NAC Executive Insights

Contingency

Key Points

- Five levels of cost estimate classification are described.
- Building and process projects are compared.
- Tendency of complex projects to behave more consistent with process projects is noted.
- Elements of cost are described at a macro level and attention is called to the inclusion of allowances in the base cost estimate.
- Elements of contingency are described.
- Tendency of contingency analysis to underestimate variability of outcomes is flagged.
- Management reserve is described as not being a part of contingency.
- Unique features of public projects as they relate to contingency are highlighted.
- An example of sharing contingency for result is provided.

Introduction

This Executive Insight focuses on contingency in capital construction projects. It seeks to address questions often raised by owners as to what are appropriate contingency levels to include in project and budget estimates. This Insight addresses:

- Cost estimate classification
- Elements of cost
- Allowances
- Elements of contingency
- Management reserve
- Unique features of public projects
- Sharing contingency for result

Cost Estimate Classification

Cost estimates can be classified based on degree of project definition (Table 1), end usage of the estimate, estimating methodology, and the effort and time needed to prepare the estimate. The "primary" characteristic used in Association for the Advancement of Cost Engineering (AACE) guidelines[1] to define the classification category is the degree of project definition.

Table 1 contrasts cost estimate classifications and expected accuracy ranges for general building projects and those associated with process facilities[2]. It is the experience of the author that large complex projects, irrespective of sector, more closely model the process industry behaviors.

Table 1
Cost Estimate Classification Comparison

			General Buildings		Process/Complex Projects	
Estimate Class	**Level of Definition**	**Typical Use**	**Methodology**	**Accuracy Range**	**Methodology**	**Accuracy Range[3]**
Class 5	0 – 2%	Concept screening	Stochastic[4] or judgement	4-20	Capacity factored, parametric models, judgement	-30 to +50
Class 4	1 – 15%	Study or feasibility	Primarily stochastic	3-12	Equipment factored, parametric models	-20 to +40
Class 3	10 – 40%	Budget, authorization or control	Mixed but primarily stochastic	2-6	Semi-detailed unit costs with assembly level line items	-15 to + 30
Class 2	30 – 70%	Control or bid/tender	Primarily deterministic	1-3	Detailed unit costs with forced detailed take-off	-10 to +15
Class 1	50 – 100%	Check estimate or bid/tender	Deterministic	1	Detailed unit cost with detailed take off	-5 to +10

[1] AACE International Recommended Practice No. 17R-97; Cost Estimate Classification System; TCM Framework: -15 to + 307.3 – Cost Estimating and Budgeting

[2] AACE International Recommended Practice No. 18R-97; Cost Estimate Classification System – As applied in Engineering, Procurement, and Construction for Process Industries; TCM Framework: 7.3 – Cost Estimating and Budgeting

[3] Process industry estimates as reflected in AACE 18R-97 include low and high range variations. These have been simplified here based on experience and are consistent with Figure 1.

[4] Randomly determined; having a random probability distribution or pattern that may be analyzed statistically but may not be predicted precisely

Figure 1 illustrates the relationship between estimate accuracy and project definition.

