WorleyParsons

resources & energy

PROJECT CONTROLS DEVELOPMENT PROGRAM

MODULE 5 - INTRODUCTION TO TIC COST ESTIMATING

SPECIAL ACKNOWLEDGMENTS:

Andris Drulle

"your positive attitude may not solve all our problems, but it will annoy enough people to make it worth the effort!"

MODULE 5 - Introduction to TIC Cost Estimating					
Rev	**Description**	**Originator**	**Review**	**Approved**	**Date**
0	Released for Global Implementation	Humphrey Kerger	Project Controls R5 Management Team	Project Controls R5 Management Team)	16 Mar 2011

PROJECT CONTROLS DEVELOPMENT PROGRAM

This Training Module is part 5 of an 8 modular training program designed to provide the participants with an overall introduction to the skills & knowledge required by Project Controls when executing an EPCM / PMC project.

The complete training program consists of the following modules:

Module 1 - Introduction To Project Controls

Module 2 - EPC Schedule Development (including P6 user skills)

Module 3 - Services Management (including InControl V8.0 user skills)

Module 4 - Commercial Performance Management

Module 5 - Introduction to TIC Cost Estimating

Module 6 - TIC Management (including Prediction Plus / InControl V10 user skills)

Module 7 - Schedule Risk Analysis (including Pert Master user skills)

Module 8 - Cost Risk Analysis (including @Risk user skills)

The aim of this document is to provide a base-principle guideline to assist the project controller in understanding the fundamentals of CAPEX Cost Estimating and interfaces with the key Project Delivery functions.

Upon completion of Module 5, participants will be able to:

- Understand the Estimating processes
- Understand WPMP Estimate classes and how they relate to the AACEI Estimate classes
- Understand the interfaces between the Project Delivery functions and the Estimating function.
- Understand the various Estimating techniques, methods, definitions and specific terminology.
- Understand the correlation between Control Budget and TIC Estimate.

INTRODUCTION TO TIC COST ESTIMATION

Module Content

Module Content

1.0 INTRODUCTION

2.1 INTRODUCTION TO COST ESTIMATING

Module 5 - Introduction to CAPEX Cost Estimating has been designed and written to allow Project Managers, Project Engineers, and Project Controls specialists to understand the process in which estimates are developed.

It also addresses how the Estimating department interfaces with the multi- discipline departments within the WP organisation when preparing their estimate deliverables.

The training module is based on the WorleyParsons Project Management Process (WPMP) and uses examples of the Tatanka Project to illustrate the estimating process as an integral part of the management and control of Project Execution.

In order to set a basis for understanding terminology and definitions, the training commences with a high level review of the correlation between the WPMP phases and the Estimating classes

Once the definitions are understood, the training will drill deeper into the process of aligning the estimating function to the requirements of a project and explores the various stages in preparing and populating the estimate.

The underlying theme through this training module will be that the preparation of the estimate is one (essential) link in the chain of events required for successful delivery of any project.

And that each link, like in a batten race, must pass smoothly onto the next runner to allow the project team to achieve the overall team's goal in winning the race.

2.0 BASIC PRINCIPLES

IDENTIFY 1	EVALUATE 2	DEFINE 3	EXECUTE 4	OPERATE
Determine project feasibility and alignment with business strategy.	Select the preferred Development Option(s) & Execution Strategy.	Finalize scope, cost, schedule and get project funded	Produce an operating asset, consistent with scope, cost and schedule	Start Up, operate asset to ensure performance specifications & return to shareholders
Key Deliverables				
• Valuation Report • Class 1 – Order of Magnitude Estimate (+ / - 50%)	• Development Plan • Class 2 – Screening Estimate (+ / - 30%)	• Business Proposal / Front End Engineering Design (FEED) Package • Class 3 – Control Estimate (+ / - 15%) • Level 2-3 EPC Schedule	• Functional Asset • Class 4 – Definitive Estimate (+ / - 10%)	• Performance Assessment
Key Decision				
Approve Feasibility Review	Approve Development Plan	AFE approval (Approved For Expenditure)	Operations Acceptance	Value Enhance

2.1 WPMP

The Project Delivery process model is a process that will ensure that the value and risk is always known throughout the project life-cycle.

Most clients and contractors will have a similar model and in most instances the underlying principles are identical.

The project life-cycle is usually divided into five phases.

Each phase is subdivided into detailed management process-steps/activities.

By having decision gates at the end of each project phase, the project can be stopped, authorized to proceed or re-cycled.

To ensure a consistent Project Delivery approach that is aligned with the various project life-cycle models utilized by our clients, WorleyParsons developed the WorleyParsons Project Management Process (WPMP) as shown above.

The node points between each of the phases (commonly referred to as gates), demarks the completion of a project-phase, and is aligned with the "Go / No-Go" decision-gates for progression into the next phase.

As the project progresses through the "phase-gates", the level of definition in the project-scope increases.

WorleyParsons is involved all project phases: Identify & Evaluate (Select Group), Define (Feed studies), Execute (EPC Delivery) and Operate (*Improve*) phases. .

WPMP aligns and interfaces with the project delivery sections of WorleyParsons Enterprise Management System (EMS) where all procedures, guidelines and forms are contained.

"The chief cause of stress is reality"
~/ ~
Lily Tomlin

2.2 PROJECT PHASES

The WorleyParsons Estimate Classifications are aligned with the Project Phases in the WPMP.

Accuracy is determined by level of project definition.

Estimating Classes relate to the various project phases and accuracies listed are typical for those levels of project definition.

It should be noted and understood that other classification systems are used by different institutions.

Class 1	**Order Of Magnitude (+/- 50%)** Developed in the Identify Phase
Class 2	**Screening / Study (+/-30%)** Developed in the Evaluate Phase
Class 3	**Control / Budget (<+/-15 %)** Developed in the Define Phase
Class 4	**Definitive (<+/- 10%)** Developed in the Execution Phase

The principle of aligning the estimating classes with the WPMP project phases is as follows:

As a project moves from one phase to the next, the level of project development and definition of the project scope of work increase.

With the definition, the estimating accuracies increases (estimate matures from a class 1 to a class 4 basis).

Class 1 **WPMP Identify Phase** **Order of Magnitude Estimate** **Accuracy ± 50%**	☑ Scenarios developed. ☑ Locations of plant and main processes and facility types specified.
Class 2 **WPMP Evaluate Phase** **Screening Estimate** **Accuracy ± 30%**	☑ Major equipment specifications, flow diagrams, plot plans, location plans available. ☑ Outline Basis of Design, Project Technical Specification and Project Strategy available. ☑ Develop work breakdown structure.
Class 3 **WPMP Define Phase** **Control Estimate** **Accuracy <± 15%**	☑ Choice of technology made. ☑ BOD produced and finalised ☑ Project locations and environmental conditions studied and surveyed ☑ All Equipment confirmed, capacity ratings finalised ☑ Flow and line diagrams finalised ☑ Quantified material take offs of bulk materials produced ☑ Project schedule prepared ☑ Value improvement practices carried out. ☑ Operations and maintenance needs defined. ☑ Safety reviews completed
Class 4 **WPMP Execute Phase** **Definitive Estimate** **Accuracy <± 10%**	☑ Major equipment ordered. ☑ Design nearing completion. ☑ Final material take offs of bulk materials made. ☑ Major contracts let. ☑ Construction commences.

"Settle one difficulty, and you keep hundred others away"

~ Chinese Proverb

2.3 ACCURACY RANGES

Since the WPMP estimate classifications and accuracies are aligned with each of the WPMP Project Phases, the level of engineering effort by all disciplines will drive the accuracy of the estimate .

Definition of the estimate scope will be dependent on the level of quantification as the core of the CAPEX estimate is the physical plant - its components and systems elements.

The better the level of definition of these components and elements, the better the level of accuracy expected in purchasing and installing these items.

The following table identifies each of the phase estimates, their names, an indicative percentage of the total engineering performed at each phase supporting the estimate, the expected accuracy range of the estimate and the level of contingency required to be added to the estimate.

WPMP GATES	IDENTIFY	EVALUATE	DEFINE	EXECUTE
Estimate Class	**1**	**2**	**3**	**4**
Estimate Type	**Factored or Parametric Models**	**Factored or Parametric Models**	**Factored and/or Quantity Based**	**Quantity Based**
Estimate Category	**Order of Magnitude**	**Screening**	**Control**	**Definitive**
Level of Engineering Complete	**0% - 2%**	**2% - 15%**	**10% - 40%**	**30% - 70%**
Estimate Accuracy	**≤ ± 50%**	**≤ ± 30%**	**≤ ± 15%**	**≤ ± 10%**
Contingency	**20% to 25%**	**15% to 20%**	**< 10%**	**< 5%**

Table 2.3.1 Accuracy Ranges

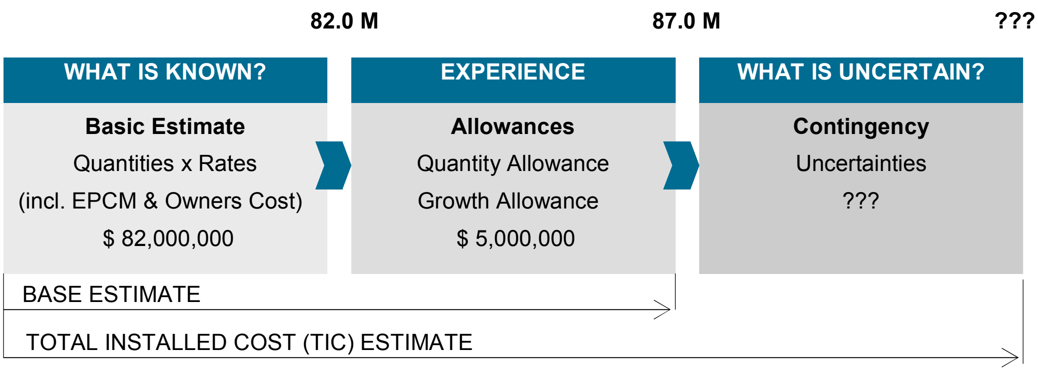
2.4 ESTIMATE BUILD UP

In preparing a capital cost estimate, it is a rare occasion when everything is known, specified and measurable.

A capital cost estimate consists of three parts:

1. What is known (in essence; the known quantities x rates)
2. What our experience tells us is required? (applying design allowances and factors, depending on the level of project definition at the time of the estimate)
3. What is uncertain (Contingency, to cater for unknown events).

A simplified example to illustrate how an estimate is built-up is shown below.



2.5 WHAT IS KNOWN?

"What is known?" is what is defined and developed from the capital cost estimate design criteria:

- process description
- process flow diagrams
- P&IDs
- plant equipment lists
- site plans, general arrangements
- material take-offs (MTO)
- labour rates
- vendor quotations
- Assumed dates of project execution

To this a cost can be assigned with a degree of certainty

2.6 WHAT EXPERIENCE TELLS US?

"What our experience tells us is required?" represents the gap between what is known and our "experience" from previously completed work.

In order to address the gap, we include adjustments and allowances on quantities and estimated costs.

Adjustments and Allowances are addressed in greater detail in Chapters 3.4 - 3.5

2.7 WHAT IS UNCERTAIN ?

"What is uncertain?" is to cover unpredictable or unforeseen items of work within the defined Scope of Work of the estimate which cannot be determined because of lack of complete, accurate and detailed information at the time the estimate is being prepared.

Contingency is added to the estimate to cover unforeseen needs of a project that is beyond the control of the appointed EPCM contractor or Owner.

Contingency is necessary to compensate for these areas of uncertainty.

The magnitude of the contingency is directly related to the probability of these uncertainties occurring.

The contingency amount is meant to be spent during project execution.

The Approved Control Budget is the sum of all costs required to construct and commission the proposed facilities as defined by the project scope, and may include Owners costs and forward escalation.

It also includes a risk amount to cover a selected portion of risk exposure for the probability of cost overrun (of the estimated amount) and may include an amount for Owners scope change provisions.

As the facility is expected to be built within the Approved Control Budget, it also becomes a measure by which the performance of the Project Leader will be judged.

