UNDER THE TOPIC "GOVERNMENT POLICIES, PROGRAMS & OVERSIGHT" OR "DECOMMISSIONING STRATEGIES & PROJECTS (10)"

COST ESTIMATING & DECOMMISSIONING PLANNING: CRITICAL DECISION POINTS WITH RESPECT TO ACCURACY

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Abstract

The Canadian Nuclear Safety Commission (CNSC) requires that all operators of licensed nuclear facilities in Canada prepare preliminary decommissioning plans that provide a basis for financial guarantees. Financial guarantees are updated on 3 to 5 year cycles. The CNSC has provided guidance for preparing preliminary decommissioning plans and financial guarantees in CNSC Regulatory Guides G-206, "Financial Guarantees for the Decommissioning of Licensed Activities." CNSC G-206 requires that the cost estimate provided for decommissioning fall within 10% to 30% accuracy range, as measured by contingency and in accordance with the American Institute of Cost Engineers and the Construction Industry Institute. In this presentation, we will consider the complexities of assessing the accuracy of a cost estimate and the challenges that are presented to decommissioning planning.

A decommissioning cost estimate, in the context of CNSC Guide 206, is not based on a decommissioning plan that is ready for implementation in the short term. Commonly the facility decommissioning may not be expected within the next 50 years and only at the end of life of a facility. The combination of CNSC's periodic reporting requirement and changes at the facility over each reporting period results in an iterative decommissioning planning process where decommissioning cost estimates and their respective accuracy my vary significantly with time.

This paper presents the fundamental building blocks required to prepare a decommissioning cost estimate and will elaborate on the variable levels of accuracy within a final submission. The paper sets realistic expectations for a CNSC submission. Fundamental concepts of how accuracy is measured are discussed.

This paper focuses on how knowns and unknowns impact accuracy, contingency and risk in decommissioning or decommissioning cost estimating. It also suggests strategies for managing limitations of an estimate caused by limitations in quantifiable data.

1. Introduction

The Canadian Nuclear Safety Commission (CNSC) requires that all operators of licensed nuclear facilities in Canada prepare preliminary decommissioning plans (PDP) that provide a basis for financial guarantees. These financial guarantees are updated on a three to five year cycle, therefore preparing and revising a PDP is required from the initial design and licensing, throughout the operation of a facility and finally serving as the basis of the Detailed Decommissioning Plan at the end of the facility's life.

The CNSC has provided guidance for preparing PDPs and financial guarantees in Regulatory Guide G-206, "Financial Guarantees for the Decommissioning of Licensed Activities."

CNSC G-206 requires that the cost estimate provided for decommissioning fall within a 10% to 30% accuracy range and meets criteria set out by the American Institute of Cost Engineers and the Construction Industry Institute.

In this presentation, we will:

- Define the important elements which make up a PDP estimate;
- Consider the complexities of assessing the accuracy of a cost estimate;
- Discuss appropriate expectations for accuracy;
- Identify what can be done over time to improve accuracy; and
- Qualifications – What's not in a decommissioning estimate

2. Estimate-elements

2.1 A defined scope of work

A cost estimate is based on many elements, but a critical foundation of the estimates is quantities and unit rates. Quantities are defined by the scope of the decommissioning plan. A well-defined scope will support well defined quantities.

The scope of a new facility can be quantified by referring to recent engineering documents, which may include material take offs, but will certainly include drawings which can be used to quantify the scope in detail. For older facilities the original engineering documents may not be readily available, and if they are available, may not be current with the ongoing evolution of the facility.

Evolution of the facility may include contamination, spills, repurposing of buildings, and the results of ongoing decommissioning. In absence of engineering documentation, the details of the scope have to be both identified, and quantified, through site surveys.

The scope of a PDP also has a chronological nature to it. Portions of a facility may be decommissioned in stages. The estimate should be coded to report decommissioning by stage. A cash flow for the project must be prepared to support escalation which will be calculated over distinct periods. The project's indirect costs are estimated based on duration and a multi-stage decommissioning will either prolong the duration of decommission infrastructure and personnel, or will demand multiple mobilizations and demobilizations to site of the contractors and the decommissioning team.

For distinct decommissioning stages, it will be more transparent to treat each stage as separate projects with their own indirect costs, escalation and contingency.

