

Cost Management of Engineering Projects



Best Practice Guideline

Cost Management of Engineering Projects

ISBN 1 873844 689

Chris Fox

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A catalogue record for this book is available from the British Library.

ISBN 1 873844 689

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Printed and bound in Great Britain.

Foreword

Construction of engineering projects, covering the process industries, infrastructure and building is Europe's largest industry (based upon employment) with an annual turnover in excess of €1,000 billion per annum. For as long as records have existed there has been evidence that effective management of the cost of such project has been a considerable challenge which in some cases, including a number of large, high profile projects, has not been successfully met. The many aspects of current global business environment have conspired to make the challenge of effective cost management even more demanding.

The document is based on the tenet that cost management is not only about containing costs within an authorised budget (though this is undoubtedly very important), but also ensuring the delivery of value in fulfilling the project's objectives and deliverables. Furthermore it aims to highlight the importance of work and studies carried out during the project development (pre final authorisation) phase in achieving a successful outcome.

The principle target audience for the document consists of the Project Managers and their teams, Client's business managers responsible for sponsoring and financing these construction projects and the contractors and consultants responsible for the detailed management of their execution. Only with a sound understanding and proactive support and involvement from these groups is it possible to achieve truly effective cost management. The involvement of the Project Manager and his team should be significant and on a continual basis throughout the project.

One of the key aims of the document is to demonstrate that the professional cost managers, estimators and quantity surveyors typically employed to record and manage budgets and costs, no matter how competent they are individually, working in isolation cannot be truly effective in managing the cost of complex engineering construction projects. So whilst the document is not aimed directly at these specialists it is hoped that it will be of interest to them and engender the necessary interactions with the other parties engaged in the overall development and implementation of construction projects.

Chris Fox
November 2008

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0. Key Points

Following is a summary of key points which should always be recognised and addressed when planning and carrying out Cost Management of Projects.

- The objective of Project Cost Management is to ensure that the cost aspects of the project are delivered. However this must be achieved within the overall project objectives, in particular the (usual) need to maximise value for the client's business.
- Most of the key decisions which will influence the cost outcome of a project will be made in the project development and definition phase. Hence effective decision making and cost management in this phase is vital. Work during project development to adequately define the scope and specification of a project and to identify the optimal project strategy strongly influences the subsequent ability to effectively manage costs during implementation.
- More money is wasted by businesses as a result of carrying out unnecessary, sub-optimal projects or from projects abandoned incomplete, than is due to poor cost management of the chosen project. Hence it is of great importance that in the development stage appropriate critical assessments are made to ensure that the optimal solution to the business needs is selected. This may not be the lowest capital cost option.
- The consequences of a project cost (budget) being announced as an unrealistically low figure due to either estimates based on ill defined preliminary scopes and / or political desire to indicate an "acceptable" cost are likely to severely compromise the subsequent ability to effectively manage costs.
- Estimates (and their related budgets) are based upon an assumed project schedule. Any significant change to the schedule may compromise the validity of the estimate / budget.
- It is foolish to ask a party to bear a cost risk where that party has minimal capability of managing the risk. It will by one means or another most probably lead to additional cost to the project. Risks should be managed by the party best able to manage and/or bear that risk.
- Clarity as to the scope of work covered by an estimate or budget is a key issue. (including identifying what is not covered by the scope).
- Effective project cost management requires the active involvement of the whole project management team with support from client and main contractor senior management. It is impossible for a cost engineer working in isolation to be truly effective.
- A properly detailed budget and a timely and reliable supply of detailed cost data are vital information to facilitate cost management.
- Changes to the scope and specification of a project during project implementation can be very expensive. Therefore a major effort to minimise and to manage such changes must be a key element of cost management.

1. Introduction

The management of cost is a key element of the overall management of (almost) any project which is to be developed and implemented for an organisation, whether it is government, a commercial organisation, a non-profit organisation or even on behalf of a private individual. Cost management should feature in the whole span of a project from the initial concept, through development and implementation to final financial closure.

The core content of this document addresses the range of tasks and requirements for project cost management together with a number of suggestions aimed at enhancing performance and outcomes.

The effectiveness of cost management is likely to influence significantly the economics of a project and is therefore important to overall business performance. This is pertinent not only to the project client, but will in most cases also apply to all the other main parties financially involved in the project, though the drivers and impact for each party may well be different. (Note – The principal focus of this document is on the cost management of the project itself)

There is a massive difference between passive cost recording and truly pro-active cost management. Cost recording on its own, no matter how well done and presented will have only a minimal impact upon the outcome of a project or contract. Nonetheless detailed, accurate and up-to-date cost recording is an essential requirement for effective cost management. Effective, pro-active cost management will however, require much more, not least sufficient, experienced and skilled personnel within the project management team with direct leadership and empowerment from the overall project manager.

The objective of Cost Management for the client should be to control costs and maximise value for the business and must therefore not be confined to controlling the main project (capital) budget, but should address all budgets related to the project and also the projected impacts upon overall business performance.

For a contractor, in addition to his obligations to the overall project, managing his contract budget will be a primary task. Additionally overall impact upon his business must also be accounted for. The scope of this document will focus upon cost management by contractors in the context of its contribution to overall project cost management.

2. Purpose of Project Cost Management

The purpose of cost management is to provide the parties concerned with a most favourable financial outcome to the project (project contract for contractors and consultants). This will be measured in terms of:

- Identifying “best value” project option selection and developing realistic budgets
- Ensuring that project budget(s) are, so far as possible, met
- Providing early warning of any potential any significant deviations from budget and implementation of corrective actions
- Managing cost risks
- Financial management of contracts
- Generating the optimal business return for the client and contractors

The principal issues within cost management will depend upon the phase of the project and the objectives of the parties for whom the cost management is being carried out. It is inevitable that cost management will be being undertaken by the client (or PMC contractor / consultant on behalf of the client), the managing contractor (where one is engaged) and every other contractor working on the project. Each will be doing this for somewhat different (though inter-related) reasons and the much of the data will be required to be shared. Where a managing contractor is employed (and depending on the type of contract), he may well have a significant role in managing the overall project budget on behalf of the client.

Client

- In the development phase a client is aiming to optimise the overall value of the project, though in some cases this may be constrained by an overall limit on capital available and /or cash flow constraints.
- Control the cost of project development work, though this should not be at the expense of sufficient quality of project optimisation and definition.
- During the implementation phase the client’s primary aim will be:
 - To minimise project cost whilst ensuring fulfilment of the project objectives and deliverables
 - To ensure he has a current and realistic projection of cash flow and final costs
- Client must carry out detailed cost management for both the overall project and for the many individual contracts within the project (However in some cases he may delegate major elements of this work to others. See below)
- Client must maintain overview control of overall project cost management
- Where multiple clients are involved, there may be an additional requirement for allocation of cost elements to each of the clients

Note some of the above tasks may be carried out by a managing contractor, PMC or consultant acting on behalf of the client.

Engineering Contractor (or consultant) supporting Client in Development Phase

- To manage own costs versus budget. In many cases this budget will have been agreed with the client.
- To act on behalf of the client in estimating, cost reporting and management of work he is carrying out.
- To manage the cost of any specialist contractors utilised in this phase
- Supporting the client assessing options for the proposed project to achieve optimal value.

Engineering (Managing) Contractor carrying out EPCM role for project implementation

- To manage own costs versus budget and his contact with the client.
- To provide effective overall cost management of the scope under his control. This will include keeping the client apprised and involving client in management decisions where appropriate. In many cases the EPCM contractor's role will be the prominent element of overall project cost management.
- If financial incentive schemes operate, he will be required to maintain data to allow assessment of payments due. Such schemes may apply to various contracts within the project.

Contractor / Consultant acting as PMC for Client

- To manage own costs versus budget and his contact with the client.
- Takes on the role of the client for all (or nearly all) aspects of the management of the project during implementation. This will usually include overall project cost management.

Material Suppliers

- To advise cost of materials to be supplied and any foreseen changes in those costs.

Construction / Service Contractors

- To manage own costs versus budget and to submit claims for payments
- Required per terms of contract to provide cost data to the client and others who are managing overall project costs. This should include both current costs and projections of final costs.
- Participates as appropriate in measures aimed at controlling costs

External Finance Provider

- To ensure that the funds he provided are used properly for the purpose the were provided, including any specific restrictions (particularly for government grants)
- To be satisfied that the project is economically robust and therefore does not put repayment of loans at risk.
- To be satisfied that there is sufficient financial control of the project.
- Note it is often the case that external financing is only released upon demonstration of achievement of specified milestones.

3. Core Project Cost Management Issues

Click on topics to access checklists and guidance on each subject

3.1. Project Concept & Feasibility →→→→→

1. Identification of Objectives and Deliverables
2. Project Options and Preliminary Estimates
3. Cost Risks associated with Project Options
4. Economic Evaluation of Options

3.2. Project Development & Definition →→→→→

1. Funding of Development & Definition
2. Study Estimates
3. Cost Management of Development & Definition
4. Cost Risk Management
5. Economic Evaluation of Proposed Project
6. Project Implementation Strategy
(Cost Management and Contracting Strategy)
7. Conditions of Contract
8. Value Engineering Studies
9. Identify funding sources and availability
10. Project definitive budget estimate

3.3. Project Implementations →→→→→

1. Set up Project Cost Management Systems
(Project Accounts, Cost Management & Change Management systems)
2. Contract Tender Evaluation
3. Ongoing Cost Risk Management
4. Scope / Implementation Changes
5. Change Order Management
6. Claims Management
7. Comparison of Cost versus Physical Progress
8. Review Estimates
9. Scope adjustment to contain Costs
10. Cost Management of Precommissioning Works
11. Insurance and Liability
12. Force Majeure

3.4. Project Commissioning & Financial Close out

1. Cost Management of Commissioning Works and other outstanding works
2. Management of outstanding accounts and claims
3. Financial Close out and final reporting

3.1 Project Concept & Feasibility

- 3.1.1 Identification of Objectives and Deliverables
- 3.1.2 Project Options and Preliminary Estimates
- 3.1.3 Cost Risks associated with Project Options
- 3.1.4 Economic Evaluation of Options

Checklist and Guidance Notes

3.1.1 Identification of Objectives and Deliverables

Identify and define the key objectives and deliverables for the proposal **i.e. those which are vital**

Guidance

- It is essential that this exercise is carried out as soon as practicable following the basic identification of the business need.
- It is essential that this exercise is carried out with involvement of the key stakeholders. This should always include those who will finally authorise the expenditure and those who will operate / occupy the completed facility.
- Objectives and deliverables should be challenged to confirm their vital need. This may well require development of an initial financial assessment of business justification and how this would be influenced by differing levels of objectives attainment.
- Financial data (capital costs and business returns) at this stage is likely to be (very) inaccurate. Assessments must recognise this limitation
- Cost is always important, but for every project the importance relative to other key objectives should be addressed. If unavoidable, will additional expenditure to fully achieve all objectives override the desire for low cost? Gain management agreement to the answers to these questions.
- Project Cost Management will be a required deliverable for the Project Management Team. Specific requirements for the whole project should be identified during project development.

Identify the preferred time frame for delivery and how time sensitive the proposal is. Check credibility

Guidance

- Project timeframe is likely to have a significant impact upon capital cost and (usually to a lesser extent) subsequent return on investment. In many cases initially proposed timeframe though technically feasible is very optimistic and not truly credible due to the many constraints and delays in developments which (very) commonly occur. Changes in timeframe can be a cause of major cost growth between original concept and eventual outcome.
- The time required for project development and definition is often very much longer than initial proposal. This is due to many constraints including resources, funding for development, regulatory issues and others. These

should be critically addressed when determining the proposed overall project timeframe.

- Typically the cost of project development phase is closely linked to duration. Hence significant extension of this phase will result in higher costs, both for development itself and subsequent escalation of project implementation cost due to escalation and in some cases a desire to recover “lost time”.
- Reduced development work to save time and/or cost is however usually counter-productive as inadequate definition is a major cause of project cost overrun.
- If the project is required to be completed in a challenging time frame then the cost risk of such a strategy must be addressed and the risk accepted by those responsible for project budget authorisation.

Identify other objectives and deliverables which are highly desirable

Guidance

- When identifying objectives and deliverables it is important to segregate those which are vital from others which are merely desirable. However in the latter category there may well be items which can deliver real benefit to the client and therefore should not simply be discarded. They should be considered when evaluating the options for addressing the overall business need. However it is important to recognise their status (as not vital) and ensure that they do not unduly compromise the project selection process.
- For each item there should be clarity as to why it is desirable and, if possible, quantification of the reasons for the desirability. What is the value of the item, preferably expressed in financial terms?
- If possible determine the value of these highly desirable (additional) objectives / deliverables.
- Determine whether or not these items could be achieved separately from the project being contemplated. i.e. is the project the only opportunity to achieve them or could they be achieved separately?

Checklist and Guidance Notes

3.1.2 Project Options and Preliminary Estimates

Identify all the credible options and develop a rough implementation cost for each

Guidance

- Develop a list of all the credible options which will fulfil the essential objectives and deliverables. Failure to do this leaves a major vulnerability that a less than optimal solution will be adopted to meet the business need. Preparation of this listing should involve all key stakeholders and possibly the use of an external party with relevant expertise (e.g. Consultant) to ensure that all attractive possibilities are considered.
- Include the following options:
 - Do nothing option (unless totally unacceptable)
 - Options to solve the need by means other than capital expenditure (e.g. changed operating processes, contracting out)
 - Options which mostly but not fully meet objectives and deliverables. Identify (and if possible quantify deficiencies, e.g. needs a longer timeframe to implement)
- Identify for each option additional features which represent desirable objectives / deliverables. Also identify any critical deficiencies of each option.

Preliminary Estimates for options are to allow comparative evaluation (they are unlikely to be suitable for project financial authorisation)

See section 4 for further details

Guidance

- Aim to assess the quality of information available to produce the estimates. In particular try to identify areas which are, at this stage substantially undefined. See also Appendix C – Estimate Scope.
- Initial estimates are unlikely (unless based upon actual cost of recently completed very similar works) to be highly accurate. At best $\pm 30\%$, and more often in the area of $\pm 50\%$. It is very common that these initial estimates are a significant underestimate of the final outcome. This limitation must be recognised when assessing options. It may be appropriate to state an indicative cost range rather than a single figure. (Note HM Treasury advise that “Optimism Bias” at this stage leads, on average, +50% increase in eventual outcome cost for UK public sector construction projects).
- Identify any significant difference in quality (accuracy) between the various options. Recognise this in financial evaluations and comparisons.

Recognise the limitations of early estimates

Guidance

- Early estimates are almost always of very limited accuracy. i.e. the range of possible outcomes is large. See comments above.
- Clearly state the cost levels on which the estimates are based, e.g. Current costs, basis of provision for future escalation, currency exchange rates, vulnerability to commodity price changes, schedule assumptions etc.
- Ensure that any economic evaluations and funding requirements take account of this uncertainty.
- Ensure that the client's senior business management (and any others who will provide funding) fully understand the limitations and potential for cost growth.
- If the estimate is based on actual cost of a previous (similar scope and specification) project, identify the basis of how the estimate has been derived and how differences have been accounted for, e.g. different location, time (escalation), scope differences etc. Note – the older the costs related to the previous project are, the greater the risk of using them as a basis for the now proposed project. Typically if more than 5yr old then need for adjustments and risks associated with use are likely to be high.
- It may be helpful to provide a cost range as the output from early estimates rather than a single figure. This would highlight both the overall uncertainty of costs at this stage and also identify any (significant) differences in the confidence level of costs for different options, e.g. provide figures for both 50% confidence and 90% confidence. (50% chance of being exceeded and 10% chance of being exceeded respectively).

Identify an absolute maximum cost

Guidance

- Many project proposals can only proceed if the cost will be less than a certain figure. This may be due either to the projected economic return from the investment or from a limitation of the client's ability or willingness to provide funding. This limit needs to be identified as early as possible in order to avoid work on proposals which will subsequently be excluded.
- If for any proposal the preliminary indicated cost is approaching (say within 20%) the identified cost limit, then it should be critically reviewed before proceeding further. In particular assess
 - The potential for project cost growth, which is a very common occurrence during project development
 - The robustness of the projected return on investment (i.e. check probability of a less favourable return)

Project Development Cost Estimates

See also section 3.2.1. and section 4

Guidance

- As part of initial studies and estimates there will be a requirement to identify the funding required to allow for the further development of the project up to the point of full authorisation.
- Recognise that to provide this estimate, it will be necessary to define (at least in outline) the strategy for the development works, the quantity of resources needed and the expected time required. Almost inevitably at this early stage any such estimate of requirements will be very approximate and hence other than for small projects it is usual to include in the strategy to provide for at least one further review (stage gate) part way along the development process where the project finances are again reviewed and if necessary adjusted. This will usually include review of requirements for the completion of development works.
- Where it is intended to utilise consultants and/or contractor to support development works ensure that firm quotations (at least for unit rates) are obtained. Agree with consultant / contractor re foreseen resources needed for his work (services) and the probable range of potential cost. Where practicable include some incentive scheme to control contractor costs within reimbursable type contracts.