"When it is a question of money, everybody is of the same religion"
~/ ~
Voltaire

3.0 ESTIMATING METHODOLOGIES

Basically there are three types of estimates:

1. Ratio or Factored estimates (Top Down)
2. Quantity Based estimates (Bottom Up)
3. Combination of both (Hybrid estimates)

The method used for any particular estimate will depend on:

- End use of the estimate
- Amount of time and money which is available to develop the estimate
- Estimating tools available
- Availability of historical data

3.1 TOP DOWN ESTIMATES (CONCEPTUAL ESTIMATES)

A Conceptual capital cost estimate is prepared when the level of engineering and design is not yet matured to a level from which detailed quantities can be generated.

The quantities are derived via a ratio to basic Equipment data such as weight, size or kW, using historic benchmark data- from similar projects, modified to reflect economic changes, size, location and other factors to predict future cost.

Conceptual Estimating methods are used in the early phases of a project, when the design is not or partly defined.

A conceptual estimate is often developed using one of the following methods:

- Analogy Estimating
- Capacity Factor Estimate

- Equipment Factored Estimate
- Parametric Estimating
- Assembly Estimating
- Hybrid of the above

Analogy Estimating

Analogy estimating compares a new proposed plant, system of facility with a similar (or analogous) project completed recently, providing that there is fairly accurate cost and technical data available.

When applying this method, the estimator will:

1) ensure that there is a reasonable correlation between the proposed and known projects
2) remove cost for known scope items in the analogous project that are not required in the proposed project.
3) normalize for time and location
4) make subjective cost adjustments for differences in technical scope, technology, complexity, infrastructure, logistics, location, time or market conditions

The Analogy estimating technique is often used when developing estimates for new and emerging technologies.

Capacity Factor Estimating

Capacity Factor estimates are also referred to as:

- Cost/Capacity estimates
- Scale of Operations estimates
- “Six Tenth’s” Factored estimates

A capacity factor estimate is an estimate in which the cost of a new plant is derived from the cost of a similar plant of known (but usually different) capacity by using a cost-multiplier.

The method is based on the principle that there is a correlation between the capacity of a plant and the cost of building this plant.

This correlation is not linear, but exponential . The estimator must work with Process Engineering to understand the configurations of the plant. If multiple trains are involved in a plant, the cost of a single train would be capacity factored, then the cost could double or triple or more depending on the configuration and number of trains.

This exponential relationship is

The exponent to calculate the Capacity Factor for complete process plants is calculated from a ratio of cost and capacities using the formula
e = ln($A/$B) / ln(CapA/CapB)

To illustrate this principle, a simple example is provided on bottom of this page

In 1950, Cecil H. Chilton published an article in Chemical Engineering applying to 38 selected projects. The capacity factor ranged from 0.32 to 1.02, but when eliminating the "multiple train" plants with the higher factors, the average and median values were 0.62.

The Capacity Factor method is often used to determine whether to continue with a proposed project; or to make decisions between alternative designs or plant sizes.

Therefore, the emphasis of a Capacity Factor Estimate is not on detailed accuracy, but to support meaningful management decision making.

When applying this method, the estimator will follow the following key-steps:

- deduct cost for differences in the Base Case that are not applicable in the Factored Case
- apply location and escalation adjustments to normalize cost
- apply the Capacity Factor Equation. As illustrated in the example on page 14, the capacity factor for complete process plants is calculated from a ratio of cost and capacity using the formula e = ln($A/$B) / ln(CapA/CapB)
- Add costs for differences in the Factored case that did not exist in the base case

Equipment Factored Estimating

Equipment Factored estimates are estimates used to develop costs for facilities that are

equipment centric (such as process and utility units).

The method relies on the principle that the costs of Direct Labor and Bulk Materials for installation is correlated with the cost of the major equipment purchase.

This relationship is also expressed as a factor or ratio.

These factors were introduced back in 1947 by a chemical engineer named Hans Lang as a method for for estimating the total installation cost for plants and equipment. Therefore this method is also referred to as the Lang Factor method.

The formula is as follows:

Total Plant $ = Total Eqmt $ x Factor.

Lang proposed 3 separate factors:

Solid Process Plants	**3.10**
Solid-Fluid Plants	**3.63**
Fluid Plants	**4.74**

A simple example of an estimate using Lang Factors

- Fluid Plant
- Total Estimated Equipment = $ 1.5M
- Total Plant $ = $1.5M x 4.74 = $7.11M

Assumptions:

Gas processing plant to produce 105MM SCFD Sour Gas.
New plant requires Jetty Facilities that are not included in the reference plants. Assume cost for these facilities of $28M

Reference Plant #A	90MMSCFD Sour Gas. Total Field Cost $ 164.7M
Reference Plant #B	75MMSCFD Sour Gas. Total Field Cost $ 146.5M

Capacity Factor

Formula e = ln [CostA / Cost B] / ln [CapA / CapB]
Formula e = ln [164.7 / 146.5] / ln [90 / 75]
Formula e = in (1.124) / ln (1.2) = 0.117 / 0.182 = 0.64

Estimate for new 105MM SCFD Plant:

$164.7M x (105/90)$^{.64}$ = $164.7M x 1.1 = $ 181,170,000

Plus Jetty facilities $ 28M

$181,170,000 + $28,000,000 = $209,170,000

"Discovery is seeing what everybody else has seen, and thinking what nobody else has thought"
~/~
Albert Szent-Gyorgy

The Lang factors change over time because construction labor, bulk materials (concrete, pipe etc.), engineering design, indirect costs, and major process equipment prices often do not change at the same rate.

In the late 1960s and early 1970s Kenneth Guthrie further expanded on this concept, generating different factors for different types of process equipment (pumps, exchangers, vessels, etc.), so these are sometimes referred to as "Guthrie factors".

Other alternative equipment factored estimating methods:

- Equipment factors based on equipment capacity, metallurgy, and design conditions as opposed to cost.
- Equipment factors to generate discipline or labor cost, as opposed to TIC cost.
- Equipment factors to generate bulk material cost and from bulk materials generate factors to generate labor hours.

Parametric Estimating

Capacity Factor and Equipment Factor estimates are simple examples of parametric estimates.

Parametric estimating is an estimating technique that uses a statistical relationship between historical data and other variables (for example, square meters in construction) to calculate an estimate for activity parameters, such as scope, cost, budget, and duration.

An example for the cost parameter is multiplying the planned quantity of work to be

performed by the historical cost per unit to obtain the estimated cost.

A parametric cost estimating model is made up of one or more algorithms or cost estimating relationships (CERs) that translate technical data (parameters) about an asset into cost results.

The algorithms are commonly developed from regression analysis of historical project information.

The models are very useful for cost and value evaluations early in the project life cycle when not much is known about the project scope.

The models are limited in accuracy and usage due to the many assumptions built into the algorithms.

Also, the validity of the model is usually limited to certain ranges of parameter input values.

Due to these limitations and constraints, it is essential that the user to understand the basis of a parametric model thoroughly.

An example of a Parametric Estimating Model is shown on Page 14.

Assembly Estimating

An assembly is a group of items that typically go together in predictable patterns.

For example; on average, 1000 meters of pipeline will include a certain number of fittings, flanges, welds etc.

The estimator can create a pre-built assembly estimate model so that the user only needs to know the total length of pipe to determine the total cost of the assembly in terms of bulk materials and installation costs.

There can be many assemblies for different design and situations:

- Above ground piping vs. underground piping
- Shop fabricated piping vs. field fabricated piping
- Concrete by type of structure etc

Assembly estimate output is typically fairly detailed, however, they are still conceptual since the content of the assembly is uncertain and based on historic data only.

Hybrid Methods

It is rare for any major cost estimate of any class to be prepared using only one method.

For example, a pipeline estimate could be developed using:

- Capacity factoring for equipment, pipeline and major fittings
- Assemblies for key components
- Equipment or other factoring for minor elements and indirect costs

"Don't compromise yourself. You are all you've got"
~/~
Janis Joplin

Example Parametric Estimating Model (Source AACEI)

PARAMETRIC COST ESTIMATING MODEL FOR BUILDINGS

Specify the model input parameters by completing the form below. You may also click on the "**Example**" button to use a generic set of parameters. If you have questions regarding the definition or use of a particular parameter, simply click on the parameter's name to view its description. After all you have entered all the input parameters, click on "**Calculate**" to generate the estimate (Output/Results).

Case Description and Remarks (Optional):	
Usable Floor Area (s.f.):	
Average Floor to Floor Height (ft.):	12.00
Number of Floors:	
Percent of Area as Office:	
Percent of Area as Wet Labs:	
Percent of Area as Dry Labs:	
Percent of Area Heated:	
Percent of Area Cooled:	
Number of Building Corners:	4
Substructure Strength Index:	(0) … 50 lbs/sf (1) … 96 lbs/sf (2) … 142 lbs/sf (3) … 188 lbs/sf
Superstructure Strength Index:	(0) … 50 lbs/sf (1) … 96 lbs/sf (2) … 142 lbs/sf (3) … 188 lbs/sf
Exterior Finish Quality/Duty Index:	(1) … Minimal Quality/Minimal Duty (2) … Below-Average Quality/Minimal Duty (3) … Average Quality/Light Duty (Means) (4) … Above-Average Quality/Light Duty
Interior Finish Quality/Duty Index:	(1) … Minimal Quality/Minimal Duty (2) … Below-Average Quality/Minimal Duty (3) … Average Quality/Light Duty (Means) (4) … Above-Average Quality/Light Duty
Mechanical Services Quality/Duty Index:	(1) … Minimal Quality/Minimal Duty (2) … Below-Average Quality/Minimal Duty (3) … Average Quality/Light Duty (Means) (4) … Above-Average Quality/Light Duty
Electrical Services Quality/Duty Index:	(1) … Minimal Quality/Minimal Duty (2) … Below-Average Quality/Minimal Duty (3) … Average Quality/Light Duty (Means) (4) … Above-Average Quality/Light Duty
Escalation Factor (1995 US$ Base):	1.00
Location Factor:	Rural Area US Average Major or Innercity Urban
Productivity Factor:	Good Fair Poor Very Poor

CALCULATE RESET CANCEL

"Money is better than poverty, if only for financial reasons."
~/~
Woody Allen

3.2 BOTTOM UP ESTIMATES (DETAILED ESTIMATES)

A detailed estimate (or "First Principle" estimate) is an estimate in which each component of the project scope has been defined, measured (quantified) and priced using the most realistic unit prices available.

This method involves using a detailed WBS and pricing out each work package making up the project, so it's critical that the design is well defined and substantially agreed to.

The design data should include as a minimum:

- Piping & Instrument Diagrams
- Plot Plans / Equipment layout drawings
- Equipment data sheets
- Motor lists
- One-line diagrams
- Piping isometrics and layout drawings
- Specifications

The Estimator will price each individual cost elements required to price a unit rate, e.g. in the material and installation costs for foundations they will work out the individual costs for all the required concrete, rebar, formwork, excavation, backfill, accessories.

All computed cost are based on quantities or defined deliverables (i.e, minimal use of factors). Pricing data should include:

- Vendor quotations
- Current pricing (from POs etc)
- Current pricing books or database
- Current productivity and labour rates
- Subcontract quotations

The "Bottom Up" method may be laborious and time consuming, but it can result in a fairly accurate estimate if the work content is well understood.

This level of detail is normally carried out by an EPC contractor estimator to support their proposal bid process.

3.3 HYBRID 'BOTTOM UP - TOP DOWN' ESTIMATES

Estimates developed during the Define phase (FEED) are most likely computed using data from a partly defined engineering design.

Some parts of the design are well defined, and some parts are still very much in the conceptual stage.

In this event, the estimator can opt to estimate the insufficient defined design components using the Ratio or Factored approach (Conceptual) and apply the Quantity based principles to the parts that are well defined (Detailed).

3.4 ADJUSTMENTS

Typically, the rates and costs (hours, wages, item cost) applied to the estimate line-items are derived from an estimating database (in-house or commercial), Vendor Quotes or the Procurement/Contracts department.