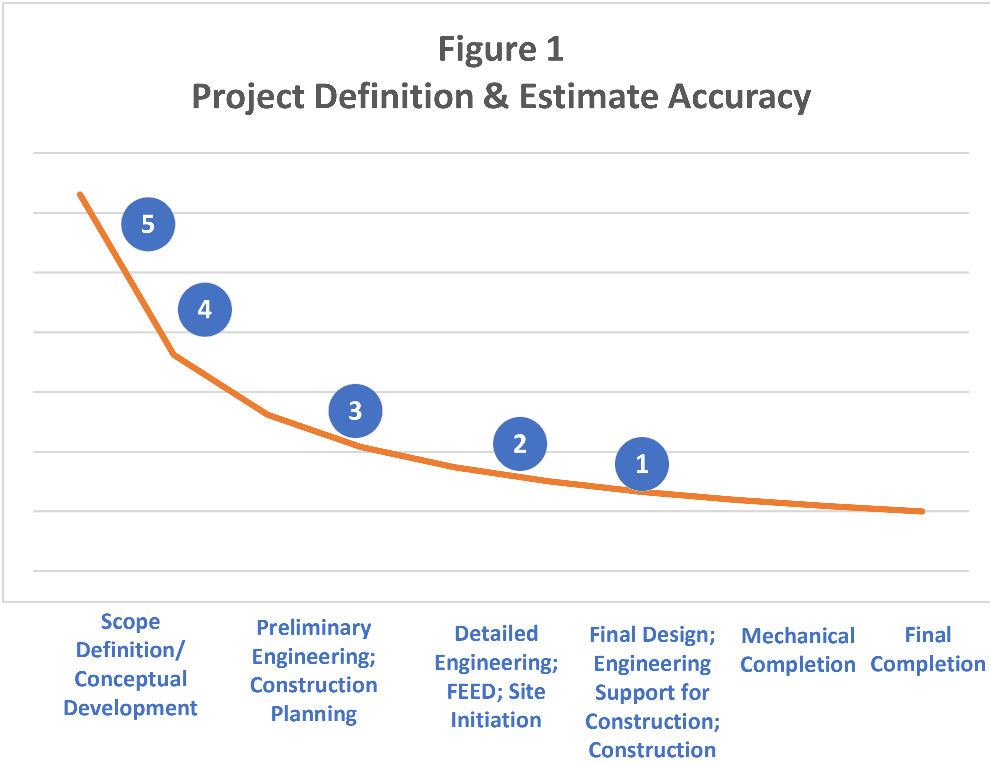

Figure 1
Project Definition & Estimate Accuracy

Class	Estimate Name	Estimate Range
5	Capacity Factor	"-30/+50%"
4	Equipment Factor	"-20/+40%"
3	Semi-detailed	"-15/+30%"
2	Forced Detailed	"-10/+15%"
1	Fall-out Detailed	"-5/+10%"

Elements of Cost

Prior to assessing required contingencies, it is essential to have the most complete base estimate consistent with the intended end use. The elements of cost must include:

- Direct field costs – these include all direct construction labor, plant equipment, and materials of construction.
- Indirect field costs (IFC)[5] – these are more fully discussed in the Executive Insight, “Indirect Field Costs”

[5] Executive Insight, Indirect Field Costs

- Home office costs – these include labor, expense, payroll burden, office overhead costs, and fees
- Allowances

Other factors which may be considered in base cost estimates (often as allowances) include errors and omissions (reasonable and routine rework); costs associated with delays to engineering (delayed client approvals); costs associated with delayed receipt of materials and equipment (schedule related delay costs); and construction delays from delayed permits, utility relocation, or reasonable (expected) weather delays.

When estimates are based on factoring, diseconomies of scale may exist.

Allowances

Estimating allowances are not part of contingency. Rather these are an element of project cost and must be documented in the estimate. Two specific allowances are illustrative:

- Material Take-Off (MTO) Allowances – These reflect the level of design development. Included are quantities not reflected in the design but that will likely be required. They are elements beyond the values derived from the quantity take-offs provided at a specific point in project development. Typically, MTO is associated with bulk quantities such as steel, concrete, piping (including small bore piping), and miscellaneous fittings. Despite inclusion of these allowances, there is still a probability of a quantity overrun and hence they are included in base costs (subject to contingency) and are not part of project contingency.

- Design Development Allowances – These reflect minor changes to mechanical and electrical equipment that is not yet fully designed. These may include additional nozzles or drains to meet O&M needs; lifting lugs to support initial installation and maintenance; and minor modifications to improve safety, constructability, or maintainability. Civil/structural elements may include allowance for architectural details (doors, windows, drains, handrails) and embedments.

Elements of Contingency

Contingency includes estimate contingency. Some organizations also consider “event risk” as part of contingency. For simplicity in this discussion, “event risk” is part of contingency.

Probability levels are associated with the contingency levels (estimate plus event). This is important since an early estimate will have higher contingency levels (hopefully including event contingency); therefore, the percentage distribution (against base estimate) will be higher than at the time when a contractor gets hard money quotes for items and subcontracted work.

The probability levels also are a function of a mix of uncertainty and risk. They are often characterized in terms of a cumulative density function (CDF)[6] around a base case estimate of risk (the base case assumes all risks happen at their individual probable impact values). The CDF weights these with individual probabilities and distribution and then combines independent risks. It is important to note that for many projects, especially the more complex, estimators assume an independence of risks which does not reflect experience or reality. In complexity, risks tend to be coupled or correlated and as such the CDF yields a lower estimate than would realistically be expected. This results in an expectation of estimate accuracy not consistent with historical behaviors.

At a late stage, a (contractor) estimate of the difference between a P60 and P90[7] estimate would be something like 10 percent of the base case estimate of risk in the case of a P60 estimate (that is, the risk money added would be 10 percent of the probable risk cost for the sum of each and every risk) and say 80 percent in the case of a P90 assessment.