Checklist and Guidance Notes

3.1.3 Cost Risks associated with Project Options

The great majority of risks related to the implementation of any project carry an associated cost risk. Hence risk management is a key input to cost management.

Identify the risks associated with each option

Guidance

- These can normally be sub-divided into two categories Project Risks and Business Risks and most of these risks will have a cost or difference in projected income associated with them. At this early stage it is only practicable to identify “major” risks. (Those with a reasonable probability of occurring and a significant impact if they do occur).
- Seek to identify any political, social and economic risks. If possible identify the possible cost associated with these risks and where appropriate identify any significant differences between the different options being considered.
- In particular it is important to identify those risks which are significantly different from one option to another in order to assist in project option selection.
- For business risks (other than for HSE driven projects) it is always important to assess the robustness of the projected business return. What is the risk that the products or services provided by the project will not yield the income stream projected? The possible spread of outcomes should be critically assessed and a probability chart produced. Of course any such chart of outcomes is only as good as the input data it is based upon, no matter how sophisticated the

(computer based) analysis is, so it is vital that every practical step is taken to ensure realistic (rather than optimistic) input data is used.

- For project risks, the most common risk at this stage is project schedule and this should always be assessed for its cost impact both on the project itself and upon the following return on the investment.
- The risks of the “Do nothing” option should always be assessed. “Do Nothing” is very often an option which should be considered as it sets a benchmark against which other options can sensibly be compared. The option does however usually have risks attached which could in some cases be severe so this option needs to be addressed exactly as for any other option.

Estimate Risks

Guidance

See section 3.2.2 and section 4

Quantify the risks

Guidance

- Identification of risks (per the above) is only the first step and in order to be useful information it is necessary to quantify the risk. This means identifying both the probability of the event occurring and the consequences of that occurrence. Also any linkage to other risks should be identified; i.e. is the probability of occurrence of the second risk made more or less likely as a result of the first risk occurring.
- In some cases quantification of risk can be done by reference to existing data from other projects and from other business information. However in many cases no such relevant information is available and it is necessary to depend upon the judgement of experienced staff. Just who has the relevant expertise and experience will depend upon the nature of the risk. For many project risks Engineering Contractors may be in a better position to assess than is a Client, whereas for general business risk to the client it must be the client himself who assesses the risk, though this may well require input from outside the project development team. In any event it is almost always valuable to obtain multiple opinions for quantification of risks in order to mitigate the bias of any individual.
- For some risks the probability of occurrence and impact cannot be assessed simply as single percentage with single consequence, but need to be addressed as a range of possible probabilities and consequences, e.g. if new technology is to be utilised as a part of a project then there may be a range of risks of it not functioning as intended This could range from requiring minor (simple to implement) modifications to a major revision / replacement and could have consequences ranging from minor additional cost with limited impact upon use of the project through to major additional project cost and major disruption of the income stream. The probabilities of occurrence are likely to be very different for the two scenarios.

Manage the risks

Guidance

- Risk management (mitigation or elimination if practicable) is a key element of project management and this of course includes cost management. Hence the cost management team will be a core part of the overall management of risk.
- Clearly if a risk for a given project option can be significantly mitigated then it can change the overall perception of the attractiveness of the given option.
- Some purely financial risks, such as those related to foreign currency exposure or commodity price volatility can be addressed by forward purchasing of options through the financial markets, usually for a relatively modest cost.
- Another option is to ask a supplier or sub-contractor to take on the risk. This strategy is however not really mitigation, but transferring of risk, which in itself may be costly if the party bearing the risk has no ability to mitigate that risk other than charging a risk premium. In this case the risk has been eliminated by the client, but in exchange for a definitive additional cost.
- Many risks are not fundamentally a cost risk, but will have a cost risk impact. In particular any schedule risk will (almost always) have an associated cost risk.

Checklist and Guidance Notes

3.1.4 Economic Evaluation of Options

- Inevitably at the early stages of project development the information available related to the following points is likely to be rather broad brush. This is usually acceptable as the initial objective is only to determine the relative merits of each option. A more detailed economic evaluation will be carried out later for the proposed project option. (See 3.2.5 below)

Identify the Value streams delivered by each option. Return on Investment and other (not directly financial) values

Guidance

- Long-term projections for product selling prices or other income streams and for feedstock, utilities and other costs have significant potential for error. Company marketing departments tend to be over-confident in predicting future market demand and selling margins. It is therefore vital that those techniques adopted for economic appraisal include scenarios less favourable than the base case. Which less favourable scenarios are considered needs to be carefully considered by the owner's business management; they should reflect credible cases rather than doomsday scenarios, but care should be taken to identify those which are likely to occur concurrently, for example plant under-loaded coupled with weak market price.
- In the early stages of project development, estimates are likely to have large margins of error. Therefore, it is sensible to test economics against significant deviations from the base line figures. This is not the same issue as the less favourable scenarios referred to above, though in practice they may well yield similar results. For an estimate which is 'order of magnitude' only, the owner

should require the project to remain robust using at least a +30% cost figure. If the project fails such a hurdle, it should be further critically appraised.

- Values which are not financial may often need to be considered as well as direct Returns on Investment, e.g. Health, safety, environment benefits, e.g. for a new road project the benefit of reduced congestion would be the significant value. For a school its ability to serve the community outside school hours could be significant. Sometimes (but not always) these can be converted into quasi financial returns which helps in a numeric (financial) based assessment.
- Each option should show projected cash flow for the investment and subsequent related income streams. Where non-financial elements are significant, it may be valuable to show both the “pure” financial return and also the total “quasi” financial return.
- Consideration of the “do nothing” option should normally be included as it serves as a useful baseline, and in some cases analysis may prove to demonstrate that this option should be chosen. There are cases of course where doing nothing is totally unacceptable as it would result in major impairment of the business, e.g. compliance with a regulatory obligation.

Identification of key financial constraints for each option

Guidance

- Are there specific financial constraints which may influence selection e.g.
 - An absolute limit on capital available
 - Restriction on timing of cash availability
 - Conditions imposed on availability of government grants.
 - Taxation implications

Compare the merits and demerits of the options

Guidance

- In most cases there will be multiple merits and demerits of the various options, and (unless one option clearly stands well clear of all others) it will be necessary to quantify the relative importance of each. This should be done with involvement of all key stakeholders.
- Are there any killer issues, e.g. an option with the best Roil, but which will not meet (near) future environmental regulations may be unacceptable.
- Return on Investment (RoI) is usually a key consideration. But there also is a need to address whether the different options have significant differences on the probability profile for range of RoI outcomes.
- What are the significant cost risks and RoI risks associated with each option? This may be a key issue in determining which option is selected. See 3.1.3 above

Option Selection (Elimination of Options)

Guidance

- One of the key tasks in the early stages of project development is to carry out evaluation of options for the proposed project. Whilst it is usually valid to initially identify every credible option, it is easy to allow this review of options to consume excessive time and resource with requests for ever more detail with resultant delay to overall progress and additional cost. Hence one of the most valuable cost management (and indeed overall project management) duties at this stage is to reduce the number of options being considered as quickly as is practicable. For each remaining option:
 - Is the option truly credible? i.e. will it work and does it meet all the key objectives?
 - Is there one option which is very obviously much better than the others for sound objective reasons?
 - Does an option have serious risks attached? If so is there a credible means of mitigation? If not it probably should be discarded
 - Is there concurrence within the client senior management team? If not what identify the dissenting issues and clear them as rapidly as practicable
- A balance must be struck between carrying out sufficient work to positively identify the preferred option and get client management support for it, and the real risk of carrying out too much work on options which will subsequently be discarded. Regular interface with client senior management is very important.
- Selection of preferred option may also need to involve other key stakeholders, in which case regular interface with them is also necessary, e.g. joint venture partners, regulatory authorities, local and national government, external financiers and even in some cases key suppliers if the proposed equipment is new / developing technology.
- When options are discarded, a written note explaining the reasoning should be placed on project development files and strenuous efforts not to reopen consideration should be made.

3.2 Project Development & Definition

- 3.2.1 Funding of Development and Definition
- 3.2.2 Study Estimates
- 3.2.3 Cost Management of Development & Definition
- 3.2.4 Cost Risk Management
- 3.2.5 Economic Evaluation of Proposed Project
- 3.2.6 Project Implementation Strategy (Cost Management and Contracting Strategy)
- 3.2.7 Conditions of Contracts
- 3.2.8 Value Engineering Studies
- 3.2.9 Identify project funding sources and availability
- 3.2.10 Project Definitive Budget Estimate

Checklist and Guidance Notes

3.2.1 Funding of Development and Definition

What funding is required for development and definition and when

Guidance

- At the outset, when it is likely that the proposed solution (project option) to the business requirement is not clear, it is also probable that the nature, extent and timeframe of project development are unclear. Hence at this stage it makes no sense to make any firm commitment as to cost of development. However it is reasonable to:
 - Identify the expected work required and who will do it to address the initial identification and evaluation of options, and how much it is likely to cost. (order of magnitude)
 - If a consultant is to be engaged at this early stage, he needs to be identified and contacted in order to confirm the outline scope for work and associated cost
 - Identify which budget(s) will bear these costs
 - Authorised and set up a project specific budget. This needs then to be set up in the appropriate accounting systems. Initial authorisation may be for a relatively limited amount to cover only those preliminary studies needed to better identify the scope (and potential cost) of the overall project development works
- For the main part of project development and definition the cost for larger projects may well be significant (though usually still less than 10% of total project spend) so the owner will certainly wish to have adequate control of costs. Before proceeding it is usually necessary to provide:
 - Identification of proposed project (outline scope and schedule) for implementation, together with anticipated cost (likely to be only Order of Magnitude at this stage) and associated economic or other justification
 - Identification of key cost risks
 - Identification of cost of development and how firm that cost is.

- Identification of any other costs likely to be incurred during the development phase.
- A statement of “cash flow” expectations for development.
- As a general rule there is significant benefit to the expenditure of the necessary money in the development phase in order to optimise the project scope and achieve a better quality of project definition. Better quality definition results in fewer changes during project implementation, with consequent improvement in project cost certainty and lower absolute cost many times any additional expenditure incurred in development.

Stage Gate Approvals

Guidance

- Stage Gates provide the client with formal opportunities to review whether the proposal is continuing to meet the client’s key objectives. Does the proposal remain compatible with overall business plans and can it be financed. The outcome of a stage gate review may confirm the current development programme and release the next tranche of funding, may require revision to the scope, timing or other aspects, or may indeed conclude that the proposal is no longer viable and should be cancelled or postponed.
- For many larger and complex projects it is often unclear at the outset of development as to the eventual scope and cost of that work. Additionally it is usual that the project has been selected based upon preliminary economic and cost data. For this reason many clients are (rightly) not willing to simply allow development to proceed from start to finish without review and controls during this phase. Typically a number of specific reviews and approvals are imposed; these are commonly known as Stage Gates.
- The number of Stage Gates required will depend upon the Client and upon the nature and scale of the project. Stage Gates may be required at specific time intervals, but more commonly at specific points of delivery within the project development and definition works. Ideally the number and requirements for the Stage Gates should be agreed early in the development phase.
- From a Cost Control aspect, a Stage Gate will normally require:
 - Statement of expenditure and commitments to date
 - Updated estimate of overall project cost
 - Updated assessment of project economics
 - Updated estimate of cost for remaining development and definition works
 - Statement and request for Authorisation of funding required to support works up to next Stage Gate
 - Identification of funding for any other cost which must be incurred within the development phase (e.g. licences, regulatory fees, advance implementation works)
 - The required quality of financial data should be agreed at the start of the works which lead up to each Stage Gate

Are any monies required for advanced implementation works

Guidance

- On many projects there is a desire to expedite project completion in order to achieve early gain of the benefits from the completed project. One important measure which can contribute to schedule reduction is to identify specific works which are part of project implementation but which can sensibly be commenced (and in some cases completed) within the latter stages of project development and definition. Typical examples are:
 - Land purchase
 - Site Preparation works including necessary demolitions
 - Commencement of elements of detailed design
 - Ordering of long lead materials and equipment
 - Tendering for contracts for implementation works
- The cost of these works may be significant and there exists the risk that the money may be wasted in the event that the project is not eventually authorised to proceed. The client will wish to be provided with the following information and assurance in order to mitigate the risks and understand the merits of allowing such advanced works. The information required will typically include:
 - A good quality cost estimate for the cost of the works which are proposed.
 - Advice as to how the cost of the works will be controlled
 - Will these works (or purchases) provide long term value to the client, even if project does not proceed? (e.g. land purchase may well have strategic value)
 - Provision of clauses to allow termination of the works if necessary without any punitive cancellation charges
 - For any detailed design work, does this in effect commit to use of a given contractor for the whole design. If so has the quality and competitiveness of the contract been adequately assessed in the context of the whole of the proposed designed work

How will funding be provided

Guidance

- It is necessary to identify which budgets will provide funding, and how monies from these budgets will be made available.
- Often early feasibility work (especially if by the clients own staff) is carried out against the normal business operating budgets. i.e. individuals are funded from departmental operating budgets.
- Another possibility is to utilise a general project development budget, if such a thing exists.
- For later stages of development, where the money amounts are usually much greater, it is likely that a discrete budget (or several) will need to be set up and authorised. Typically expenditure against such a budget will eventually be charged against the overall project budget if the project proceeds. It should be clarified as to how this budget will be handled in the event that the project does not proceed.

- Clarity should be obtained in respect of those individuals outside the core project development team who provide some input to the development process as and when required. Is their time to be charged to the project development budget or not?
- It is unlikely that any external funding will be available during the project development phase. Hence even where it is intended that external financing will be used for the project it is likely that the client will initially have to find the funds for development.

Checklist and Guidance Notes

3.2.2 Study Estimates

See also section 4.

Estimate Requirements

Guidance

- As an early activity in the development of a project proposal a listing of the estimates likely to be needed during the project development phase should be made. This should identify:
 - The purpose of the estimate
 - The foreseen timing within overall development
 - The desired quality
 - Resources required to allow its preparation
- Estimates of anticipated total project cost will be required to allow progressively better assessment of the viability of the project, leading eventually to the estimate required to support project full authorisation. The timing of such estimates is usually to provide data for a Stage Gate review. Study estimates for large projects can involve considerable work and this must be considered when demanding high quality (accuracy) levels.
- Estimates will also be required to support requests for funding of the next stage of development works. If the funding required is significant, the estimate quality required may result in a fairly significant work requirement to prepare the estimate. Nonetheless it is inherent in development work that the exact scope of the work needed to complete development cannot be precisely determined, hence there will (almost) always be a need to include a provision for additional work beyond that which is firmly identified.
- If an estimate is required to identify the budget required for any implementation works to be carried out prior to full project authorisation then the basis of such an estimate must be agreed between the project manager and the funding provider (client).support authorisation of funding.
 - Must the estimate include for the cost of the whole of the work elements foreseen, or only that part which is anticipated to be completed prior to full authorisation?
 - What accuracy level is required?
 - What provision for cancellation costs should be included?
 - What contingencies should be provided

Resources for Estimates

Guidance

- The preparation of good quality estimates for all but the simplest of projects requires staff with specific skills and experience. In many cases clients do not have this resource, especially to meet the requirements for large and complex projects, in which case they should hire the services of consultant or contractor with those skills. In many cases the estimating work will simply be a part of a wider remit of support being provided; and indeed this is the preferred situation as the estimator will always require provision substantial information from others about many aspects of the proposed project.
- As indicated above an estimator, no matter how skilled and experienced requires a large amount of input information to allow him to be able to prepare an estimate. This will come from the client, engineers, designers, schedulers and the project management to give advice on project requirements and strategies. Hence the preparation of estimates will certainly require involvement of the whole project team and likely also specific inputs from others outside the project team.
- The resource requirement for the preparation of estimates is often not adequately recognised with the consequent outcome that estimates are often of lesser quality (accuracy) than advertised and / or they are delivered late.

Estimate Risks

Guidance

1. By definition any estimate carries with it a cost risk. i.e. the uncertainty regarding the accuracy of the estimate. Typically the earlier in the development of a project the less accurate and complete is the information available for the estimate and hence the lower the accuracy.
2. Typically estimates are less accurate than they claim to be. i.e. the risk of deviations of actual cost from the estimate is greater.
3. Estimates accuracy (and hence risk) can usefully be subdivided into elements,
4. The accuracy and completeness of the scope of work and its associated technical specifications.
 - The accuracy of cost data which will be used to price the scope.
 - Any specific elements which may have an abnormal influence on the accuracy. (e.g. a specific uncertainty such as cost of land purchase or currency exchange rates where these would have a significant impact on overall cost)
 - An estimate is usually only valid for the project schedule against which the estimate has been made
 - Escalation of costs from current values. This potentially has two aspects; the rate at which cost levels may change and the uncertainty as to the project schedule.
5. Where estimates for different options are being compared ensure that a review of the comparative accuracy of the different estimates is included. This is a cost risk issue and should be a relevant point when assessing relative merits of options.