It maybe necessary to adjust these rates and costs to specific project conditions and commercial terms.

A few common examples for rate/cost-adjustments:

- Material costs (location, spec differences etc)
- Labor manhours (elements that drive productivity such as climate, location, logistics, permitting etc)
- Wages rates (local labor market conditions, crew-mix, union regulations)
- Overtime (double/triple shifts, week-end/Holiday etc)

3.5 ALLOWANCES

Both design scope and estimated quantities have a tendency to grow during the life of a project.

In preparing a capital cost estimate, it is a rare occasion when

The "base estimate" only reflects the scope definition at the time of the estimate.

Allowances are predictable but undefinable additional cost provided for in an estimate for Scope and Quantities growth as well as for expected variations on Budget Quotations (difference between quoted price by the vendor and the price expected during execution) and are to be included in the base estimate

Allowances are always for specific items and should therefore not be confused with contingency.

Growth allowances are usually calculated by applying a markup percentage to a detailed cost component, based on previous experiences and understanding of what is required in designing and constructing a project..

Some forms of estimating allowances are:

- Design allowance
- Equipment Cost allowance
- MTO allowance
- Overbuy allowance
- Rework allowance
- Claims and Extras allowance
- Unrecoverable Shipping damage allowance
- Allowance for undefined major items

Design Development Allowance

A provision in estimate to cover for equipment / material modifications due to better definition of project requirements and more developed design, often taking place after purchase orders are placed and due to minor engineering modifications (additional nozzles, lifting lugs, etc.).

In a detailed estimate, design allowances can range between 3 -5% of total direct cost, depending on the information provided by the client and the quality of historical data used.

Equipment Cost Allowance

A provision in the estimate to cover for the difference between estimated, factored, or quoted equipment cost and the actual expected purchase order cost. The allowance usually gets lower as the accuracy of an estimate gets higher.

Material Take Off Allowance

A provision in the estimate to cover for the difference between "neat" quantities take-offs and actual material quantities expected to be purchased, i.e. an allowance for quantities that where not taken off (due to incomplete engineering design), a percentage of material "waste" for fit-up cuts, etc.

These allowances are usually included in the estimate as both material and labour costs.

Usually, a MTO allowance will be applied as a percentage to commodity cost for each discipline. These percentages will vary by discipline and from project to project, depending on the selected estimating method and the required accuracy levels

Overbuy / Cut & Waste Allowance

Every project experiences inventory losses varying with the jobsite location and other project conditions.

The Overbuy / Cut & Waste allowance covers materials that are purchased above measured design quantities to allow for trimming of the purchased quantity, and/or the normal loss and wastage that occurs during fabrication and installation.

" Sometimes the road less travelled is less travelled for a reason"
~/~
Jerry Seinfield

Examples: Concrete over-pours, random pipe procured in standard lengths, cable drumming, fabrication waste, etc.

Overbuy allowances provide for inventory losses due to:

- Damage at the jobsite
- Cutting loss
- Misuse
- Theft

Overbuy allowances apply to material costs only, and will vary by discipline and sometimes individual types of commodities within the discipline.

Costs associated with wastage, over-pours, loss and damage will normally be included in unit rates as allowances; not in measured quantities supplied by Engineering.

Rework Allowance

The rework allowance covers the inevitable occurrence of rework in the fabrication yard or construction site, e.g. dismantling and re-routing of pipe due to field interferences, replacing materials that have sustained damage during construction work etc.

Claims and Extras Allowance

The 'claims and extras' allowance is applied to any construction subcontract (labour element only) to cover for the minor claims and extra field instructions, between the managing contractor and their subcontractors, that typically occur during the construction phase of the project

Unrecoverable Shipping Damage Allowance (USD)

USD allowances provide for damage to equipment and materials during shipment. The allowance is only to cover for losses that are not covered by insurance.

Allowances for Undefined Major items.

Occasionally, an Order-Of-Magnitude" cost for a major segment of work must be stated before definition of the work is started.

In that event, the cost is included as an allowance and be simply a best "guesstimate" to be included in the estimate until a later time when better definition can be obtained.

Percentage Allowances

There are many areas of an estimate where statistical correlations are more reliable than detailed take-offs, or where it is not economical to perform a detailed take-off.

For instance, it is very common to use percentage allowances to estimate costs of pipe supports, pipe testing & inspection and the like.
As an example, allowances for non destructive testing and stress relieving etc. can be estimated as a percentage of total pipe quantity and cost.

Minor Scope Allowances

Allowances for cost growth for minor scope changes, scope and estimating omissions, quality of bids and budget pricing, market forces and the like

are to be included in contingency, not in direct costs.

Other Allowances - Offshore Industry

Offshore transportation and installation campaigns will have their own specific allowances, such as allowances for:

- Mobilization of equipment / vessels from outside the area due to demand and lack of confidence that the region has sufficient locally based vessels and equipment to support this particular project.
- Builders Risk Insurance Premiums. These are typically very high given the nature of the work and far exceed the typical allowances for onshore construction works.
- An offshore campaign which is complex by nature and performed with a large number of different spreads and where the schedule and sequence planning is not yet adequately defined. Such programmes often lead to multiple mobilizations and demobilizations of the same equipment spread, which may not be apparent at the Class 3 schedule development stage.

3.6 CONTINGENCY

In principle, all estimates prepared by the estimating department include basic cost and growth allowances (so called Base Estimate), but they exclude contingency.

Contingency is a specific provision for unforeseeable elements of cost within the defined scope of work.

The allocation of contingency is a corporate management decision and will depend very much on the risk profile of the project.

It is not the estimators role to prescribe the level of contingency.

Contingency is the most important, yet most misunderstood element contained in the estimate.

In large part, this is due to how the different project stakeholders view contingency from their own frame of reference:

Senior Management

- Money it hopes will not expended, but instead returned at the end of a project
- Funds that will only be expended if the project is performing poorly.

Project Management

- The amount of money which, when added to the project, equals one dollar less than the amount of funds which would cause the project to be cancelled.

Engineering

- Savings account to cover the additional costs of underestimating or omitted engineering/design costs

Construction

- Funds which are expended by engineering before the project ever gets to the jobsite
- Fund to cover additional costs caused by longer schedules, construction problems, lower productivity, and any overrun due to lack of definition in the construction contract.

Estimating

- The funds which are added to the base estimate to achieve a given probability of not overrunning the estimate.

The WPMP defines contingency as

"An allowance for goods and services which at the current state of project definition cannot be accurately quantified, but which history and experience show will be necessary to achieve the given project scope."

Further, it is… "the amount required to bring the base estimate to a 50/50 estimate"; where there is an equal chance of overrunning or underrunning the estimate within its accuracy range".

In essence, contingency is an amount of funds to reduce the chances of overrunning the base estimate to an acceptable level of risk. Management must determine that risk.

It is important that the end user of the cost estimate adds additional funds to provide for unforeseeable costs within the defined project scope.

Contingency includes cost associated with:

- Errors/omissions in estimating
- Minor design changes within the agreed scope
- Quantity variability
- Productivity variability
- Wage rate variability
- Pricing variability

But it excludes:

- Changes in scope
- Major unexpected works stoppages
- Natural Disasters
- Escalation

" Who are you going to believe, me or your own eyes?"
~/~
Groucho Marx

"USA Today has come out with a new survey - apparently, three out of every four people make up 75% of the population. "
~/~
David Letterman

Another common misconception is that contingency improves the estimating accuracy. It doesn't.
However, contingency will improve budget decision accuracy.

As can be seen from the table 2.3.1 on page 9, there is a direct correlation between the Project Phase, the accuracy level and the level of contingency.

For Class 1 and 2 estimates (Order of magnitude and Screening), the contingency is added as a single, below-the-line component to the base estimate, unless the study team decides that a higher level of contingency is appropriate and a basis for this can be justified.

For Class 3 and 4 estimates (Control and Definitive), the contingency is determined using a formal risk analysis.

3.7 ESTIMATE ACCURACY

Estimate accuracy is an indication of the degree to which the final actual cost outcome for a given project will vary from the estimated cost.

An estimate is only a "prediction" of the expected cost for a given scope of work. Every estimate is associated with risk and therefore is also associated with a probability of overrunning or underrunning the predicted cost.

An estimate should not be regarded as a single point number, but as a range of potential cost outcomes, and associated probabilities of occurrence. This range is driven by risks.

Thus, the accuracy range of an estimate is a probabilistic assessment of how far a project's final actual cost can be expected to vary from the estimate.

Estimate accuracy is traditionally expressed as a +/- percentage around the TIC estimate (including contingency) with a stated confidence that the actual cost will fall within this range.

However, in some instances, the +/- range can also be applied to the base-estimate (before contingency), so it would be wise to check the point of reference first before releasing the estimate accuracy ranges into a wider audience.

3.8 RISK ANALYSIS

Risk Analysis is a statistical approach that is used to model the probability of a risks occurring and determining what provisions need to be added or deleted to an estimate to ensure that adequate budget is available to execute the project.

A forum of selected project stakeholders identify the main cost drivers and assess these drivers on their risk impact .

Responses are formulated to mitigate/remove as many threats as possible, while by the same token, opportunities need to be maximized.

The remaining risk elements are then modelled (risk ranged) using a Monte Carlo or similar statistical process of analysis.

The Monte Carlo simulation will return a range of values to predict a probable cost outcome.

All estimates prepared by the estimating department are issued based on the cost associated with a 50% probability (P_{50} value) that the project will not overrun. **) see note 1*
Together with the P_{50} cost, the accuracy of the estimate is stated and the range of costs are identified as the P_{10} and P_{90} values

An in depth study of the cost risk analysis process is defined in PCDP module 8.

Page 13 provides a graphical representation of establishing and assigning contingency levels to an estimate. It also details how the accuracy of the estimate is determined following the risk analysis.

Graph 3.8.1 on the following page depicts a typical graphical report generated from Risk Analysis Software.

The graph identifies a range of project costs across the horizontal axis and the respective probabilities of achieving these costs along the vertical axis.

Graph 3.8.2 show the base estimate costs (Basic estimate + Allowances) and the expected levels of contingency, calculated as the difference between the P50 value (determined via Monte Carlo Simulation) and the Base Estimate Value.

The accuracy of the estimate is determined by the percentage reduction or increase in costs from the 50% probability cost value to the 10% and 90% cost values, respectively as shown in Graph 3.8.3

The Client Management Reserve is an additional budget held by the client to provide for potential scope variations. Allocation of Management Reserve is an Owners Management decision and will therefore be at their discretion.

Depending the risk profile of the project, this number could be derived from the difference between the P50 number and any P value between P50 and P90.

In summary, page 21 shows an example of a base estimate ($87 M), and the ***P10*** ($80M), ***P50*** ($100M) and ***P90*** ($110M) values determined through a Monte Carlo risk simulation.

The estimated TIC value in this example is $100M (P50), the contingency amount $13M (P50 value minus Base Estimate), and the accuracy range –20/+10 % (resp. delta P10-P50, and delta P50-P90 over 100M x 100%.)

Client management Reserve was determined as $10M (P90—P50)

**Note 1:*
The reason why the P50 value is widely accepted as the basis for contingency calculations originates from practices used in Owners environments.
Owners tend to assess project performance from a portfolio perspective, and not as individual projects. Their assumption is that half of the projects in the portfolio will overrun and half of the projects will underrun, thus in a bigger scheme of things, they will level each other out.
Contractors, like WorleyParsons, will have a single project focus, so it is advisable to select a higher P-value as the basis for internal contingency and accuracy calculations. (e.g. P60-P70)

3.9 ESCALATION

Escalation is the amount calculated to cover known or anticipated cost increases beyond the base date of the estimate.

Escalation is therefore dependent upon duration.

Like contingency, escalation is also a risk fund, only not driven by the practises used by company or project management but by economic conditions.It is a unique risk that must be estimated and budgeted for.

The costs used in the base estimate will usually reflect the date of preparation.

Projections on forward escalation shall be added if appropriate to allow for the anticipated project schedule.

Forward escalation is typically included as a below the line item. Escalation studies are a core skill (& knowledge) of economists and not of cost estimators/engineers.

