are organized in a manner similar to the cost standard format.
8. The A/E Cost Standard Form was designed to provide a standard format for developing cost estimates, structuring contractor proposals, and tracking the cost performance of A/E contracts and other A/E activities. Federal statutes limit A/E cost to 6 percent of construction costs. The A/E services provided under this statute are design, drawings, and specifications. While it is our intention to minimize all A/E costs, it is our goal to keep these specific costs within the 6 percent limit. By collecting costs in this format, the Department can compare its cost performance to other agencies on a comparable basis. Therefore, field offices should ensure that all cost estimates, actual cost data collected during design and construction, and all A/E contracts are segregated to show both total ED&I costs and the subcomponents of design, drawings, and specifications. Also, each site should maintain adequate documentation on actual design and construction costs to facilitate local analysis on the site's overall performance.

Field Office managers and individual project managers are responsible for ensuring that cost estimates, contracts, and cost management of A/E services are structured according to the above standard. Subsequent historical cost data will be used for project analysis and to support local cost databases. These data should help assess contractor performance, improve future cost estimates, and generate recommendations for reducing the A/E costs, on a site-wide basis.

With A/E costs or activities being defined, data can be gathered on a more comparable basis. This will allow for easier evaluation, as well as support for the development of local cost databases for A/E costs.

E. Considerations When Estimating

ED&I costs are directly related to the magnitude and complexity of the project. The following items should be considered.

1. Comprehensiveness of the Functional/Operational Requirements

Project understanding is improved when comprehensive functional/operational (F/O) requirements are provided. For the F/O requirements to be well done, each item must be thought through by those who review the design and will use, operate, and maintain the facility or system.

2. Quality Level

Quality level, as defined below, is significant particularly as it affects the analysis, documentation, and inspection required. Design costs are increased by the additional work that may be required by the following levels.

a. Quality Level I

Applied to nuclear system, structure, subsystem, item, component, or design characteristics that prevent or mitigate the consequences of postulated accidents that could cause undue risks to the health and safety of the public.

b. Quality Level II

Any other system, structure, subsystem, item, or component that as a result of failure could cause degradation of required performance, such as plant operation, test results, and performance data.

c. Quality Level III

Items designated for minimal impact applications.

3. Design Planning Tabulation

Design Planning Tabulation (DPT) sets forth a number of important items that affect ED&I costs. The DPT sets the code requirements the design will meet, reviews to be held, quality levels, and documents to be issued.

4. Design Layout

Design layout costs are affected by the availability of existing documents and the accuracy of these documents. The need for an engineer to make detailed layouts rather than having it done by draftsmen/designers also affects cost.

5. Engineering Calculations

The amount and detail of calculations required is an important engineering cost factor. The need for review of these calculations by others and their documentation and storage can affect ED&I cost significantly.

6. Drafting

The drawing format and the method of accomplishment of the work depicted (i.e., by maintenance, lump sum construction contract, or cost plus construction contract) will affect the detail and time required to prepare drawing(s). The type of drawing and the discipline of work are also big factors in time required. The number of drawings involved is a direct indication of drafting time and cost. The availability of standard details, etc., can reduce costs appreciably. Quality Level I or II requirements can also add to drafting requirements and thus time.

7. Specification Preparation

The availability of draft specifications for the items of work involved or the need to develop new specifications must be considered. Projects requiring preliminary proposals require both an outline specification, which is normally prepared with Title I, and a detailed technical specification. Performance specifications for both the design and installation by a subcontractor of facilities and systems, such as fire protection, will reduce engineering costs. Design costs incurred by the subcontractor are classified as subcontract construction costs.

8. Checking

The need for field investigation can be a significant engineering cost. If drafting must be checked by checkers within that section, the time must be considered and costs added. Projects requiring inter-discipline checks must have time/cost provisions. Checks made by engineers must also be considered.

9. Cost Estimating

Time required for estimating is affected by the detail of the project, particularly the number of items involved and the areas in which good information from historical data or test hooks on cost are available. Specialty items usually require additional effort and cost.

10. Design Reviews

The number of design reviews and action taken will affect costs. If the design is so formal that a committee is established for the review and the designers

must present their designs step by step, the additional costs required for review must be included.

11. Safety Analysis Report

When a Safety Analysis Report (SAR) is required, the engineering costs are contingent upon similar documents having been prepared previously or the requirements to develop new ones.

12. Reports

Engineering costs for preparing reports such as preliminary proposals, design status reports, etc., must be included in the ED&I funds.

13. Government Furnished Equipment

Engineering costs for providing documents required for procuring Government Furnished Equipment (GFE) items must be included. These costs include specifications. Time required for engineering is more than if the item had been included with the other technical documents due to document control and the need to include in the technical documents information on the item being furnished.