Price Escalation

Guidance

See also section 4.10

6. Unit costs increase over time for (almost) all elements of engineering projects. A provision for escalation must therefore be made for this within the core budget for a project. It may also be appropriate to consider the possibility of higher than forecast escalation when considering contingency levels.
7. Assessment of likely escalation must be based on forecasts for the specific types of costs which will be incurred by the project (e.g. design & engineering staff, construction labour, bulk materials, manufactured items) rather than the general inflation index for the country concerned. In recent years throughout most of the world escalation of project / construction costs has been significantly higher (2-3 times) than the general all inclusive prices index.
8. For study estimates it is also useful to give a general indication of the additional escalation which may be expected as a result of delay to the project implementation schedule beyond that which the estimate is presently based.
9. Ensure that pure price escalation is segregated from increased costs due to changes (including better definition) to scope / specification of the project.

Checklist and Guidance Notes

3.2.3 Cost Management of Development & Definition

See also section 3.2.1

Identify the required cost information deliverables required in this phase

Guidance

- The following are likely to be required:
 - Recording and reporting of expenditure and commitments made
 - Payment and tracking of invoices
 - Estimates for the development and definition works, for each stage and for the whole of the development
 - Estimates for the whole project including for options still under consideration
 - Estimates for any pre-project authorisation early implementation works
 - Estimate for total project suitable for project authorisation and for project control budget
 - Information arising from tenders received for major elements of the work
- There will be a need to agree the required quality for each of the above. As always there will be a desire for high quality, but this must be tempered by realism as to the availability and quality of input data and the fact that higher quality will require considerably more work to achieve. As a broad guidance a $\pm 20\%$ Estimate will require 4 to 6 times the work compared to a $\pm 30\%$ Estimate. A $\pm 10\%$ Estimate will need 4 to 6 times the work compared to a $\pm 20\%$ Estimate. In practice the $\pm 10\%$ quality level can normally only be achieved by obtaining actual quotes based upon firm specifications for major equipment and main elements of construction which in turn demands the execution of a significant portion of detailed design. (This latter comment may wholly valid if the project contemplated is closely similar to a recently completed project, whereby actual costs can be reused as input to the new estimate)
- It is almost inevitable that the accuracy of cost estimates for development works will be limited by the fact that the exact scope of the work needed to complete development cannot be precisely determined; hence there will (almost) always be a need to include a provision for additional work beyond that which is firmly identified.

Determine what cost data recording system is to be used and set it up

(Don't forget compatibility with the system to be used for project implementation)

Guidance

- The task of cost data recording and tracking in the development phase is typically relatively straightforward as the number of transactions will be relatively low (typically less than 2% of the number during implementation). As a result data can easily be managed on a standard spreadsheet programme such as Excel.
- If a contractor or consultant is used to manage costs in the development and definition phase, they will have their own project cost management programme which will probably be well suited to the task. However there will still be a

requirement to ultimately charge costs to the client's project cost account, though this latter may not need to provide full details for cost management, but simply perform the function of making and recording payments.

- A point to note is that in the development phase a significant portion of the transactions may be the costs of client's own staff, and it is essential that these costs are captured properly. Client staff costs will probably be first charged to a departmental operating budget, so a system of transferring costs will need implemented. Additionally what charge rate will apply must be agreed.
- Whatever systems are used for this development phase it should be remembered that there will be a need to include the data in the systems which will operate for project implementation.

Identify what costs will be charged to the project budgets and get clear agreement re non-charged costs

Guidance

- During project development the client is likely to have staff providing input to the project that remain working in a variety of departments rather than being committed to a dedicated project team. It is essential that there is clarity as to whether or not the time spent by (and other expenses) such persons will be charged to the project account and if so at what rates.
- Early economic feasibility studies whether internal to the client or including the utilisation of a consultant may well have been initiated by an operating department of the client. Again there is a need to clarify whether such costs will be transferred to the project accounts.

Who is responsible for collecting and analysing cost data?

Guidance

- The collection and analysis of cost data in the project development and definition phase is on a much smaller scale (volume and complexity) than is required during project implementation. However it is a task which must be adequately done.
- Often (other than for very large projects) there will not be a dedicated cost engineer at this stage, so cost analysis will usually fall as a responsibility of the project development manager. Note that even where a contractor is used to support the client, his role will often be only to collect, collate and report cost information, but not carry out critical analysis.
- It is of course necessary to control development costs against budget, but it is also necessary to be pragmatic to recognise that inadequate development and definition will probably lead to cost risks in implementation far greater than any saving in the cost of development.

What economic evaluations are required?

Guidance

See also section 3.2.5

- An inherent part of project development is to progressively check that the fundamental objectives of the proposed project remain valid. Typically the main element of this is assessment of the project economics. As development progresses the quality of information usually improves, thereby allowing a greater confidence in the outcome of the assessments. It is of course necessary to ensure that the best possible data for economic return is used and this may well require some detailed work in order to get a better projection of future income streams and future operating costs.
- There is a need to identify who will provide the required economics data and how much work is required to get the information to the preferred quality.
- Timings for economic evaluations should be identified. Typically they are linked to the Stage Gate Reviews.
- Where external financing of the project is involved, it is likely that the financing party will demand to carry out their own economic evaluation (or use an independent party). This will of course require the provision of input data of the appropriate quality.
- Regardless of the effort put in to provide good quality economic data it will inherently have a level of uncertainty, and an assessment of this should be made in order to test worst (credible) scenario.

What project approval stages are foreseen and what data is needed

Guidance

See also section 3.2.1. Stage Gate Approvals

- It is sensible to identify as soon as practicable all the foreseen stages required for approval of the project and what information will be required at each stage. Typically the larger the project the more stages are required and many client organisations have standardised procedures.

Authorities for development expenditure

Guidance

- It is essential that there is clarity as to who has authority to commit for expenditure on project development work and also for any early implementation works to be carried out prior to full project authorisation.
- Authority should be at a sensible level which empowers the development team. Typically authority should be within the team to spend against authorised budgets.
- Stage Gate Reviews will typically be used to release funding for stages in the works. It is important that these do not in themselves result in significant discontinuities in development progress.
- Identification of who can release the next stage of funding (at Stage Gate) should be clarified well in advance of the event.
- There should be clarity as to what process is to be adopted to authorise additional work beyond that identified and budgeted within the current phase if it

becomes necessary. It is important that this process does not unduly delay the development work. This may be subdivided:

- Use of already provided contingencies
- Funding outside of contingencies

Checklist and Guidance Notes

3.2.4 Cost Risk Management

Have cost risks been included in overall risk review

Guidance

- It is normal good practice that the system for project risk management is established during the project development phase and that the first listing of significant risks to the project is prepared. Whilst most of the risks may not be directly cost risks, it is probable that they do have a potential cost impact and therefore need to be considered as cost risks.
- Specific cost risks must of course also be included.
- Business economic risks should be included (i.e. the risks associated with financial return on the project and other impacts on the overall business of the client).

What is clients attitude to significant cost risk items?

Guidance

- Most clients acknowledge that there are cost risks associated with engineering projects and are usually willing to include a (limited and non-specific) contingency within the project budget. However when the cost risks are more significant, and this is far more common than is recognised, there is often considerable reluctance to accept such risks or even acknowledge that they exist.
- It is always helpful if significant cost risks can be individually identified and quantified, as this will be the first step to managing such risks. In particular the client and other parties can then be consulted as to the optimal strategy for management of each risk.
- The management of a cost risk (as for other risk management) should normally be given to that party which is best able to manage / mitigate that risk. In some cases there may simply be a decision accept the risk without any specific action to mitigate or otherwise manage and for risks of low probability this may well be appropriate.
- Risk of currency exchange rates changes is usually better managed by the client. If the client is an international organisation, then he may well be able to offset the risk against other income streams.
- If the client is averse to cost risk, he is likely to want to shift risk to contractors and suppliers. This is reasonable when the work and/or services to be provided are well defined or the client is happy to allow the supplier to define what is supplied against functional requirements. (e.g. electric power turbo generators, where the supplier has all the detailed design, manufacture and installation expertise)

- When work and/or services are only partially defined at the time of order placement then it is usually unrealistic to aim to place responsibility for cost risk on the supplier. In reality the supplier (contractor) will build in a contingency in his prices and make claims for extras where the scope or specification proves to be unclear.

What is philosophy for use of contingency?

Guidance

- The philosophy is likely to be determined both by the client's general attitude and the specific requirements of the project.
- Clearly those projects with greater budget uncertainties, whether from the general level of budget estimate accuracy or from specific significant risks, are likely to require higher provision of contingency.
- A general contingency is normally provided to address the myriad of individually small (in value) uncertainties which will be present within (almost) any budget estimate. A decision must be made as to who has authority to spend this contingency which for most projects will need to be used at least in part. Normally this authority is given in whole or part to the project manager as withholding it will impose an additional bureaucratic burden which in turn could impact on project progress. It may however be appropriate to require the project manager to advise the project owner (and external finance provider if applicable) the status of contingency use.
 - It is important that there is a clear understanding of what a general contingency is intended to provide for (and what it does not provide for). This must be agreed by the project owner. Typically it will provide for:
 - Normal development of the detailed design. (not Scope Changes)
 - Minor changes in unit cost levels
 - Limited changes in quantities of materials.
 - Minor unforeseen costs within the original scope
 - Foreseen general cost escalation over the period of project implementation (Sometimes this is treated as a separate item)
- For individual larger cost risks it may be prudent to provide item specific contingencies. Such contingencies are to provide for a specific identified risk and will only be released in the event that the risk occurs. For such items the value of the contingency provided must be for the whole of the additional cost. There is no point in providing a part cost contingency as if the event occurs (usually) the whole or a major portion of the estimated additional cost will be required, i.e. providing €20,000 for a risk which is estimated to cost up to €100,000 with a 20% probability of occurrence is of little value. Such contingencies normally sit outside the main project budget and are requested to be released to the project manager if and when the event occurs.
- For certain, purely financial risks, the client (budget provider) may choose to take the risk totally outside the project budget. Many international companies may choose to treat currency risk in this manner and amalgamate the project currency risk with its other currency risks within its overall business.
- Commodity price risk has become a significant issue for many projects. Since 2004 the price of many metals has changed in a very volatile manner (mostly

upwards, but not exclusively so). This impacts not only on metallic bulk materials but also to some extent on manufactured goods. Rapidly increasing energy costs add to upward price pressures. Hence it may be appropriate to provide a specific contingency to address this issue if it is not addressed by other means.

Schedule risks

Guidance

- Project schedule risks occur for various reasons and they always impose an associated cost risk. Hence when assessing how to address schedule risks, the cost implications should always form an important part of that assessment.
- Project development timeframe is itself commonly subject to extension, sometimes (especially for very large projects) this extension can be measured in years rather than months and the cost impact upon the proposed project can be of major significance. If the development phase of a project is extended then costs are likely to be affected in several ways:
 - The cost of the development work itself will usually rise due to the longer involvement of key development team members; this is especially true when a contractor / consultant is involved.
 - If development work is stopped and then restarted inefficiencies arise, this is further increased if this involves replacement personnel becoming involved.
 - The timeframe for project implementation will be delayed and hence cost levels will have escalated.
 - There may be pressure to implement the project on a “fast track” basis with the associated cost risks of such an approach (see below).
- When considering the timeframe for project implementation care should be taken to identify as far as is possible, the schedule which would be optimal from a cost management view. However it is necessary to recognise that there may be other good reasons why a different schedule should eventually be adopted, but a comparison of the two will in itself assist in the management of the cost risks arising from whichever schedule is adopted. Considerations should include:
 - Allowing sufficient time for detailed design in order to not require excessive overtime working nor risks associated with excessive overlapping of elements of the design.
 - Ensuring that specifications used for tenders are sufficiently detailed and accurate to enable the provision of firm tenders which will have a low vulnerability for claims for extras.
 - Ensuring that sufficient time is provided to allow suppliers / contractors to provide good quality quotations.
 - Ensuring finalised design details and materials are available at the construction site to facilitate efficient construction work.
 - Ensuring that construction work can proceed in an efficient manner, which requires provision of finalised design data, timely provision of materials.

- Ensuring sufficient time for construction works to avoid the need for excessive overlapping of the phases of construction and/or excessive overtime working. (Note the optimal number of working hours per week on a construction site will be considerably higher where the workforce is expatriate / based in a construction camp rather than a local workforce)
- Recognise that (somewhat in conflict with the above points) that there are project fixed costs (management and provision of construction site facilities) which are largely time related, hence there is an incentive to reduce the duration of the overall implementation phase.
- The adoption of a “Fast-track” project implementation schedule is often requested by the client in order to achieve the earlier start of a return on his investment and in some cases to meet an absolute requirement to his customers and / or regulatory authorities. Quite often this desire arises as a result of the fact that project authorisation has occurred later than originally intended. Whilst fast-track schedules do not necessarily result in higher costs, they do increase the risk of additional cost.

Strategy for risk reviews

Guidance

- The initial review of risks to a project, including cost risks, must be carried out during project development in order that the significant risks are identified and strategies for their management is developed as an integral part of the overall project implementation strategy. See section 3.2.6
- It is inevitable that the risks facing a project will change over time; some will become more important others less so and new risks will arise. It is therefore vital that a regular review is carried out by the project team. At each review the cost risks should be assessed and any significant changes must be reported to the client, together with proposals for management.
- It is vital that for each risk it is identified how the risk will be managed (this may in some cases be “no action”) and who will be primarily responsible for its management. Clearly the party responsible must be selected on the basis of having the capability to do so. It is pointless or even counterproductive to require a party to manage a risk over which he has little or no capability of influencing, e.g. to ask a construction contractor to provide a lump sum price (taking the cost risk of volume and complexity of work) against a poorly defined scope of work will result in him adding a large contingency within his price and /or spending considerable effort at identifying and pursuing claims for extras. He has no ability to influence the volume and complexity of the work and even his ability to work efficiently is compromised if he does not know the true nature of his work.

Impact on Contracting strategy

Guidance

- One of the key considerations of any contracting strategy should be how risks are to be allocated. Different forms of contract result in differing allocation of risks. See section 3.2.6 and Appendix E.

Checklist and Guidance Notes

3.2.5. Economic Evaluation of Proposed Project

Many project proposals are aimed at generating commercial benefit for the business. Commonly, this is to enable manufacture of product(s) on a profitable basis over an extended period. This may be through a new manufacturing plant, upgrading an existing one for improved quality and/or efficiency or the provision of utilities and feedstocks at improved input prices. Occasionally, it may be the manufacture of a product in order to deter a competitor from entering the market or to gain market share. Other proposals may be driven by regulatory requirements or a need to upgrade infrastructure, but even for these an economic appraisal can be made in respect of the implications of not meeting the regulatory requirement or the extent of fulfilment or overall impact upon the business. Some regulatory requirements are absolute obligations but others simply impose cost penalties or incentives dependent on degree of compliance (e.g. Carbon Dioxide emissions).

Guidance

- It is absolutely vital that any project proposal is evaluated to assess the benefits it will generate for the client's business and foremost amongst these is usually the economic benefits. It is therefore very important that the economic assessment represents the best possible forecast of what the outcome will be and this should always include a view of the credible range of outcomes and the probabilities associated with the range.
- Making long term projections carries risk. There is much history of client's sales and marketing departments being overly optimistic in their view of future selling prices and volumes and similarly difficulties in accurately assessing future operating costs of a facility. Hence not only should these be critically reviewed by the client, but it may well be sensible (especially for major investments) to obtain an independent view from a consultant in the industry.
- The project cost estimate used will be subject to a limit on its accuracy. Therefore, it is sensible to test economics against significant deviations from the base line figures. This is not the same issue as the less favourable scenarios referred to above, though in practice they may well yield similar results. For an estimate which is 'order of magnitude' only, the owner should require the project to remain robust using at least a +30% cost figure. If the project fails such a hurdle, it should be further critically appraised and possibly abandoned or substantially revised.
- It is useful for a commercial requirements specification (CRS) to be developed for the proposal and that appraisals are carried out against it. The CRS must of course fully reflect the stated objectives for the proposal, which in turn should have been checked for conformity with overall business objectives and priorities.
- As there are often many parameters interacting with one another the use of computer programmes to develop overall probability curves may be useful. However it must always be recognised that the output is a function of the input data and if this is flawed then the output will also be.
- Due to the process of discounting the value of future income and costs, it is usually the case that the overall economic return is very substantially

determined by the values for the first 10years (15 at the most) even where an asset has a projected life which is much longer. Hence effort in identifying incomes and costs should be strongly focussed on this more limited period. An partial exception may be for certain civil engineering infrastructure projects where the total projected life is very long (>100years)

- Assessing a competitor's position and likely response to a proposal may be an important element of a commercial appraisal. This could significantly influence the economic return.
- Identify one off costs and gains (outside the project budget) which will occur as a result of the project (e.g. abandonment of existing facilities, redundancy costs, training costs, marketing costs, sale of redundant assets etc.) These will also impact on the overall economic return.
- What is the impact on the business of different completion dates? Is there a time imperative and if so what is its value. What is the business cost of project delay?
- It is likely that the economic evaluation for a proposed project will be revisited at one or more times during the project development stage. On each occasion a formal check on validity of date should be made.