The primary econometric measures of price change over time used by economics are price-indices.

There are three basic types of indices available; commodity indices (e.g concrete); labor price indices (e.g salaries); and economic indices (e.g capital spending rends).

An index is usually expressed as a % change in price over a given time period. For example; if the price for steel is given at 1.00 in 2010, and it is forecasted that there will be a price increase of 5% in 2011, the index for 2011 will be 1.05.

When it comes to escalation, estimators will work with economists and combine their knowledge of project cost with the economists expertise of macro economics and price-factors. Economists are the experts at forecasting commodity and wage price indices.

However, they are not experts in engineering, procurement, fabrication and construction in the process industries. Therefore the estimator must marry cost engineering and industry knowledge to customize and adjust the information provided by economists.

To apply the indices, it is important to know when future costs will be committed. This information is usually obtained via cash flow models.

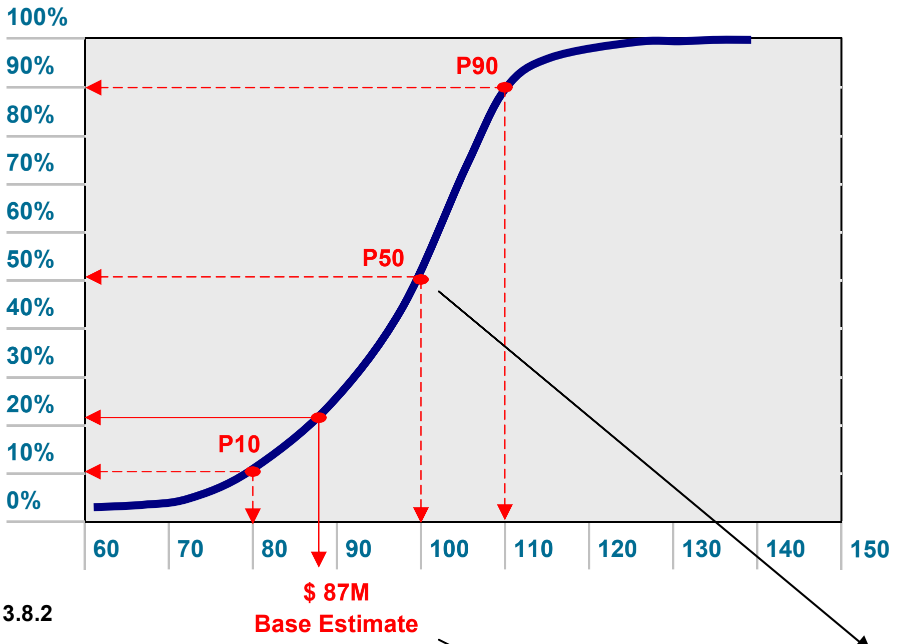
Escalation is typically estimated using ratios of price-indices and there can be a variety of simple and complex escalation calculation models.

A simplified example:

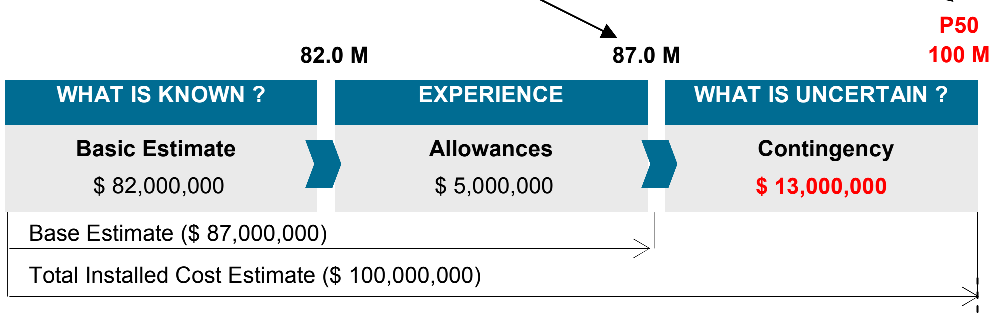
Escalation cost = $base x [(index for date committed) / (index for estimate-basis date) -1]

Escalation cost = $100 x [(1.5/1.2)-1] = $100 x 0.25 = $25

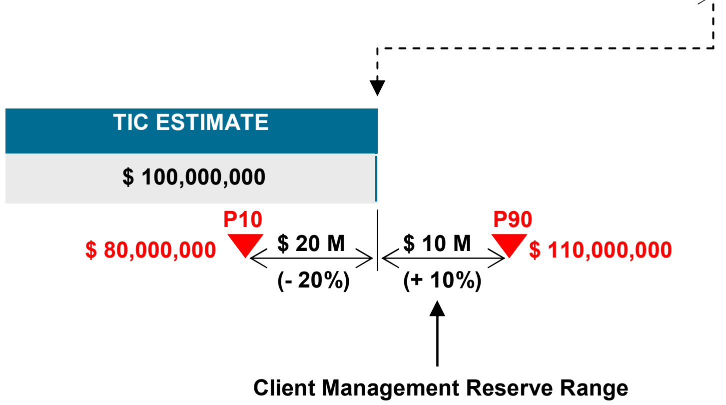
Graph 3.8.1



Graph 3.8.2



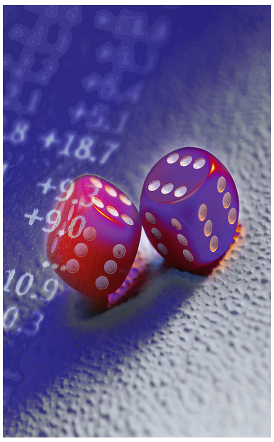
Graph 3.8.3



"There are two kinds of statistics, the kind you look up, and the kind you make up. "

~/~

Rex Stout



4.0 ESTIMATING CLASSES

Estimate classification is a method to recognize and align estimating with the phased scope definition process

Table 2.3.1 on page 9 shows the direct correlation between the Project Phase, the accuracy level of the estimate and the level of required contingency.

Integration of the estimate with the project delivery process will improve the communications among all stakeholders and will avoid misinterpretation of what the cost estimate represents (and hence avoid misapplication).

It also can serve as a guideline or basis of comparison.

This chapter will provide a high level overview of the 4 estimating classes described in WorleyParsons WPMP.

4.1 CLASS 1 (ORDER OF MAGNITUDE)

The Class 1 estimate cost is based on design definition which is very limited and conceptual in nature.

The general accuracy range for an order of magnitude estimate is +/-50%.

This type of estimate is made without any detailed engineering data.

The estimate is often developed using one the following methods:

- Analogy Estimating
- Capacity Factor Estimate
- Equipment Factored Estimate
- Parametric Estimating
- Assembly Estimating
- Hybrid of the above

Pricing is only roughly evaluated. The objective of such an estimate is usually to provide one or more of the following:

- Indication of whether there is a case for further study.
- Early evaluation at minimum expense.
- Preliminary comparisons of alternatives
- A rough indication of the economic feasibility before proceeding with the next phase
- Assistance for business development in preparing proposals and evaluating EPCM service costs
- Initial project planning and control

The emphasis is not on the detailed accuracy but rather a reasonable cost level or delta cost of sufficient accuracy to ensure that the results are meaningful and not misleading.

In these estimates the focus is to build a robust indication of what market prices would be to build a plant or facility based on 'thru puts' and to initially test the economic viability of investing in such a venture.

The skill sets required to achieve the desired estimate is a sound knowledge of the constituent parts of the plant or facility and the ability and knowledge of existing similar plants and facilities.

Extreme caution and judgment must be exercised in developing these types of estimates particularly where the desired estimate is unique in its nature.

4.2 CLASS 2 (SCREENING ESTIMATES)

The Class 2 estimate will deliver a pre-feasibility estimate during the Conceptual or Select stages Phase of Project Execution.

The general accuracy range of a screening estimate +/-30%

This type of estimate is typically prepared when engineering is approximately between 1% and 15% complete and is used to determine whether there is sufficient reason to pursue the project. It permits the evaluation of alternative processes, technologies, or alternative scenarios

"If two wrongs don't make a right, try three."
~/~
Laurance Peter

This estimate may also be used to justify the funding required to complete additional engineering and design for subsequent phases, especially the provision for proceeding to the Define Phase where a Class 3 Estimate maybe undertaken.

The Class 2 Estimate is generally used in detailed studies of economic potential as well as selection of the most economically viable process or development option.

In addition the estimate is used at the outset to establish management strategies, budgeting and planning purposes.

Generally a Class 2 estimate is developed by determining using one the following methods:

- Capacity Factor Estimate
- Equipment Factored Estimate
- Parametric Estimating
- Assembly Estimating
- Hybrid of the above

Project Specific requirements will need to be taken into consideration when applying factors as labor rates, construction productivities and other influences such as market conditions, weather in the vicinity of the project location will influence the adequacy of the factors used to generate the cost estimate.

4.3 CLASS 3 (CONTROL ESTIMATES)

The Class 3 estimate is the most important estimate, as it acts as the stepping stone to project approval and economic evaluation.

The hours and time to prepare this type of estimate should by no means be underestimated. It is an integral effort, and incorporates engineering, procurement, construction and estimating as a team to deliver a successful estimate.

The Class 3 estimate is based on a firm project scope where by 10 to 40% of the engineering has been completed.

The accuracy levels of these estimates are within a +/-15% Range.

Class 3 Control Estimates normally provide one or more of the following "

- A mechanism for a Client to present to the board for project sanctioning and AFE Approval
- Establish a project Budget
- A yardstick to monitor and control project costs during the execution phase
- Basis for evaluating future changes in scopes
- A basis for negotiating contracts for the execution of the works
- For inclusion in a Bankable Document

The Class 3 Control Estimate is a detailed estimate, which means that it requires that the scope is clearly defined and quantified, pricing is obtained based budgetary quotations, and site specific costs are clearly understood.

They usually involve a high degree of unit cost line items, although these may be at an assembly level of detail rather than individual components. Factoring methods may be used to estimate less defined and/or less significant areas of the project.

4.4 CLASS 4 (DEFINITIVE ESTIMATES)

The Class 4 Definitive Estimate is prepared after the project has been sanctioned.

Typically, engineering is from 30 to 70% complete, and would comprise virtually all engineering and design documentation of the project, and complete project execution and commissioning plans.

The prime purpose of this estimate is to confirm the existing project cost forecasts and to provide a more accurate estimate of construction quantities and costs.

This estimate is very similar in its preparation as the Class 3 Control Estimate.

However higher accuracies levels are achievable due to improved engineering definition and quantification of scope this also coupled with the fact that large portions of the work have been or are in a competitive tender process and awarded contract values forming committed costs for the Project

4.5 AACEI ESTIMATING CLASSES

The Association for Advancement of Cost Engineering (AACE International) is the leading-edge professional society for cost estimators, cost engineers, schedulers project managers, and project control specialists.

Its recommended best practice with regards to Estimate classifications is the reverse of the preferred WorleyParsons WPMP approach.

The AACEI estimating classes increase accuracy using descending class numbers (Classes 5 - 1 , where Class 1 is the most accurate class), while the WPMP approach increases accuracy with ascending class numbers (class 4 is the most accurate class).

Considering that the AACEI guidelines are often referred to as the industry-norm and, as such, quite present in many of the WP regions and markets, a parallel map between the two approaches is provided below for future reference:

WPMP GATES	IDENTIFY	EVALUATE	DEFINE	EXECUTE
Estimate Class	1	2	3	4
Estimate Type	Factored or Parametric Models	Factored or Parametric Models	Factored and/or Quantity Based	Quantity Based
Estimate Category	Order of Magnitude	Screening	Control	Definitive
Level of Project Definition	0% - 2%	2% - 15%	10% - 40%	30% - 70%
Estimate Accuracy	≤ ± 50%	≤ ± 30%	≤ ± 15%	≤ ± 10%
Contingency	20% to 25%	15% to 20%	< 10%	< 5%

aace International

AACEI GATES	IDENTIFY	EVALUATE	DEFINE		EXECUTE
Estimate Class	5	4	3	2	1
Estimate Type	Factored or Parametric Models	Factored or Parametric Models	Factored and/or Quantity Based	Quantity Based	Quantity Based
Estimate Category	Concept Screening	Study / Feasibility	Budget Authorization	Control / Bid Tender	Check Estimate
Level of Project Definition	0% - 2%	1% - 15%	10% - 40%	30% - 70%	50% - 100%
Estimate Accuracy	-50%/+100%	-15% / +50%	-10% / +30%	-5% / +20%	-3 / +15%
Contingency	30% to 50%	20% to 25%	10% to 15%	< 10%	< 5%

"If estimators were doctors, they would today be mired in malpractice suits"

~ John Ralston Saul

5.0 ESTIMATING PROCESS

Good cost estimating requires a supportive environment in the organization.

