ONTARIO POWER GENERATION

Manual

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Title:
PROJECT ESTIMATING

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PROJECT ESTIMATING

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Reviewed by: Kendra Flagler
Manager - Project Services
Enterprise Projects

Approved by: Lindsay Greenland
Director - Project Services
Enterprise Projects

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Revision Summary

Revision Number	Date	Comments
R000	2019-03-26	Initial issue.
R001	2019-11-19	- Clarified language in sections 3.2.6 and 3.2.7 - Revised section 3.2.11 to recommend third party or Estimating department review of Direct Award services to align with changes to supply chain governance (no longer required in supply chain governance) - Revised Appendix A to remove reference to the Estimate class - Added Appendix B

1.0 DIRECTION

Cost estimating is the process of determining the total cost of labour, materials, equipment, professional fees, and other resources, required for the execution of a project or part of a project. A quality cost estimate leads to a more precise project schedule and budget which forms the basis for project planning, decisions, value and performance. Estimates are also used to evaluate changes, alternatives, and what-if scenarios to assist in decision making.

This document receives authority from the Project Management standard [R1] and is a component of the overall Enterprise Project Management governance framework. The Enterprise Project Management governance is applicable to all projects planned and executed within OPG.

Each project needs to fulfil the specific estimating requirements for the different project levels as defined in the Scalable Project Delivery Model [R2]. This includes the use of established Project Management Information Systems (PMIS) tools and software for managing related project work.

> The Scalable Project Delivery Model [R2] provides a scaled application of project management principles and processes reflective of a projects complexity and cost. The model provides the minimum requirements for a project by knowledge area. It is expected that Project Managers will apply the intent of the knowledge area and exceed the minimum requirements as appropriate. The Business Unit Execution Line Management and/or Project Management Office may define additional requirements based on the specific project and portfolio requirements.

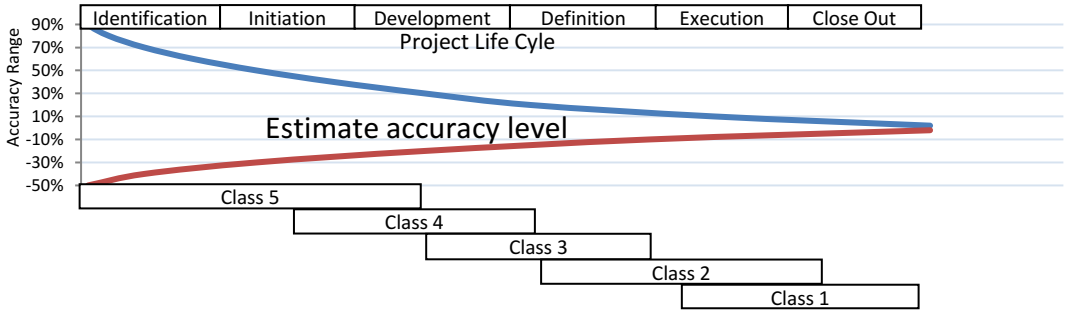
All project information and documentation that does not exist within the PMIS should be maintained and stored within SharePoint in a standardized project working folder structure. Related project records and controlled documents should be managed in accordance with the Project Communication and Stakeholder Management manual [R3].

Note: ***Strategic Projects and/or Programs*** may have additional or varied expectations or requirements for projects within the program, and for the overall program itself. These should be documented in a project controls plan (or equivalent) for the program.

1.1 Overview

Cost estimating is a key component of the Project Cost Management [R4], Project Schedule Management [R5] and Project Phase-Gate Management [R6] process. The key benefit of the cost estimating process is that it determines the monetary resources required for the project. The process is generally applied during each phase of the project life cycle as the project scope is defined, modified, and refined. As the level of scope definition increases, the estimating methods used become more definitive and produce estimates with increasingly narrow probabilistic cost distributions as illustrated in Figure 1.

Figure 1: Total Project Estimate Accuracy during Typical Project Life Cycle



The cost estimating process is typically performed concurrent to or iteratively with the project planning and evaluation processes. Because costs are often dependent on time duration, while resource requirements identified in cost estimating may affect the schedule, the estimation of the time duration of activities must be considered concurrently with costs. Iterative approaches are used because outcomes of a cost estimate often lead to changes in scope or plans. The estimating process can be viewed as part of the scope definition process because iterative trading off between cost and scope intertwine the processes.