Infrastructure Projects

Guidance

- Significant infrastructure upgrading projects often combine a commercial benefit with other, non commercial objectives. Commercial appraisal will focus on savings for the business rather than creation of income. Examples are:
 - An upgraded cooling water system may have lower running costs. Improved water quality may result in less corrosion and better heat transfer and hence improved efficiency on process units. Such items can be valued.
 - Renovation of a supply pipeline where there is an identified risk of failure can be assessed in terms of lost business from the facility being supplied and also reduction of the risk of leakage which could have serious environmental / safety / public relations impacts.
 - Complete resurfacing of roadways can be assessed against the cost of repeated minor maintenance and delays to traffic.

Checklist and Guidance Notes

3.2.6 Project Implementation Strategy (Cost Management and Contracting Strategy)

Provision of Implementation (Execution) Strategy

Guidance

- The objective of an implementation strategy is to identify the key processes and requirements to be adopted in order to optimally implement the project. A key part of this will be the strategy for management of costs.

- All engineering projects should have a written Project Implementation Strategy. This should be agreed by the client's senior business management, and where already involved, by any managing contractor or consultant assisting in project development. Certain elements may also require agreement of other parties, e.g. regulatory authorities, external finance providers.
- The Implementation Strategy should be a coherent whole, with each element being compatible with the others. Key parts of the implementation strategy will be the Contracting Strategy and the Cost Management Strategy and these two elements usually have a significant influence one to the other.
- The Implementation Strategy is typically developed by the project development team (which may well include a contractor or consultant) progressively during the development phase. The strategy should be presented to the clients senior management and other critical stakeholders progressively (typically at intermediate Stage-gates) so that the finalised strategy is not a surprise to anyone.
- The Implementation Strategy should normally be completely finalised prior to the preparation of items such as the budget estimate and other documents required for project authorisation.

Contracting Strategy

Guidance

The contracting strategy is a key element of the overall project management strategy and must be compatible with the other elements. It will have a significant influence upon the cost management strategy. The following provides some guidance to the development of the strategy with emphasis on those elements which are likely to impact on cost management.

- Identification of the work and responsibilities intended to be contracted out. Identification of how contracted work will be allocated – number and scope of contracts and relationships one to another. The scope must address not only work required and deliverables but also responsibilities. In particular, will a single managing contractor be appointed for the whole (or at least most) of the implementation works or does the owner, possibly via a PMC, propose to manage the works and let multiple contracts?
- Identification of those works and responsibilities the client intends to retain or carry out themselves
- Identification of forms of contract to be adopted. In particular, this needs to reflect the quality of the information to be provided to the contractor and the risks they will be responsible for. See Appendix E for common forms of Contract.
- Where a contractor has provided support in project development and definition work, will they be allowed to tender for implementation work, or to negotiate on a single tender basis? Alternatively will they continue in a PMC type role acting on behalf of the owner?
- If an overall management-type contract is to be employed, does the owner wish to influence how sub-contracts are let?

- Should specific incentives be included in contracts? If that is the case, the owner must consider which aspects of the project to be of particular importance as the incentive may encourage the contractor to focus on achieving the incentive, possibly at the expense of other aspects. See also section 3.2.7 and Appendix E
- Are specific performance guarantees to be included and if so will they be linked to specific financial incentives / damages. See also section 3.2.7
- If there is a requirement to commence contracted-out implementation works prior to final project approval, ensure that there are provisions to allow for termination without payment of significant penalties.
- Any requirements for local procurement, imposed by central or local government, and how this will impact upon overall project costs.
- Identification of critical materials and how they will be procured. Criticality may be as a result of schedule constraints and/or technical requirements. Are premium payments likely to be required to achieve required deliveries?

Cost Management Strategy

Guidance

Following should be addressed:

- Confirm the party responsible for preparation of project authorisation / control estimate(s).
- Confirm the quality and detail of estimate required for authorisation / control estimate
- Requirements for and timing of estimate(s).
- Provisions for contingency, general and specific. What will contingencies provide for?
- Who will be responsible for cost monitoring and control? What resources are needed?
- Identification of financial authorities including any specific authorities which are retained by the client.
- Agree accounting systems to be utilised for cost management and reporting.
- Cost review and reporting detail requirements and frequencies.
- See also section 3.3.1

Change Control Strategy

Guidance

Changes to projects often result in their requiring additional time and/or cost. In most cases the additional cost is disproportionately high relative to the base cost levels for the project. Typically, the later a change occurs the more severe the impact. It is therefore necessary to employ an effective change control procedure.

- Identify procedure(s) to apply internally (Client, PMC, and Managing Contractor) during the development and execution phases. These should cover technical aspects as well as cost and schedule change.

- Identify procedures to apply to contractors and ensure that the contracting provisions will highlight requirement for compliance.
- Specify authority levels for changes.
- Specify change reporting procedures.
- Identify how Changes will be funded and procedures for provision of additional funds where required

Checklist and Guidance Notes

3.2.7 Conditions of Contracts

Types of Contracts

Guidance

- It cannot be said that one type of contract is better than another. The optimal type is dependent upon circumstances. See Appendix E. The types chosen will significantly influence the methodology of cost management required for their control.
 - Fixed Price Lump Sum (or series of lump sums). These place the majority of cost risk on the contractor and hence he is likely to factor this into his prices. The purchaser (client or managing contractor) can focus his cost management on contractor fulfilment of deliverables, determining any incentives or damages due and close scrutiny of any claims.
 - Reimbursable. Here the cost risk remains largely with the purchaser and so he will need to undertake detailed cost management of the contract. This will require a detailed budget for each element of the works or services and a matching supply of fully detailed costs with appropriate supporting documents. For a large contract this could mean several thousand items of cost data.
 - Intermediate. There are many types of contract between the 2 extremes referred to above, including Remeasurable bills of Quantities, Fixed prices but with additional reimbursement of cost escalation etc. In these cases there is a sharing of cost risks.
 - Most of the basic types of contract can also include incentives (additional payments if specific targets are met and /or damages (compensation if specific targets are not met). Such schemes need to be carefully constructed to ensure common understanding of requirements and then managed to ensure that the required criteria are properly measured.

Terms of Payment

Guidance

- Terms of payment must be defined for all types of contract. This should address:
 - What intermediate payments will be made and what criteria must be achieved to permit a payment.

- If the contract provides for reimbursement of actual costs or remeasurement of quantities the procedures by which the needed measurements will be made (and audited) must be specified.
- In order for a payment to be made, there may be a requirement for the contractor to demonstrate that he has completed specific tasks or achieve a certain progress of his overall work. Required documentation should be specified.
- Where payments include reimbursement of monies paid out to sub-contractors or sub-suppliers, evidence of payment may be required.
- Are retention monies or bonds required? Both of these have a financial impact upon the contractor and he may adjust his pricing level to reflect this.
- The method of submission of invoices and the lead time to make a payment should be specified. The stated process should then be followed; unjustified delays in payments are a source of friction between contracting parties and can lead to claims for additional financing costs.
- Process required for any additional payments (claims) should be specified. It is usually good Practice to insist that any claims are treated entirely separately from submissions for normal (already specified by the contract) payments. See also Claims Procedures below.
- The terms of payment will have a significant impact upon cash flow for both the purchaser (client) and for the contractor or supplier.
 - Careful consideration should therefore be given to the number and timing of any intermediate payments. This may well be a negotiating item prior to contract award.
 - Usually (but not always) the aim should be or a relatively neutral impact; i.e. contractor or supplier is able to obtain interim payments which broadly match his outgoing costs, but with the profit element of the contract only paid on completion.
 - For small value / short duration contracts it usually makes no sense to have interim payments.
- Where a project is subject to financial support from external lenders (banks, private equity, government loans etc.) there may well be an imposed requirement not to make payments until tangible assets are handed over. This will result in less favourable cash flow and some additional cost risk for the contractor, which is likely to be reflected in the tender price for the works.

Incentives and Damages

Guidance

- Incentives and /or damages should only be applied where the contractor (supplier) has real ability to influence achievement and that the parameter which is subject to the incentive / damages provision is of key importance to the purchaser (client / managing contractor)
- Incentive schemes should be simple in their formulation and payments / damages should be progressive relative to the targets. A scheme where the contractor is vulnerable to a large step change in payment as a result of a marginal failure to achieve a target are likely to have an overall negative impact

upon the behaviour of the contractor and lead to argument aimed at recovering the payment.

- The terms, including how measurement will be made, for any scheme should be clear and relatively simple.
- Note any payment of damages will require that the claimant is able to demonstrate that relevant loss or damage has occurred. In English Law (and many other countries) the imposition of penalties is not legally enforceable.
- The requirement of demonstration of loss or damage equally applies to “Liquidated Damages” It will be necessary to reasonably show (but not value in detail) that the damages are not trivial. The only difference (from non-liquidated damages) is that there has been a prior agreement as to the value of those damages and the limit of any such damages; and hence there is no requirement to quantify the value in detail. Most commonly Liquidated Damages are imposed in relation to delay caused by the contractor, but they can be applied to other aspects, in particular to in service performance of the supplied asset.
- Performance guarantees are of importance where the purchaser (client) is relying on the contractor (supplier) for his expertise in both the basic design and the key elements of detailed engineering and manufacture of the works. Typically such guarantees will specify the required key performance parameters to be achieved and what additional payments will be due if exceeded or damages if not achieved. Usually these will be “Liquidated Damages” as in many cases it would be extremely difficult to accurately assess actual costs (such costs usually would occur over a period of many years in the future). A good example is supply of an electricity generating power station. Performance guarantees would include target for power output, thermal efficiency and reliability (on stream factor). Each of these parameters would need to be carefully specified as would methodology for measurement. In most cases there would be an opportunity for the contractor to remedy (at his own cost) any deficiencies before imposing the damages.

Change Order Procedures

Guidance

- During the execution of almost any contract there is potential for changes to the requirements (scope, specification, schedule etc.) placed upon the contractor, and regardless of the form of contract these should always be formally recorded as Change Orders.
- A record of all Change Orders received should be kept, detailing timings of receipt, acceptance (or rejection) and associated costs. Also reference to any key relevant information.
- It is important to operate a change order procedure even on wholly reimbursable contracts in order to control expenditure.
- The procedure by which change orders are raised and subsequently accepted (or rejected) should be clearly stated in the conditions of contract. The required timings associated with the procedure should also be stated and during execution rigorous effort should be made to ensure compliance. Timings should be such as to ensure expeditious notification and responses, but must be realistic to allow for sufficient time for collection of data and evaluation. The

client (managing contractor) should where appropriate remind contractors / suppliers of their obligations for timely information, with the threat of rejection if failing to reasonably comply. However the nature of some claims will be such that their value cannot be immediately determined as the exact impact of the change will only become apparent over time; the client has to recognise this and allow for it where appropriate.

- It is valuable to include in conditions of contract where practicable, some guidance as to how any changes will be valued. (Agreed rates etc). Failure to provide this allows the contractor / supplier considerable opportunity to price additional works or services at significantly higher rates than for the core work within the tender price.
- See also section 3.3.5

Invoicing Procedures

Guidance

- The terms of payment including the procedures for submitting invoices should be clearly identified in the terms of contract. This should include;
 - The timing of invoices. When they can be submitted (by time, or achievement of milestone etc.)
 - The required format of the invoice, including required detailing of the payments being requested.
 - The requirements for supporting documents.
 - The process by which invoices will be reviewed, authorised and paid, including the time required for payment.
 - Special requirements for any invoices related to claims for additional costs.

Requirements for Cost Data

Guidance

- In order to effectively manage costs the client and / or managing contractor will need to have a continuous feed of up to date data from all those parties who are carrying out works and / or services related to the project and will be receiving payments as a result. It is important that this information is up to date and provides sufficient detail. Requirements including timing and frequency of provision should be detailed in every contract / purchase order.
- Requirements will vary significantly dependent upon the type of contract / purchase order and the nature of the goods or services being provided.
 - For most material supply orders and for fixed price contracts, there usually will only be a requirement for prompt notification of the value of any change in costs which are expected to be claimed as a result of a claim, change order or other perceived change in the supply. This should include a requirement to identify the reasons for the change in costs and the how the cost change has been calculated.
 - Where works or services are reimbursable, remeasurable or otherwise subject to adjustment for external factors (e.g. escalation formulae), then it is good practice to require that the provider supplies a monthly update of

the forecast final cost. Any changes from previous figures should be highlighted and explained.

- Where a supplier / contractor considers an event has occurred (or is likely to occur) which will change his payment entitlement, then he must be required to provide relevant information as soon as is practicable.

Legal Basis

Guidance

- Consider carefully with country's laws will apply, this can have a significant impact upon the interpretation of the contract and how any disputes will be settled. Whilst most developed countries have systems which provide a reasonably effective legal basis, some are in practice much clearer and effective than others. In many developing countries the legal system may well not be adequate or impartial so if possible use of international law or the law of a developed country should be adopted if possible.
- Additionally a contract should specify in which country any legal hearing should be conducted. Preferably this should be the same country as the law applying to the contract. For international law, there should be identified the specific international court which would hear any case.
- It is worth considering the inclusion of a clause which requires the use of an independent adjudicator as a means to settle claims which cannot be directly resolved by the parties themselves. This will in many cases avoid the need for litigation or formal arbitration. Such a clause can specify :
 - Who the adjudicator is and / or how he will be appointed.
 - Whether his decisions will be final and binding or not.
 - How he will be paid
 - How he will act in terms of receiving and reviewing any claims.
 - How the parties must respond to any interim judgements.

Checklist and Guidance Notes

3.2.8 Value Engineering Studies

The purpose of value engineering studies is to optimise the scope and specification of the project the best to achieve the required project objectives whilst maximising value.

Guidance

- Value Engineering studies are ideally carried out when the design scope is reasonably well detailed: this is usually immediately prior to finalising the scope within the project definition package, towards the end of the development phase. For large projects, it is often worthwhile to carry out an initial review somewhat earlier in the development phase as a part of overall initial scoping.

- Whilst the aim is to yield significant cost savings it must not be seen simply as a cost cutting exercise and every proposed change must be checked to ensure that it does not compromise the achievement of project objectives and / or the URS.
- If plant / facility reliability, operability or other performance capability is compromised then any cost saving may be trivial compared with subsequent cost to the business. It is vital that any Value Analysis considers the Whole Life Value of any proposal.
- Proposals which may involve some additional cost but which will yield significant whole life benefit may also be considered. However, in doing so it must be confirmed that the benefit will be of real value to the business. For example, additional or higher specification product must be capable of being sold profitably. If the increased project cost is more than marginal, then firm support from the project sponsor will be needed and authorisation must be obtained before proceeding.
- If value analysis is to be an effective and valid tool, it is important that sound data is available to address the cost implications of any proposal together with an assessment of the impact on operating and maintenance costs and revenue. If the proposal compromises any aspect of the URS then this must also be assessed. It is usually relatively straightforward to develop a cost estimate for a proposed change in scope (at say $\pm 30\%$), but accurately identifying the extent of future cost impact is likely to be much more difficult. It is therefore useful to identify the range of possible outcomes, assign probabilities and use this as a means of assessing the value of the proposed change. Clearly, obtaining such data will require the involvement of those responsible for managing the costs in question.
- In order to limit the time required for such an analysis, normal practice is initially to carry out a rapid brainstorming in order to identify those items which may yield significant saving, of say $>€50,000$ or $>5\%$ of project cost for small projects. After this initial screening it will be necessary to carry out additional work on scope, costs etc leading to a more detailed review to judge their practicality and validity.
- Minor adjustments to objectives and deliverables which are confirmed as acceptable to the client, can in some cases allow significant optimisation of the scope / specification with associated cost reduction.
- Whilst it is preferable to carry out value engineering and analysis during the project development phase, the possibility that opportunities will be identified in the detailed design phase should not be discounted nor ignored if its potential benefit is sufficiently attractive. However it is inevitable that the later any change is made, the greater will be the potential for disruption, delay and additional cost.
- Value Engineering studies should be carried out by a multi-disciplinary team including the plant/facility operator / user and the engineering contractor who will carry out the detailed design.