It's therefore essential to implement standard work processes and ensure that these are adequately communicated to the project. (see example on page 26)

This chapter will address some of the key components and documents delivered as part of the estimate preparation process, making references to the WPMP and sharing of experiences and future directions in improving Worley Parsons estimating capability:

- Pre-estimate activities
- Responsibilities
- Estimate Reviews
- Historical and Benchmarking Data

5.1 PRE-ESTIMATE ACTIVITIES

There are a number of activities that need to occur before an estimate commences.

The main activities are:

- Estimate Plan
- Estimate Kick-off Meeting
- Estimating System selection
- Estimating Schedule
- Establishing Estimate Structure and Project Code of Accounts

These main activities will be discussed further in the following sections.

In many instances the client is invited to participate in this meeting, in order to have the customers buy-in on the approach.

Estimating Plan

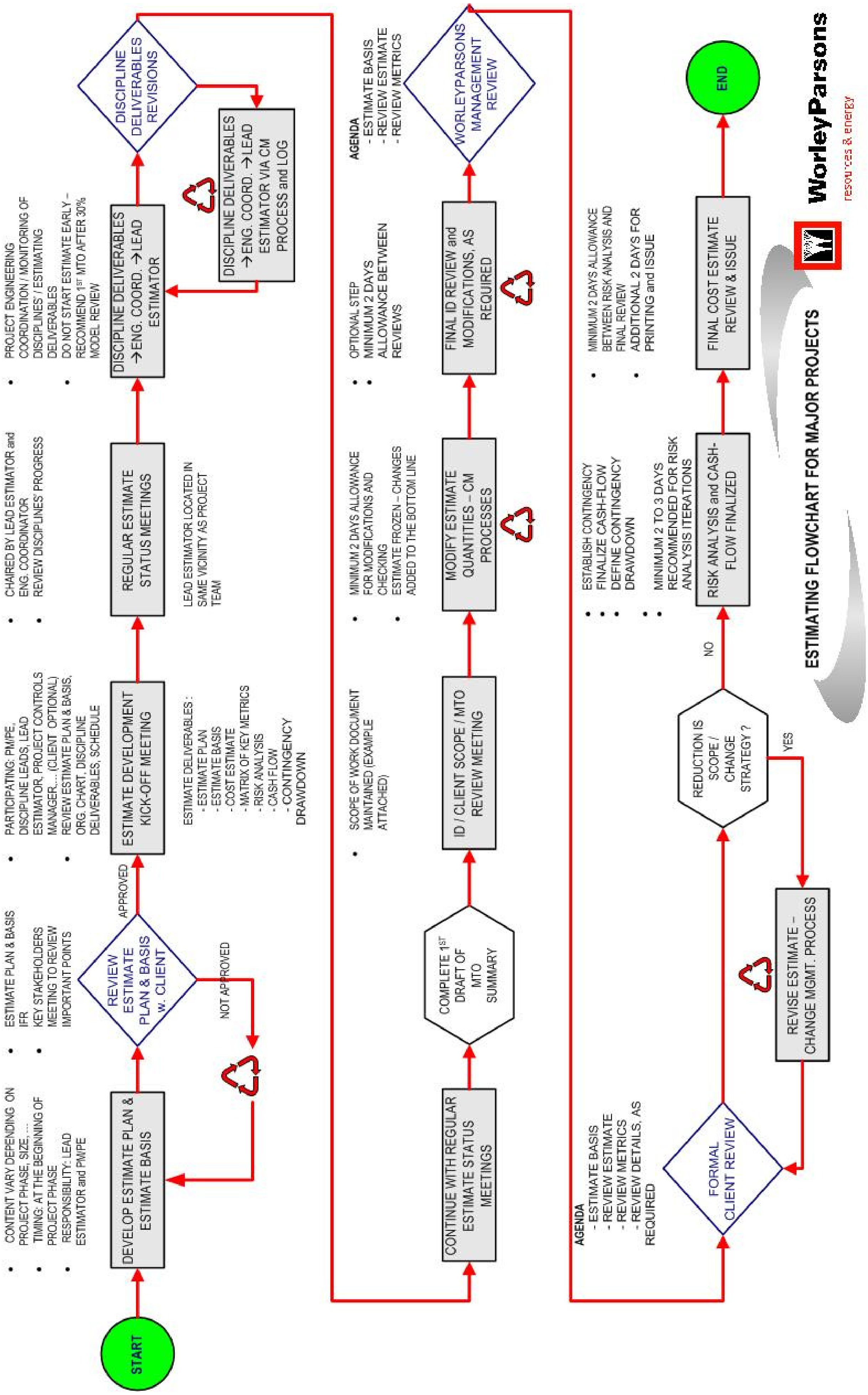
The Lead estimator has the responsibility to formulate the Estimate Plan.

The Lead Estimator may have to source information from various departments in order to finalise the document.

The Estimate Plan document sets the estimate ground rules and establishes uniformity across the project team.

Depending on the required estimate classification, the estimate plan could address the following issues:

- Brief Scope Description
- Client Strategies and Objectives
- Estimate Deliverables
- Key Personnel Contact List
- Estimating System
- Estimate Methodology
- Quantity development
- Allowances


ESTIMATING FLOWCHART FOR MAJOR PROJECTS
START
DEVELOP ESTIMATE PLAN & ESTIMATE BASIS
CONTENT VARY DEPENDING ON PROJECT PHASE, SIZE, …
TIMING: AT THE BEGINNING OF PROJECT PHASE
RESPONSIBILITY: LEAD ESTIMATOR and PM/PE
REVIEW ESTIMATE PLAN & BASIS w. CLIENT
ESTIMATE PLAN & BASIS IFR
KEY STAKEHOLDERS MEETING TO REVIEW IMPORTANT POINTS
NOT APPROVED
APPROVED
ESTIMATE DEVELOPMENT KICK-OFF MEETING
PARTICIPATING: PM/PE, DISCIPLINE LEADS, LEAD ESTIMATOR, PROJECT CONTROLS MANAGER…. (CLIENT OPTIONAL)
REVIEW ESTIMATE PLAN & BASIS, ORG. CHART, DISCIPLINE DELIVERABLES, SCHEDULE
ESTIMATE DELIVERABLES :
- ESTIMATE PLAN
- ESTIMATE BASIS
- COST ESTIMATE
- MATRIX OF KEY METRICS
- RISK ANALYSIS
- CASH FLOW
- CONTINGENCY DRAWDOWN
REGULAR ESTIMATE STATUS MEETINGS
CHAIRED BY LEAD ESTIMATOR and ENG. COORDINATOR
REVIEW DISCIPLINES' PROGRESS
LEAD ESTIMATOR LOCATED IN SAME VICINITY AS PROJECT TEAM
DISCIPLINE DELIVERABLES →ENG. COORD. →LEAD ESTIMATOR
PROJECT ENGINEERING COORDINATION / MONITORING OF DISCIPLINES' / ESTIMATING DELIVERABLES
DO NOT START ESTIMATE EARLY – RECOMMEND 1ST MTO AFTER 30% MODEL REVIEW
DISCIPLINE DELIVERABLES REVISIONS
DISCIPLINE DELIVERABLES →ENG. COORD. →LEAD ESTIMATOR VIA CM PROCESS and LOG
CONTINUE WITH REGULAR ESTIMATE STATUS MEETINGS
COMPLETE 1ST DRAFT OF MTO SUMMARY
ID / CLIENT SCOPE / MTO REVIEW MEETING
SCOPE OF WORK DOCUMENT MAINTAINED (EXAMPLE ATTACHED)
MODIFY ESTIMATE QUANTITIES – CM PROCESSES
MINIMUM 2 DAYS ALLOWANCE FOR MODIFICATIONS AND CHECKING
ESTIMATE FROZEN – CHANGES ADDED TO THE BOTTOM LINE
FINAL ID REVIEW and MODIFICATIONS, AS REQUIRED
OPTIONAL STEP
MINIMUM 2 DAYS ALLOWANCE BETWEEN REVIEWS
WORLEYPARSONS MANAGEMENT REVIEW
AGENDA
- ESTIMATE BASIS
- REVIEW ESTIMATE
- REVIEW METRICS
FORMAL CLIENT REVIEW
AGENDA
- ESTIMATE BASIS
- REVIEW ESTIMATE
- REVIEW METRICS
- REVIEW DETAILS, AS REQUIRED
REVISE ESTIMATE – CHANGE MGMT. PROCESS
REDUCTION IS SCOPE / CHANGE STRATEGY ?
YES
NO
RISK ANALYSIS and CASH-FLOW FINALIZED
ESTABLISH CONTINGENCY
FINALIZE CASH-FLOW
DEFINE CONTINGENCY DRAWDOWN
MINIMUM 2 TO 3 DAYS RECOMMENDED FOR RISK ANALYSIS ITERATIONS
FINAL COST ESTIMATE REVIEW & ISSUE
MINIMUM 2 DAYS ALLOWANCE BETWEEN RISK ANALYSIS AND FINAL REVIEW
ADDITIONAL 2 DAYS FOR PRINTING and ISSUE
END
WorleyParsons
resources & energy

- Material Pricing
- Fabrication and Modulisation
- Freight
- Pre-commissioning, Hook Up and Commissioning
- EPCM Services
- Contingency
- Code of Accounts (Facility & Commodity codes)
- Engineering deliverables required to support this type of estimate
- Contracting Strategy
- Procurement Strategy (the determination of which items of equipment should be issued for firm quotation (major equipment items) and which items will be costed on the basis of budget quotations, historical/database information or by other techniques (minor equipment items))
- Construction Input
- Material Take-off formats
- Escalation
- Qualifications and Exclusions
- Roles and Responsibilities Matrix
- Estimate Reviews
- Final Report

Estimate Kick-off Meeting

The Estimate kick-off meeting is only held, once the Estimate Plan is developed.

The Lead estimator will develop the estimate plan and present this document to the key players of the project team.

As a minimum, this meeting should be attended by the Project Manager, the Lead Discipline Engineers, the Lead Estimator, and representatives of the Procurement and Construction functions.

The purpose of this meeting is to highlight the estimate requirements and establish responsibilities and communication links between the departments, such that there is no misunderstanding as to what role each department must play in the cost estimate development.

Normally the client is invited to participate in this meeting, to ensure the customers commitment to the proposed estimating development approach.

System selection - Quest

WorleyParsons utilises the commercially available Quest estimating system (by GTS Software) as its preferred tool for bottom-up, detailed capital cost estimating.

Quest is an estimating system designed as a tool to aid estimators in the preparation of major capital cost estimates.

The system does not pre-empt the important contribution the estimator makes to an estimate in the form of assurance of complete scope definition; quantity development; productivity assessments; pricing of equipment, materials and labour; evaluations of indirect costs and offsite services; and contingency escalation evaluations.

The system does relieve the estimator of much of the number crunching that is inherent in the generation of an estimate.

Quest enhances the quality of the estimate by automating the calculations within a disciplined structure and thereby eliminating a major source of estimate errors.

- The main benefits of this system are:
- Automatic retrieval of standard information;
- Maximised computer calculation – reducing possible estimating errors;
- Automated budget consolidation;
- Use copy estimate facility to estimate different cases or options;
- Can be used to identify estimate trends during project implementation.

System selection - Aspen Capital Cost Estimator (Kbase)

Aspen Capital Cost Estimator supports conceptual and detailed cost estimates over the project lifecycle.

