12 Contingency Management: Estimating and Allocation

12.1 Overview

Establishing an estimate for project cost is a critical factor in determining whether the subsequent execution of the project is viewed as a success or a failure. Upward revisions of a project's cost estimate invariably tend to be viewed as "cost overruns" regardless of the merits and justifications for the cost growth. In developing the cost estimate for a project, risks and uncertainties are handled by establishing appropriate contingencies within the cost estimate. Three types of contingencies are needed and used in formulating cost baselines as follows:

- DOE contingency for changes external to the contracted scope
- contingency for addressing cost uncertainties related to in-scope work
- contingency for providing the contractor management flexibility in executing in-scope work and dealing with unforseen in-scope events.

A key concept in establishing contingency is the understanding that project costs cannot be controlled (reduced) by reducing contingency. Factors that influence a project's final costs include

- actual scope executed, DOE and regulatory requirements under which the scope was executed
- resource (funding) availability in relation to the project's time-phased resource needs
- performance in scope execution

In principle, increasing the contingency does not increase project costs if the scope is controlled. The unavailability of contingency when needed by a project is likely to result in further increases in cost through schedule delays. The proper role of contingency is to provide a better forecast of expected costs at project completion and <u>not</u> project cost "control."

12.2 TPC, TEC Baseline Formulation Approaches

There are three approaches to the formulation of TPC, TEC Baselines.
See Figure 12-1.

1. *Unplanned TPC, TEC Rebaselines.* Project initiation and TPC, TEC formulations with limited contingency, but without adequate scope/design definition. During project execution, cost estimates grow necessitating one or more TPC, TEC rebaselines, the project is viewed as "out of control" with significant "cost overruns." See Figure 12-1.

2. *Planned TPC, TEC Rebaselines.* Project initiation and initial TPC, TEC formulations with limited contingency, but without adequate scope/design definition. One or more TPC, TEC rebaselines are carried out as planned during project execution as the scope/design definition evolves. Though project costs appear to be "in control," the key disadvantage is that the project's final costs were not estimated and available at the *Mission/Project Justification of Need* stage, compromising the evaluation for project approval at the project initiation phase. See Figure 12-2.

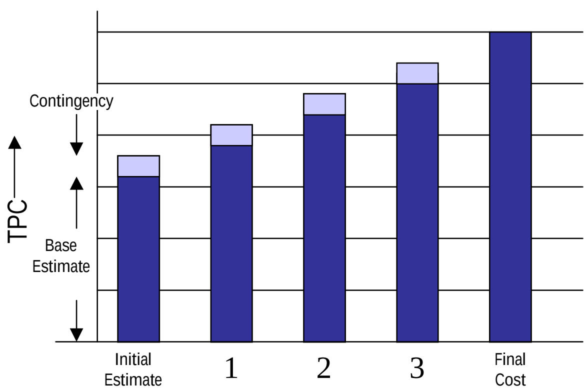

Figure 12-1. Unplanned Rebaselines

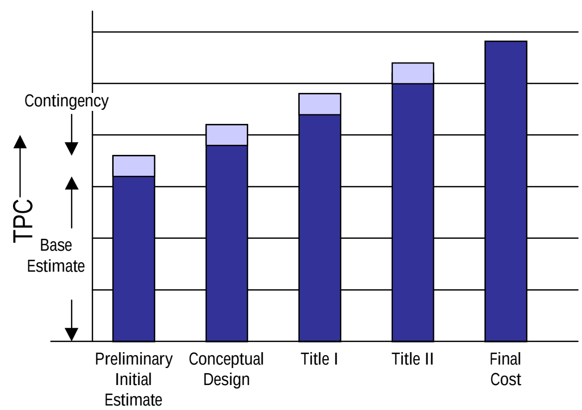

Figure 12-2. Planned Rebaselines

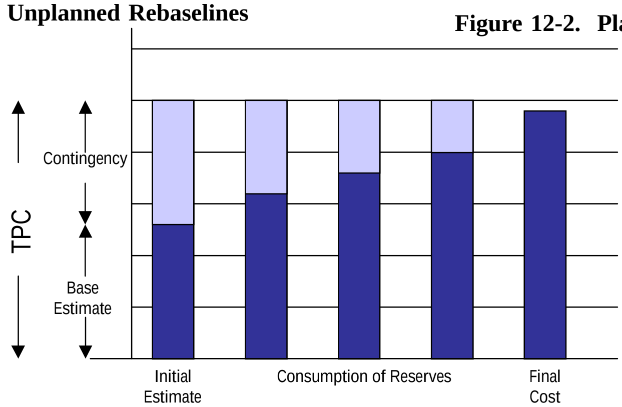

Figure 12-3. Risk Analysis-Based Formulation

3. *Risk Analysis-based TPC, TEC.* The TPC, TEC formulations based on systematic risk analysis and development, and inclusion of estimates for contingency to account for uncertainties in scope/design definition, cost estimating, DOE/Regulatory requirements, and project and programmatic risks. During project execution, the contingency transferred into budgeted scopes as needed without increasing the TPC, TEC. The key disadvantage is that contingency may constitute an unfamiliarly high percentage of the initial TPC, TEC formulations. See Figure 12-3.

This section identifies the more common factors responsible for cost growth during project execution and the methods/techniques available for estimating and managing contingency to account for these risks and uncertainties, and increasing the probability of successfully completing the project within the cost baseline.

12.3 Project Baselines and Interrelationships

In general, four different scope/cost/schedule baseline formulations are used for measuring progress/success of a project:

TPC. Total Project Cost, an estimate of expected costs at project completion including both capital and OPEX-funded costs, and provisions for scope, design, and requirements evolution/changes during project execution.

CBB. Contract Budget Baselines, representing the contractor's budget commitment for project completion encompassing the currently intended/defined and contracted project scope.

TEC. Total Estimated Cost, an estimate of construction-related capital costs limited to design/procurement/construction of facility/system including provisions for scope/design requirements evolution/changes during project execution.

PMB. Performance Measurement Baseline, an aggregation of time-phased budgets allocated to project scope elements for project execution and performance measurement.

These baseline cost (and schedule) estimates are linked to each other through estimated cost elements designated as contingency.

These formulations are applicable even when the project is entirely OPEX-funded. In relation to conventional construction projects, remediation projects may often have significantly higher uncertainties in scope definition at project inception making contingency estimates even more critical for project completions within the cost baselines.

12.3.1 Remediation Projects

For remediation projects, scope definition and the associated cost estimating uncertainties are chiefly dependent on the following two factors:

- Characterization of the facilities to be remediated.
- Definition/decisions of end-point states for the facilities to be remediated.

In some instances these two factors will evolve during the execution of the project rather than be known or definitized at project initiation. Unless adequate contingencies or TPC ranges have been established at project inception, to address these uncertainties, there is a strong likelihood that the TPC will have to be increased and rebaselined during project execution. Cost estimates developed for the EIS/ROD are conceptual and relative in relation to the alternatives being evaluated. The ROD estimate may need to be revised/adjusted for formulating a project execution baseline.

12.3.2 Total Project Cost Estimate

The Total Project Cost (TPC) is intended to be an estimate of costs at project completion, representing the cost/schedule baseline against which overall project success is frequently measured. The TPC includes both the capital and OPEX funded cost components. The capital component is limited to design/procurement/construction activities related to facility or system acquisition and referred to as total estimated cost for construction (system or facility cost). Development, engineering, and system/facility startup costs are generally OPEX-funded and referred to as other project costs (OPC). For conventional construction projects, project completion equates to turnover of the system/facility to the facility manager for operation, i.e., costs related to operation/maintenance of the facility are not generally included as part of the project costs and accordingly are excluded from the TPC. For construction projects the TEC is often a high percentage of the TPC.

In a scope execution context, the TPC can be viewed as having two components: the Contract Budget Baseline (CBB, see below) which represents the cost of the currently contracted scope of work, and DOE contingency which represents the potentially necessary additions to the contracted scope of work during project execution. These may be either additions of scope or budget increases to cover cost increases not in the contractor's control, risks and uncertainties in scope/ design definition, technology development, cost estimating, DOE/regulatory requirements, or unforeseen factors.

