COST ESTIMATE CLASSIFICATION SYSTEM – AS APPLIED IN ENGINEERING, PROCUREMENT, AND CONSTRUCTION FOR THE PETROLEUM EXPLORATION AND PRODUCTION INDUSTRIES
AACE® International Recommended Practice No. 87R-14

COST ESTIMATE CLASSIFICATION SYSTEM – AS APPLIED FOR THE PETROLEUM EXPLORATION AND PRODUCTION INDUSTRY

TCM Framework: 7.3 Cost Estimating and Budgeting

Rev. July 31, 2019

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As a recommended practice (RP) of AACE International, the Cost Estimate Classification System provides guidelines for applying the general principles of estimate classification to project cost estimates (i.e., cost estimates that are used to evaluate, approve, and/or fund projects). The Cost Estimate Classification System maps the phases and stages of project cost estimating together with a generic project scope definition maturity and quality matrix, which can be applied across a wide variety of industries and scope content.

This recommended practice provides guidelines for applying the principles of estimate classification specifically to project estimates for engineering, procurement, and construction (EPC) work for the petroleum exploration and production industries. It supplements the generic cost estimate classification RP 17R-97[2] by providing:

- A section that further defines classification concepts as they apply to the petroleum exploration and production industries.
- A section on the geopolitical nature and investment regulation of petroleum exploration and production projects that impact the estimating process and its basis definition deliverables.
- A chart that maps the extent and maturity of estimate input information (project definition deliverables) against the class of estimate.

As with the generic RP, the intent of this document is to improve communications among all of the stakeholders involved with preparing, evaluating, and using project cost estimates, specifically for the petroleum exploration and production industries.

The overall purpose of this recommended practice is to provide the petroleum exploration and production industries with a project definition deliverable maturity matrix that is not provided in 17R-97. It also provides an
approximate representation of the relationship of specific design input data and design deliverable maturity to the estimate accuracy and methodology used to produce the cost estimate. The estimate accuracy range is driven by many other variables and risks, so the maturity and quality of the scope definition available at the time of the estimate is not the sole determinant of accuracy; risk analysis is required for that purpose.

This document is intended to provide a guideline, not a standard. It is understood that each enterprise may have its own project and estimating processes, terminology, and may classify estimates in other ways. This guideline provides a generic and generally acceptable classification system for the petroleum exploration and production industries that can be used as a basis to compare against. This recommended practice should allow each user to better assess, define, and communicate their own processes and standards in the light of generally-accepted cost engineering practice.

As a final note regarding purpose, users must be aware of the industry’s well documented history of challenges with overruns of budget authorization, appropriation, or funding estimates. An intent of this RP is to help improve upon past performance.

INTRODUCTION

For the purposes of this addendum, the term petroleum exploration and production industries is assumed to include any firm encompassing “all the steps involved in finding, drilling, processing, transporting, and marketing of oil and natural gas.”[1]

The projects are generally bigger, cost more and are in remote and challenging environments where risks and the cost variability are greater than in the manufacturing and processing industries.

This recommended practice is intended to cover petroleum exploration and production (E&P) projects covering drilling, completion, gathering systems, and processing to a marketable product, including all associated process and infrastructure facilities within the scope of the project. Infrastructure facilities may be especially significant. Offshore facilities, such as subsea systems, fixed platforms, and floating facilities, are covered by this RP. Early seismic and exploration studies may be expensed and excluded from this RP. All facilities downstream of the production facilities are also excluded.

This guideline reflects generally-accepted cost engineering practices. This recommended practice was based upon the practices of national oil and gas companies (NOCs) and international oil and gas companies (IOCs) who are engaged in petroleum exploration and production (upstream) projects around the world, as well as published references and standards.

This RP applies to a variety of project delivery methods such as traditional design-bid-build (DBB), design-build (DB), construction management for fee (CM-fee), construction management at risk (CM-at risk), and private-public partnerships (PPP) contracting methods.