This can be confusing. Here is an example for a late stage (contractor) estimate:

Base Cost without estimate or event contingency	$ 2,000,000,000	
Base cost includes direct cost, indirect costs, and professional services and allowances; this would be a Class 1 estimate with a range from -5 to +10%		
Estimate Contingency at P90	97,000,000	
Event Contingency at P90	23,000,000	
Total Contingency at P90	**120,000,000**	(6% of Base Cost)
Estimate Contingency at P60	12,000,000	
Event Contingency at P60	3,000,000	(25% of estimate contingency in this example reflecting a well-balanced contract)
Total Contingency at P60	**15,000,000**	(0.75% of Base Cost)

A contingency for P90 versus P60 is 8 times more. $\frac{\$120,000,000}{\$15,000,000} = 8$

If an earlier stage estimate is considered, such as a Class 3 semi-detailed budget estimate with a range from -15 to +30 percent, it might expect to have a total P90 contingency of 18 percent and a P60 contingency on the order 2.25 percent or a 15+ percent difference.

[6] Cumulative density function (CDF) is a function that gives the probability that a random variable is less than or equal to the independent variable of the function. For a normal distribution, this is the "S" curve we often see in risk, cost, schedule, and progress cumulative values.

[7] P60 and P90 reflect the probability that the actual value would not exceed these values 60 and 90 percent of the time respectively.

The real challenge comes from the fact that many public works owner estimates are highly factored estimates more resembling a Class 4 estimate at this stage.

Management Reserve

Management reserve is not an element of contingency. It is an amount added to the owner's estimate of the project but not allocated to any party or activity. It is set aside for discretionary purposes outside the established project scope. It is important for an owner to not include this as part of project contingency.

Management reserve is associated with changes to project requirements or design parameters. It may also be associated with a changed approached to construction execution, sourcing decisions, or project schedule.

In some reimbursable projects, elements of event risk are included with contingency and may be completely undertaken. Responsibility then is assumed by the owner with the cost considered as included in management reserve instead of contingency.

Unique Features of Public Projects

Repeatedly the owners of public sector projects have an overassessment of the quality of their estimate and, therefore, its classification.

Large public works infrastructure programs have two cost exposures not traditionally encountered in best of class projects. The first deals with the planning fallacy. In general, the stage gate processes in a non-political/not-public environment squeeze out many (but not all) opportunities for an optimistic bias. This is not always the case in public projects.

The second deals with the cost of delay. Large scale industrial projects often involve the sanction of large up-front equipment and material purchases. As such, when the trigger is pulled, it is really an all-out sprint. This does not mean events do not stop or slow a project. In general, however, the cost of general delay is not a significant cost risk.

Public works projects and their approval processes add a cost of time to a project not typically reflected in the agency's estimate.

Sharing Contingency for Results

Sharing contingency is an approach used on some "giga" programs. While this approach is not broadly applicable, it highlights possibilities for effectively managed contingency.

In one giga program, a tiered shared contingency approach[8], as shown in Figure 2, was used and ensured that risks that did not squarely fit into one "box" for management by a single party instead straddled two contracting levels or organizations and was adequately managed for shared success.

The approach is based on:

- a balance between risk and incentives.
- a shared approach to sharing saved contingency amounts.
- overlapping contingency pools between organizational levels to promote achievement of broader program objectives.
- multi-factor contingency pools to promote balanced achievement of program objectives.

The approach attempts to "fill in" much of the "white space"[9] between project and organizational elements to ensure the risks lurking in between well-defined contract packages (inherently retained by the owner) are squeezed out to the extent possible.

Giga programs carry risks well beyond those encountered on mega programs because of the nonlinear increase in scale and complexity risks. The tiered contingency pools provide for augmented risk management, recognize that a greater percentage of risks require the efforts of one or more parties, and reduce the number of risks totally within the owner's purview, thus allowing appropriate risk management to be focused on the remaining retained risks.

[8] OPMT – Owner's Program Management Team; IPMT – Integrated Program Management Team; the IPMT contractor was responsible for infrastructure, off-sites and utilities (IOU) and power in this program.

[9] "White space" risks are that class of risks which fall in between well-defined organizational, policy, process, and scope elements (discrete projects or tasks for example) and are not otherwise reflected in risk assessment and management activities. See the Executive Insight on White Space Risks https://www.naocon.org/wp-content/uploads/White-Space-Risks.pdf