Figure 12-4 and Figure 12-5 schematically show the decomposition elements of the TPC and their interrelationships.

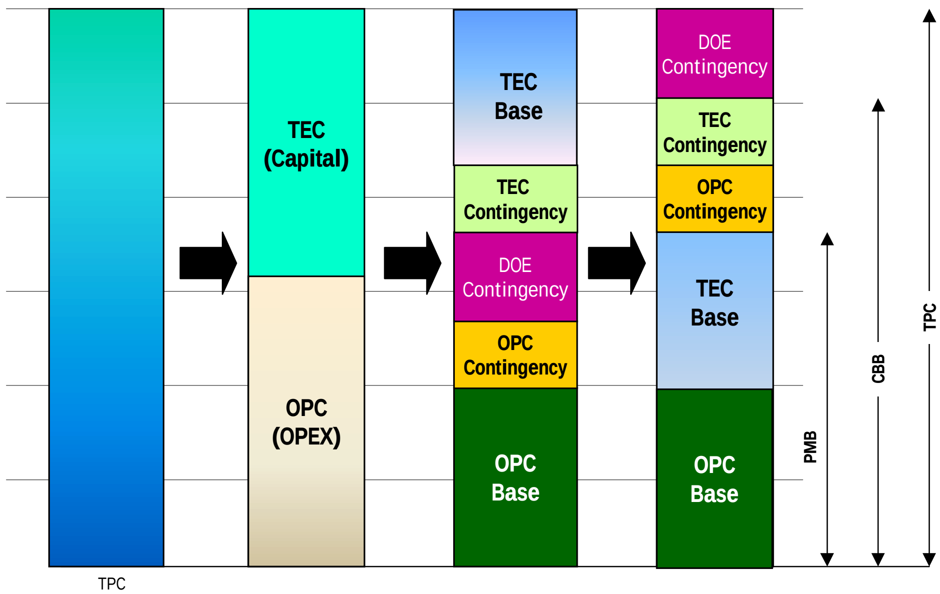

Figure 12-4. TPC Decomposition into Component Elements and their Interrelationships

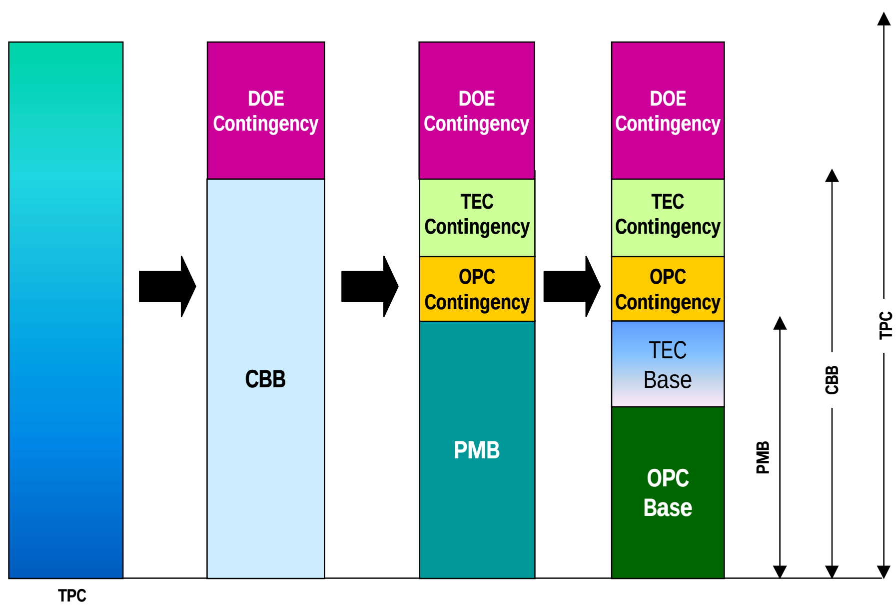

Figure 12-5. TPC Decomposition into Component Elements and their Interrelationships

During project execution, as needed, the DOE budgets are transferred via change control to the CBB for scope execution (see Figure 12-6).

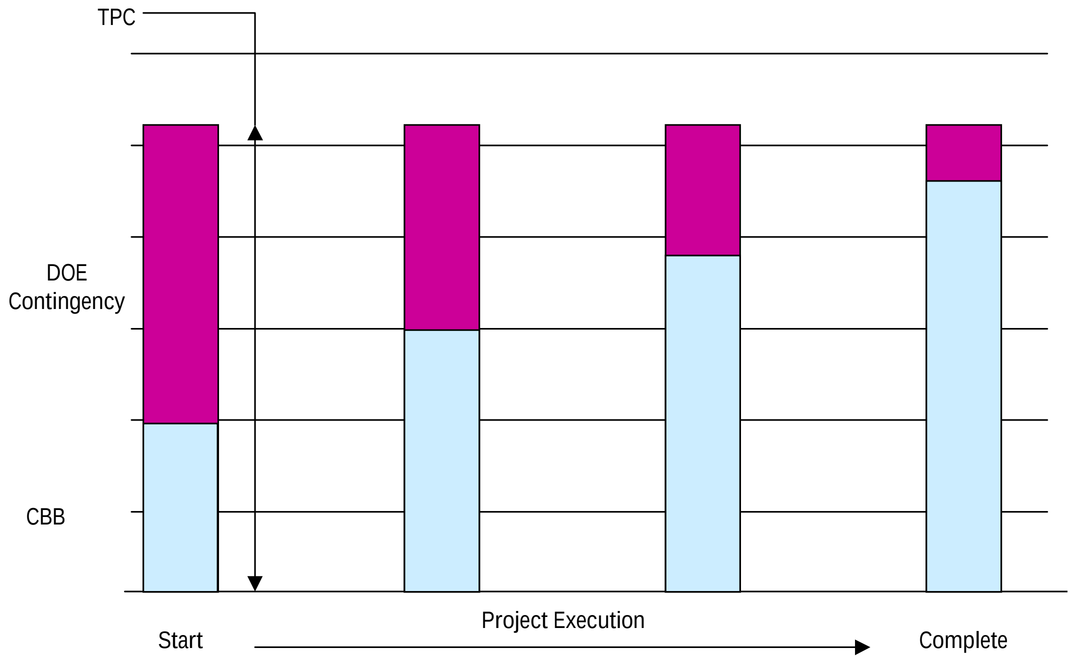

Figure 12-6. Contract Budget Baseline Growth During Project Execution: changes in scope/ requirements accommodated without increasing TPC by transferring DOE Contingency to CBB

12.3.3 Contract Budget Baseline

At any given time in the life of the project, the CBB represents the contractor's budget commitment for project completion encompassing the currently intended scope of the project. While the CBB includes TEC and OPC contingencies (Figure 12-5, and see below) to account for risks/uncertainty associated with the currently intended scope, it is not designed to accommodate additions of scope and/or requirements, or account for factors not under the contractor's control.

12.3.4 Performance Measurement Baseline (PMB)

The Perform Measurement Baseline (PMB) is an aggregation of the time-phased budgets allocated to scope elements within the currently intended and defined scope of the project. Normally, it does not include any contingency though, during the execution of the project, budget may be transferred from contingency to the PMB via documented change control (Figure 12-7). Any changes to scope/cost/ schedule for the PMB must be documented and approved via change control.