Table – Typical Rating Criteria for Value Analysis

A	B	C	D	E	F
Rating	Capital cost saving (Net)	Impact on project schedule	Operating cost savings	Other operational impact (capacity, product specification, reliability etc)	Overall assessment
1	<€50,000	Significant delay	Minor negative	Minor negative	Do not consider
2	€50k - €250k	Minor delay	€0 - €20k / year	None	Further review to refine assessment
3	€250k - €1.0M	None	€20k - €100k / year	Minor gain	Probably worthwhile
4	>€1.0M	Shorten	>€100k / year	Significant gain	Must proceed

Notes for use of table

1. For every proposed item, it is important to consider each of the four impacts before arriving at an overall assessment
2. It is not valid to add the scores in each column in order to arrive at an overall assessment. Overall score is a judgement to be made by the project manager after liaison with other management
3. Items which require additional capital cost should only be considered if scoring 4 in columns D or E. or assist in achievement of project schedule for fast track projects
4. Capital cost savings assessed must be the net cost after deduction of any costs associated with making the necessary changes
5. Anything which has a major negative impact upon operational performance is likely to be unacceptable even if significant capital cost savings are available. Such an impact most probably represents a severe compromising of the primary project objectives
6. Operating costs will include maintenance cost, and change in cost of utilities, feedstocks, waste disposal costs etc
7. Other operational impact must address any impact upon the potential revenue stream resulting from the project

3.2.9 Checklist and Guidance Notes

Identify project funding sources and availability

See also section 5 Project Financing

Guidance

- No project, no matter how desirable the objectives nor how well justified, can proceed without the money being available to pay for the needed work to develop and implement the project. Hence it is vital that this issue is addressed at an early stage and revisited as necessary to reconfirm availability.
- Projects which are abandoned part way through due to lack of funds usually result in a total write-off of the money spent. Projects delayed (stopped then restarted or deliberately slowed) almost always result in costs substantially higher than would have been if the project had been developed and implemented to an optimal schedule.
- Where a project is to be funded partly or wholly from external sources (project specific) it is important to enter negotiations with potential providers at a fairly early stage in order to confirm that the funding can be made available on terms which are acceptable. Typically:
 - External funding will not be available during project development, so the client will need to fund this at least in the interim. (The cost may be later recoverable if the project is implemented)
 - There will be a requirement for a “high accuracy” estimate prior to confirmation of the funding deal. This may well require obtaining firm tenders for many of the key elements of the project, which in turn means that the project definition quality must be sufficient to provide required quality scopes for the tenders.
 - The provider may wish to influence the project implementation strategy. There will be a strong desire by the provider to minimise his cost risk. This may include a demand for a “Turnkey” type approach and an absolute limit on the amount of funds he will provide.
 - The provider will require to critically review the economic evaluation of the project in detail. He may require an independent 3rd party to also review. This may well require the client to divulge commercially sensitive information.
 - Funding will only be released at achievement of specific milestone in the project’s progress; hence there may well be a need to provide interim funding of some costs.
 - Depending upon how the funding provider is to be repaid (including interest payments) this may affect project economics, so the evaluation of project economics will need to be adjusted accordingly.
 - Funding provider will require to be provided with regular cost reports and may well also demand the right to audit the reports.
 - In many cases the funding provider will only finance up to a specific figure and hence any additional costs to the project will be borne directly by the client.

- Regardless of how project funding is provided there will be a need to identify the projected cash flow requirements for the project. Cash flow is strongly influenced by the terms attached to each of the individual orders and contracts related to the project. This could suggest that the aim should be to impose terms which delay payments as much as possible, however this would be a flawed strategy leading to higher quoted prices and potentially disputes over delays in payment all of which would tend to raise the cost of the project.

Checklist and Guidance Notes

3.2.10 Project Definitive Budget Estimate

(Estimate used for project authorisation and setting the project budget)

See also section 4 Estimating and section 3.2.2

Quality of Estimate required

Guidance

- Almost all projects will require formal approval before proceeding with the main implementation phase and a standard requirement for approval is the provision of an estimate of project costs. It is vital to ascertain what quality (accuracy) of estimate is expected, failure to do so may well result in the request for approval being rejected with a requirement for further work to provide a “better quality” estimate, which will result in delay and extra cost.
- The often-stated requirement for a ‘±10% estimate’ should be challenged given the work and time needed to provide this for certain types of projects. This is a particular problem for
- Smaller projects, typically retrofit, which are scope unique, (little or no scope commonality with already completed projects) and hence have a very limited ability to use historic data from similar scope projects.
- Fast track projects where there is a need to initiate detailed design and procurement, based upon an incomplete scope detail and specification.
- If a ±10% estimate (90% probability that cost will not exceed 110% of net estimate value) is required then there must be recognition of the extensive work which is likely to be needed to achieve this. Unless there is reasonably up to date (not more than 5yrs old) cost data from projects with a very similar scope / specification then it is probable that in order to provide sufficient detail of the scope/ specification up to 25% of the detailed design and engineering for the project will be needed and quotations obtained based upon detailed specifications for all main equipment and other high value items.
- If it is intended to execute the main part of the project based upon a “turnkey” provision (detailed design, supply install) of the main elements of the whole project, then it is essential that any estimate leading to authorisation is based upon quotations for the turnkey contract(s).

Clarity of estimate scope

Guidance

- Estimate quality is limited by the accuracy of the scope against which the estimate is prepared. This in turn can be sub-divided into two elements
 - General completeness of the scope
 - Detail including specifications
- Whilst both are important, it is the completeness of the scope (or lack of it) which usually the more critical to limiting estimate quality. For every estimate there should be an accompanying statement of the scope it is based upon, what has been included and what is excluded.

Unit Costs

Guidance

- Estimate quality is limited by the accuracy of the unit cost data used to price each element of the estimate. Historically, if the estimator had a database of reasonably up to date data (less than 5yr old), he could simply apply relevant escalation to the data, together with a few spot checks from contact with suppliers and this would provide a sufficiently accurate database for all but highly non-standard bespoke items. Recent experience (2003 onwards) however indicates a general increase in the rate of escalation of costs versus local retail prices coupled with much higher degree of price volatility. This phenomenon appears to be occurring to a greater or lesser extent worldwide.
- It is therefore now essential in order to get good quality unit cost data, to put considerably more effort into finding current price levels from suppliers and also getting their best estimate of future price escalation. However even this approach will not eliminate uncertainties given that suppliers are vulnerable to many external cost influences which have proven to be very hard to predict. Discussing with suppliers the best means of mitigating future unit cost risk may be valuable to identify the optimal approach.
- In many cases the only accurate unit costs will only be valid for the time at which the estimate is prepared this may well have to be the basis upon which an estimate is declared, with provisions for future cost level changes tackled completely separately.
- Rapid increases in cost levels cannot continue indefinitely, and a worldwide economic recession could trigger a rapid reversal of cost increases. It is however impossible to predict with any accuracy when and to what extent this may occur, but the possibility cannot be ignored when considering the cost of future projects and the associated level of tendered prices for works and services. Essentially the longer that the rapid increase continues, the higher the risk of a sharp reversal.

Project Schedule influence on Estimate

Guidance

- Estimates are based upon an advised project schedule and are generally only valid for that schedule. If the schedule is subsequently changed, it is likely that the cost of the project will change, usually upwards.
- It is essential that an estimate which is to be used for the project budget is based upon a schedule which is genuinely realistic, including a realistic assumption of the date at which overall project implementation can proceed (unfettered).
- Where a project is to proceed on a “fast track” basis there will be a requirement for the estimate to reflect –
 - Additional costs for premium time working and for some inefficiency.
 - Premium costs where accelerated deliveries of materials are required.
 - Cost savings for activities omitted (e.g. competitive tendering, certain time related costs) these saving can only be assumed if there is explicit acceptance by the client for the measures needed to achieve fast track.
 - Provision of additional contingency for raised cost risks.

Cost risks and contingency provision

See also section 3.2.4 and Appendix B

Guidance

- Cost risks at the time of the budget estimate arise from essentially three basic causes:
 - Scope / specification uncertainty
 - Unit cost uncertainty
 - Schedule uncertainty

Each of these can be considered in two parts,

1. General uncertainties representing the general limitation of accuracy related to (almost) all data each individually relatively small, but in total likely to be significant.
 2. Specific major uncertainties.
- General uncertainties are typically addressed by providing a general contingency added to the base value of the estimate, but inherently this contingency cannot address major changes to the assumptions made for the base estimate. The level of general contingency added will need to be considered carefully to reflect both the general accuracy of the estimate and the overall approach to use of contingency.
 - Specific major uncertainties will have probably been identified by an initial Risk Analysis exercise. Unless another approach has been adopted to eliminate the risk, then there is a need to provide a contingency for the risk. Such contingencies are usually specific to each individual risk and the contingency can only be used the fund the cost of that risk in the event it occurs.

- A common risk presently occurring is the future cost of raw materials, which may have a “knock-on” impact on both commodity materials and custom made equipment. This risk could be addressed by one or more of the following -
 - Provision of a specific raw material cost contingency having stated the cost levels at the time of the estimate.
 - Hedging the cost levels of the key raw materials in the expectation that changes in their cost will translate consistently through to purchased materials (not always the case). Note hedging is not practicable for steel cost as raw steel is not a formally quoted commodity.
 - Placing orders with an escalator clause for raw material cost.

Note: simply placing material orders on a fixed price basis or as part of a turnkey contract, does not eliminate the risk, it simply transfers it to the supplier who will aim to include that risk in his prices.

Estimate Narrative

Guidance

- All estimates should be accompanied by a narrative explaining the basis upon which the estimate has been prepared. For project budget / authorisation estimates this should be considered an essential requirement. The narrative should include:
 - Summary of the scope of work, including scope boundaries
 - Summary of the assumed contracting strategy
 - The project schedule assumed
 - Listing of specific exclusions from the scope. See also Appendix C
 - Estimate Accuracy overall and any particular limitations (i.e. specific risks)
 - Basis of provision for escalation
 - What contingencies have been included and the basis of their value.
 - Assumptions for currencies (if relevant)
 - Estimate split in case of Joint Ventures
 - Relationship to other budgets. (Shared costs, related costs borne by other budgets etc)

3.3 Project Implementation

- 3.3.1 Set up Project Cost Management Systems
- 3.3.2 Contract Tender Evaluations (Financial)
- 3.3.3 Ongoing Cost Risk Management
- 3.3.4 Scope / Implementation Changes
- 3.3.5 Change Order Management
- 3.3.6 Claims Management
- 3.3.7 Comparison of Cost versus Physical Progress
- 3.3.8 Review Estimates
- 3.3.9 Scope adjustment to contain Costs
- 3.3.10 Cost Management of Precommissioning Works
- 3.3.11 Insurances and Liability
- 3.3.12 Force Majeure

Checklist and Guidance Notes

3.3.1 Set up Project Cost Management Systems (Project Accounts, Cost Management & Change Management systems)

The outline requirements for Cost Management Systems and how they will function should be identified in the Project Implementation Strategy See section 3.2.6. Ideally all the project cost management systems should be in place at the time that implementation commences, though in practice this may not always be feasible. However it is important to at least have a clear vision of what will be required so that it can be fully set up as soon as is practicable.

Basic Requirements for Cost Management

Guidance

- In order to provide the ability to manage and control costs, the following should be in place-
 - Provision of targets against which performance will be measured. (principally a detailed budget or budgets)
 - Processes for collection of cost and other relevant data.
 - Processes for monitoring and measuring performance.
 - A process for implementing actions as needed to bring actual performance to meet, or get closer to, targets.
 - Clarity as to who is responsible for monitoring and measurement and for implementing any needed actions.

How and who will manage project costs during implementation

Guidance

- These questions should be addressed within the project implementation strategy.
- If major elements of the overall cost management are to be carried out by a managing contractor (MC) or a project management consultant (PMC) then it is vital that their responsibilities and deliverables are properly detailed within the scope of their works and services. Even in the case where the MC or PMC will not commence his responsibilities until after full project authorisation, it is highly desirable that consultation between them and the client has occurred to ensure complete clarity as to what is required in this respect.
- It must be recognised that effective cost management is a significant and integral part of overall project management which must have sufficient skilled resource.
- In addition to those individuals with prime responsibility for cost management it is essential that all other members of the project management team are actively involved.
- It is necessary to identify all the potential sources of input cost data, both specific numeric data and early warnings of potential risks and changes which may impact costs. Each of these sources needs to be advised of their obligations and then to be proactively involved.

Use of a Managing Contractor or Project Management Consultant

- Where a management-type contract is in place, the MC or PMC should have prime responsibility for project controls. They may further delegate the detailed work to sub-contractors. The Client (owner) will, however, normally wish to:
 - Ensure that contractor has proper processes for project cost controls.
 - Ensure allocation of sufficient skilled resources to manage project controls.
 - Require regular reporting and review of performance versus targets.
 - Audit data to ensure that it is complete, accurate and up to date.
 - The client will also need to control any aspects of the project implementation which are not within the contractor's responsibilities.
 - The client must also ensure provision of cost data relating to his own costs which are chargeable to the project budgets.

Project Cost Monitoring and Control

Guidance

- In order to manage project costs it is vital to have an effective cost monitoring system. This must be able to compare actual and currently forecast costs against budgets in sufficient detail to allow management of each financial element of expenditure. It is also important that the information is always as up to date as is practicable with monitoring on a continuous basis.
- This is typically achieved by setting up on a custom or propriety accounting programme a detailed budget which is broken down to identify the anticipated cost of each element of the project and then inputting actual costs and current

forecasts as they occur in order to assess cost progress versus budget. The extent of detail will depend upon the detail of the budget and detail of incoming actual cost data (contracting strategy). Whilst more detail is generally beneficial, it is important to ensure sufficient focus of the detail on the larger items such as major equipment and main contracts which are much more likely to be the determinants of cost performance

- The system will only be effective if the data is maintained such that it represents an up to date and valid reflection of the cost status for the project. This requires considerable effort in obtaining and inputting data. It is vital at the outset and to regularly reinforce the need for supply of this data from a wide range of parties such as suppliers and contractors.
- Following is an example of an extract from a spreadsheet type monitoring system. This example spreadsheet shows a small potential overspend versus budget for the category of materials concerned. Such a situation would merit further analysis to review the probability of actual overspend, what if any remedial action could be taken and what the implications are for the overall project budget. Such a review should be carried out by all relevant members of the project management team, not simply the cost manager.

Valves	A	B	C	D	E	F	G
Order No	Description	Current Estimated Cost	Value of invoices received	Value Charged	Outstanding Commitment	VC + OC	Budget
VA/001	Large CS Valves	€ 46,400	€ 33,000	€ 42,200	€ 4,200	€ 46,400	
VA/002	Small CS Valves	€ 12,000	€ 11,300	€ 11,300	€ 0	€ 11,300	
VA/003	St.St. Valves	€ 77,000	€ 37,600	€ 34,500	€ 37,000	€ 71,500	
VA/004	Needle Valves	€ 8,500	€ 4,400	€ 7,900	€ 600	€ 8,500	
VA/005	Rotary Valves	€ 34,000	€ 0	€ 0	€ 31,700	€ 31,700	
VA/006	Cryogenic Ball Valves	€ 86,000	€ 24,000	€ 22,500	€ 54,900	€ 77,400	
	Other Valves not committed	€ 15,000		€ 0	€ 0	€ 0	
	Total	€278,900	€110,300	€118,400	€128,400	€246,800	€270,000

Notes

1. The above table is an extract from a typical spreadsheet type project accounts system which might be used for a small or medium sized project.
 2. Column B is the current forecast which must be reviewed regularly. Entries in B can never be less than the value in column E, but may be greater to reflect provision for additional uncommitted costs where the final item cost is not yet confirmed (e.g. additional quantities, claims for extra costs, escalation, currency exchange costs, additional freight costs etc.)
 3. Column C may in many cases be a lower value than column D due to delay in receipt of invoices for a variety of reasons. However if C is greater than D then there must be a clear identified reason for it, otherwise D should be adjusted to at least match C.
 4. Column D is the amount assessed to reflect materials received, work done or services provided. It is often considerably higher than the value of invoices received as the latter often have a considerable lag in receipt.
 5. Column E is an assessment of commitments against orders for which have not as yet been assessed as value charged. This may include for any extra costs which the cost management team reasonably expects to pay (claims likely to be accepted, escalation etc.). However care should be taken not to include such provisions twice, i.e. in both B and E.
 6. Column G is the budget. It is unlikely that the budget will have been broken down into the level of detail that matches each individual order; hence comparison can only be at the total category level.
- Whether a stand-alone spreadsheet type programme or a part of the client's or contractor's integrated accounting system is used is a matter of judgement and company policy. However it is vital that whatever is chosen that it is capable of showing information at least in the detail indicated above and is amenable to updating as frequently as needed (i.e. daily or even more often). If an integrated accounting system is used it is essential that all relevant personnel will still have access to the system and that may well include personnel from other organisations.
 - Detail of cost management is very dependent upon contracting strategy. If a large contract is let on a Lump Sum Turnkey basis then the contractor will probably only provide statements as and when he is making claims for additional monies. He has no obligation to advise of the costs and profitability of the contract and indeed such numbers are largely irrelevant to the overall management of cost by or on behalf of the client. Conversely if a contract is reimbursable or remeasurable, then the client must be party to detailed financial data.

Integrate development phase cost data into overall cost management system

Guidance

- Budgets and Costs from the development phase of the project must (unless it is agreed that they will be funded entirely separately) be integrated into the overall project cost monitoring systems.
- It is entirely possible that the recording and monitoring systems used in the development phase are not the same as those to be used for the project implementation phase. Additionally a different party may well have the prime responsibility for cost management. It is therefore vital that transfer of data is accurate and complete and detailed checking that this is the case should always be carried out.

What are required interfaces with other business accounting systems? Check that the interfaces work properly. This may include interfaces between different organisations

Guidance

- There will be a number of interfaces with other accounting systems of the client and / or managing contractor. In particular:
 - Systems for tracking payments against invoices
 - Transfer of actual (cash out) expenditure into the overall business accounts
 - Accounting for taxation (e.g. VAT)
 - At the completion of the project transfer of the new assets into Capital Asset Accounts

As these interfaces will normally be electronic it is vital to test that they function reliably and correctly.