2.2 Execution plan

The execution plan defines the intended methodology to be used for decommissioning. The manner in which the work will be executed will determine cost. This will include:

- Defining the site's limitations which might include items such as work hour restrictions due to proximity to, or waste haulage through, residential neighbourhoods,
- Defining the expected contract strategy (lump sum or time and materials),
- Defining the specific methodologies required to meet regulatory standards, health and safety issues, as well as defining the critical-path dates.

Due to the sensitivity of nuclear facilities, the execution plans may require multiple iterations as numerous stakeholders go through cycles of reviews to achieve consensus.

2.3 Unit rates

Costs are developed based on applying unit rates against a quantified scope of work, using the intended execution plan. Unit rates may be defined from published data, quotations from local contractors, or the estimator's knowledge and experience.

2.4 Provisional costs - contingency

Contingency is an integral part of an estimate and is expected to be spent. Contingency is not intended to compensate for errors and omissions, or for items which are specifically stated as being excluded in the Basis of Estimate document.

Contingency is not the same as risk. Risk funds may be added to a project budget to account for low probability events which may happen, and can alter cost. Risk funds may include such items as: changes in government regulations; labor strikes; unusually inclement weather; or other events beyond the control of a project management team. Risk will include errors, omissions and even possible incompetency of the project execution team.

Contingency is added to account for uncertainty. The major drivers of uncertainty in an estimate include:

- The level of Project Definition: This has been discussed in conjunction with Figure-2. On a global view, the level of project definition is the largest driver of uncertainty;

- **Unit Rates:** For example four contractors may bid a project, and the spread between the lowest bidder and the highest bidder is 20%. Since we cannot be certain who will bid, and who will abstain, we have uncertainty in unit cost. Since the unit rates of a PDP will almost certainly not be based on firm quotes, the uncertainty in a PDP will be even greater than during the final execution phase.

- **Scope or Quantities:** Most contract disputes result from unclear scope definition within the contract documents. The lack of scope definition may be the result of numerous causes, some controllable, while at times, scope may simply be impossible to define with precision.

- **Experience of the Project Team:** An experienced team will foresee problems, execute all functions with more precision, fill in information gaps based on past experience, and apply best practices to ensure that the team's efforts are synergetic;

- **Execution Complications:** There is a statistical correlation between the length of the period of project execution period and uncertainty. The execution stage itself has uncertainty in the details embedded in contract documents, and any event which can be disputed as a change, may be disputed by a contractor.

- **Allowances added to Direct Costs:** Contingency will take into account allowances which have already been added, or not added, to the direct costs of an estimate.

The accuracy of an estimate and the uncertainty levels within an estimate are linked. Adding contingency will not improve accuracy, but will place the project budget within the project's accuracy range.

This is best described by Figure-1. All points on the curve would be possible costs for the project, based on the uncertainty and accuracy range. The most probable is the P50 or 50% probability point shown.