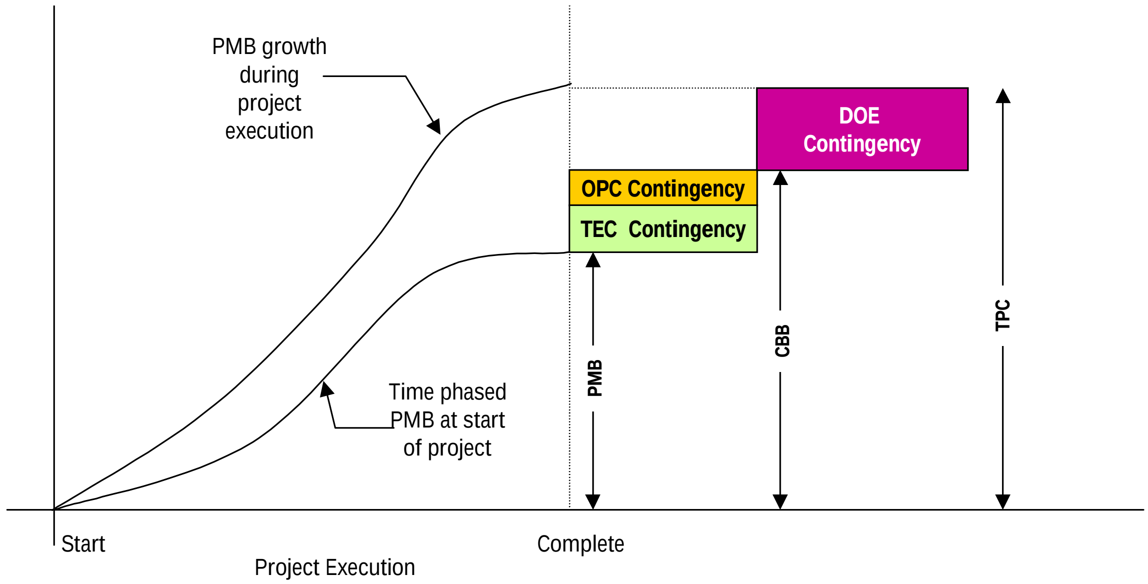

Figure 12-7. During project execution, contingency is transferred to the PMB—project completion achieved without TPC growth

12.3.5 Total Estimated Cost

The TEC, sometimes referred to as the total estimated construction cost (TECC), reflects the capital component of the total project costs (TPC). These capital costs relating to design, equipment procurement, and construction are considered to be the facility/system acquisition costs. The TEC does not include development, engineering, or startup costs which are generally OPEX-funded.

The TEC has the following two components: a base estimate, reflecting budget allocations for scope elements for the currently defined/intended scope of work, and a TEC contingency, the capital portion of contingency addressing cost estimating uncertainties associated with the hardware design/procurement/construction costs.

TEC = TEC (base) + TEC Contingency

The TEC concept is applicable even when the construction is OPEX-funded.

12.3.6 Baseline Interrelationships

TPC = CBB + DOE Contingency

TEC = TEC (base) + TEC Contingency

OPC = OPC (base) + OPC Contingency

PMB = TEC (base) + OPC (base)

CBB = PMB + TEC Contingency + OPC Contingency

Figures 12-4 through 12-8 illustrate the component elements of the TPC and the interrelationships between the various baselines and contingency.

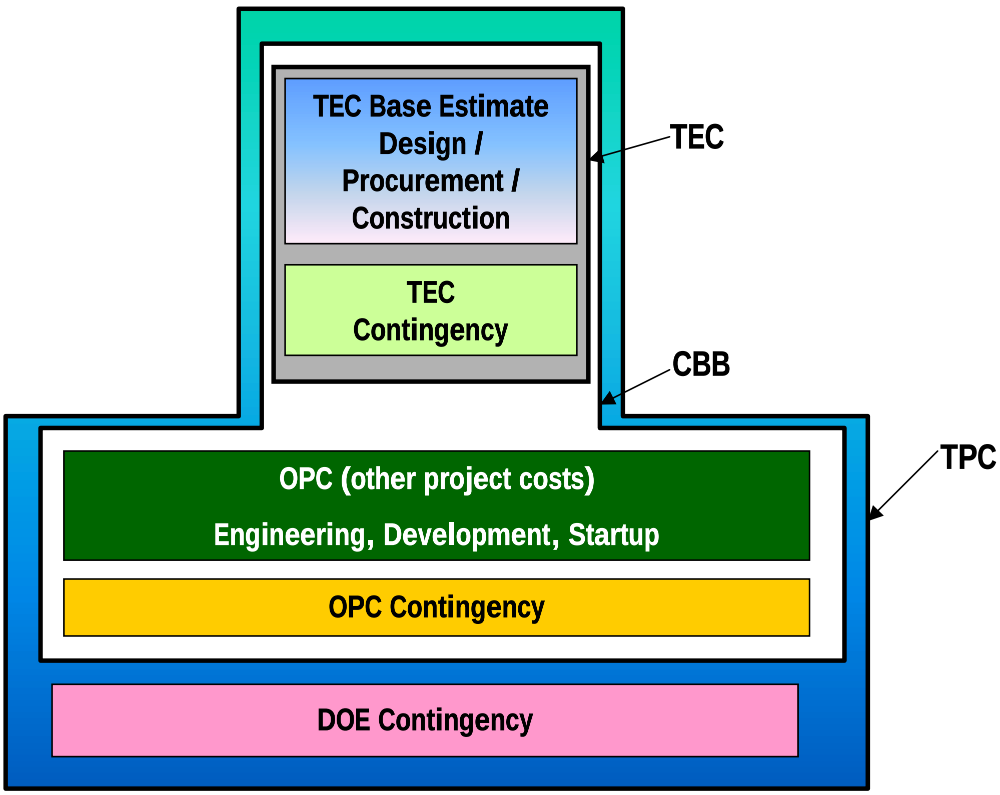

Figure 12-8. TPC Elements and their Interrelationships

The performance baseline (PB) represents the DOE commitment to Congress to assess Total Project Cost (TPC). The TPC baseline is a guide by which Congress assesses DOE performance and is a reference point for Congressional and GAO inquiries related to DOE project management performance. **Therefore, TPC baseline shall be established with a high degree of confidence so that project completion can be achieved within the cost and schedule baselines.** An element in formulating the performance baseline is a systematic risk analysis that identifies and assesses uncertainties related to project scope and design definition; and also the development and inclusion of adequate contingency to address factors that might cause cost/schedule growth during project execution. Project completion without an increase in the TPC is the primary measure of success in formulating the TPC performance baseline.

The TPC for the performance baseline shall be established at CD-2. If established earlier, it is done after careful consideration. Establishing a performance baseline earlier than CD-2 is a contributor to baseline growth. The project manager is responsible for project completion within the performance baseline.

In establishing the performance baseline, project completion shall be clearly and unambiguously defined. A primary consideration is whether project completion is defined as system/facility turnover to the user, or whether subsequent costs (operating and D&D) are included in the performance baseline (life-cycle approach).

From a Congressional accountability perspective, the Performance Baseline shall capture all project costs (Total Project Cost (TPC) includes both the capital and OPEX components) even if the project is fully OPEX funded. Thus,

TPC = TEC + OPC (including all contingency)

TEC is Total Estimated Cost, representing system/facility design/procurement/construction costs related to system/facility acquisition, executed with capital funds.

OPC is Other Project Costs related to engineering, development, startup, and operations. These activities/costs are essential for project execution, and are not considered a part of the normal capital system/facility acquisition costs, and are thus OPEX funded.

12.3.7 TPC Baseline and Contingency

Total project cost formulation is based on the development of the component baselines that are linked together by estimating and allocating appropriate contingency based on risk analysis.

The DOE project execution is through a Contract Budget Baseline (CBB) that represents the DOE/contractor contractual agreement for execution of the currently defined project scope of the project. Thus, while the CBB represents the project scope as presently understood/intended, the TPC includes expected project completion costs.

TPC = CBB + DOE Contingency

The DOE contingency is controlled by DOE, held outside the CBB, and transferred to the CBB as needed during project execution via documented change control. This Contingency is intended to account for evolution/changes to the project scope, and other events that occur between establishing the CBB and project completion that are beyond the control of the contractor. Simply stated, the DOE contingency should be adequate to cover all out-of-scope changes that occur during project execution. The DOE contingency should include a 3 percent to 5 percent (management decision) allowance to account for the unknown unknowns.

The CBB itself is comprised of two components:

CBB = TEC (Capital) + OPC (OPEX) (including TEC and OPC contingencies)

TPC = CBB + DOE Contingency

For both the TEC and OPC, the uncertainties related to design evolution, estimating, and changes within the contractor's scope are addressed through establishing contingency.