14. Off-Site A/E

If an off-site A/E is to be used for the design, travel costs for field investigation, design reviews, and management of the design should be considered. Cost is a percentage of construction cost. If changes are required, onsite A/E may have to make the changes, which could lead to problems in interpreting or understanding the basis of the original design.

15. Inspection

Included as part of Title III, all construction work, including procurement and installation of associated equipment, shall be conducted in all cases prior to acceptance. Inspection should be made at such times and places as may be necessary to provide the degree of assurance required to determine that the materials or services comply with contract and specification requirements, including quality level requirements. The type and extent of inspection needed will depend on the nature, value, and functional importance of the project and its component parts, as determined by project requester/proposer. Specifically, the following should be considered.

16. Duration

Duration is the number of actual construction days anticipated for the project. Unforeseen conditions, such as delays in start-up and waiting for materials, are not included in this duration.

17. Labor Density

Labor density is the ratio of estimated costs of materials to costs of labor. In general, construction with a high labor density will require more inspection.

18. Complexity

A project having a high degree of instrumentation of a large amount of “code equivalent” welding will require more inspection per dollar of labor than will earth work or ordinary concrete work.

19. Overtime

The time schedule of utility outages, reactor windows, and the overall project schedule may require overtime.

20. Adequacy of Plans and Specifications

If the technical package is clear, with a minimum of ambiguities, and will require few field changes, the inspection cost will be lower.

21. Offsite Fabrications

Inspection costs will increase if source inspections are required. Supplies and services shall be inspected at the source where:

- a. inspection at any other point would require uneconomical disassembly or nondestructive testing;
- b. considerable loss would result from the manufacture and shipment of unacceptable supplies or from the delay in making necessary corrections;
- c. special instruments, gauges, or facilities required for inspection are available only at source;
- d. inspection at any other point would destroy or require the replacement of costly special packing and packaging;
- e. a quality control system is required by the contract, or inspection during performance of the contract is essential;

f. it is otherwise determined to be in the best interest of the Government.

22. Location of the Job

Travel time to and from the job must be taken into consideration.

23. Guideline

ED&I costs have been between 15 percent and 26 percent of the total construction cost for detailed design.

24. Performance Specification

This type of specification requires the subcontractor to supply the amount of detail required to complete the project. The amount of ED&I required for a performance specification is appreciably less than that required for the detailed design.

F. Engineering

Although these services may seem similar to conventional engineering, design, and inspection, there are several important differences that distinguish cleanup design from engineering design on other projects. These differences need to be underscored when estimating cost and schedule requirements. Major factors to be considered by the estimator include the following.

1. The regulatory process requires rigorous examination of design alternatives prior to the start of cleanup design. This occurs during remedial investigation/feasibility studies under CERCLA to support a record of decision (ROD) or during corrective measure studies under RCRA to support issuance of a permit. Cleanup design executes a design based on the method identified in the ROD or permit. This often narrows the scope of preliminary design and reduces the cost and schedule requirements. The estimator needs to assess the extent to which design development is required or allowed in cleanup design. In some cases, the ROD or permit will be very specific as in the case of a disposal facility where all features, such as liner systems, as well as configuration, are fixed. In other cases, such as when treatment options like incineration are recommended, considerable design effort may be required.
2. Requirements for engineering during construction including, construction observation, design of temporary facilities, quality control, testing, and documentation, will often be higher than for conventional construction. This results from the need to conduct construction activities for environmental projects in compliance with rigid regulations governing health and safety, quality assurance, and other project requirements.

CHAPTER 25

ATTACHMENT 25-1

A/E COST STANDARD FORM USAGE GUIDANCE

The Architect/Engineer (A/E) Cost Standard Form was designed to provide a standard format for the collection of A/E costs. Federal statutes limit the A/E costs to a percent of total construction cost, and these statutes have specific definitions of what is included in A/E costs. By collecting costs in the format of this form, the Department will be consistent with the definition of A/E costs used by other Federal agencies and will be able to determine what is being spent on A/E costs on a uniform basis throughout the Department.

The form, attached, is divided into three sections:

- Section A - Design
- Section B - Title III Services
- Section C - Engineering Services

Some departments may use different names for some of the functions described in the form. If this is the case, a crosswalk sheet can be developed and used to aid in converting the terms used locally to fit those in this form. If necessary, items can be added to each section. Sheets should be attached to completely define any items added. Minimal additions or changes are anticipated in Sections A and B, while Section C will more commonly have additions.

This form is used to collect Engineering, design, and inspection (ED&I) costs according to DOE Order 2200.6. Pre-Title I activities are not a part of ED&I. Pre-Title I activities include surveys, topographical services, core borings, soil analysis, etc., that are necessary to support design. These activities are charged to operating costs. Other costs that, according to DOE Order 2200.6, are not part of operating costs, include project management, the maintenance and operation of scheduling, estimating, and project control systems during design and construction, and the preparation, revision, and related activity involved in producing the final safety analysis report.