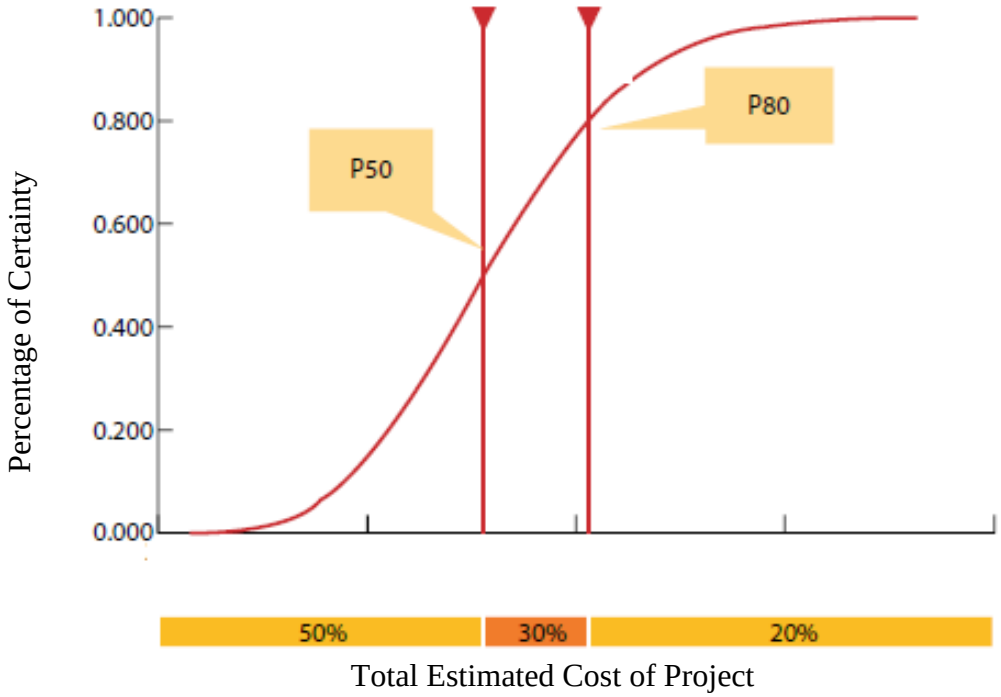

Figure 1 Uncertainty and Accuracy

The extreme limits of the curve express the limits of the accuracy; the point chosen on the curve express the level of certainty one want to carry by inserting contingency into the estimate.

3. Complexities of assessing accuracy

The nature of the word “Preliminary” within PDP should lead one to expect variability in the accuracy of the final estimate. All of the estimate-elements listed above will be in various stages of development. It would not be prudent in terms of the stakeholder’s time and resources to go to extreme details of definition for a plan which may not be executed for decades.

A PDP is intended to guarantee that the facility is prepared for unexpected early closure at all times but it is more probable that decommissioning will take place at the end of useful life of the facility. By that time, the regulatory framework, technological options, state of the facility or even the stakeholders may have changed dramatically.

4. Appropriate expectations for accuracy

The CNSC’s periodic reporting requirements are commonly every three to five years and successive iterations of the PDP offer an opportunity to improve the accuracy of each element within the estimate.

The PDP for a new facility may contain the most accurate estimate that one can expect. A good understanding of the labor market is readily available from recent construction records. All the engineering documents are available and there are minimal complications regarding contamination cleanup.

Figure-2 shows the relationship between estimate accuracy and the amount of definition available. For a new facility, the definition of scope is high, and accuracy might approach +15%/-10%. The only thing preventing higher levels of accuracy would the limited effort put into the development the execution plan and not having firm quotations for unit rates. Demolition contractors can provide estimates, but the effort (and accuracy) would remain appropriate to a theoretical project, which might not be executed for 50 years.

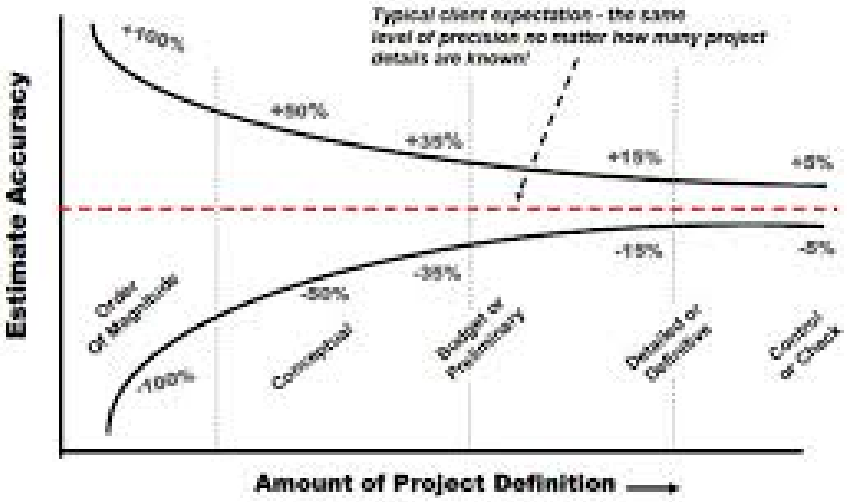

Figure-2 Estimate Accuracy with Project Definition

For older facilities the original engineering documents may not be readily available, and if they are available, may not be current with the ongoing evolution of the facility. Evolution of the facility may include contamination, spills, repurposing of buildings, new processes, abandoned processes and reductions of scope from ongoing decommissioning efforts. In absence of engineering documentation, the details of the scope have to be both identified, and quantified, through site surveys.

With older plants the execution plan will be more complex, unit rates will not be based on firm quotations, and scope will be more difficult to quantify. One would move to the left on the project definition scale, and the accuracy limits will expand. Contingency will grow due to the level of uncertainty.