TEC = TEC (base) + TEC Contingency

OPC = OPC (base) + OPC Contingency

Note that during project execution, as the TEC and OPC contingencies are utilized and become part of the TEC (base) and OPC (base), the TEC and OPC do not change. The TEC and OPC increase only when the DOE contingency is utilized through change control and transferred to the CBB.

There are two approaches to budgeting the TEC and OPC contingencies that are part of and included within the CBB:

1. Contingency is part of and included within the cost account budgets established in the Performance Measurement Baseline (PMB) for scope execution. In this case, the PMB is equal to the CBB.

2. The TEC and OPC contingencies are held outside the PMB cost account budgets and during project execution transferred to the PMB cost accounts via the change control process. Thus

PMB = TEC (base) + OPC (base)

CBB = PMB + TEC Contingency + OPC Contingency

TPC = CBB + DOE Contingency

Contingency is part of the expected costs at project completion and, therefore, must be included in the TPC established as the performance baseline. During project execution, contingency is transferred, via a documented change control systems, to the CBB and/or the Performance Measurement Baseline for scope execution. Tracking of the consumption of contingencies during project execution is part of the periodic review/update of the Risk Management Plan. This plan serves as the documented basis for developing and establishing project contingency used for formulating CBB and TPC baselines.

In summary, the TPC established as the project's performance baseline must include contingency. The three components of contingency are:

- TEC Contingency
- OPC Contingency
- DOE Contingency

The TEC and OPC contingencies are included in the Contract Budget Baseline. The DOE contingency is included in the TPC as part of the expected cost, but is held outside the CBB.

Several "baselines" have been discussed in this section including TPC, TEC, OPC, CBB and PMB. These "baselines" are linked to each other through the various contingency elements as discussed above. The baseline formulations presented here are intended to ensure the following:

1. Project execution and completion without an increase in the TPC. This is accomplished by establishing the DOE contingency as part of the TPC, which is totally controlled by the DOE, and initially held outside the Contract Budget Baseline.

2. Significant progress in project execution without any changes to the CBB, TEC or OPC baselines unless and until the DOE Contingency (controlled by the DOE) is utilized in the project.

3. Significant ability during project execution to address uncertainties and changes without increases to the TEC or OPC through transfer of the TEC contingency and OPC contingency to the Performance Measurement Baseline via documented change control.

4. Tracking and reporting of rate of consumption of each contingency allowance—TEC, OPC, DOE.

12.4 Responsibilities

12.4.1 Federal Project Manager

The FPM is responsible for developing and establishing the TPC, TEC baselines, defining and controlling the scope of the project, and project completion within the TPC, TEC cost and schedule baseline. The FPM develops and implements the acquisition and Project Execution Plan.

12.4.2 Contractor Project Manager

The contractor project manager is responsible for executing the currently intended, defined, and contracted scope of work within the CBB in accordance with all DOE requirements, procedures, and standards. The project manager is responsible for executing the project within approved cost, schedule, and scope baselines as defined in the project execution plan.

12.4.3 Risk Identification and Analysis

An essential part of project planning is to ensure that the risks associated with the project have been identified, analyzed, and determined to be either avoidable or manageable. Risk identification and analyses should be continued through the succeeding stages, including the acquisition plan and the Project Execution Plan. Each of the identified risks is monitored at each CD to ensure that they have been satisfactorily addressed, eliminated, or managed.

The Acquisition Plan is developed by the project manager. The contractor may be consulted during development of the acquisition plan. At DOE’s discretion, and when appropriate, the contractor may also participate in the development of the Project Execution Plan which is an agreement on project planning, management and objectives between the Headquarters program office and the field. The Project Execution Plan shall include the following elements:

- Project cost, schedule, and scope baselines (including separately identified contingencies)
- Risk management plan

12.5 TYPES OF CONTINGENCIES

12.5.1 DOE Contingency

The DOE contingency is the part of the expected cost estimate established outside the CBB, but inside the TPC, to account for scope evolution/definition changes and changes in requirements. During project executions, this contingency is transferred to the CBB via documented change control to reflect scope additions/ changes to the CBB without impacting the project TPC. The DOE contingency has both Capital and OPEX funding components.

Factors that influence the amount estimated for DOE contingency within the TPC include the following:

- *Confidence Level.* The greater the desired confidence level for project completion within the TPC, the higher the allocation of DOE contingency. This approach would require utilization of probabilistic and statistical techniques including Range estimating and Monte Carlo simulations (Figure 12-9).

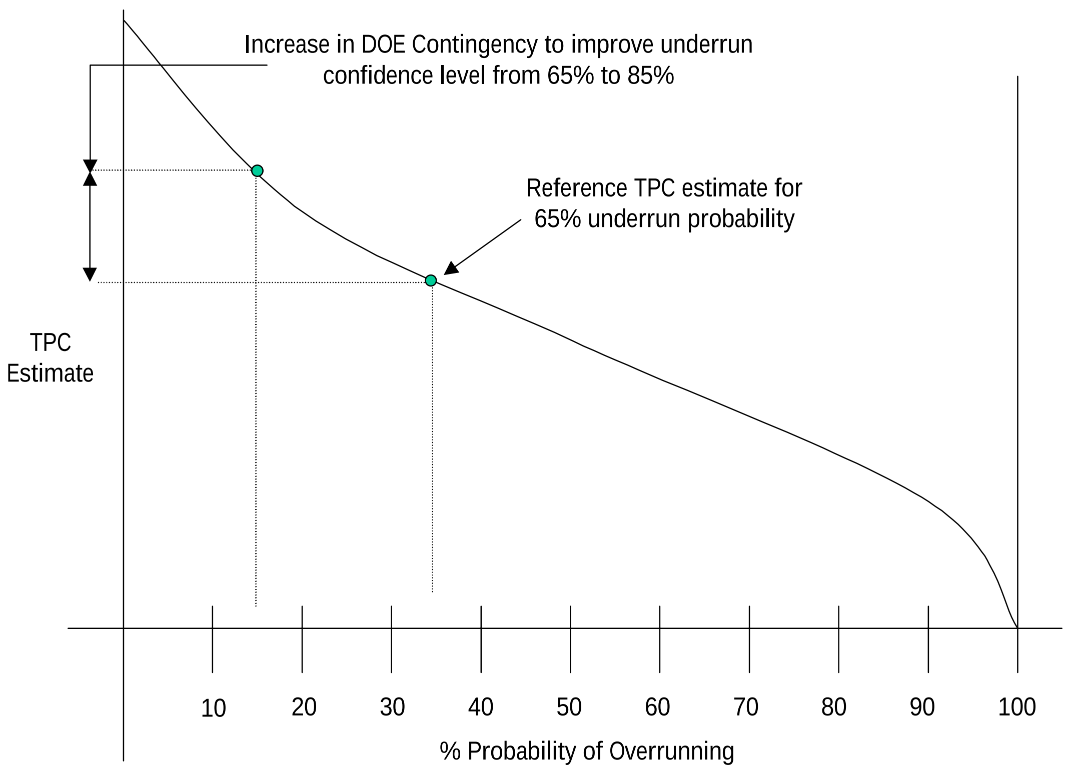

Figure 12-9. Monte Carlo Simulation: Estimating and Allocating Contingency

- *Nature of Project.* First-of-a-kind projects, that have a significant level of development effort that include new processes and technologies, have greater uncertainties in definition of requirements and scope definition, requiring higher level of DOE contingency. These projects would require use of probability-based estimating techniques and Monte Carlo simulations to envelope the uncertainties associated with developmental work, lack of prior experience, and inexact scope definition. On the other hand, projects that are similar in nature to projects executed in the past (experience) would require lower levels of DOE contingency.