GEOPOLITICAL NATURE AND REGULATION OF PETROLEUM E&P INDUSTRIES

The geopolitical nature and significant risks in the petroleum E&P project industries increase the public profile and influence the capital cost estimating process, including the interpretation of estimate classifications. Examples of regulatory bodies which are applicable to the petroleum E&P industries include:

- National departments of energy.
- Society of Professional Engineers.
In estimating the capital costs for petroleum E&P projects consideration must be given to the political and regulatory environment. The political and regulatory environment includes relations with developing nations, which may impose additional regulations and taxes on the investment; or in the worst case, may expropriate the investment.

Geopolitical circumstances for petroleum E&P projects may directly or indirectly impact the interpretation of the status and quality of project definition deliverables and hence estimate classifications. Examples of status considerations include:

- Petroleum E&P projects are often in remote locations and have unique logistical and environmental issues.
- Resources are often seen as national legacies with attendant political, legal and socio-economic considerations.
- Improved petroleum prices and/or extraction technologies may lead to reacquisition of leases that have unforeseen environmental legacies and regulatory implications.
- Feasibility studies may tend to focus on technical issues and less on business and project delivery issues associated with the political and/or regulatory environment (e.g., execution strategy and planning deliverables).
- Drilling and completion risks can change as the drilling program progresses, especially involving multi-year drilling programs.
- Site specific factors, such as lease boundaries and expirations, can affect development plans.
- The industry historically has been characterized by the interplay of significant swings in supply and demand.

**COST ESTIMATE CLASSIFICATION MATRIX FOR THE PETROLEUM EXPLORATION AND PRODUCTION INDUSTRIES**

A purpose of cost estimate classification is to align the estimating process with project stage-gate scope development and decision-making processes.

Upstream scope development and decision making must be aligned with petroleum resources definitions, classification, and categorization. Industry guidelines for that purpose are defined in the *Guidelines for Application of the Petroleum Resources Management System (PRMS)* by the Society of Petroleum Engineers (SPE)[7]. These guidelines are complex and must be read directly to get a full understanding, but the following discussion summarizes the ties between petroleum resource and estimate classification.

Per the SPE, the PRMS is a project-based system, where a project: “Represents the link between the petroleum accumulation and the decision-making process, including budget allocation...In general, an individual project will represent a specific maturity level at which a decision is made on whether or not to proceed”. The PRMS guidelines explain in detail the unique portfolio nature of resource development (upstream) projects and the need to evaluate the complex integration and phasing of resources and development alternatives.
The PRMS has two distinct dimensions: “(1) the development project...and, in particular, the chance of commerciality of that project; and (2) the range of uncertainty in the petroleum quantities that are forecast to be produced and sold in the future from that development project.” The PRMS addresses commerciality with discounted cash flow/net present value methods incorporating the capital expenditure, the operating expenditure, and forecasted sales of petroleum quantities.

Table 1 provides a summary of the characteristics of the five estimate classes. The maturity level of project definition is the sole determining (i.e., primary) characteristic of class. In Table 1, the maturity is roughly indicated by a percentage of complete definition; however, it is the maturity of the defining deliverables that is the determinant, not the percent. The specific deliverables, and their maturity or status are provided in Table 3. The other characteristics are secondary and are generally correlated with the maturity level of project definition deliverables, as discussed in the generic RP.[1] The post sanction classes (Class 1 and 2) are only indirectly covered where new funding is indicated. Again, the characteristics are typical and may vary depending on the circumstances.

<table>
<thead>
<tr>
<th>ESTIMATE CLASS</th>
<th>Primary Characteristic</th>
<th>Secondary Characteristic</th>
<th>Expected Accuracy Range</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>MATURITY LEVEL OF PROJECT DEFINITION DELIVERABLES</td>
<td>END USAGE</td>
<td>METHODOLOGY</td>
</tr>
<tr>
<td>Class 5</td>
<td>0% to 2%</td>
<td>Conceptual plans</td>
<td>Capacity factored, parametric models, judgment, or analogy</td>
</tr>
<tr>
<td>Class 4</td>
<td>1% to 15%</td>
<td>Screening options</td>
<td>Equipment factored or parametric models</td>
</tr>
<tr>
<td>Class 3</td>
<td>10% to 40%</td>
<td>Funding authorization</td>
<td>Semi-detailed unit costs with assembly level line items</td>
</tr>
<tr>
<td>Class 2</td>
<td>30% to 75%</td>
<td>Project control</td>
<td>Detailed unit cost with forced detailed take-off</td>
</tr>
<tr>
<td>Class 1</td>
<td>65% to 100%</td>
<td>Fixed price bid check estimate</td>
<td>Detailed unit cost with detailed take-off</td>
</tr>
</tbody>
</table>