4.1 A caution regarding uncertainty

Work planned verses work implemented is differentiated according to Hofstadter's Law which states:

> *It always takes longer than you expect, even when you take into account Hofstadter's Law.*

There is certainly a corollary of this law for cost and is evident in Figure-3 which addresses construction budgets for mega-projects.

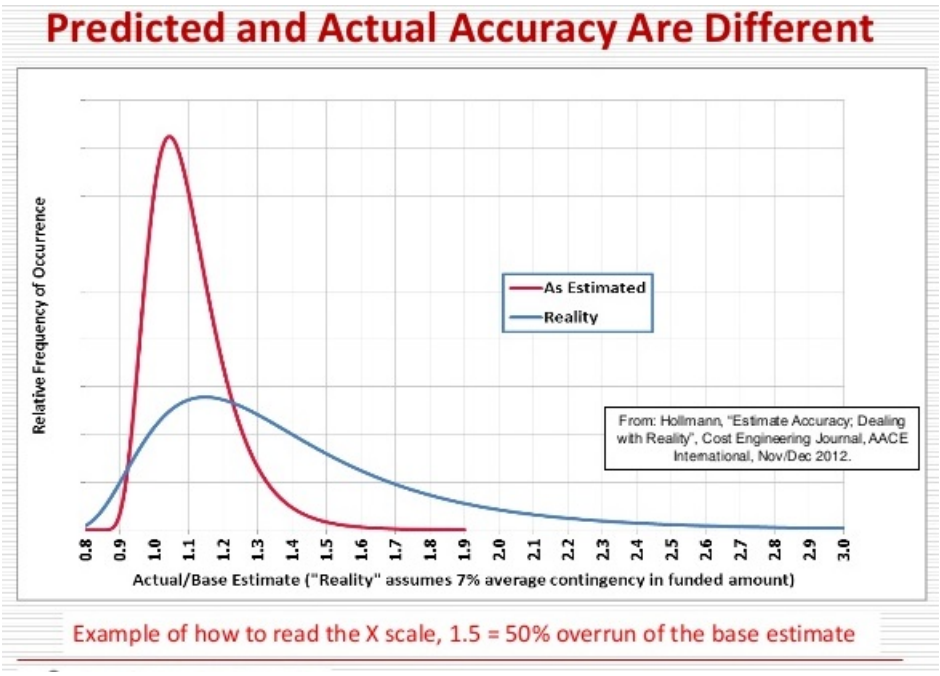

Figure 3 Predicted and Actual Accuracy

Decommissioning can be less complex than construction, but the optimism inherent in the planning process should be recognized. For example, when planning a project, particularly a preliminary plan, a common underlying assumption is that tasks will flow seamlessly from one to the other, no bottlenecks occur, no delays or last-minute changes will occur, and there will be no "unknown-unknowns."

5. What can be done over time to improve accuracy

For a PDP, the planning process should be viewed as a cumulative effort, with the resultant accuracy proportionate to the probability of immediate decommissioning.

- Ongoing decommission during the life of the facility can help define an acceptable execution plan and provide reliable benchmark unit rates;

- Expert consultants can be used to help define the closure techniques, which contractors or estimators will use as a basis for their estimate;

- For successive PDP reports, extra effort can be spent to define soft areas of the facility's scope. As an example, in older facilities original drawing may not be available. As well, facilities go through slow but constant change as time goes on. It may not be practical to produce detailed material take-offs for the entire facility each two years, but the definition of individual areas can be improved during each successive PDP study phase;

- Alternative execution strategies for select portions of work can be reviewed with stakeholders;

- Obtaining a good study team may require trial and error. A knowledgeable study team is crucial to improving accuracy;

- As Figure-2 would suggest, more project definition will result in greater accuracy.

6. Qualifications – what is not in a PDP estimate

Risk is part of any project execution budget, but risk is not included in a PDP estimate. Risk may include, but not be limited to:

- Regulations change over time;

- Community input changes over time;

- The facility changes over time;

- The technology of decommissioning changes over time;

- Variations in exchange rate or escalation rates;

- Errors and omissions;

- Contingency will commonly provide a 50% probability that the budget will not be overrun, based on the level of uncertainty measured. During execution, contingency will commonly be increased to an 80%-90% level of certainty that the budget will not be overrun.

The exclusions section of the PDP Basis of Estimate will include other risks and scope which is specifically not included in the estimate.