Are key financial terms properly defined and agreed by relevant parties

Guidance

- It is vital that all of the individuals in the project management team have a common definition for the key terms used for project cost monitoring. Hence terms such as Current Estimated Cost, Value Charged, and Outstanding Commitment should all be defined in detail and so that the definitions are consistently applied throughout the project.
- Example 1. Whether outstanding commitment should include a provision for known claims not yet agreed and if so on what basis the provision should be applied. If claims are not considered here, where will they be identified within the overall project cost monitoring system.
- Example 2. How will Value Charged be measured during the progress of a work element? Methods of measurement will be needed for services, material supply, construction contracts etc. Will claims for additional costs not yet agreed be included?

Identify / agree the frequency and content of cost reviews

Guidance

- The norm for cost reviews should be at least once per month, but some may require more frequent review. In any case whenever it becomes evident that an event has occurred or is likely to occur that will be of significance to the project forecast costs, then an appropriate review should occur.
- Copies of financial status reports must be issued in advance of the review to allow participants to study the status and focus on key issues at the review meeting.
- All cost reviews should focus on those elements of cost which are seen as possibly being significant to the outcome rather than routinely addressing every single cost element. Inevitably what merits the focus of review will change as the project progresses.
- Reviews should not be carried out by the project cost manager alone, but also must include the project manager, any sub-project managers, procurement / contract managers and any other cost advisors such as Quantity Surveyors to address issues where they have an involvement. The client should also be invited where the project manager is not a client employee. Additionally where there will be a detailed review related to specific cost elements the engineer most closely involved with that element should be involved.
- As a general rule a cost review must acknowledge any claims and agree how they should be accounted for within the project accounts, but detailed consideration of the merits of claims and how they should be tackled is best handled separately from the cost review.

Specify points where the owner must be consulted or provide approval before commitments are made

Guidance

- Where the client (owner) has delegated much of the responsibility for project management to a Managing Contractor or Project Management Consultant, he may still wish to require to approve decisions of major financial significance. Similarly even a project manager who is a client employee may not be delegated unlimited financial authority. Examples may be:
 - Approval of any single order / contract above a certain value (e.g. >€5M)
 - Approval of contract change orders above a certain value (e.g. > €50,000 or >5% of contract value). Note this value is typically much lower than the value for new orders.
 - Approval of any project scope changes
 - Agreement to settlement of claims above a certain value.
 - Commitment of contingencies within the overall budget
- Whatever the requirements are they must be clearly stated and understood by all concerned.
- It is important that the client does not set limits which are so low that the project manager frequently has to revert for approval. Such a situation compromises the ability to manage and indeed would in reality partly move responsibility for cost management back to the client.

- Within the clients organisation it must be clear as to who has the retained authorities to approve such items and a recognition that projects require authorisations to occur expeditiously

Invoice / Payments Tracking

Guidance

- It is essential that the status of invoices and payments against all orders is tracked on a continuous basis. This may often be done automatically by the accounts system of the payee (client or managing contractor) but such systems sometimes do not provide sufficient detail or accessibility to the project management team, and it may therefore be necessary to use a parallel spreadsheet based system.
- The tracking system should for each purchase order / contract related to the project identify:
 - Order / Contract Number
 - Name of Supplier / Contractor
 - Brief summary of scope of works covered by order
 - Value of order
 - Statement of schedule of payments
 - List of all Change Orders issued and pending and their value (estimate if not agreed)
 - List of all invoices received, summary of what the invoice is for, and value
 - Indication against each invoice current status re payment
 - Where payment is outstanding, due date and any reasons why payment should be withheld
 - Total of payments made and pending
 - Cross reference to other orders / contracts with same supplier

Change Order Procedures

See section 3.3.5

Turnkey Contracts

Guidance

- If the project is being supplied on a 'turnkey' or similar basis, where the contractor has taken main responsibility for the cost risk, (at least for the identified scope within their contract) then the detailed cost control process of the contract will be an internal issue for the contractor. The client will still need to have a cost control system for the overall project but the cost of the turnkey contract which may well form the great majority of the overall project cost will usually be represented as a single or a small number of items within the clients cost management system.
- A Change Order system will be required as for any other type of contract.

- The client should recognise that changes to turnkey contracts (fixed price, lump sum) may be expensive relative to the base cost. To mitigate this he should ensure that within the terms of contract there is an agreed methodology for the valuation of changes. Preferably by including agreed rates for staff and labour and an auditable means of checking the reasonableness of additional material and sub-contract costs. Without this the turnkey contractor would have a broad ability to charge for changes at more or less whatever level he wishes.

Issues for Emergency Projects

Emergency Projects whilst relatively rare do arise from time to time for a number of reasons. They are characterised by having little or no development phase prior to the start of implementation, together with one of the primary objectives being to complete in as short as practicable timeframe.

(Note this is not the same as a “fast track” project.)

Guidance

- Ensure that all commitments are properly recorded from day 1.
- Set up a basic cost monitoring system as soon as is practicable.
- Ensure that resource to manage costs, or at least manage collection of data is available.
- Ensure that the business management recognise the particular difficulties which will be incurred in cost management and that in order to achieve early completion additional premium costs are probable. Advise and gain agreement to the potential need for strategies such as single tendering, use of overtime, overlapping of work phases all of which compromise cost control.
- There are likely to be repeated requests from business management to provide a definitive estimate in order to set a firm budget for the project. This should be refused until such time as there is genuinely sufficient data (completeness and quality) to allow such an estimate to be prepared. If figures are demanded earlier it is suggested that a broad range is quoted with the higher figure including a substantial contingency and a strong (preferably written) qualification of the figures given.
- Many of the contracts awarded are likely to be on a reimbursable or unit rates basis, so that their final value is not likely to be known at the outset and have considerable potential for cost growth

Checklist and Guidance Notes

3.3.2 Contract Tender Evaluations (Financial)

Note. For many projects a considerable part of this work will be carried out within the Project Development and Definition Phase.

Decision to Tender

Guidance

- Tendering for works or services is a costly and time consuming task for both the party calling for the tenders and for each of those submitting a tender. However obtaining competitive tenders is normally (though not exclusively) the best means of ensuring that the works or services are obtained at the currently best pricing level. Competitive tendering also reduces the risk of claims of unethical behaviour.
- Competitive tenders only achieve their objective of best pricing if they are truly competitive and it is worth in cases where there may be doubt, checking that this will occur.
- Care should always be taken to select for tendering only those parties who are considered to have the best capability (technical, managerial and commercial) to fulfil the required work or services. Where needed appropriate prequalification should be carried out. Do not include any party, where even before the tender is requested there are significant doubts as to capability. Typically tenders should be requested from not less than 3 parties and not more than 6. (There will however be occasions where a different number may be decided upon for a variety of reasons).
- In some countries there may be an obligation to preferentially select local bidders, this may well result higher prices (and a less capable supplier) than had unfettered tendering been allowed. Where there are serious reservations as to the capability of local supplier / contractors, then it may well be sensible to ask the locals to enter into some form of partnership with an international contractor for the work, even if this leads to an initially higher tender price.
- Many clients and many external finance providers will require competitive tendering as a part of their standard procurement process, so any desire to deviate from this practice will require specific justification and approval.

Timing of Contract Tendering

Guidance

- Tendering (including the preparation of the required specification and tender documents) is costly and time consuming, there may well therefore be a desire to minimise the amount of such work carried out before a project is fully authorised. The decisions in this respect must be carefully considered in the context of the overall project strategy. Early contract (and material purchase order) tendering has significant merits:
 - Allows input of better cost data into the budget (project authorisation) estimate. For major lump sum items this may well make a substantial difference to the overall accuracy of the estimate.

- Work done in the development phase may reduce the overall implementation duration or at least provide more certainty for the schedule.
- Allows more time for negotiation of complex contracts and hence may yield better prices.
- In practice it is typical that some tenders are obtained in the project development phase and others are left to project implementation.

Time for tendering

Guidance

- If truly competitive tenders are to be received it is important to allow the bidders sufficient time to prepare their tenders. This will be a function of the scale and complexity of the scope and the form of contract proposed. In general, lump sum, and in particular turnkey-type contracts require more work from the bidder as they are taking a much greater financial risk and responsibility. Contractors would always like more time, but inadequate time will result in:
 - The contractor including large contingencies in their prices and/or qualifying their tender.
 - Additional tender appraisal time to sort out non-compliances and lack of detail in tenders.
 - The contractor later becoming highly focused on recovering the results of the inadequacies of their tender.
- Ensure that clarifications, and any other additional information provided during the tender period, are given to all bidders so that their tenders will be on a comparable basis.
- Ensure that all bids are received concurrently. Any extension of time must be given equally to all bidders.

Tasks (commercial) for tender evaluations

Guidance

- Identify and agree the process and key elements which will contribute to selection of a preferred tender and develop a scoring system. Gain agreement of the process with the management body, for example the tender board, which will later be responsible for reviewing and accepting the project manager's recommendation.
- Carry out an initial review of tenders received. Eliminate those which, for commercial and/or technical reasons, are unlikely to be finally selected. This will allow focus on the remaining, potentially acceptable, tenders. Reasons for rejection of tenders should always be recorded and confirmation sought from the appropriate management body, for example the tender board.
- Evaluate the potential cost of any omissions or qualifications. Aim to eliminate or confirm cost before contract award.
- Beware of tenders which are significantly lower than any other tender or the budgeted value. Take needed steps to ensure that the tenderer has properly understood and provided for the complete scope of work / services required.

Entering into a contract where the supplier is likely from the outset to make a loss has great potential for disputes delays and additional costs.

- For contracts which are financially significant to the contractor ensure, so far as is practicable that he has the financial resources needed. A contractor with cash-flow difficulties is likely to behave in a manner not conducive to the best interests of the project, which may well result in additional costs or in the worst case the need to reassign the contract.
- Review payment terms, cash flow is an issue for many suppliers and contractors. Offering improved payment terms could gain a few percent reduction in prices.
- Are the procedures for any additional works clear, including the basis for the evaluation of their cost? Is there a significant difference in pricing of additional works between the tenderers?
- Are any incentive payments proposed? If so are the mechanisms by which payments are due clearly stated and understood. Do the incentives yield an overall benefit to the project? If not why are they being used?
- Check the quality and experience of the key personnel the contractor is offering. If they are satisfactory, ask the contractor to confirm they will be allocated to the project.
- Ensure any non-conformances of tenders are resolved. If resolution affects other tenders still being actively considered, then ensure that other bidders are immediately informed.
- Ensure, so far as is possible, that all contractual issues are resolved and exact wordings agreed before contract award. To leave this until later simply stores up problems which are likely to lead to disputes and extra costs.
- Where bids are rejected due either to their being commercially and/or technically unattractive, advise the bidder as soon as practicable. However, be aware of sensitivity concerning other bids still being considered.

Time & resources to evaluate tenders

Guidance

- To properly evaluate tenders plus any needed negotiation may (depending on complexity) require substantial time and resource. The same requirements are often underestimated leading to either delays or inadequate evaluation and negotiation which in turn leads to placement of contracts with outstanding issues or in the worst case to a bidder who will not provide the best outcome. Failure to adequately evaluate and negotiate tenders is likely to lead to disputes and additional costs.
- The option of proceeding to award works on the basis of a letter of intent, pending resolution of outstanding issues, has the considerable drawbacks. It places the contractor or supplier in a very strong negotiating position as he knows the (probable) serious consequences for the purchaser if he were to terminate the agreement and subsequently place the work elsewhere.
- Bidders may aim to be relatively slow in responding to clarifications and amendments to their tender, especially if they believe they are in a strong position, in order to push the purchaser to award without ensuring the best

terms. This tactic must be resisted as best possible, both by ensuring sufficient time is available and placing pressure on the tenderer for prompt responses.

Single tenders / negotiated contracts

Guidance

- Notwithstanding the reasons for normally requiring competitive tendering there are a number of situation when it is sensible to seriously consider the use of either a single tender or a negotiated contract approach. The benefits include –
 - Reduction in the time and resource requirement to get to a position where an order or contract can be placed.
 - Saving in tendering costs.
 - A bidder who is fully focussed on getting the contract agreed and performing well.
 - In many cases, the use of contractor or supplier who is well known to the client and/ or main contractor and who has previously demonstrated capability will provide enhanced confidence of a satisfactory performance.
- Appropriate situations may include:
 - Where the client or main contractor already has in place a long term framework type agreement for the type of goods or services concerned. This will usually provide highly competitive pricing, but if the volume now required is substantially greater than the original framework agreement provided for there will be merit in revisiting the pricing levels.
 - Where there is a strong technical reason for choosing a specific supplier. The technical requirement needs to be demonstrated and suitable steps taken to (as far as is possible) determine that the prices offered are reasonable. If the prices are higher than provided for in the budget there is likely to be a challenge to the single tender approach. It may be necessary to demand that the bidder provides full detail of the make up of his prices on an “open-book” basis. Technical reasons may include:
 - No other supplier can meet technical requirements.
 - Requirement for compatibility with other equipment.
 - Ability to provide quality and quantity of management and labour (construction contracts)
 - “Fast track” projects where there is simply no time to provide for competitive tendering. The contract is likely to be awarded on an incomplete (in detail) scope and therefore will not be lump sum but negotiated rates. It may be necessary to demand that the bidder provides full detail of the make up of his prices on an “open-book” basis.
 - Where the order / contract is essentially a repeat (or very similar) of a previous supply.
- “Open Book” tendering, where the tenderer provides full details including demonstrating his input costs of how his prices are made up, can be helpful in demonstrating value for money in the case of a single tender. The tenderer must be willing to allow his overall business accounts to be audited by the purchaser in order to demonstrate validity. The purchaser must recognise that the amount allocated for certain indirect costs will inevitably be a matter of

judgement, but that a supplier must (if he is to stay in business over the long term) include for indirect costs and still make a reasonable profit.

Checklist and Guidance Notes

3.3.3 Ongoing Cost Risk Management

See also section 3.2.4 Cost Risk Management

Ongoing risk management

Guidance

- It is essential during project implementation that each of the significant risks to the project is actively managed, by the relevant parties. Inevitably the relevance and importance of some risks will increase and for others it will decrease or disappear. Additionally new risks will arise. It is therefore standard good practice that the project manager conducts a regular review of risks with the project team and others who have a direct interest in the risks. This review should always address the potential costs associated with the risks and hence the project cost manager has a key role in risk reviews.
- In addition to the risks included on a risk register it must be recognised that every outstanding claim or potential claim from a supplier, contractor or other party represents a cost risk. Hence a listing of such items and a regular review of them should also be carried out.
- A detailed review of cost risks may need to be carried out separately from the general risk review as it is probable that some of the financial data will be commercially sensitive.

Notification of changed risks

Guidance

- It is vital that all members of the project team recognise that they have a role to advise project management of any new or significantly changed risks and this includes any changes in the expectations of the costs associated with such changes.
- It may be worthwhile to remind the team prior to each risk review of the need for advice.

Accounting for cost risks

Guidance

- The main project accounts (especially if they are a subset of a broader company accounting system) will not be able to adequately display the required information for cost risk management. It is therefore appropriate to set up a spreadsheet listing details of each item.
- An example covering one risk is provided below. Its value is that the table can show the range of cost exposure, which is difficult to show in the main project accounts.

A	B	C	D	E	F	G	H
Item No	Description	Probability of requirement	Minimum Cost	Max Cost	Provided in Project base Budget	Stated in Project Costs	Funding of Cost
1	Cost associated with Premium time working to ensure on time shutdown completion						Specific Contingency of €150,000. / Possible extra funding required
1A	Mechanical Contractor	100% - 30%	€60,000	€125,000	€30,000	€80,000	
1B	E & I Contractor	100% - 30%	€20,000	€ 50,000	€10,000	€20,000	
1C	Scaffolding Contractor	100% - 40%	€10,000	€20,000	€0	€10,000	
1D	Insulation Contractor	40% - 0%	€0	€10,000	€5,000	€5,000	
1E	Provision of additional temporary lighting	100% - 30%	€8,000	€12,000	€5,000	€8,000	
1F	Provision of additional security staff	100%	€2,000	€2,000	€0	€2,000	
1G	Additional managing contractor costs for planning and supervision	100% - 60%	€10,000	€30,000	€5,000	€10,000	May be partly recoverable due to late design changes
	Totals		€110,000	€249,000	€55,000	€135,000	

Notes

- Column C indicates the assessed probability of the minimum and maximum costs respectively. Where the 100% figure appears it simply means that there is a minimum cost (>0) which will definitely occur. In 1D only a single figure is given which is the probability for the maximum cost
- Column D represents the assessed minimum cost. In some cases this will be zero. i.e. it is possible that there will be no cost.
- Column E indicates the assessed maximum (credible) cost.
- Column F shows what is included in the project budget (excluding contingency). The numbers represent the amounts provided specifically for premium time working within the base budget. In this case the amount provided is not sufficient to meet even the minimum requirement.
- Column G identifies what is presently shown as costs (commitments) in the main project expenditure accounts.

6. Column H identifies how the possible extra cost might be funded. In this case a specific contingency has been provided as part of the overall project budget, but as can be seen the amount may be insufficient.
7. Row 1F could have been omitted as there is no remaining cost risk for this item; it is however shown to provide completeness of costing for the overall topic of premium time working.