A key element of Project Estimating is the Estimate Classification (Section 2.1).

The Project Estimating processes are:

- Plan Estimate (Section 3.1)
- Develop Estimate (Section 3.2)
- Review / Validate and Document Estimate (Section 3.3)

Desktop guides and templates associated with this manual are available on the Enterprise Project Management website.

2.0 PROJECT ESTIMATING ELEMENTS

2.1 Estimate Classification

As per the Association for the Advancement of Cost Engineering (AACEi) recommended practise, 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 with a generic project scope definition maturity and quality matrix. This supports the Project Phase-Gate Management [R6] and decision making processes.

Cost estimates are categorized by four characteristics: maturity level of project definition deliverables (primary); end usage; estimating methodology; and expected accuracy. 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 determinate of accuracy; risk analysis is required for that purpose.

While the maturity level of project definition is a continuous spectrum, five cost estimate classes have been established. The estimate class designations are labeled Class 1, 2, 3, 4, and 5. A Class 5 estimate is based upon the lowest maturity level of project definition, and a Class 1 estimate is closest to full project definition and maturity. The five classes and their respective characteristics are detailed in Table 1.

Table 1: Cost Estimate Classification Matrix

	Estimate Class	***Primary Characteristic***	***Secondary Characteristic***		
		Maturity Level of Project Definition Deliverables Expressed as % of complete definition	**End Usage** Typical purpose of estimate	**Methodology** Typical estimating method	**EXPECTED ACCURACY** Typical variation in low and high ranges
Required classes for Gating process	**Class 5**	0% to 2%	Concept screening	Capacity factored, parametric models, judgment or analogy	L: -20% to -50% H: +30% to +100%
	Class 4	1% to 15%	Study or feasibility	Equipment factored or parametric models	L: -15% to -30% H: +20% to +50%
	Class 3	10% to 40%	Budget authorization or control	Semi-detailed unit costs with assembly level line items	L: -10% to -20% H: +10% to +30%
	Class 2	30% to 75%	Control or bid/tender	Detailed unit cost with forced detailed take-off	L: -5% to -15% H: +5% to +20%
	Class 1	65% to 100%	Check estimate or bid / tender	Detailed unit cost with detailed take-off	L: -3% to -10% H: +3% to +15%

As per AACEi, the expected accuracy +/- value represents typical percentage variation of actual costs from the cost estimate **after** the application of contingency (typically at 50% level of confidence) 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 into the ranges identified (although extreme risks can lead to wider ranges).

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

- Level of non-familiar technology in the project
- Complexity of the project
- 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

Systemic risks such as these are often the primary driver of accuracy; however, project-specific risks (e.g. risk events) also drive the accuracy range. Additional details are provided in Project Risk Management [R7].

The goal should be to always have an unbiased and objective estimate. A concern in estimates is potential pressure for a predetermined value (either overall estimate, or estimate class) that may result in a biased estimate, or misrepresentation of the estimate accuracy. 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 risk analysis impacts the resulting probability distribution of the estimate costs, and therefore the interpretation of estimate accuracy.

The required inputs to achieve an estimate classification are provided in the Estimate Input Checklist and Maturity Matrix [Appendix A].

2.1.1 All estimates should be classified as per the cost estimate classification matrix [Table 1]. An estimate may contain multiple scopes of work with differing classification depending on the associated level of maturity of each scope of work.

2.1.2 The cost estimator, in accordance with the Scalable Project Delivery Model [R2], should determine the estimate class based upon the maturity level of project definition based on the status of specific key planning and design deliverables. The percent design completion may be correlated with the status, but the percentage should not be used as the Class determinate. The cost estimator may use the Estimate Classification Checklist in Appendix B to help determine the estimate classification.

3.0 PROJECT ESTIMATING PROCESS

3.1 Plan Estimate

Plan Estimate is the process of defining how and when the project costs will be estimated. Plans should consider the project gate strategy, the required estimate classification, the estimate input requirements and the contracting strategy. The key benefit of this process is that the projects are planned and executed to support estimate generation and increased project accuracy.

3.1.1 The project estimate should be developed in alignment with the project work breakdown structure (WBS). As a result, estimate planning should be integrated with the other project planning processes including Project Scope Management [R8], Project Cost Management [R4], and Project Schedule Management [R5]. The estimate should be planned in accordance with the requirements detailed in the Scalable Project Delivery Model [R2] and Project Phase-Gate Management [R6] manuals.