Table 1 – Cost Estimate Classification Matrix for the Petroleum Exploration and Production Industries

This matrix and guideline outline an estimate classification system that is specific to petroleum E&P industries. Refer to Recommended Practice 17R-97[2] for a general matrix that is non-industry specific, or to other cost estimate classification RPs for guidelines that will provide more detailed information for application in other specific industries. These will provide additional information, particularly the Estimate Input Checklist and Maturity Matrix which determines the class in those industries. See Professional Guidance Document 01, Guide to Cost Estimate Classification. [12]

Table 1 illustrates typical ranges of accuracy ranges that are associated with the petroleum E&P industries. The +/-value represents typical percentage variation at an 80% confidence interval of actual costs from the cost estimate after application of appropriate contingency (typically to achieve a 50% probability of project cost overrun versus underrun) for given scope. Depending on the technical and project deliverables (and other variables) and risks associated with each estimate, the accuracy range for any particular estimate is expected to fall within the ranges identified. However, this does not preclude a specific actual project result from falling outside of the indicated
range of ranges identified in Table 1. In fact, research indicates that for weak project systems and complex or otherwise risky projects, the high ranges may be two to three times the high range indicated in Table 1. [13]

It should be noted that the average quality and accessibility of reservoirs in production are declining, and processing complexity is increasing; therefore, the high end of the expected accuracy range may be higher than is currently stated in this RP.

In addition to the degree of project definition, estimate accuracy is also driven by other systemic risks such as:

- Level of familiarity with technology.
- Unique/remote nature of project locations and conditions and the availability of reference data for those.
- Complexity of the project and its execution.
- Quality of reference cost estimating data.
- Quality of assumptions used in preparing the estimate.
- Experience and skill level of the estimator.
- Estimating techniques employed.
- Time and level of effort budgeted to prepare the estimate.
- Market and pricing conditions.
- Currency exchange.
- The accuracy of the geotechnical data.
- Geo-political, environmental, and other regulatory circumstances.
- Socio-economic conditions.

Systemic risks such as these are often the primary driver of accuracy, especially during the early stages of project definition. As project definition progresses, project-specific risks (e.g. risk events and conditions) become more prevalent (or better known) and also drive the accuracy range.

Another concern in estimates is potential organizational pressure for a predetermined value that may result in a biased estimate. The goal should be to have an unbiased and objective estimate both for the base cost and for contingency. The stated estimate ranges are dependent on this premise and a realistic view of the project. Failure to appropriately address systemic risks (e.g. technical complexity) during the risk analysis process, impacts the resulting probability distribution of the estimated costs, and therefore the interpretation of estimate accuracy.

Petroleum E&P projects are very sensitive to volatility in oil and gas pricing as well as geopolitical issues. Early geological studies may be highly speculative and entail a lot of uncertainty as to the commercial viability of a new E&P project. Conversely, a project may have a history of feasibility studies from current and previous owners that can be readily revived to meet securities disclosure rules when the technology and oil and gas prices improve sufficiently to spark interest among investors.

Figure 1 illustrates the general relationship trend between estimate accuracy and the estimate classes (corresponding with the maturity level of project definition). Depending upon the technical complexity of the project, the availability of appropriate cost reference information, the degree of project definition, and the inclusion of appropriate contingency determination, a typical Class 5 estimate for a petroleum exploration and production industry project may have an accuracy range as broad as -50% to +100%, or as narrow as -20% to +30%.

However, note that this is dependent upon the contingency included in the estimate appropriately quantifying the uncertainty and risks associated with the cost estimate. Refer to Table 1 for the accuracy ranges conceptually illustrated in Figure 1. [14]

Figure 1 also illustrates that the estimating accuracy ranges overlap the estimate classes. There are cases where a Class 5 estimate for a particular project may be as accurate as a Class 3 estimate for a different project. For example, similar accuracy ranges may occur if the Class 5 estimate of one project that is based on a repeat project...