Use of contingencies

Guidance

- It is important that there is clarity as to what contingencies have been provided for and that they are only used for their stated purpose.
- Specific contingencies should only be used in the event that the specified circumstances arise. This is often ensured by the fact that use of such a contingency has to be requested from the client's authorising body (senior management) by the project manager.
- It tends to be much easier to use general contingency, which by definition is not specific and is usually provided to allow for the general limit on the accuracy of (almost) all elements of the budget estimate. If the general contingency is used to cover the additional costs arising from major risk items, then there is a real risk that the myriad of small additional costs which arise in most projects will not be provided for. However, if close to the end of a project it is clear that some of the general contingency funds remain available, then it makes sense to use them to cover any other additional costs rather than having to apply for release of additional funds.

Checklist and Guidance Notes

3.3.4 Scope / Implementation Changes

Scope changes are a major cause of additional cost to projects and the true cost is often significantly higher than the visible cost. The management of scope changes and their costs must therefore be a key part of project cost management.

Definition of a Scope Change / Implementation Change

Guidance

- An implementation change is a revision to the detail of the design / specification necessary to ensure compliance with the existing scope / specification / objectives for the project. It is almost inevitable that even in the best defined project a number of these will arise.
- A Scope Change is a revision to the scope / specification of a project arising due to earlier inadequate or erroneous definition or an additional or changed requirement imposed during project implementation.
- A change in the circumstances under which the work or services are to be carried out may also constitute a scope change.

- In practice it is impossible to make draw a clear boundary between the two and what may be considered as an implementation change by the client or managing contractor may (quite reasonably) be considered a Scope Change by another party.
- It may be of some value to provide in contract documents examples of items which should be considered as Implementation Changes rather than Scope Changes. However it is impracticable to cover every possible eventuality so such an approach whilst having some merit will not eliminate disagreements on this issue. Furthermore even an Implementation Change may well give rise to a legitimate request for a change order from the party who has to implement it, dependent upon the scope and terms of his order / contract.

Timing of Scope Changes

Guidance

- Scope Changes arising during project implementation a disruptive and are a major cause of cost growth in projects. Hence ensuring that project development and definition is carried out thoroughly in order to provide a clear and final scope and specification is one of the key means by which project cost can effectively be controlled.
- Research suggests that for a given Scope Change if the cost of the requirement identified during the project development phase is 1 unit of cost; then for the same change:
 1. Initiated during detailed design cost will be 3 to 5 units of cost
 2. Initiated during project construction will be 10 to 30 units of cost

Cost Impact of Scope Changes

Guidance

- Typically the cost of a scope change will be very much greater than had the work or service been a part of the original project scope /specification. The later in the project that the change is initiated then the greater the likely cost. (See above). Furthermore there is considerable evidence that the true cost of a change will be considerably more than the identified direct cost, research suggests that this is typically in the range 1.5x to 2x the direct cost.
- The greater the total value of scope changes, then as a general rule the greater the degree of disruption to the overall project. As a guideline if the direct cost of changes exceeds 5% of total project costs, then the cumulative disruption impact is likely to be severe.
- Additional costs arise due to additional, abortive work, disruption to schedules and sequence of working, higher unit rates often (legitimately) charged for such work and the administration and supervision associated with the change.
- When assessing the potential cost of a change it is important to identify:
 - All of the parties, who will be affected by the change and so far as is practicable identify and quantify the additional work which will be required from them.
 - Identify the rates at which this work is likely to be charged at.

- Identify any broader disruption which may be caused to the project, such as requirement for rescheduling, requirement for overtime working, administration of change orders. The disruption may extend to parties who do not directly have any change in work required from them as a result of the Scope Change
- If the change will result in a delay to project completion then the impact upon project economics may need to be considered.

Control of Scope Changes

Guidance

- Control (minimisation) of Scope Changes is a key element of project cost management. There must therefore be a rigorous process by which they are considered and, if appropriate approved. Given the potential impact, it is normal practice that all proposed scope changes are vetted by the project manager and for larger changes, their authorisation may be at a level above the project manager.
- The whole project team (including contactors where appropriate) should be formally advised by the project manager of the required approach to Scope Changes. This will include:
 - A strong desire to minimise changes, hence a requirement for a strong justification.
 - Requirement to consider alternative less costly, less disruptive options. In particular to consider whether the propose change can be done after project completion.
 - Requirement to fully comply with the Scope Change Procedure.
 - Guidance as to bringing draft proposals to the project manager sooner rather than later in order to avoid / reduce abortive.
- Where the detailed management of a project is given to a Managing Contractor or PMC it may still be appropriate that approval of any Scope Changes remains with the Client, with the possible exception of a waiver for those of very low cost.
- It is vital that a clearly stated Scope Change Procedure is in place and is consistently complied with. The procedure generally operates in a number of steps typically as follows:
 1. Scope change proposal is initiated and the initiator identifies the reason and justification. He then, with assistance from others, outlines the foreseen work required, which parties will be involved, implications for the project schedule and a first pass estimate of cost.
 2. Project Manager carries out a first review from which he may:
 - Reject the proposed change.
 - Ask for more details, including possible alternatives.
 - Accept in principle the need for the change and authorise further work to better define the scope, the cost and the impact on project schedule.
 - If the change is minor and funds are available he may fully authorise immediately.

- If the proposed change is large and /or will require additional funding he may review the proposal with client's senior management at this stage.
- 3. Needed work, including a detailed assessment of the cost of the change, is carried out and if the outcome still indicates that the proposed change is desirable it will be passed back to the project manager for approval.
- 4. The project manager will further review and may -
 - Reject the proposed change.
 - Ask for more information.
 - Accept the change and authorise it, if it is within his authority.
 - Take the proposal to client's senior management and recommend authorisation
- The project cost manager is normally the custodian of the Scope Change Procedure. His role will include:
 - Maintaining a record of each Scope Change proposed.
 - Maintaining a record of budgeted cost and actual costs.
 - Acting as a first filter on behalf of the project manager. In particular reviewing the indicated costs and benefits to assess their validity.
 - Expediting the progress of scope change proposals through the authorisation process.

Funding of Scope Changes

Guidance

- The funding of Scope Changes must be addressed. In general contingency included in a project budget does (to some extent) provide for what may be considered as implementation changes, but not for Scope Changes. In practice, provided that the contingency appears to be sufficient, then smaller (in value) Scope Changes are often funded from contingency, though this risks contingency not being available later in the project for other requirements.
- On some (large) projects a specific contingency budget for Scope Changes, retained by client's senior management, is set up. When a Scope Change is required then the project manager must apply for release of funds. Equally if there is no budget the project manager will need to request funding from client senior management.
- The Project Manager and /or Client Senior Management should only authorise a Scope Change if there is a strong justification for the change and that the consequences of not carrying out the change within the project are severe. However it should always be impressed upon the authorising party that any delays in approval (or indeed rejection) are in themselves disruptive and will lead to further increase in costs.

Accounting for Scope Changes

Guidance

- Almost all scope changes will have an impact upon project costs, in the great majority of cases it will be an increase in cost. It will always be useful to aim to identify the costs associated with scope changes so far as is practicable, though recognising that it may be difficult to accurately identify these costs within the overall project costs.
- Where a scope change is funded separately from the main project budget, it will be necessary to maintain a separate record of costs for the scope change. However even in this situation it has to be accepted that (unless all costs are lump-sum extras) this will be done on a best efforts basis given that it may be practicably impossible for contractors to separate the costs in a highly accurate manner.

Checklist and Guidance Notes

3.3.5 Change Order Management

Need for a change order system

Guidance

- It is vital that for any project / contract there exists a clear change order procedure which is consistently applied in respect of all contractual relationships. This is a fundamental tool for project control. Change Orders are a major source of additional cost to projects and hence a key element of project cost management.
- Change orders are required to reflect and authorise changes to project scope, specification, deliverables, schedule, changes in responsibilities and obligations and other changes in the circumstances under which the contracted supplies, works and services are carried out. Hence scope changes and implementation changes are a source of Change Orders, but not the only source.
- Many (though by no means all) Change Orders will result in a change to the project costs and hence are a significant tool in project cost management.
- For many larger projects it is likely that there is a multiple tier of change order procedures.
 1. Change Orders the client issues to the main (managing) contractor
 2. Change Orders the main (managing) contractor issues to suppliers and contractors
- It is vital that a Change Order system operates even in the case of fully reimbursable orders / contracts. It is the means of imposing some control on changes, which otherwise could very easily occur without any management involvement as there is no other contractual constraint.

Contractual Requirements

Guidance

- Every contract and every purchase order should clearly state the process by which a request for a change order must be raised. For major contracts it is suggested that the requirements are reiterated at the start of the contract.
- The process requirements must be practicable. In particular the time requirements must be reasonable and this may involve allowing additional time where quantification of the consequences of a change is complex and / or still dependent on future events.
- Every effort should be made to comply with the procedure by the supplier / contractor and the purchaser.
- Purchaser should make it clear that failure to comply may prejudice any claim made not in compliance with the procedure. (Note. Failure to comply with a change order procedure will not in itself legally disqualify a party from presenting a requesting recognition of a change to a contract, but can be used as part of an argument to disqualify or limit a claim dependent upon circumstances)

Operation of the change order system

Guidance

- The procedure should identify the following –
 - The requirement for the recipient of a Change Order to accept that order. There should however be provision for request for clarification and discussion as to how it should in detail apply.
 - How and when a Change Order May be requested. In particular the time limit from when an event becomes apparent to when the order must be requested (typically 5 working days). The client may at his own volition issue a Change Order at any time.
 - The time in which the party who will issue any Change Order must respond in principle (i.e. whether or not it is accepted that a change order is justified). Note at this point it will not necessarily recognise that any change in costs is appropriate.
 - Identify the time period in which the supplier / contractor must detail the impact of any change order on his contract. i.e. provide full details of any revisions to the work or services and consequent change in costs and schedule. It is sensible to set a fairly tight time for this such as 10 working days. The reality is that the reasonable time to be allowed is dependent upon the nature and complexity of the proposed change and to impose without exception a short time can be counterproductive as it may well result in a demand for excessive cost simply because the supplier / contractor has not been given sufficient time to properly accurately determine the impact on his contract.
-

- There should be clarity as to who has responsibilities:
 - To approve change orders.
 - Is the custodian of the change order recording system? Typically the project cost manager has overall responsibility, with the relevant purchase order and contract administrators having responsibility for the data related to their particular orders / contracts.
- In practice many requests for a change order will be initiated by a supplier / contractor presenting a claim and this cannot be avoided as it is (normally) his contractual entitlement to do so. This should not prevent the Change Order system operating, so long as it is made absolutely clear that issuance of a Change Order does not constitute per se acceptance of the claimed value. See also section 3.3.6.

Recording of Claims and Change Orders

Guidance

- It is important that for each significant purchase order and each contract that a register of claims, potential claims and change orders issued is prepared and maintained up to date. Such a document set will be of key use for cost risk assessment and provides input to both the overall project accounts and to the Cost Risk Spreadsheet. (Ref. section 3.3.3).
- The register of claims should identify the key aspects of the claim. This will include:
 - Date received and reference to claim document.
 - Brief summary of scope
 - Amount claimed (for large, complex claims this should be subdivided into main elements)
 - Cross reference to other connected claims
 - Preliminary view of claims (do they have merit in principle etc).
 - Current assessment of (conservative) settlement value
 - Assessment of maximum credible exposure
 - Resolution status
- The register of Change Orders should identify the key aspects of the Change Order, including:
 - Raise a CO as soon as there is reasonable evidence that one will be required. In the event it is not required it can be indicated as such.
 - Unique CO Reference Number
 - Brief summary of scope of CO
 - Status. Approved or Pending. Summarise outstanding requirements to allow approval
 - Value of CO. Indicate whether this is a firm or estimated value. If estimated indicate also maximum exposure
 - Cross reference to other connected COs and/or claims

Checklist and Guidance Notes

3.3.6 Claims Management

This section addresses claims management only in respect of its impact upon overall project cost management. Claims management is a complex subject which demands careful consideration by those concerned. Effective claims management can have a significant impact upon project budgets and equally on contractors contract budgets.

Sources of Claims

Guidance

- Claims are likely to arise when any party considers he may entitled to payments beyond those he already has a clear and undisputed entitlement to under provisions of any contract or other type of agreement he has pertaining to supplies, works or services he is providing related to the project. Claims may be initiated by:
 - Client
 - Contractors and sub-contractors
 - Suppliers and sub-suppliers
 - Consultants
 - Others who are affected by the project (e.g. land owners allowing right of way)
- The source of most claims will be from required additional materials, works or services, changes to the materials, works or services, and/or changes in the circumstances under which they are to be provided (delay and disruption).
- Client or Main Contractor may wish to make a claim for non performance of another party due to delay or perceived diminution of quality (These types of claims are however often not pursued in detail until the end of the contract)
- Additionally claims may be received from 3rd parties (those with no direct contractual involvement in the project) who believe they have suffered a loss or damage as a result of the project.
- There is nothing to prevent a party submitting a claim based purely on his belief of entitlement.
- A claim may arise from an event which is outside the control of the party against whom the claim is lodged, e.g. A construction contractor may claim for delay and disruption to his work if a major item of equipment he is to install is delivered significantly late. The client (or managing contractor) may in many cases be unable to recover monies from the supplier for such late delivery on a scale comparable to the claim from the construction contractor.

Evaluation and financial recording of Claims

See also section 3.3.5

Guidance

- It is important that as soon as a potential claim arises it is formally recorded in the project cost control system. This should typically include:
 - The amount claimed (If it is a large and complex claim this may usefully be subdivided into several elements of the claim)
 - An initial assessment of the maximum and most probable cost for settlement of the claim
 - Indication of which party(s) are exposed to the cost of the claim.
 - The inter-relationship of the claim with other (potential) claims either from the same party or from others.
- It is good practice as a part of ongoing cost management to pro-actively consider potential claims which have a (significant) possibility of arising in the future. i.e. when an unscheduled event occurs (or a scheduled event fails to occur) to consider the possibility of a claim arising as a consequence.
- When a claim is received (or is identified as likely to occur) it is sensible to consider whether any other claims are likely to occur due to the same or linked cause. If there are any then they should be recorded as potential claims within the project cost management system.
- Where the potential cost of the claim (or several associated claims) will have a significant impact upon overall project cost, then those providing the project funding must be immediately informed. This is especially important if the indication is that the project budget may be exceeded as a result.
- As soon as is practicable a more detailed evaluation of the likely cost of the claim should be carried out in order to gain a better estimate the exposure to the project and to better estimate the resources needed to negotiate a settlement of the claim. For major claims such detailed evaluations may need considerable work and it is often valuable to gain an independent view of the potential financial exposure.
- It is often the case that claims, when initially received are lacking in detail. In such cases the recipient should demand the additional information as a first step in the overall process of claim negotiation. In particular it is vital to have detail of how the claimed costs have been derived.
- Take care to avoid evaluating the claim based upon personal (emotional) consideration of what is fair. Evaluation must be based upon contractual (legal) obligation, unless there is an overriding reason that one or both parties may agree to something significantly different. This does occasionally occur for reasons of goodwill or in return for some other, non-financial consideration.
- Large and complex claims may take a considerable time to resolve (months or even years). The evaluation of likely outcome cost should be reviewed regularly as a part of overall project cost review. In many cases for such claims it is prudent to indicate a (credible) range of outcomes. The indirect costs of managing the claim (staff time, legal costs etc.) should be addressed.

Approach to settlement of Claims

Guidance

- This is a very complex issue and the preferred approach will be dependent upon many factors including the attitude of the parties involved, their relationship one to the other, the overall status of the project and its finances, the nature of the claims and how large is the perceived “gap” between the parties as to legitimacy and value.
- How vigorously a claim is contested will again depend on circumstances, balancing the desire to defend budgets and only accept what is absolutely legitimate in terms of the contract, with a pragmatic need to avoid damaging the overall project (or contract) as a result of a prolonged dispute.
- For straightforward claims (those where the legitimacy is agreed in principle and the difference in perceived value is not very great) it is usually beneficial to aim to settle them fairly quickly and directly between the managers of the parties concerned. This removes uncertainty for both parties and a potential source of friction.
- For complex claims, especially those of high potential value and a significant difference in perceived value between the parties, it may be sensible to not aim to settle quickly but to allow sufficient time (and resource) to ensure that it can be properly evaluated and negotiated. This of course means that there will be a contingent liability for the claim attached to the project accounts for this period.
- A claim should not (other than in exceptional circumstances) be used as an excuse to withhold payment of monies to the claimant not related to the claim. To do so is likely to be a breach of contract, will certainly cause deterioration in relationships and may lead to a legitimate claim for interest payments. Conversely there is no obligation to make part payment against claims not resolved, though this may be done for tactical reasons in some cases.
- It is rare that a resort to litigation or formal arbitration will lead to a satisfactory resolution for either party. The time, resources and cost involved will be significant and there is no certainty as to the outcome even for cases where the apparent justification is strong. In many cases even where one party receives a favourable settlement it may well be that costs are by no means fully recovered. There is merit in specifying the use of Alternative Dispute Resolution in the event that a dispute cannot be settled directly between the parties.