3.1.2 Where the cost estimating detail is undertaken by and is the responsibility of the contractor(s), the contractor's schedule submittals and other supporting documents are

inputs to OPG's process and should be planned in alignment with the execution strategy and procurement planning. i.e. OPG should ensure that contracts include deliverables and timelines that support the estimating, and ultimately phase-gating processes.

3.1.3 The estimate planning should include the estimate review cycle. The plan should identify the required reviewers and ensure adequate time is allocated for estimate review and validation activities, and any corrective actions.

3.2 Develop Estimate

Develop estimate is the process of obtaining all of the estimate inputs, quantifying the project scope, costing each scope element, optimizing the project costs, analyzing the cash flow, classifying the estimate and documenting the basis. The key benefit of this process is that it produces a cost estimate that can lead to a more precise project schedule and budget which forms the basis for project planning, decisions, value and performance.

3.2.1 Estimates and supporting documentation should be developed in accordance with the requirements within the Scalable Project Delivery Model [R2] outlined below.

- **Level A:** Estimate should be prepared by an estimating subject matter expert (SME) within the PMO (hereafter referred to as the PMO Estimator). The PMO Estimator should be embedded within the project team and prepare the supporting Basis of Estimate (BoE) document.
- **Level B:** Estimate should be prepared by a PMO Estimator. Estimate will be developed based on the projects Scope of Work (SoW) document, and the PMO Estimator should prepare the supporting BoE. Note: SoW requirements are detailed within Project Scope Management [R8].
- **Level C:** Estimate should be prepared by the project manager based on received competitive bids OR, where a competitive bid process was not used, prepared by the project manager and reviewed by the Project Manager Line organization.
- **Level D:** Estimate should be prepared by the project manager and reviewed by Project Management Line organization.

Note: PMO Estimators may support the preparation and development of level C and D project estimates as requested. Support will be provided on a priority basis, based on resource availability.

Note: Certain sections of scope may be estimated by different people or groups in relation to expertise and responsibility.

3.2.2 Estimates should be prepared in the standardized Scope Estimate Template(s) and align with the project WBS. The estimate should provide:

- **Time-Phase Cost** - A tabulation of time-phased costs by work package that are formatted for aggregating to the control account level or higher, and loaded into EcoSys. This will form the cost baseline as described in Project Cost Management [R4].

- **Resource Requirements** - Quantities of resources such as labor, material, and equipment. The resource requirements are used as a basis for resource planning and procurement. The quantities of labour should be loaded into the schedule (level A and B projects only). This will form the schedule baseline as described in Project Schedule Management [R5].

Note: The scope estimate template should be selected in accordance with the intended estimate class. Refer to the Enterprise Project Management Website for the Scope Estimate Template(s).

3.2.3 Estimates should be prepared in accordance with the level of project scope definition, and utilize the appropriate estimate inputs required to achieve an estimate class. This includes technical deliverables, schedule information, WBS, cost breakdown structure (CBS), historical cost information (as applicable) and any supporting estimate information. Additional details on the estimate inputs by classification are provided in Estimate Input Checklist and Maturity Matrix [Appendix A].

Note: In order to achieve a specific estimate classification, a vendor prepared estimate and supporting documentation may be required as an input into the OPG estimate.

3.2.4 Estimates should be prepared with the intent to achieve the required estimate class specified in the Project Phase-Gate Management [R6] manual; however, the actual estimate class should be a true representation of the estimate accuracy.

3.2.5 Estimates should include 100% of the SOW and 'cost only' items such as expenses, interest etc. Estimates for the next immediate project phase should be of sufficient detail and accuracy to enable thorough resource planning and cost control.

3.2.6 After completion of estimate, the appropriate amount of contingency should be added to the estimated cost in accordance with Project Risk Management [R7].

3.2.7 Estimates typically represent only the 'current value' cost of the project. Escalation should be added to each cost breakdown structure (CBS) element as appropriate, after completion of estimates and prior to establishing cost baseline.

3.2.8 Interest on the estimate should be added as a segregated line item as per the cost breakdown requirements established in Project Cost Management [R4].

3.2.9 To facilitate efficient estimate development, the project manager should:

(a) Ensure that the required project detail, scope definition and supporting documents needed to prepare the required class of estimate are available and static.