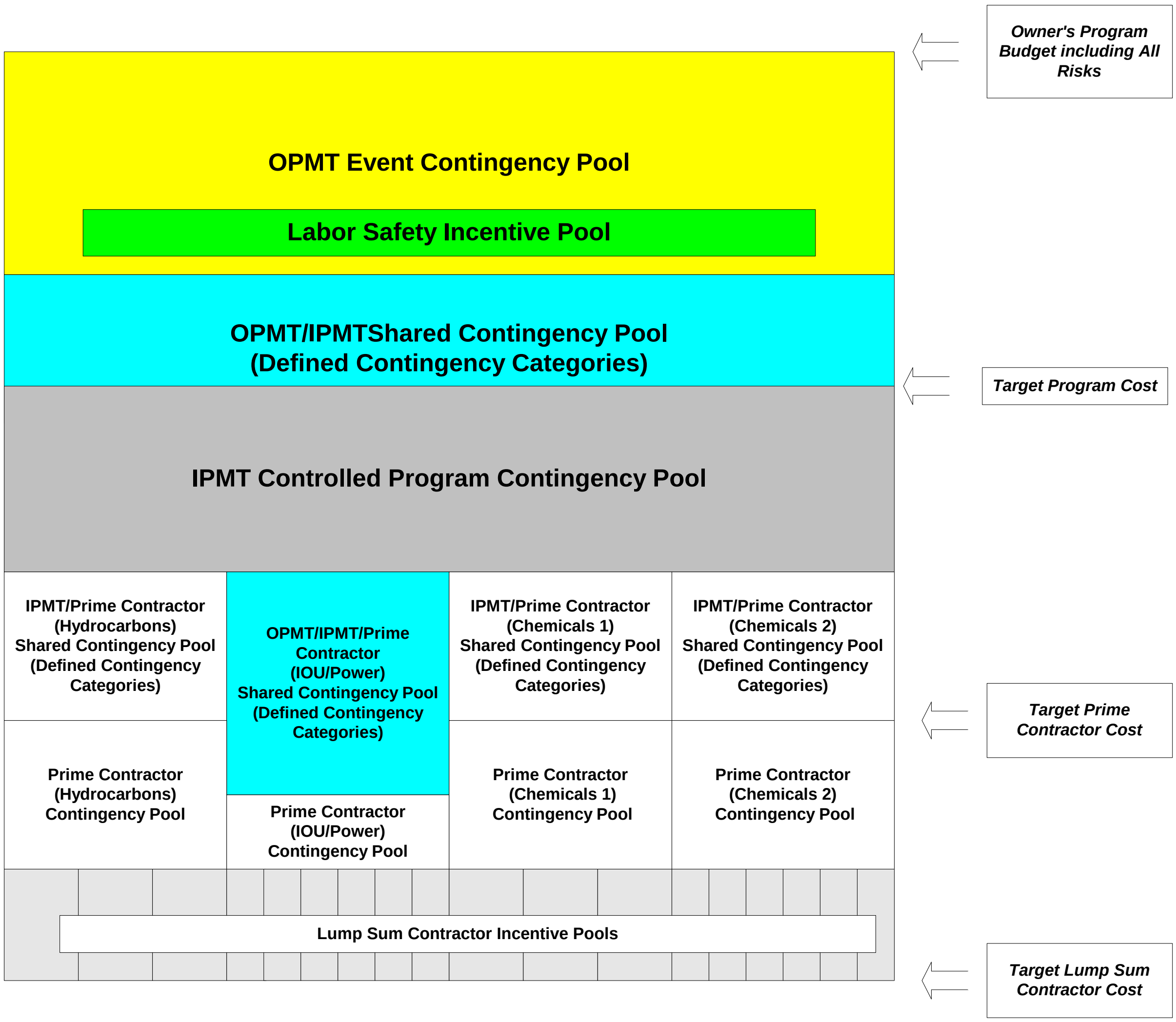

Figure 2. Tiered shared contingency approach on a giga program[10]

Summary

Five levels of cost estimate classification have been described and are consistent with AACE guidelines. Building and process projects are compared and the tendency of complex projects to behave more consistent with process projects is noted. While not developed in this Executive Insight, AACE has classification guidance for different facility types.

Elements of cost are described at a macro level and attention is called to the inclusion of allowances in the base cost estimate. Elements of contingency are described and an example provided as to how risk appetite influences overall contingency levels. The tendency of contingency analysis to underestimate variability of outcomes is flagged and contributes to the high proportion of overruns experienced by large complex projects.

Management reserve is described and it not being a part of contingency is clarified. It is recognized that in some contracting models event risk may be considered as part of management reserve.

[10] Owner's Project Management Team (OPMT) and Integrated Project Management Team (IPMT)

Unique features of public projects as it relates to contingency are highlighted and an example of sharing contingency for result is provided.

About the Author

Bob Prieto was elected to the National Academy of Construction in 2011. He is a senior executive who is effective in shaping and executing business strategy and a recognized leader within the infrastructure, engineering, and construction industries.