It creates budgets from conceptual definitions, supporting project leaders analyse execution strategies, manage change orders, and control costs.

Aspen Capital Cost Estimator is used primarily by cost estimators to analyse investment options during conceptual engineering.

Costs are automatically updated as engineering specifications change, providing clear visibility of how changing assumptions affect project economics. Additional benefits include:

- Obtain detailed EPC estimate from minimal input in a fraction of the time required by traditional methods
- Reduce estimation variability by adopting a consistent methodology

System selection - Cost Risk Analysis @Risk

WorleyParsons uses the commercially available software @RISK as its preferred tool to conduct cost risk assessments.

The system uses Monte Carlo simulation to show a range possible outcomes and expected values in the project – as well as the likelihood they are to occur.

Estimating Schedule

The key dates and milestones (i.e. engineering cut-offs, reviews etc.) of the estimate schedule are normally established early and presented in the estimate plan at the estimate kick-off meeting.

It is important the Lead Estimator has a thorough review of the steps required to complete the estimate and in doing so, prepare a bar chart showing the estimate input required and their dates and durations.

The development of the schedule normally requires coordination with the Project stakeholders.

Typical information should include:

- Engineering input to the estimate broken down by discipline
- Pricing data from Procurement
- Data to develop direct costs from Procurement, Industrial Relations and Engineering personnel
- Data from Construction with regard to Fabrication Yards and Marine Spreads
- Estimate preparation breaking down, direct costs, indirect costs, reviews and final estimate preparation and presentation
- Estimate Reviews

Estimate Breakdown / Code Of Accounts

Coding structures allow large volumes of data to be organized, sorted, filtered and reported on; and in their hierarchical and dynamic forms, are the foundation of management systems.

Enterprise management, project management (project delivery), engineering & design, procurement, finance, or other functions exchange relevant data based on coding structures definition, at any level of data resolution required

In order to meet ever changing and increasing demands of the business environment, management systems ought to have coding structures that would make them robust, flexible and adaptable, and LOVs (Lists of Values) in them carefully defined to avoid ambiguity and redundancy to ensure successful project-delivery throughout the organization.

"If you board the wrong train, it is no use running along the corridor in the other direction"

~ Dietrich Bonhoefer

Project Breakdown Codes

Entity Code + Project Number + WBS Code + CoA Code

Attributes +

Project Controls	Activity Detail Codes (Services)
Project Controls	Cost Types (TIC Management)
Cost Estimating	Standard Estimating Commodity Codes
Procurement	Procurement Commodity Codes
Finance	Expenditure Categories / Types
Etc...	

The degree of alignment, adoption and implementation of coding structures will be a factor in our ability to successfully collect meaningful historical project data for benchmark purposes

Codes (code "values") contained in the various coding structures, have their own attributes, and are mostly variable (i.e. a WBS changes from project to project, while the CBS or Code of Accounts are "constant" across the organization.

WorleyParsons has developed a standard approach to the application of the Project Breakdown Code for its projects

The Global Code of Accounts (CoA) is the component of WorleyParsons Project Breakdown Code (PBC) that ties the various specific coding structures for each function.

While some components of the PBC are project specific, the CoA field is one which (when globally applied) enables consistent cost classification across all projects and easy comparison of Return Data.

The Global CoA is a comprehensive set of standardised codes that defines the content of each account code and is methodically structured to facilitate finding, sorting, compiling, summarising, defining and otherwise managing information the code is linked to.

The information is used to support total management practices such as cost estimating, cost accounting, cost reporting, cost control, planning, scheduling and benchmarking.

The Global CoA must be used on all projects.

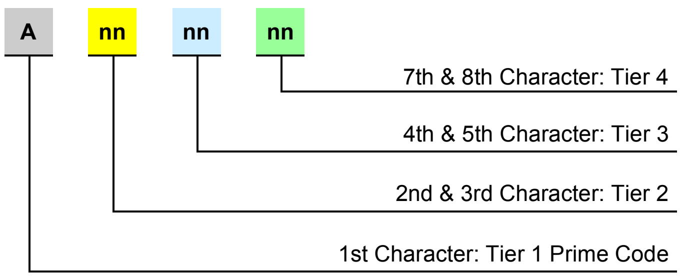
The CoA structure caters for both Services Codes and Total Installed Cost (TIC) codes and comprises a four level hierarchy, where each level rolls up to the level above.

The four levels have been established to meet the varying needs of the different levels of detail typically occurring in the quantity reporting versus budget control of labour versus material\subcontract.

While a CoA is required for project cost control purposes, the primary purpose of a global, standard, mandatory Code of Accounts is to facilitate the capture of consistent return data.

A four level hierarchical code structure is required to enable "roll up" to various control levels. At the first level, a single ***alpha*** field identifies the discipline.

At the second, third and fourth levels are double digit ***numeric*** fields.



"It's not a lie. It's a gift for fiction"

~/~

Walt Price

The current code utilisation at each level is as follows:

The 1st character, primary code provides breakdown into the major disciplines areas

The 2nd and 3rd character, level 2 codes provide the major commodity groupings under each of these areas (and so forth for the remaining two levels).

Se below an extract from the Mechanical Codes:

1st Digit - Primary Codes

A	Civil Works	**N**	Protection & Coating
B	--- Spare ---	**O**	--- Spare ---
C	--- Spare ---	**P**	Pipelines
D	Structural Steel	**Q**	--- Spare ---
E	--- Spare ---	**R**	Other Direct Costs
F	Buildings & Architectural	**S**	Construction Indirect Costs
G	Mechanical	**T**	--- Spare ---
H	Turnkey Packages	**U**	--- Spare ---
I	Infrastructure	**V**	--- Spare ---
J	Marine & Offshore	**W**	EPCM & Consulting Services
K	Piping	**X**	Taxes & Duties
L	Electrical	**Y**	Contingency & Escalation
M	Instrumentation	**Z**	Owner's Costs

G000000 Mechanical

G020000 Static Equipment

G020100 Boilers

G020101 Coal Fired Boilers

G020102 Gas Fired Boilers

G020103 Liquid Fuel Boiler

G020104 Waste Heat Boilers

G020105 Dual Fuel Boiler

Tier 1 **Tier 2** **Tier 3** **Tier 4**

The structure of project Total Installed Cost (TIC) estimates are typically aligned with the cost control structure or CoA.

However, the CoA seldom provides sufficient levels of detail to generate a bottom-up estimate.

Therefore, the Estimating group requires a set of "extension" estimating codes which roll up/ down to/from the "core" CoA.

These Standard Estimating Commodity codes can be accessed via EMS under Estimating, document PDP-0015.

For a variety of reasons, not all TIC estimates generated by WorleyParsons will ever get rolled over into an Execute Phase project control budget.

So the requirement for data transfer from estimating systems to cost control systems is infrequent.

Projects in Execute Phase will sometimes require a Class 4 re-estimate, which requires extraction of actual cost data from the cost control system back into the estimating system where the remaining work is re-estimated and rolled up to give a "cost to complete".

This requirement to transfer data from the cost control system back to the estimating system is also infrequent.

5.2 RESPONSIBILITIES

Every project manager is responsible to ensure that the WPMP Estimating processes are observed and followed when preparing, presenting and reviewing an estimate.

The development of an estimate is a team effort, and needs input from many other functional groups.

An experienced estimator is required to facilitate this process and will need input and support from project management, engineering, procurement and construction to achieve the level of accuracy required at this phase of the project.

The Senior or Lead Estimator has the responsibility for determining that the scope available is sufficient to complete the desired classification of estimate requested, and that the estimate can realistically be accomplished based on the overall schedule and staffing availability.

The estimator has the primary role to facilitate the estimating process, and deliver, present and review a capital cost estimate that meets the accuracy desired for this Class of estimate.

Detailed below is an example of a responsibility matrix for Offshore estimates such as the Tatanka Development. It lists the input required for the successful completion of the estimates and the responsible function for providing that input.

Scope	Responsibility
1. Scope Definition, Documentation and Execution Strategy. For Offshore transportation and Installation programs, the execution strategy and assumptions adopted have a high degree of sensitivity to the estimate.	Project Manager / Engineer / Client
2. Quantity and Pricing Development	
Major Equipment	
Equipment list of all process, utility, and specific site support plant identifying necessary information and design data, design allowance percentage for quoted items and spare parts. Prepare existing data sheets to issue to Procurement for reconfirmation of equipment pricing.	Engineering
Prices quoted by vendors, current market pricing information, inland and ocean freight rates and related data for shipment of equipment, import duties if required, vendor representative rates and expenses	Procurement
Construction and installation methods and schedules, labour availability and productivity information.	Construction
Labour rate information.	Estimating\Construction
Sales and other taxes, foreign currency issues and import duties.	Procurement\Estimating
Major equipment estimate, including review of scope, material and labour pricing.	Estimating
Bulk Quantity Development	
Development of the various levels of scope including take-offs.	Engineering
Methods used to develop quantities	Estimating
Contracts	
Contracting Plan	Construction\Contracts\Team Leader

Estimator:
A person who believes figures don't lie, but admits that under analysis some of them won't stand up either.

~/~
Evan Esar

Scope	Responsibility
3. Fabrication Yards	
Productivity compared to baseline location Labour Rates compared to baseline location	Estimating\Construction Estimating\Construction
4. Offshore Transportation & Installation – Execution plan and Costs	
Mobilization and demobilization basis of marine construction vessels and points of origin for pre-fabricated facilities (pipelines, platforms, PLEMS)	Project Manager / Construction Support.
Construction / Transportation spreads identified as required for the work and Day rate costs thereof.	Estimator / Construction Support
Mob and demob, logistical and preparatory costs associated with identified spreads to be mobilized and overall execution plan and basis.	Estimator / Construction Support.
Duration assessment for identified marine spreads including non-working periods	Estimator / Construction Support.
Assessment of Construction Management and construction support engineering costs and durations	Estimator / Construction Support
5. Services Estimate	All
Engineering job hours, other direct costs.	Engineering
Department Estimate of hours and other direct costs.	Department Managers
Total cost of EPCM Services.	Team/Estimating
7. Escalation Analysis	
Escalation rates	Project Owner (client)
Instructions and information to the estimating team concerning operations policy on escalation rates, indexes and projections.	Project Owner (client)
8. Contingency Analysis	
Development of estimate and the best measure of potential variance in project costs. (Risk Analysis)	Project Team / Client
Final estimate figure.	Project Management

9. Estimate Reviews

Engineering Review (Quantity/Scope)

The Quantity Review meeting is held to ensure the estimate detail has been completely and correctly quantified for all direct account categories according to the scope document. This meeting is a team review of scope and quantity details for each account, and it is a key review of the direct account quantities where agreement on the total package must be reached among all attendees.

The estimate detail sheets that are to be reviewed must be issued to engineering at least two working days before the meeting, to provide sufficient time for independent reviews.

<u>WorleyParsons In-House review – (offshore Transport and Installation programs)</u>

A WorleyParsons in house review meeting shall be held to ensure all elements of the estimate has been correctly applied and quantified. Particular emphasis with appropriate test shall be directed towards:-

- Scope and quantity and their surrounding basis and principles which drive project scope and quantity.,
- Assumptions / principles adopted as part of the estimate basis and the test of reasonableness against these assumptions. (e.g. Point of mobilization of Marine Spreads, Vessel selections, Construction methods assumed).

5.3 ESTIMATE REVIEWS

The principle purpose of the estimate review is to present information about the estimate and the project that allows the reviewer to evaluate that the estimate is of sufficient quality to meet its intended purpose.

WorleyParsons developed methods for the process of reviewing estimates and validating capital cost estimates that are prepared by ourselves and by others.

A formal estimate review process ensures quality, accuracy; completeness and consistency and is usually comprised of a series of reviews:

- Engineering Review
- Project Team Review
- Cold Eyes PEER Review
- Management Review

The estimator should ensure the estimate is well documented, consistent, reliable and fit-for-purpose before releasing it for review. As a minimum, the Estimate Package should contain the following supporting documents:

- Basis Of Estimate
- Estimating Summaries - by WBS and by CoA
- Estimate Detail
- Estimating Benchmarking Report
- Estimating Reconciliation Report
- Estimating Back-up

Basis of Estimate (BOE)

The estimate review team will review the estimate for QC (screening for errors) and QA (validate whether the estimate is developed following our standard procedures and guidelines).