(b) Initiate and/or facilitate estimate development or clarification meetings with the estimator and project management team as required to obtain and document any further scope clarification and ensure alignment.

(c) Facilitate a project walk-down with the estimator or provide a walk down report (if required).

3.2.10 Vendor prepared estimates (e.g. bid proposals) may require validation of the estimate and class by a PMO Estimator (as defined in the Scalable Project Delivery Model [R2]). The PMO Estimator should confirm the integrity of the bid by verifying estimating methods, assessing the assumptions, and making sure that the adopted ground rules are consistently applied throughout the submitted estimate/bid.

3.2.11 For Direct Award for Services procurement activities, preparation of a validation estimate by a third party estimator or a PMO Estimator (for project levels A and B) is recommended. The estimate should be prepared prior to, and for use during, the review of a cost estimate from the supplier.

3.2.12 All estimates should include a BoE or equivalent documentation to record how the estimate was derived, as per the Scalable Project Delivery Model [R2]. The BoE should be:

(a) Prepared by the responsible PMO Estimator in the Basis of Estimate template (level A and B projects); or prepared by the project manager and documented notes and assumptions recorded in the estimate file (level C and D projects).

(b) Reflective of complexities of the project and should consider the level of project definition, project cost, type of project, WBS, contracting strategy etc.

(c) Prepared in parallel with the estimate to ensure that any changes in assumption, exclusions or exceptions are captured, and finalised once estimate is complete.

Note: A formal BoE is typically not required for estimating the cost of changes, alternatives analysis and what-if scenarios. Refer to the Enterprise Project Management Website for the Scope Estimate template(s) and BoE template.

3.2.13 The project manager should ensure that the estimate package (including the estimate calculations, BoE or notes and assumptions, and all relevant supporting documents) are recorded within the project working files as per Project Communications and Stakeholder Management [R3]. The estimate package should be complete, retrievable and auditable.

3.2.14 Estimating tools (iTwo or Excel templates) may be used by the PMO Estimator for estimate development, tracking and storage. External estimate cost databases may be referenced for pricing.

3.3 Review, Validate and Document the Estimate

Review, Validate and Document the Estimate is the process of formally verifying the details of the estimate including the BoE. The key benefit of this process is an agreement and an alignment on the total estimate package by the estimator and project team, and confirmation that the estimate meets the project and organization requirements.

The end result of an estimate review should be a set of consistent, clear and reliable documentation (i.e., the estimate and its backup) that has the concurrence and understanding of the project team and management and follows industry standards or best practices (e.g., for authorization, control, bid, etc.). Each project team member must

accept and take ownership of those parts of the estimate and budget for which they will be responsible.

3.3.1 At a minimum, estimate reviews should occur by the appropriate authority defined in the Scalable Project Delivery Model [R2]. For A and B projects, PMO Estimator peer reviews should occur.

Note: It is recommended that estimate reviews be performed by anyone that provided significant input to the project estimate and/or that was involved in its preparation, and/or will be responsible for managing some element of the costs should be considered as a review team participant at the appropriate phase and step. This may include technical (engineering/design)/scope reviews, estimating team reviews, project team reviews, and management reviews.

3.3.2 Estimate reviews should confirm that the estimate:

(a) Reflects the project strategy, objectives, scope, and risks.

(b) Is suitable for a given purpose (e.g., cost analysis, decision making, control, bidding, etc.).

(c) Ensures that all parties agree on and understand the estimate's basis, content and outcome, including the estimate's probabilistic characteristics (e.g., range, cost distribution, etc.).

3.3.3 The level of detail and diligence used during the estimate review should be commensurate with the strategic importance, total value, and purpose of the particular estimate.

3.3.4 Estimates including the BoE and supporting documentation should be accepted by the project manager.

4.0 ROLES AND RESPONSIBILITIES

4.1 BU Executing Line

(a) Reviews and classifies estimates.

4.2 Project Manager

(a) Preparation of estimates based on scope of work, including all notes and assumptions

(b) Classifies estimates.

(c) Reviews and verifies cost estimates prepared by internal (e.g. Enterprise PMO) and external (i.e. Vendor) sources.

(d) Reviews basis of estimates prepared by the Enterprise PMO.

4.3 BU PMO

(a) Assists the project manager with the preparation of estimates, as required.