The attached “A/E Cost Standard Form - Engineering and Design Activities” table lists the Title I, Title II, and Title III activities and groups them in Sections A, B, or C as they appear on the A/E Cost Standard Form

A/E COST STANDARD FORM
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The following will discuss each section individually.

Section A - Design

Section A includes the Title I and Title II costs directly related to developing the design drawings and specifications necessary for the project. Note that Section A includes only the cost of labor hours that are necessary to perform this design work. If, because of project requirements, other disciplines are required, they can be added. Note that other Title I and Title II costs can be covered in Section C.

Section B - Title III Services

Section B includes the costs for reviewing shop drawing submittals, inspection services, and the preparation of as-built drawings.

Section C - Engineering Services

Section C includes the support services required during the Title I, Title II, and Title III project work. This includes such activities as the energy conservation study, cost engineering, value engineering services, travel, computer equipment costs, etc. Note that the Computer Aided Drafting (CAD) operator's time is included in Section A. Note also that some of the activities in Section C, such as travel and per diem, can occur in Title I, Title II, and Title III work.

Design Schedule

The design schedule should be filled out in the bottom left-hand portion of the form under Section C. The cost summary is filled out to the right of the design schedule and includes the costs of Sections A, B, and C, which are added together to generate a total ED&I cost.



A/E COST STANDARD

DOE Architect-Engineer
Cost Standard Form

A/E Firm Name:				Consultant's Name(s):				A/E Contract No:				
Project Title:								DE No:		Field Office:		
Location:								Est.Const.Cost:				
SECTION A DESIGN	DRAWINGS	Engineering Discipline	Est. No. Dwgs.	Hourly Rate	Title I		Title II		Total Design			
					Est. Hrs.	Estimated Cost		Est. Hrs.	Estimated Cost		Est. Hrs.	Estima- ted Cost
						A/E	Consul- tant		A/E	Consul- tant		
		Project Engineer										
		Architect										
		Stru Engineer										
		Mech Engineer										
		Elec Engineer										
		Civil Engineer										
		Fire Engineer										
		Coordination QC										
		Arch Draftsman										
		Stru Draftsman										
		Mech Draftsman										
		Elec Draftsman										
		Civil Draftsman										
		Fire Draftsman										
		Total Drawings										
SPECIFICATIONS	Spec Writer											
	Typist											
	Total Specifications											
Total Est. Cost A/E & Consultant												
Overhead A/E _____ Consult. _____ %												
Subtotal												
Profit _____ %												
Subtotal												
Total cost of section A (Design)					\$ _____ sheet		% of ECC _____ %					

COMPUTE COST PER SHEET AND DESIGN PERCENTAGE OF ESTIMATED CONSTRUCTION COST



**A/E COST STANDARD FORM
ENGINEERING AND DESIGN ACTIVITIES**

	TITLE I ACTIVITIES	TITLE II ACTIVITIES	TITLE III ACTIVITIES
S	Preliminary Design Calculations and Analyses	Final Design Calculations and Analyses	
E	Preliminary Drawings	Definitive Drawings	
C	Preliminary Plans	Definitive Plans	
T	Outline Specifications	Procurement and Construction Specs	
I	CAD and Computer Services (operators)	CAD and Computer Services (operators)	
O	A/E Internal Design Coordination	A/E Internal Design Coordination	
N	Design Cost and Schedule Analysis and Control	Design Cost and Schedule Analysis and Control	
	Design Progress Reporting	Design Progress Reporting	
A	Regulatory/Code Overview by A/E		
Design QA and Support			
S	Design QA Plan and Overview	Travel to Support Design	Inspection Services
E	Travel to Support Design	Reproduction During Design	Review Shop Drawings
C	Reproduction During Design	Designs Reviews, QA, and Overview (not Third Party)	Prepare As-Built Drawings
T	CAD and Computer Services (support)	CAD and computer Services (support)	
I	Project Schedules	Project Schedules	
O	Construction Cost Estimates	Constructability Reviews	
N	Constructability Reviews	Safety Reviews by A/E	
S	Safety Reviews by A/E	Construction Cost Estimates	
	Value Engineering	Acceptance Procedures	
B	Identify Long Lead Procurements	Certified Engineering Reports	
	Design Studies Not Included in Pre-Title I	Bid Package Preparation	
and	Preliminary Safety Analysis Report if Not Included in the CDR		
	Design Change Control	Design Change Control	
C		Inspection Planning	

Note: This representative list of functions was developed from FAR and DOE definitions.
All functions meet FAR criteria, and the categories are segregated according to the FAR.