- *Project Scope and Requirements Definition.* The better defined the project scope, requirements are, the lower the potential for significant scope changes during project execution. Thus, scope definition at the initiation stage of a first-of-a-kind project involving technology development would have a greater uncertainty than a conventional construction project supported by extensive prior experience. As a result, a TPC developed for a first-of-a-kind project (greater scope definition uncertainty) would have a higher share of DOE contingency than a TPC for a conventional construction project (for equal TPCs).

  Scopes that are essential to a project, but not defined well enough to be included in the CBB, may be estimated and held in the DOE contingency for subsequent transfer of scope/budget to the CBB.

12.5.2 TEC and OPC Contingency

The TEC contingency accounts for cost-estimating uncertainties associated with the hardware design/procurement/construction costs. The uncertainty is primarily associated with the degree of scope definition, the project functional requirements, and the level of design definition. Thus, at the conceptual design stage, facility, equipment, and footprint requirements are less well defined than at final design stage. The DOE cost-estimating handbooks and guides associate percent contingency with level of design definition, and nature of equipment/facility (e.g., first-of-a-kind, nuclear). Contingency is estimated at both elemental design level and in an overall sense. TEC contingency is considered a part of the TEC and is not intended to accommodate changes/additions of scope or accommodate events outside the contractor's control. TEC contingency is held outside the Performance Measurement Baseline (PMB). All transactions to and from the TEC contingency are documented via change control.

Similar considerations apply to project cost elements that are not a part of the TEC and designated as OPC. OPC contingency is treated the same way as TEC contingency.

During the course of the project, contingency is expected to transfer to the base budget within the PMB via change control and be expended.

Contingency is an integral part of the expected costs of a project. Definitions of contingency include the following:

- Specific provision for unforeseeable elements of cost within ***the defined project scope.*** Contingency is particularly important where previous experience relating estimates and actual costs has shown that unforeseeable events that will increase costs are likely to occur

- Covers costs that may result from incomplete design, unforeseen and unpredictable conditions, or uncertainties within the defined project scope. The amount of contingency will depend on the status of design, procurement, and construction, and the complexity and uncertainties of the component parts of the project. Contingency is not to be used to avoid making an accurate assessment of expected cost.

A written contingency analysis and estimate should be performed on all cost estimates and maintained in the estimate documentation file.

The ranges provided in the DOE cost-estimating guide can be used for estimating contingency for small projects. However, larger projects require a more detailed analysis including a cost-estimate basis and a written description for each contingency allowance assigned to the various parts of the estimate. For large projects with significant uncertainties, a probability based risk analysis (e.g., using Monte Carlo simulations) should be used for estimating contingency.

Table 12-1. Contingency Allowance Guide by Type of Estimate

	Type of Estimate	**Overall Contingency Allowances % of Remaining Costs Not Incurred**
1	PLANNING (Prior to CDR) Standard Experimental/Special Conditions	 20% to 30% Up to 50%
2	BUDGET (Based upon CDR) Standard Experimental/Special Conditions	 15% to 25% Up to 40%
3	PRELIMINARY Design	10% to 20%
4	FINAL Design	5% to 15%
5	GOVERNMENT (BID CHECK)	5% to 15% Adjusted to suit market conditions
6	CURRENT WORKING ESTIMATES	See Table 11-2
7	INDEPENDENT ESTIMATE	To suit status of project and estimator's judgement

Justification must be documented in writing when guide ranges for contingency are not followed. If extraordinary conditions exist that require larger contingencies, the rationale and basis should be documented in the estimate.

Estimate types 1 through 5 in Table 12-1 are primarily an indication of the degree of completeness of the design. Type 6, current working estimates, found in Table 12-2, depends upon the status/progress of design, procurement, and construction activities (elements). Contingency is calculated on the basis of remaining costs not incurred. Type 7, the Independent Estimate, may occur at anytime, and the corresponding contingency would be used (e.g., 1, 2, etc.).

TABLE 12-2. Contingency Allowances for Current Working Estimates

		Item Contingency on Remaining Cost Not Incurred
a. ENGINEERING	Before Detailed Estimates:	15% to 25%
	After Detailed Estimates:	10%
b. EQUIPMENT PROCUREMENT		
	Before Bid:	
	Budget	
	Title I	15% to 25%
	Title II	10% to 20%
	After Award:	5% to 15%
	Cost Plus Award Fee (CPAF) Contract	15%
	Fixed-Price Contract	1% to 5%
	After Delivery to Site (if no rework)	0%
c. CONSTRUCTION		
	Prior to Award:	
	Budget	15% to 25%
	Preliminary Design	10% to 20%
	Final Design	5% to 15%
	After Award:	15% to 17-1/2%
	CPAF Contract	15% to 17-1/2%
	Fixed-Price Contract	3% to 8%
d. TOTAL CONTINGENCY (CALCULATED)		

12.5.3 Conventional Construction Projects

Table 12-1 presents the contingency allowances by type of construction estimate for the seven standard DOE estimates. Table 12-2 presents the guidelines for the major components of a construction project.

Factors that need to be considered in calculating contingency for specific elements in the estimate include: state-of-the-art design, required reliability, equipment complexity, construction restraints due to continuity of operation, security, contamination, environmental (weather, terrain, location), scheduling, and other items unique to the project, such as nuclear and waste management permits and reviews. Contingency ranges for these elements are 5% to 50%.

12.5.4 Design Completeness or Status

Design definition at the conceptual design phase would have a greater uncertainty than at the detailed design phase. Thus a contingency estimate developed at conceptual design would be a higher percentage share of the TEC than at the detailed design phase for equivalent TEC scopes (Figure 12-10).

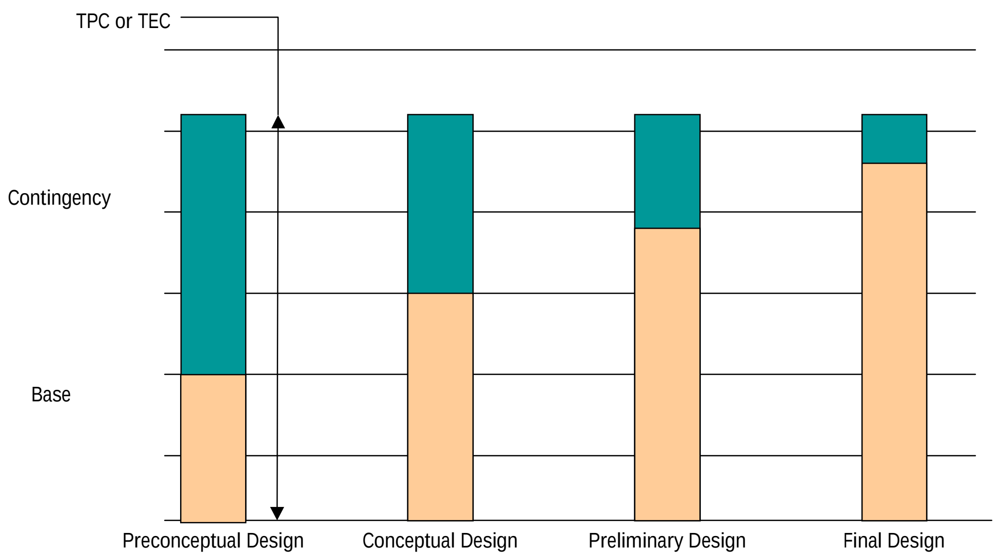

Figure 12-10. Higher Percent Allowance Needed for Contingency Depending on Degree of Lack of Design Definition

The degree of detailed design to support the estimate is the primary factor. This is the major reason that the ranges in Table 12.2 vary from 20 to 30 percent in the planning estimate to 5 to 15 percent at the completion of detailed design. Different elements of the estimate may have different degrees of design completion, and the appropriate contingency percent should be used.

12.5.5 Market Conditions

Market condition considerations are an addition or a subtraction from a project cost that can be accounted for in contingency. The closer the estimated element is to a firm quoted price for equipment or construction the less the contingency, until reaching 1 to 5 percent for the current working-type estimate for fixed-price procurement contracts, 3 to 8 percent for fixed-price construction contracts; and 15 to 17.5 percent for cost-plus contracts that have been awarded. Higher contingency percentages would be used if significant “change notices” are expected/planned.