4.4 Enterprise PMO

(a) Acts as single point of contact and SME for estimating methodologies, processes, and associated tools and templates.

(b) Prepares estimates based on scope of work and conducts peer review of estimates.

(c) Classifies estimates.

(d) Prepares BoE.

(e) Supports procurement activities by confirming the integrity of bids by verifying estimating methods, assessing the assumptions, and ensuring that the adopted ground rules are consistently applied throughout the submitted estimate/bid.

5.0 DEFINITIONS AND ACRONYMS

5.1 Definitions

Cost Estimate Classification System	A matrix used to classify a cost estimate based on the maturity level of project definition deliverables (primary); end usage; estimating methodology; and expected accuracy.
Strategic Projects/Programs	A large and complex project/program approved by the Enterprise Leadership Team as strategic, and executed by the Enterprise Projects Organization.

5.2 Abbreviations and Acronyms

AACEi	The Association for the Advancement of Cost Engineering International
BoE	Basis of Estimate
CBS	Cost Breakdown Structure
PMIS	Project Management Information Systems
PMO	Project Management Office
SME	Subject Matter Expert
SOW	Scope of Work

6.0 REFERENCES

6.1 Performance References

Ref #	Document Number	Document title
R1	OPG-STD-0148	Project Management Standard
R2	OPG-MAN-00120-0010	Project Integration Management – Appendix A: Scalable Project Delivery Model
R3	OPG-MAN-00120-0017	Project Communication and Stakeholder Management
R4	OPG-MAN-00120-0013	Project Cost Management
R5	OPG-MAN-00120-0014	Project Schedule Management
R6	OPG-MAN-00120-0019	Project Phase-Gate Management
R7	OPG-MAN-00120-0015	Project Risk Management
R8	OPG-MAN-00120-0011	Project Scope Management

6.2 Developmental References

AACE Recommended Practices and Standards:
- Practice No. 18R-97 Cost Estimate Classification System
- Practice No. 19R-97 Estimate Preparation Costs in the process industry
- AACE Total Cost Management Framework

FAA Life Cycle Cost Estimating Handbook

NASA Cost Estimating Handbook 2008

Project Management Body of Knowledge (PMBOK Guide)

Appendix A: Estimate Input Checklist and Maturity Matrix

	General Project Data:	G1 Initiation	G2 Develop Prelim Eng	G3 Develop Detail Eng	Project Team Comments
1	Project Scope of Work	S	P	D	
2	Contracting Strategy	P	P	D	
3	Risk Register (for the next phase)	S	S	S	
4	Definition of Project Phases (per gated process)	P	P	D	
5	Project Schedule for all Phases (Level 3 for next phase)	S (L1)	P (L2)	D (L3)	
6	Work Breakdown Structure (with all details)	S	S	D	
7	Shifts Pattern	P	P	D	
8	Field walk down with Estimator	TBD	TBD	TBD	
9	Project List of Assumptions/Constraints	P	P	P	
10	MRs and POs for long lead material	P	D	D	
11	List of all Work Packages for the next phase in Excel	D	D	D	
	Engineering Deliverables:				
12	Eng Work Resources Request (EWRR) form for Prelim Eng	D	-	-	
13	Eng Work Resources Request (EWRR) form for Detail Eng	-	D	-	
14	Conceptual Design Report	D	-	-	
15	Modification Outline	P	D	-	
16	Modification Design Requirement	-	D	-	
17	Master Engineering Changes	P	D	D	
18	Design Plan and Design Requirements	-	S	D	
19	Design/Project Engineering Changes	-	S	D	
20	Engineering studies/reports	-	S	D	
21	Number of Engineering Changes	S	P	D	
22	Non-Committal Budgetary Quote of Construction Work	-	P	D	
23	Specifications and Datasheets	-	P	D	
24	General Equipment Arrangement Drawings	-	P	D	
25	Number of NICR ☐, PMOD☐,TMOD☐	S	P	D	
26	Major Equipment List	S	P	D	
27	Bill of Materials / Quantity	-	S	D	
28	Spare Parts Listing	-	S	D	
29	Walk Down Report	S	S	D	
30	All Discipline Drawings (Elec/I&C/Mech/Civil)	S	S	D	

Legend:

Started (S): Work on the deliverables has begun. Development is typically limited to sketches, rough outlines, or similar levels of early completion
Preliminary (P): Work on the deliverables is advanced. Interim, cross-functional reviews have usually been conducted. Development may be near completion except for final reviews and approvals.
Defined (D): The deliverable has been reviewed, approved and issued for design (if applicable) as appropriate.