The Basis of Estimate (BOE) may be the single most important document in the estimating package.
Besides documenting the requirements for all estimate stakeholders, the BOE is also the guide for all communication and reviews; it acts as a bridge to cost control and change management; and is the key to historical knowledge of what's behind the estimated numbers.

The BOE document should include:

> Purpose of the Estimate

> Scope description

> Estimate exceptions

> Estimate exclusions

> Assumptions & Allowances

> Pricing

> Execution/Contract Strategy

> Escalation

> Risk Analysis/Contingency

> Benchmarking

> Reference documents

Engineering/Design Review

The purpose of this review is to validate whether the estimate represents the projects scope, verify the completeness of the engineering deliverables used for the estimate and confirm whether the take offs (MTOs) reflect those deliverables.

The estimate review team should include core members of the engineering team and estimating teams.

Project Team Review

After passing previous reviews, the estimate is ready for review by the project team.

The project team must fully understand how the estimate is prepared in order to present and defend the estimate to their management and the client.

The purpose of this review is to ensure that the estimate is aligned with the schedule (escalation impacts); examine in-directs and other home office costs; verify constructability and start-up/commissioning costs.

It usually also involves some reconciliation to estimates generates in earlier project phases, so the differences can be clearly explained.

Corporate Management Review

The number of management reviews and level they are presented to will vary with the strategic importance and/or total value of the project.

A management review is held at a high level of analysis and will focus on substantiating overall adequacy of the estimate with regards to its intended use.

Areas that are typically covered:

- Estimate reconciliation ("how does this estimate compare to the last estimate?")
- Estimate validation ("how confident are in terms of the presented numbers?")
- Cost Risk assessment ("what are the cost risk drivers and how are these risk mitigated?")
- Project Alternatives ("have we considered alternative design/cost options; what was the decision process leading to the adopting the selected options"?)

Cold Eyes PEER Review

When developing an estimate, it is not uncommon that the project will develop an optimistic view about uncertainties concerning scope and process issues.

This optimism could be the result of inexperience of the estimating-team; it could be driven by client expectations on what the "right number" should be or even by our own corporate management in its ambition to secure the project.

To ensure that WorleyParsons is adequately protected against financial or reputational risks, it is mandated that every TIC estimate will have to be examined via a so-called "cold eyes" Peer review before it is in released to the clients.

This review is typically done by a senior or Lead estimator who possesses the appropriate experience & skills and is familiar with our procedures and workflows, but who is alien to the project.

The purpose of the "Cold Eyes" review is to examine the estimating processes and project data carefully and present the findings and amendments to the project stakeholders, in order to achieve the right balance between a realistic estimate and the companies commercial interests..

Client Presentation & Review

This final step in the cost estimate development and submittal includes a formal presentation of the estimate package by the Project Manager to the client. The presentation seeks to obtain final client approval of the estimate submission.

5.4 BENCHMARKING

Estimate benchmarking is the process of comparing one's processes and performance metrics to other bests and/or best practices from earlier completed projects (and estimates).

Dimensions typically measured are quality, time and cost.

Measurement is done using a specific indicator (cost per unit of measure, productivity per unit of measure, cycle time of x per unit of measure or defects per unit of measure) resulting in a metric of performance.

These metrics can be utilized for estimate development (conceptual estimates) and for comparison to other estimates.

The term benchmarking was first used by cobblers to measure people's feet for shoes. They would place someone's foot on a "bench" and mark it out to make the pattern for the shoes.

Benchmarking is one of the main drivers behind the development and implementation of standard cost elements (CoAs) on projects.
The global Codes of Account enables WorleyParsons to collect actual costs in a historical cost database in a consistent manor across the globe.

Estimating: The only science that enables different experts using the same figures to draw different conclusions.

~/~

Evan Esar

6.0 RECASTING

The Baseline Control Budget is the reference point to which actual costs (expenditures) will be measured or monitored during project execution.

A Baseline Control Budget will reflect the Project Breakdown Structure (WBS and CBS).

It is derived from the approved Class III estimate but will involve some level of recasting to enable effective project controls.

Recasting literarily means:

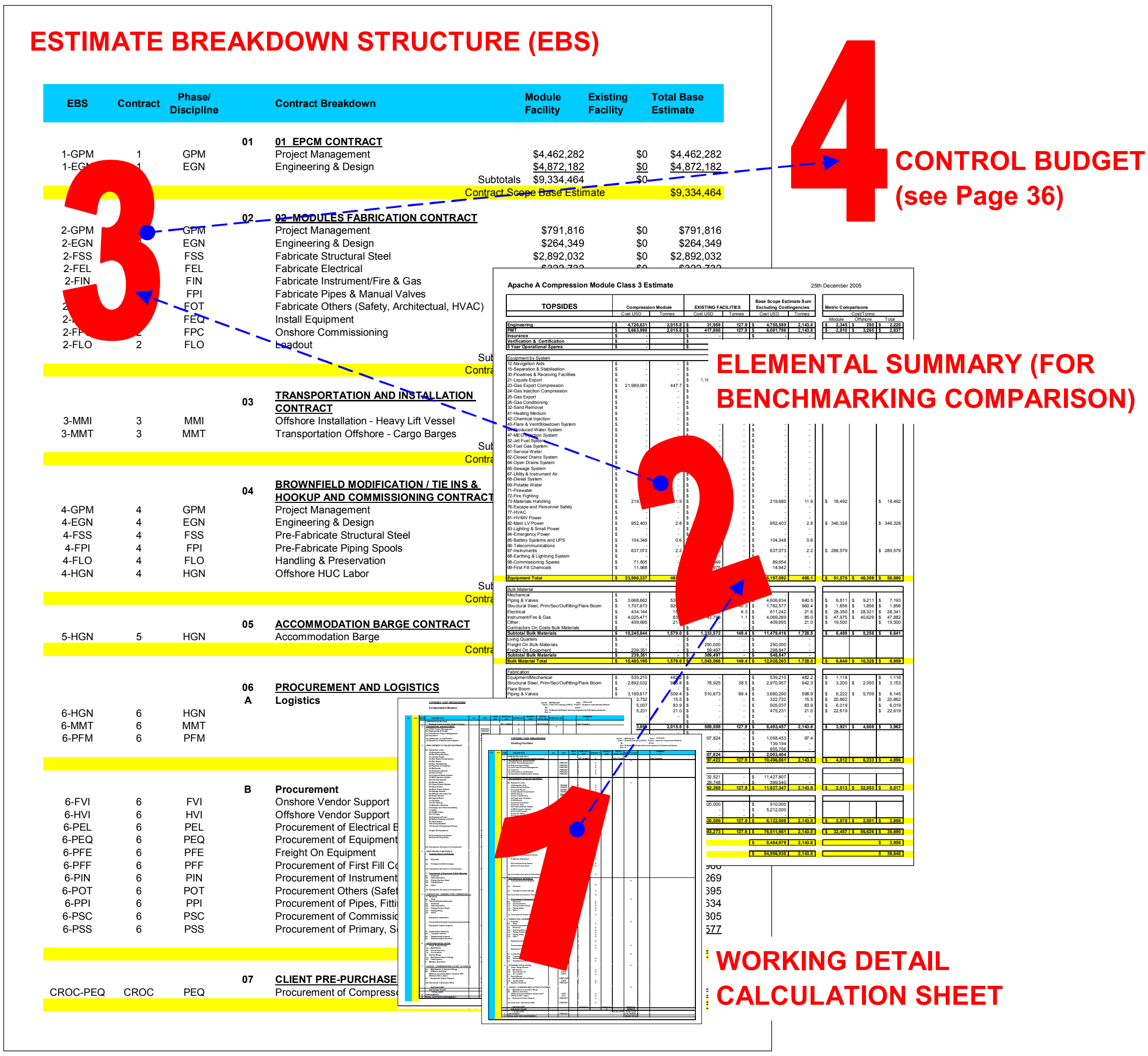
1. Give something a different form by melting it down and reshaping it.

2. Present or organize something in a different form or style.

Recasting of an Estimate is a necessity because the way a budget is estimated can be completely different from the way a budget is managed and monitored:

- The estimate line-item detail may differ from the level of detail required for Project Control. (different Units/ Quantities e.g lengths of Pipe units vs Dia-inch units)
- The final contract strategy may differ from the planned contract strategy at the time the estimate was prepared. (different breakdown of cost)
- The execution strategy can differ from the planned execution strategy (e.g. Construction Work packs and Procurement packages)

Recasting the estimate is a Project Controls responsibility but will require some support from the estimator.



4 CONTROL BUDGET

Control Accounts		Control Account Description	Original Budget
WBS Code	**Codes of Accounts**		
2 - 06 - FAD	G - 0 0 - 0 0 - 0 0	Mechanical	$ 539,210
2 - 06 - FAE	L - 0 0 - 0 0 - 0 0	Electrical	$ 527,880
2 - 06 - FAF	M - 0 [illegible] - 0 0 - 0 0	Instrument / Telecom / P & G	$ 422,116
2 - 06 - FAG	F - 0 [illegible] - 0 0 - 0 0	Architectural	$ 253,080
2 - 06 - FAH	G - [illegible] [illegible] - 0 0 - 0 0	HVAC	$ 275,000
2 - 06 - FAI	J - [illegible] [illegible] - 0 7 - 0 0	Weighting	$ 53,827
2 - 07		**Pre-Commissioning**	
2 - 07 - COI	J - 1 0 - [illegible] [illegible] - [illegible] 2	Pre-commissioning for Topsides Systems	$ 249,486
2 - 08		**Load Out**	
2 - 08 - LOA	[illegible] - 0 4 - 0 7 - 0 1	Preparation of Load Out	$ 400,000
2 - 08 - LOB	J - 0 4 - 0 7 - 0 2	Load Out & Sea fastening	$ 352,440
2 - 11		**Final Documentation**	
2 - 11 - FDA	W - 0 3 - 9 8 - 0 0	Final Documentation	$ 129,417
3		**Transport & Installation**	**$ 5,802,000**
3 - 09		**Offshore Installation**	
3 - 09 - ISA	J - 1 0 - 0 9 - 0 2	Heavy Lift Vessel	$ 5,212,000
3 - 10		**Transportation**	
3 - 10 - TRA	J - 0 4 - 0 7 - 0 4	Transport Cargo Barge	$ 590,000
4		**Brownfield Mods/Tie-Ins/HUC**	**$ 6,130,762**
4 - 01		**Management & Support**	
4 - 01 - PMA	W - 0 2 - 0 0 - 0 0	Project Management & Support	$ 372,800
4 - 01 - PME	S - 0 2 - 0 0 - 0 0	Contractors Preliminaries	$ 45,000
4 - 03		**Engineering & Design**	
4 - 03 - EDC	W - 0 3 - 0 0 - 0 0	AFC Drawings	$ 3,200
4 - 03 - EDD	W - 0 3 - 0 0 - 0 0	Shop Drawings	$ 15,973
4 - 03 - EDE	W - 0 3 - 0 0 - 0 0	MTO	$ 4,800
4 - 03 - EDG	W - 0 3 - 0 0 - 0 0	Red Marked-up Drawings	$ 7,985
4 - 06		**Onshore Pre-Fabrication**	
4 - 06 - PFA	K - 1 0 - 0 0 - 0 0	Prefab Supports	$ 166,131
4 - 06 - PFB	N - 6 0 - 0 0 - 0 0	Blasting & Painting	$ 101,871
4 - 06 - PFC	K - 0 8 - 0 0 - 0 0	Prefab Tie-in Piping	$ 267,220
4 - 06 - PFD	K - 2 0 - 0 0 - 0 0	NDE / Pressure Testing	$ 85,923
4 - 06 - PFE	J - 0 4 - 0 7 - 0 0	Preparation Offshore Shipments	$ 39,259
4 - 12		**Offshore Brownfield Works**	
4 - 12- OBA	K - 0 2 - 0 0 - 0 0	Piping Brownfield Works	$ 617,305
4 - 13		**Turnaround Shutdown Works**	
4 - 13 - SDA	D - 0 0 - 0 0 - 0 0	Structural Shutdown Works	$ 762,990
4 - 13 - SDB	K - 0 2 - 0 0 - 0 0	Piping Shutdown Works	$ 161,830
4 - 13 - SDC	L - 0 0 - 0 0 - 0 0	Electrical Shutdown works	$ 115,780
4 - 13 - SDD	M - 0 0 - 0 0 - 0 0	Instrument Shutdown works	$ 79,880
4 - 14		**HLV Works**	
4 - 14 - HLA	D - 0 0 - 0 0 - 0 0	Structural HLV Works	$ 1,192,075

7.0 QUESTIONNAIRES

7.0 INTRODUCTION TO CAPEX ESTIMATING - QUESTIONNAIRES

7.01 An estimate in which the cost of a new plant is derived from the cost of a similar plant of known (but usually different) capacity is called a

☐ Capacity Factor Estimate

☐ Parametric Estimate

☐ Assembly Estimate

7.02 The Lang and Guthrie Factor methods are relying on the principle that there is a correlation between the cost of Direct Labour & Bulk Materials for installation and the purchase price of major equipment.