12.5.6 Special Conditions

When a technology has not been selected or developed for a project, an optimistic-pessimistic analysis can be completed. For each competing technology, an estimate is made. The difference in the estimates of the optimistic and pessimistic alternative can be used as the contingency. Alternatively, a probabilistic approach (Monte Carlo simulation) may be utilized.

12.5.7 Environmental Restoration Projects

Environmental restoration projects usually consist of an assessment phase and a remediation/cleanup phase. Contingency plays a major role in the cost estimates for both phases. Recommended contingency guidelines for each phase are shown in Table 12-3.

TABLE 12-3. Contingency Guidelines for Environmental Restoration Projects

Activity and Estimate Type	Expected Contingency Range
Preliminary Assessment/Site Investigation Planning Estimate for All Assessment Activities	Up to 100%
Preliminary Estimate for All Assessment Activities	30% to 70%
Remedial Investigation/Feasibility Study Detailed Estimate for All Assessment Activities	15% to 55%
Planning Estimate for All Cleanup Phase Activities	20% to 100%
Contingency Guidelines for Remediation/Cleanup Phase	
Pre-Design Preliminary Estimate for All Remediation/Cleanup Phase Activities	Up to 50%
Remedial Design and Action Detailed Estimate for All Remediation/Cleanup Phase Activities	0% to 25%

- *Assessment Phase.* An assessment determines and evaluates the threat presented and evaluates proposed remedies. As a result, the assessment encompasses such items as field investigations, data analysis, screening and evaluation studies, and the production of reports. Unlike the remediation phase, the assessment phase does not include the physical construction of a remedy. Since the assessment is one of the initial stages of the environmental restoration process, there is a high degree of uncertainty regarding the technical characteristics, legal circumstances, and level of community concern. As a result, the scope of the assessment often evolves into additional operable units and increased sampling and data evaluation. More than one assessment may be required.

  The degree of project definition will depend on how well the scope of the assessment is defined. Higher levels of project definition will correspond to increasing levels of work completed on the assessment.

  Other considerations that affect the contingency ranges include:

  — Number of alternatives screened and evaluated

  — Level and extent of sampling analysis and data evaluation

  — Technical and physical characteristics of a site

  — Level of planning required.

  Table 12-3 shows the estimate types for the assessment phase of an environmental restoration project and their corresponding expected contingency ranges.

  These are only general guidelines based on the level of project definition. A higher or lower contingency may be appropriate depending on the level of project complexity, technical innovation, market innovation, and public acceptance.

- *Remediation/Cleanup Phase.* For the remediation/cleanup phase, contingency factors are applied to the remaining design work. The contingency percentage will depend upon the degree of uncertainty associated with the project, particularly the degree of uncertainty in the scheduled completion dates.

  Table 12-3 shows the estimate types for the remediation/cleanup phase and their corresponding contingency ranges. While the ranges are relatively broad, they reflect the amount of contingency that would have been needed for a set of completed projects. The wide variance accounts for differences in project definition when the estimate was generated, project complexity, technical innovation, and other factors.

12.5.8 Monte Carlo Analyses Methodology

Monte Carlo or risk analysis may be used when establishing a baseline or baseline change for any major construction or remediation project. Monte Carlo analyses and other risk assessment techniques use similar methodology to obtain contingency estimates. A sample is illustrated in Table 12-4. The estimator and project team subdivide the estimate into separate phases or tasks and use their judgement to assess probability that the cost will fall within the specified range along with an assumed distribution.

Table 12-4 : Sample Monte Carlo Risk Assessment Methodology

Task 1		$1,000,000	Fixed Price
Task 2	40% 40% 20%	$100,000 to $250,000 $250,000 to $500,000 $500,000 to $600,000	Step-Rectangular Distribution
Task 3	50% 20% 30%	Less than $100,000 $100,000 to $200,000 $200,000 to $220,000	Discrete Distribution
Task 4	Normal Distribution	Mean = $235,000 Standard Deviation = $25,000	Normal Distribution

The distribution of the ranges is based on the estimator's judgement. For example, Task 1 is a fixed price of $1,000,000 with no anticipated change orders. For Task 2 there is a 40 percent chance the cost will be between $100,000 and $250,000, a 40 percent chance the cost will be between $250,000 and $500,000, and a 20 percent chance it will be between $500,000 and $600,000. A step-rectangular distribution was chosen.

A computer program is utilized (1000 or more iterations) to calculate the mean cost as a base estimate. With the base estimate, there is a 50 percent probability that the project will be underrun. The results in Table 12-5 show the contingency that should be used to achieve various probabilities of cost overrun. For example, a contingency of 11.1 percent should be used to achieve an 85 percent probability of project cost underrun. Therefore, the total cost estimate would be $1,902,000. If the worst case cost of each variable had been used, the total estimate would be $2,078,000, or 21.4 percent contingency.

Table 12-5: Sample Monte Carlo Simulation Methodology

Probability of Underrun	Estimate $K	Contingency (Estimate-Base) $K	Contingency % of Base
.50	1,712*	0	0
.60	1,745	33	1.9
.70	1,823	111	6.5
.80	1,875	163	9.5
.85	1,902	190	11.1
.90	1,937	225	13.1
.95	1,991	279	16.3
1.00	2,078	366	21.4

* $1,712K @ 50% underrun probability established as base estimate
$2,078 @ 100% underrun probability equates to summation of worst case costs
13.1% contingency ($225K) provides 90% confidence level.

12.6 Funding Considerations

12.6.1 Funding Profile

The cost/schedule formulations of the TEC and/or TPC baselines are predicated upon assumptions regarding the funding profile for the schedule duration of the project, constituting a de-facto baseline funding profile. Funding appropriations (current FY) and Budget Formulations (FY +1 and FY +2) at levels below the baseline funding profile can only be accommodated by scope deletions and/or scope deferrals to the outyears, thereby increasing project duration and hence the TEC and/or TPC (see Figure 12-11). The impacts of these reduced budget formulations should be documented and reported as TEC/TPC forecasts. A chart documenting baseline versus actual funding should be maintained and reported.

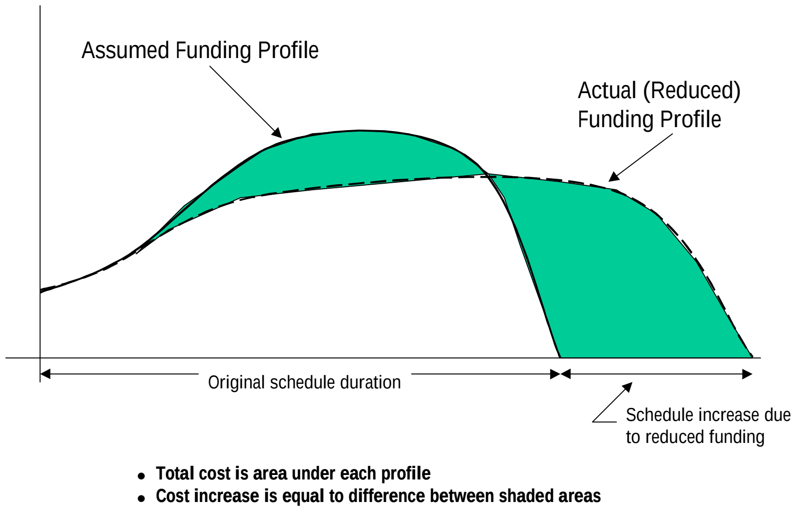

Figure 12-11. Impact of Reduced Funding

Funding profiles for Capital Funded Projects with multi-year Budget Authority loosely follow the expected expenditure profile (Figure 12-12). In contrast, for OPEX-funded projects with budget authority one fiscal year at a time, for the same schedule, the funding profile would have to be based on the expected "funds commitment" profile (Figure 12-13). This would result in a front-loaded funding profile with significantly larger year end uncosted balances. A more stable OPEX funding profile would require resequencing and rescheduling of the multi-year contracts thereby increasing project duration and total project costs (see Figure 12-14).