Appendix B: Estimate Classification Checklist

Estimate Class / Characteristic	Class 5 Estimate		Class 4 Estimate		Class 3 Estimate	
Methodology	Using Parametric models or Stochastic Estimating Methods etc. E.g. Variables can include equipment weight, size, number of components to be installed …	☐	Using Equipment Factored or Parametric models. E.g. Replacing a dryer in the reactor building, while a actual costs of a dryer replacement project in the RAB exist	☐	Using Deterministic Estimating Methods or Quantity based Estimate. E.g. Determining the cost of a project from design bill of materials or detailed contractor quotes.	☐
Scope Of Work	Scope of work is defined at General level. *E.g. Changing 10,000 Light fixtures at different station locations, within 2 years.*	☐	Scope of work is defined at Preliminary level. *E.g. Changing 4,500 Light fixture type -A in turbine hall and 5,500 Light fixtures type-B in offices, within 2 years.*	☐	Scope of work is defined at detail level. Contract strategy is defined. *Drawings and detail plan are available for 60% of Light fixture.* *Installation plan per Level 3 Schedule.*	☐
Schedule used for Estimate	Level 1 Schedule.	☐	Level 2 Schedule.	☐	Level 3 Schedule.	☐
Project Management Cost	Percentage based or rough number of PMT personnel per project duration. *E.g. Percentage of the direct field labour cost: $1.2M (DFL cost) x 70%= $ 0.84M*	☐	Resource load schedule using level2 schedule. *E.g. 2Yr's duration x 50% utilization factor x PM rate.*	☐	Schedule-based estimate per org chart and level 3 schedule (considering schedule gaps).	☐
Engineering Cost	Based on guesstimated EC numbers , estimates is per average EC hours or schedule based. *E.g. 3 ECs x 3,000 Hrs average hrs per EC x average engineering rate or 10 people for 10 months.*	☐	Same as Class-5 but the number of Master ECs is defined and number of design EC is assumed.	☐	Based on detailed engineering tasks and deliverables. *E.g. include many Line items such as: walk down, meeting, prepare, validate, etc.* *For nuclear projects, completed EWRR sheet is considered as a class 3 estimate .*	☐
Procurement Cost	Percentage based or non-committal budgetary quote or historical data.	☐	Non-committal budgetary quote or historical data.	☐	Major items: based on BOMs and vendor quotations , other items based on historical data.	☐
Inspection Cost	High level; percentage based.	☐	High level; based on resource and hours .	☐	Detail level; based on resource and hours. Considering the project requirements Such as the number of ITPs, NDE or Special inspection services. *E.g. 1 ITP = QA hours x QA senior Rate + QA Hours x QA inspector rate.* *NDE cost= 4 systems x 240 hrs x specialist rate.*	☐
Construction Cost	Based on average cost. *E.g. 10,000 light x 8 hrs per light x labour rate.* *Plus 20% scaffolding* *Plus 8% small tools,* *Plus 30% indirect and QA.*	☐	Based on average cost per each area/system/discipline etc. E.g. 4,520 lights in turbine Hall x 10.3 hrs per light 2,300 lights in offices x 6.75 hrs per light. Plus 20% scaffolding Plus 8% small tools, Plus 30% indirect and QA.	☐	Based on engineering documents and drawings. The hours are broken in to deliverables/ activities. *E.g.* *Mobilization 300 hrs.* *Erecting scaffolding - 100 hrs* *Removing 200M cable and hangers - 120 hrs* *Installing 200 cable - 200hrs* *Removing existing 25 lights in turbine hall - 160hrs (considering x 2.1 Difficulty factor x 1.2 height factors)* *Installing new 25 lights in turbine hall - 250hrs (considering x 2.1 Difficulty factor x 1.2 height factors)* *etc.*	☐
Commissioning Cost	Percentage of the direct field labour cost.	☐	High level; based on resource and hours .	☐	Based on schedule (considering the project detail deliverables).	☐
Close out Cost	Based on average for similar project. *E.g.800 Hrs x average PMT rate.*	☐	Based on average for similar project. *E.g.800 Hrs x average PMT rate.*	☐	Based on detailed close out engineering tasks and deliverables.	☐