☐ Only true for Lang Factor method

☐ Only true for Guthrie Factor method

☐ True for both Lang and Guthrie Factor methods

7.03 a) Contingency is an amount of funds to reduce the chances of overrunning the base estimate to an acceptable level of risk.

b) The accuracy range of an estimate is a probabilistic assessment of how far a project's final actual cost can be expected to vary from the estimate

☐ a) is correct

☐ b) is correct

☐ Both a) and b) are correct

7.04 A P50 CAPEX estimate of $740M Total Installed Cost, with an +15/-20% Accuracy range tells you that the TIC at project completion is expected to be anything between … and … ; with a 50/50 chance that it will be ... (P50 value).

☐ 978M; 680M; 851M

☐ 888M; 629M; 740M

☐ 851M; 592M; 740M

7.05 a) WPMP Class 3 and 4 estimates are based on limited design definition

b) WPMP Class 3 estimate is used as a mechanism for project sanctioning and AFE approval

☐ a) is correct

☐ b) is correct

☐ Both a) and b) are correct

(CONT'D) INTRODUCTION TO CAPEX ESTIMATING - QUESTIONNAIRES

7.06 a) The Basis Of Estimate (BOE) document sets the estimate ground rules and establishes uniformity across the project team during the development of the estimate.

b) The Estimate Plan document is the guide for all communication and reviews; it acts as a bridge to cost control and change management and is the key to historical knowledge of what's behind the estimated numbers.

☐ a) is correct

☐ Both a) and b) are incorrect

☐ Both a) and b) are correct

7.07 Estimate line-items are coded using the following code build up principle:

☐ Entity Code + Project Number + WBS Code + Code of Accounts + Estimating Commodity Code

☐ Entity Code + Project Number + WBS Code + Code of Accounts + Activity Detail Code

☐ Entity Code + Project Number + WBS Code + Code of Accounts + Cost Type

7.08 A Review to *"validate whether the estimate represents the projects scope, verify the completeness of the engineering deliverables used for the estimate and confirm whether the take offs (MTOs) reflect those deliverables"* is called:

☐ An Engineering Estimate Review

☐ A Cold Eyes Peer Review

☐ A Project Team Estimate Review

7.09 The mandated Review to *"ensure that the company is adequately protected against financial or reputational risks before the Estimate is in released to the clients"* is called:

☐ A Project Team Estimate Review

☐ A Corporate Management Review

☐ A Cold Eyes Peer Review

7.10 A Review to "*ensure that the estimate is aligned with the schedule (escalation impacts); examine indirects and other home office costs; verify constructability and start-up/commissioning costs*" is called:

☐ A Project Team Estimate Review

☐ A Corporate Management Review

☐ A Cold Eyes Peer Review

7.11 Recasting of an Estimate is a necessary because .

☐ a) The estimate line item detail may differ from the level of detail required for Project Control

☐ b) The final Contract & Execution strategy may differ from the planned Contract/Execution strategy at the time the estimate was prepared

☐ Both a) and b) are correct

8.0 EXERCISES

8.1 SUB SEA ESTIMATE

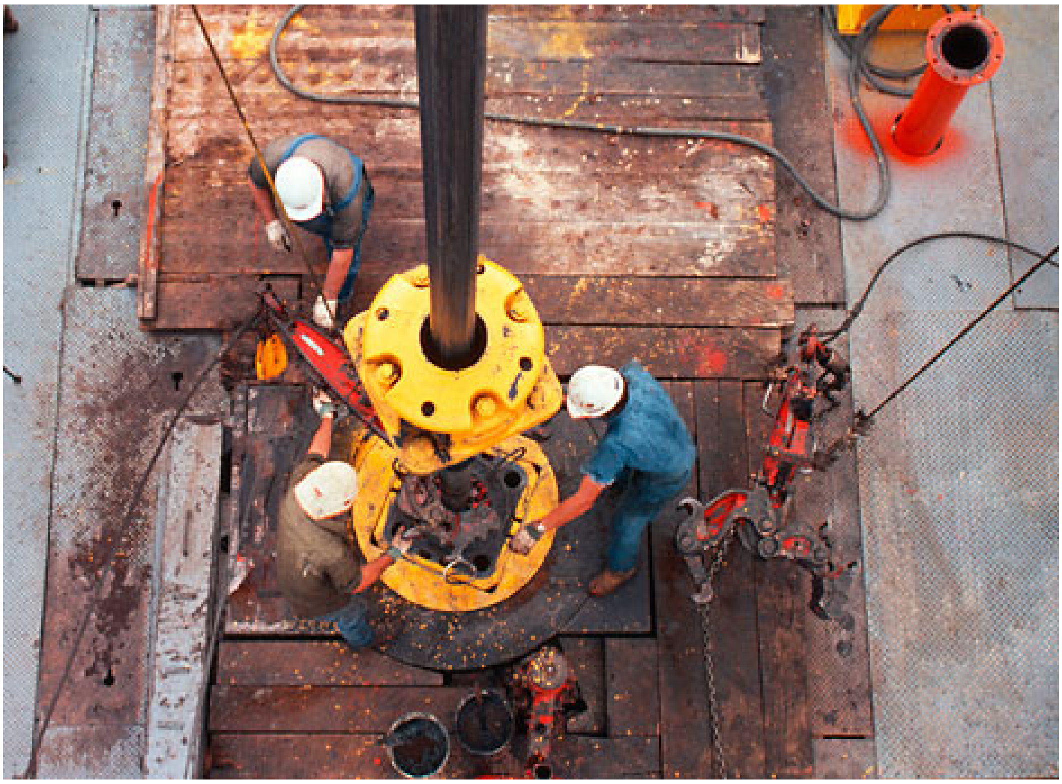
Aquarius Inc. has been awarded an EPC contract to install a 12" diameter sub-sea Pipeline from a Wellhead Platform to Onshore Gas receiving Facilities (3.1 km).

- The material is CS with corrosion Resistant Alloy Coating. The Material cost is $ 1,150 per Meter
- All-in Labor cost is $ 150 per Meter (excluding Pipe-lay vessel)
- The Operating Rate for the Pipe-lay vessel (and associated tugs, support/services vessels, Remote Operated Vessels and other equipment) for placement of the sub-sea pipeline is $ 250,000 per Day. Scheduled duration is 6 days.
- Mobilization/Demobilization of the Pipe-lay vessel package for loading of supplies/materials, transport to installation site and demob to point of origin is estimated at $ 175,000 per day. Aquarius allowed 10 days for mob/demob of the pipe-lay vessel.
- Construction Management cost is budgeted at 13% of the Direct Field Cost
- Engineering cost is assumed to be 18% of the Total Field cost
- Contingency was set at 10% of the base estimate.
- Disregard Escalation

The EPC contract value is USD 13 M.

Aquarius Inc. is targeting a minimum gross profit margin of 20% (of the Contract Value).

Assuming this project will be delivered on time and on budget; is that target profit margin achievable with this budget?



8.2 DRILLING AND COMPLETIONS ESTIMATE

A customer requested WorleyParsons to provide a quick estimate for the cost of Drilling and Completions for a major offshore development.

The following scope details were provided:

3 wells drilled from an existing unmanned platform; 1 Vertical Well, True Vertical Depth (TVD) = 3,500 Meters and 2 Horizontal Wells, Measured Depth (MD) = 5,000 each

Drawing down on its historical benchmark database, WorleyParsons based the estimate on the following assumptions:

- Drilling Rate (duration) = 60 Meters per Day
- Completion Days at 20% of Drilling Days
- Drilling Rig Rate (Drilling and Completions) at $ 160,000 per day.
- Drilling and Completion Direct Field work is assumed as Total Drilling cost x Multiplier 2.7
- Mobilization/Demobilization of 8 days. Drilling Rig Towing Package rate = $ 6,000 per hour.
- 2% allowance on Total Drilling and Completion cost for internal Engineering support

Based on these assumptions WorleyParsons estimated a Total Drilling & Completions Cost of:

Drilling $ 73,440,000

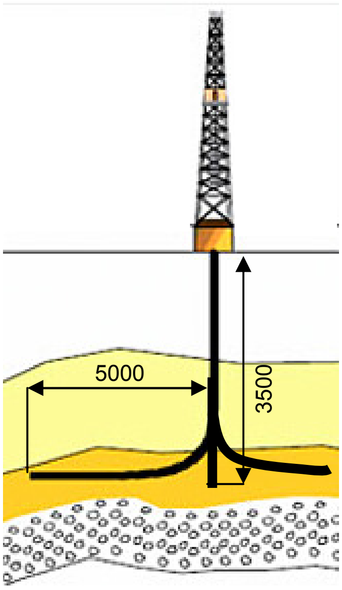
Mob/Demob $ 1,152,000

Engineering $ 2,035,840

Total D &C Estimate = $ 103,827,840

During the estimate review a huge error was discovered in the Drilling Cost.

What should be the correct Total of the Drilling & Completions Estimate ?



8.3 WELLHEAD PLATFORM ESTIMATE

WorleyParsons is preparing a Estimate for the fabrication and installation (towed and set in place) of a 4 Leg Wellhead Platform supported by a 4 Leg Jacket.

The Topsides consist of two levels; a Cellar Deck and a Production Deck to support production equipment.

Deck dimensions are approximately 12 x 10 Meters

Jacket dimensions are approximately 30 x 20 Meters

Jacket Legs will contain pre-installed risers with horizontal flanges for connection to subsea pipelines.

Four conductor slots will be located at the north centre of the platform. Initially three conductors shall be driven.

Support piles at each leg (20 meters through muck to firm soil).

The estimate was prepared based on the following assumptions:

- Structural Steel weight of platform = 1060 MT (Piles, Jacket, Topsides).
- Structural Steel fabrication cost of $ 5,500 per MT.
- Equipment material cost of $ 12,500,000 (25 pieces of equipment).
- An Equipment Factor of 2.8 to cover for equipment installation, and material installation for associated piping, electrical, instrumentation, painting, insulation and architectural (at fabrication shop)
- Derrick Vessel (and associated tugs, support/service vessels, remote operating vessels and other equipment) for placement of the Wellhead platform for duration of 12 days @ Operating rate of $ 350,000 per Day.
- Mobilization/Demobilization for Derrick Vessel Package of 12 days for loading of supplies/materials, transport to installation site, demobilization to point of origin @ rate of $ 225,000 per Day.
- Cable Installation for control/power cables from Onshore Facility @ $ 350,000 per km (Material and Labor). Distance 2.1 km.
- Construction Management cost at 12% of Direct Field Costs.
- Engineering Costs at 20% of Total Field Costs.
- Allow 15% Contingency
- Disregard Escalation

What's the total Wellhead Platform Estimate?