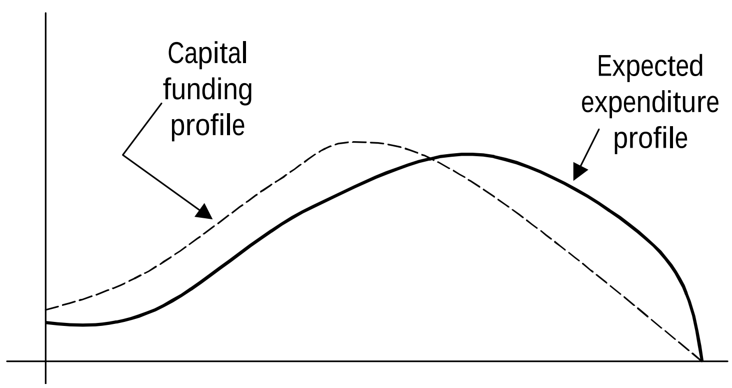

Figure 12-12. Capital Funding Profile Matches Expected Expenditure Profile

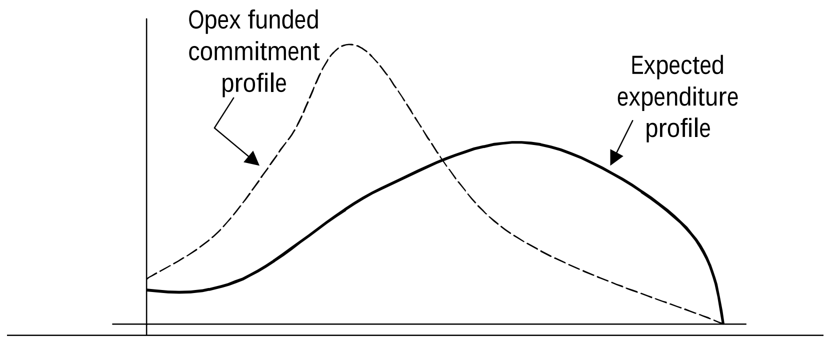

Figure 12-13. Front-loaded OPEX Profile (need for entering commitments) for same Expenditure Profile

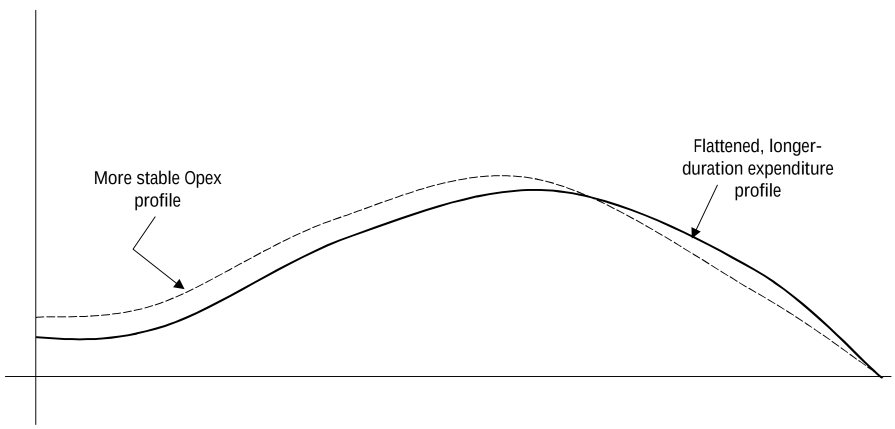

Figure 12-14. Project duration and Costs Increase when Front-loaded Commitment Profile not Supported

12.6.2 Capital vs. OPEX Funding

Capital funding with multiple fiscal year budget authority acknowledges and provides for the need by the contractor to enter into multiple fiscal year contractual commitments for design, GFE procurement, and construction activities. Planning and execution of these multi-fiscal year contracts becomes a significantly greater challenge in the OPEX funding environment which is based on fiscal year appropriation and annual budget authority. For these multiple fiscal year contracts, compliance with federal anti-deficiency statues requires significantly higher levels of “committed, but unspent” (carryover) funds at the end of any given fiscal year. The project manager must plan appropriately and adequately to protect these fiscal year end uncosted balances.

12.6.3 Flat Funding

A project schedule optimized to lowest total project cost is likely to exhibit an asymmetrical bell curve for resource needs over time (see Figure 12-15). A schedule that is constrained by flat funding resource availability will require a longer project duration resulting in increased project costs. If the TPC/TEC formulations are based on a schedule requiring a resource need (funding) profile judged to be at risk, the baseline formulations must include adequate resources for schedule extension and resultant cost increases.

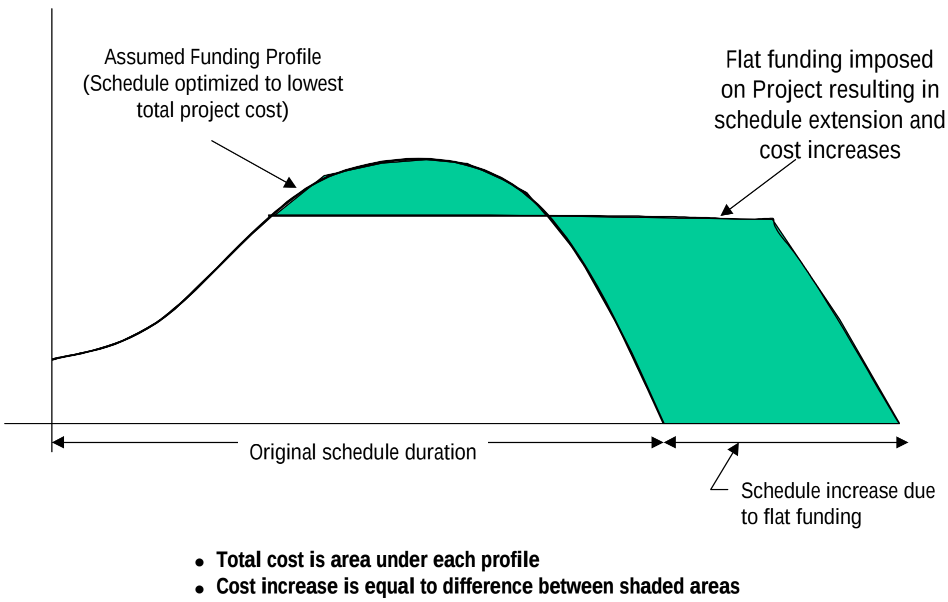

Figure 12-15. Impact of Flat Funding

12.7 Project Scope Structure

Conventional construction projects are likely to have the design/GFE procurement/ construction costs (i.e., the TEC or capital component of cost) as a high percentage of the TPC. First-of-a-kind projects are likely to require significantly higher engineering and development costs (non-TEC, other project costs) making the TEC a smaller percentage of the TPC. Furthermore, if a project is defined to include a greater share of what would otherwise be considered operating costs or site support costs, the TEC as a percentage of the TPC is reduce even further.

12.8 PROJECT COST STRUCTURE

The TPC for any given project is directly linked to the planned duration of the project. However, the sensitivity of the TPC in relation to project duration is strongly dependent on the project cost structure. In this context, project cost may conceptually be divided into two components:

- Fixed annual costs, totally dependent on project duration
- Fixed scope cost, variable annual cost dependent on funding.

Fixed annual costs may be viewed as annual costs incurred as part of the "cost of doing business" or a baseload annual cost, relatively fixed, that will be incurred for the duration of the project. Fixed scope variable annual costs represent, for example, $60M in GFE procurements that can be executed in 4 years at $15M/year or 5 years at $12M/year, depending on funding.

In conventional construction projects, the fixed annual cost may be only 10% to 15% of the total cost, making the total cost less sensitive to schedule delays that increase project duration. In other cases, e.g., first-of-a-kind or some remediation projects, the fixed annual costs may be significantly higher (40% to 60%). In these cases the total cost is much more sensitive to increases in project duration resulting from funding reductions, scope additions, or poor schedule performance.

Figure 12-16 illustrates an approach for determining TPC sensitivity to schedule extensions in relation to the project's cost structure. Projects A and B both have four-year durations and TPCs of $200M. Project A has fixed annual costs of $20M /year, $80M total for four years. Project B has fixed annual costs of $5M/year, $20M total . If, for the same fixed scope costs, the durations are increased to five years, Project A's TPC increases to $220M (a 10% increase) while Project B's TPC increases to $205M (a 2.5% increase). Project A will require significantly higher allowances to account for schedule extension risks than Project B.

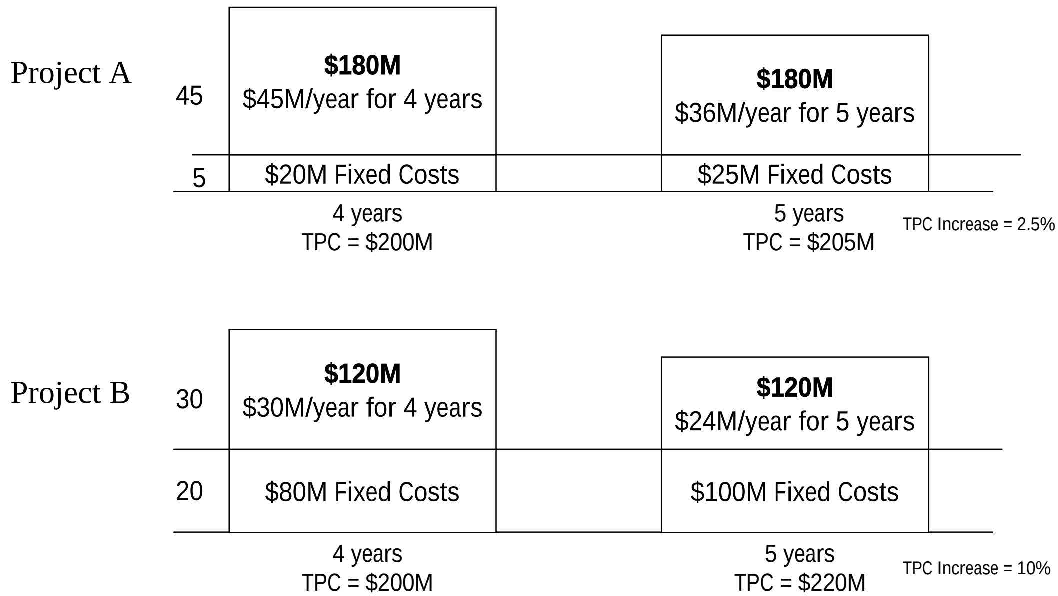

Figure 12-16. Project Cost Structure

12.9 ESTIMATING AND ALLOCATING CONTINGENCY

The risk based approach to estimating contingency to account for the cost estimating uncertainties inherent in formulating a TPC baseline utilizes Monte Carlo simulation techniques. These techniques establish an 85% to 90% underrun confidence level for the TPC (see Figure 12-17). The probability and cost distributions assigned to the Monte Carlo simulation elements must account for all the uncertainties, including the degree of scope and design definition, maturity of technology versus first-of-a-kind efforts, project cost structure and funding profile assumptions, and potential cost impacts due to scheduling uncertainties. If all these uncertainties are not captured in the Monte Carlo simulation elements, then the 85% to 90% “confidence” level is likely to provide a false and misleading sense of security. The Federal project manager is responsible for selecting the confidence level and for project completion within the resulting TPC.

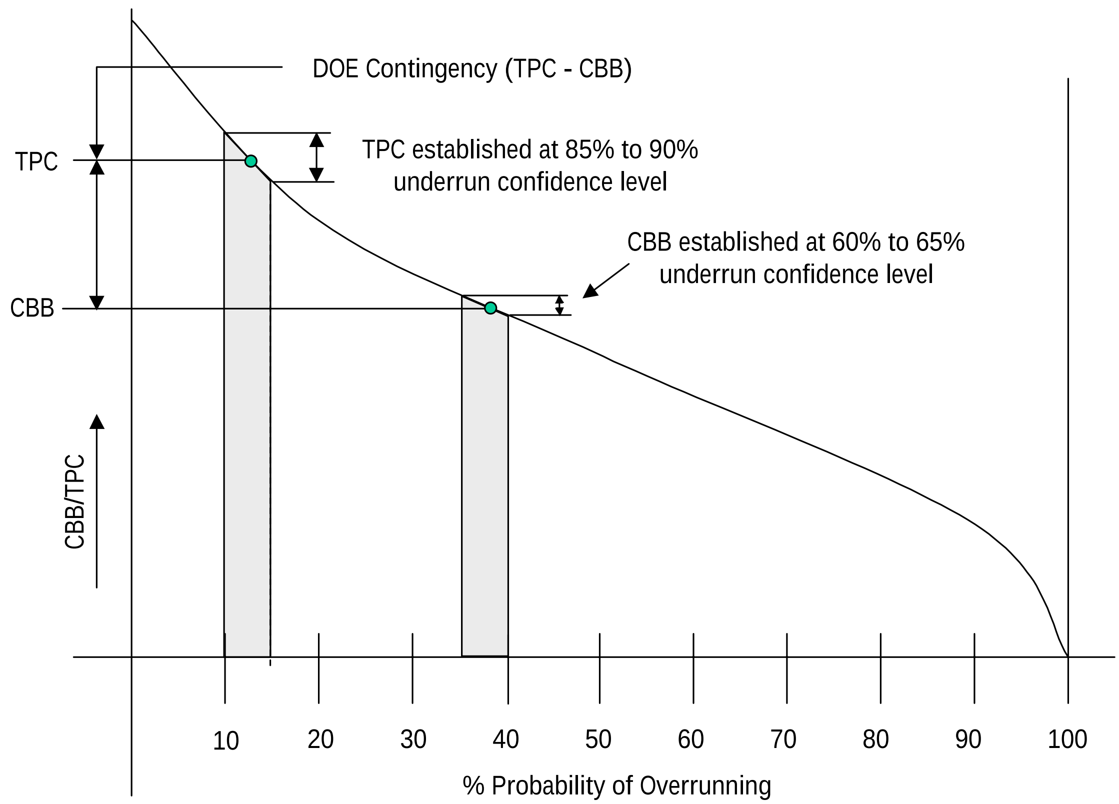

Figure 12-17. Monte Carlo Simulation: Estimating and Allocating Contingency

The “allocation” of contingency utilizing this approach establishes the project’s contract budget baseline at the 60% to 65% underrun confidence level at the start of the project. During project execution, the DOE contingency is transferred to the CBB via documented change control in response to events/changes that are not within the contractor’s control.

The Contractor Project Manager is responsible for execution of the defined scope within the contract budget baseline.

The assumptions used in the Monte Carlo simulation and the confidence levels used to establish the TPC and CBB baselines must be documented in the Project Execution Plan. During project execution, the risk analysis basis should be periodically reviewed and revised.

12.10 Change Control and Reporting

Change control is vital to project cost control and must be well organized and functioning. A few change control guidelines include:

- A formal change control procedure must be established that defines and documents the process for changes and control of the scope/cost/schedule baselines.
- Change control thresholds and the required levels of approvals should be tailored to the needs of the project.
- Within the Contract Budget Baseline, the contractor establishes the change control thresholds and approval levels.
- Changes to the Contract Budget Baseline and/or the TPC baseline require DOE approval.
- All changes to any element of the scope/cost/schedule baselines must be documented and maintained.
- The TPC, CBB, PMB, and TEC constitute the project's upper level baselines. Changes to these baselines must be reported in monthly and quarterly reports.
- If the TEC and/or TPC baselines have been impacted (i.e., due to funding short falls or scope changes), a forecast incorporating the impact must be reported while awaiting approval to revise the baseline.
- The rate at which the contingency is being consumed during project execution should be monitored, evaluated, and reported periodically to assess whether the remaining contingency is adequate for project completion.

12.11 Budgeting of Contingency

Contingency should be budgeted each fiscal year for each applicable Budgeting and Reporting (B&R) code for each project.