Indirect Costs of Claims

Guidance

- Most claims are likely to result in the project (and indeed all the parties involved in the claim) incurring some additional costs beyond simply the direct cost of settling the claim. This will occur whether the claim is met in full, totally rejected or some intermediate settlement is eventually agreed. For small and straightforward claims the indirect costs may be small and reasonably considered to be within the overall provision for management of the project.

- Major and complex claims are likely to require considerable effort from the project management team (Client, PMC, Managing Contractor etc.) and from the party making the claim. They in turn may well engage the services of independent consultants and/or lawyers to advise them and act on their behalf. Experts on specific subjects may also be engaged. The costs of these people can be very significant, especially if the resolution of the claim proceeds to litigation or formal Arbitration.
- The costs of managing the claim (per the above) may well not be recovered by the party “winning” the claim.
- Dependent upon the terms of contract, a PMC or Managing Contractor is likely to require reimbursement from the Client for his work to manage and negotiate major claims.
- If the negotiations are protracted there may be a legitimate additional claim for interest payments on any amount finally agreed.

Financial recording of claims in project accounts

Guidance

- It is vital that all claims and potential claims are recorded in the project cost management system, such that they are clearly and readily available to the project management team any others who have a legitimate interest in the cost management of the project. The detail of how they are recorded is for the project management team to determine, but it is essential that the system is agreed by those concerned and operated effectively and consistently.
- For each claim there should be a statement addressing:
 - A short summary of the basis of the claim
 - Whether the claim has merit in principle (regardless of whether the amount claimed is reasonable)
 - The amount claimed
 - The credible maximum exposure
 - The estimated likely settlement cost (or range)
 - Indication (if applicable) of additional indirect costs
 - Indication of linkage to other claims if applicable (including potential claims)
 - Indication of possibility of recovery of costs from other parties. For complex claims the data should be subdivided in to each main element of the claim, if practicable.
- Within the project accounts, normal good practice (conservative) is to indicate an outstanding commitment equal to the credible maximum exposure and also separately to provide an additional commitment for forecast indirect costs.
- Whichever procedure is adopted for the project accounts it is essential to be consistent and to ensure that all those using the accounts are aware of the philosophy adopted.
- For potential claims (those not received, but anticipated), provision should normally be made within Uncommitted Costs with a note of explanation. Inevitably any such provision is tentative in its nature.

- The recording of claims in Project accounts must be promptly updated to reflect latest information and assessments.

Notification of major claims to the client (and any other party responsible for payment)

Guidance

- It is vital that when any significant claim is received, that the party who will be ultimately responsible for payment is informed of this potential liability and how the claim is to be managed. This information should (for a major claim) be presented directly, not simply buried in a project report.
- If possible information as to when any additional payments may be made is desirable.
- Information must be updated as new information an opinion arises.

Counter Claims

Guidance

- As a matter of routine the project cost manager should collect data throughout the project of potential charges against suppliers and contractors arising from their failure to meet their obligations, whether in terms of work quality, omissions, delays or other aspects. This data should include references to key pertinent documents and an assessment of costs arising.
- Whether such potential counter claims are immediately advised to the supplier or contractor is a matter of judgement by the project manager and others.
 - Clearly if the potential claim is significant (especially if it arises partly as a result of the direct requirement to make additional payments to others) then it must be advised at least in outline as soon as is practicable.
 - Equally if the issue is one of defective work or an omission which is unacceptable and must be remedied by the supplier / contractor then he must be advised immediately.
 - There are however numerous other instances where the data is simply retained for future reference. Some common examples are:
 - Defects in design contractors work, later corrected, but resulting in additional costs from suppliers or construction contractors.
 - Supplier's late provision of design data.
 - Materials / equipment not fully complying with specification. (acceptable but some diminution of value)
 - Construction Contractor failure to provide updated detailed planning / schedule information
 - Construction Contractor failure to hand-over completed parts of his work in sequence agreed.

This retained data may later be very valuable as a counter in negotiating any claims for additional costs submitted by the supplier / contractor.

Checklist and Guidance Notes

3.3.7 Comparison of Cost versus Physical Progress

The measurement of project progress, both for the overall project and for individual elements is a vital tool for project management. For most complex, multi-disciplinary projects, cost (i.e. monetary units) is the only credible measure of progress which can commonly be applied to all the elements which together constitute the overall project. However cost (expenditure) is often not the optimal direct means of measuring progress of individual elements of the project.

The Physical progress of a given element will usually be directly measured by a unit of measure which is a suitable direct measure of the type of work or service covered by that element. It is very important that physical progress data is contemporaneous. It is necessary to strike a balance between the complexity and detail of the measurements and accuracy required. A truly high accuracy system would require an enormous amount of work to set up, measure and check. This would be expensive and often lead to limitation in frequency of updating information. Given below are some practical measure units used for different types of works and services. These will usually provide a fair (but not high) accuracy assessment of progress.

- Design & Engineering – Weighted assessment of progress on each of the many documents to be prepared by the D&E contractor. Additionally it is useful to measure man-hour consumption vs. man-hour budget, for whilst this is not a direct physical progress measure, it is often a good indicator of cost for this element.
- Procurement Services – Weighted by value assessment of progress on each purchase order and contract, from preparation of tender documents right through to close out of the order / contract Weighing for each is relative to value of materials / contract.
- Materials – Weighted by value assessment of materials delivered to the construction site or to another location (e.g. for pre-fabrication or preassembly). For major value items some credit is often attributed at major milestones of manufacture, otherwise the probability of a significant discrepancy with Value of Work Done (i.e. cost progress) will arise. Note. Where materials are supplied by a construction contractor, then both the physical progress measure and cost progress can only be assessed within the context of that construction contract.
- Civil Construction Works – m³ of excavations, m³ of concrete poured, m² of roadways laid, m of drains installed, m² of brickwork, m² of flooring installed and many other measures. Usually need to use several measures within one contract and weight them relative to value within the contract. However this presents scope for inaccuracies in true reflection of physical progress as inevitably many smaller elements of the diverse works tend not to form part of the measure and complexity of excavations, concrete pouring etc. may differ significantly within the overall contract.
- Steelworks – Tonnes of steel fabricated and erected. Tends to over report progress early in the works as large section steel need proportionately less work (both for fabrication and erection) than small section and flooring.
- Installation of Equipment – Weighted by value of the installation cost for each item. Installation progress for more complex items (e.g. large turbines, engines, compressors, and other items which require part site assembly) will be

subdivided into achievement of milestones in their installation including any testing required.

- Fabrication of pipework – Metres x diameter squared as the unit of measure. For different materials weight by relative unit cost within the contract.
- Installation of pipework and ducting – Metres x diameter squared as the unit of measure. For different materials weight by relative unit cost within the contract. Often the last 10% of progress is only credited once the piping has been tested, checked out and cleaned. This measure tends to overstate early progress as typically large bore and straight runs of pipe are installed first. It is often valuable to keep a measure of man-hours versus budget for this labour intensive activity.
- Cable Laying – Metres of cable installed. Possibly segregate underground cabling from above ground cabling.
- Major Electrical Equipment – As per Installation of Equipment above.
- Minor Electrical Equipment (light fittings, power sockets, switches etc.) Number of individual items installed, retaining 10% of progress for testing.
- Instrumentation and control systems – Number of individual instruments installed plus weighting by value for individual major items such as DCS, PLC systems, Alarm and safeguarding systems. Retain 10% of progress for testing. Additionally for the major items where software installation / configuration is included within the scope this must be allowed for and can be a very significant part of the work for that item.
- Insulation works – m² of material installed.
- Painting – m² of painting completed
- Temporary works and services (including scaffolding) – There are usually no units of physical measure which can sensibly be applied so for these items it is simply a matter of carrying out a judgement by experienced personnel. Individually these items typically do not constitute a significant portion of overall physical progress, though they should not be ignored entirely
- Construction Management (staff of Managing Contractor / PMC) – Can only be by expenditure of man-hours versus budget or current forecast. There is a need to check that recorded progress does not significantly differ from overall construction progress.

Cost progress will however be a financial assessment of Value of Work Done, usually made by the contractor which is reviewed by the managing contractor and/or client.

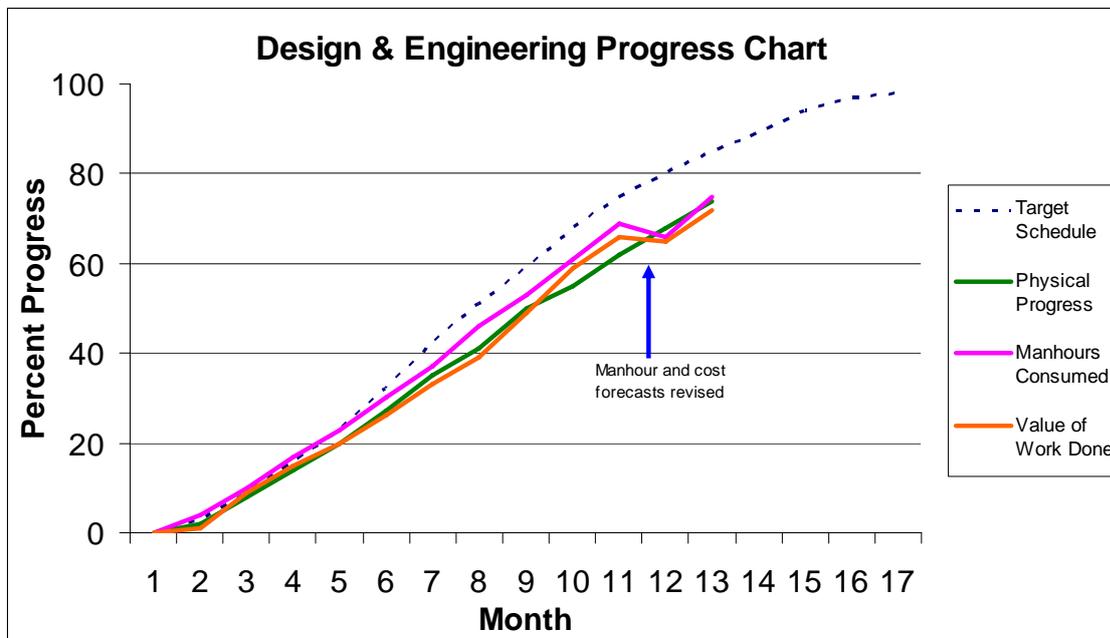
In theory Physical progress and Cost progress should match, the reality is that in most cases (except at 0% and 100% progress) there will be a discrepancy. The fact of a discrepancy, especially if it is small, is not necessarily a major concern, but it is valuable for cost management to always analyse the reasons for any discrepancy as it may be an early indicator of a required change in the forecast cost of the work.

Who has the major interest in comparing physical progress with cost progress and, where applicable with man-hour progress will depend upon the forms of contract operating for the project.

- For reimbursable type contracts including those payable against unit rates (and including those with cost performance incentives e.g. “Target Cost”) then both the client and contractors will have a strong interest. Any significant deviations between the measures should be a cause to analyse the reasons and assess the implications for the project including the overall cost forecast.
- For lump sum fixed price contracts, it is likely that the contractor will not divulge the details of either his physical progress or cost progress measurements to the client. However the client should require within the contract that the contractor provided a regular (typically monthly) statement of progress supported by sufficiently detailed measurement system to demonstrate credibility. The client has a right to know if progress is deviating from the contracted schedule and may need to consider implications for project cost.

Example

Below is a chart showing measure of progress in Design & Engineering. Detailed analysis of reasons for deviations between the different measures may well indicated the need to revise project cost projections.



Analysis of the deviations could indicate the following:

- Completion of design & engineering is 1½ to 2mth behind the plan. It is unlikely that this can be recovered. Implications on overall schedule and cost for the project.
- Man-hours and hence costs have been revised (Absolute man-hours consumed cannot decline from one month to the next, the graph reflect that the forecast has been increased and this almost inevitably results in an equivalent need to increase the cost forecast.
- Physical progress is shown as ahead of cost progress (though the difference is small) If the gap widens then there will be a need to assess whether physical progress is in fact being overstated in which case the delay to schedule is even greater.

- Man-hour trend must be a concern and suggests that a further increase in forecast costs is probable.
- Overall the above chart (whilst not catastrophic) should provide concern for both contractor and client and a need to carry out further analysis to understand reasons and what remedial measures may be needed. There may also be a need to negotiate responsibilities and allocation of the additional cost which are now anticipated.
- How serious the situation is does also depend upon how tightly or generously the original budgets used for man-hours, physical progress and cost progress measurement were set. If tightly set, then increases now foreseen may still fall within the overall project cost budget provisions

Similar charting should be carried out for all main elements of the project.

Checklist and Guidance Notes

3.3.8 Review Estimates

Requirement for review estimates

Guidance

- Review estimates are those re-estimates carried out to reassess a part or the whole of the project at any time after the project has been authorised. A review estimate is a more formal exercise than the simple review of the existing budget(s) which should be carried out on a regular basis by the project cost manager.
- In general there should not be an automatic requirement for a review estimate. Such an activity is time and resource consuming and for a project where all the evidence suggests that the existing budget remains valid the added value provided by review estimate will be limited.
- Reasons to carry out a review estimate include:
 - Project manager is of the opinion that project costs will deviate significantly from the existing budget and hence there is a need for a more accurate projection of (current expectations of) cost.
 - It is evident that there is a significant change to project schedule or that extra-ordinary measures will be required to maintain the existing schedule.
 - Some clients (and external finance providers) will require a review estimate as a matter of standard procedure for major investments.
 - A review estimate towards the end of detailed design can be a useful “last chance” to revisit the economic merits of the project, based upon a high accuracy estimate, before financial commitments are so great that a change of course is almost impossible. Such an approach is particularly valuable if the initial estimate used for project authorisation was of a relatively low accuracy and also for mega-projects.

- When the cost of a specific part of a project is in doubt. A common example is the precommissioning and commissioning costs for process plant. Very often the original authorisation estimate provides for such costs based upon a very limited definition of the work required. Much closer to the time when precommissioning and commissioning is to be carried out the work required and the conditions under which it must be carried out are much better defined and so it may be valuable to re-estimate based upon this much better data.
- On or near to physical completion of the project, to review the projected outstanding costs such as finishing off works, site cleanup, provisions for outstanding claims, ongoing project team costs etc.

Timing of review estimates

Guidance

- In general review estimates should only be carried out when the project manager considers one to be necessary.
- Some clients will mandate for major projects that a review estimate shall be provided at a specified point in the progress of the project. The most common timing for this is towards the end of detailed design but before any major elements of field construction have commenced. At this point the financial commitments will still be relatively low compared to the overall projected cost and so it is a genuine “last chance” to revisit the merits of the project, based upon a high accuracy quality estimate. In order to provide such an estimate considerable work is required (see below)

Quality of review estimates

Guidance

- A review estimate must aim to both be of a significantly higher accuracy than prior estimates and be current (i.e. reflect the presently projected outcome for the project)
- Typically a review estimate should achieve at least a genuine $\pm 10\%$ level (90% probability that cost will not exceed 110% of stated base figure excluding contingencies) or preferably better. To achieve this the following steps should be taken:
 - Clearly identify who will carry out the review estimate, what work is required and ensure sufficient resource is in place to allow its execution without otherwise disrupting the progress of the project.
 - Ensure that actual quotations against firm specifications are provided for all significant cost materials and all significant construction and service contracts.
 - Ensure that the scopes for items such as temporary works, precommissioning, commissioning, and “peripheral” items (See Appendix C) have been reviewed and updated.
 - Ensure that latest actual cost data is available related all work done and commitments made to date.
 - Ensure realistic provisions are made for any known or reasonably anticipated claims.

- Ensure that the review estimate is based upon a currently credible project schedule.
- There may however be circumstances where a less accurate review estimate may suffice. In the case where a project is subject to a very significant change in overall schedule, the first requirement may be for a “broad brush” review estimate to identify the order of magnitude change in costs.

Checklist and Guidance Notes

3.3.9 Scope adjustment to contain Costs

If it becomes evident that there is a probability that the project overrun cost will significantly exceed its budget then it is vital that a thorough analysis of what remedial measures can be taken must be carried out. Such a review must involve the client's senior management (and any other parties involved in funding the project) as they will eventually have to agree any funding increase or other strategy revisions. To this end it is important that Client's senior management is informed and involved as soon as there is substantive evidence that such a review is likely to be needed. The review should address all credible strategy options and critically revisit the assessed range of possible outcome costs. Options to be considered may include:

- **Review of project economics to assess attractiveness at new projected cost**
Review of project economics based upon both latest forecast project costs and updated income projections will help to identify whether the project remains economically robust or not. If the project remains robust then the option to request additional funding is entirely credible and the information gained from the review will provide support for any such request.
- **Temporary stop of project to assess situation**
If it becomes apparent that the viability of the project is in doubt it may be appropriate to temporarily stop work whilst a detailed assessment and decision is made regarding the future of the project. The temporary halt might be in respect of all work or limited to avoiding the making of any new financial commitments or other partial deferring of works. Additionally the client may request that his main contractor or PMC carries out studies to assess the possible financial implication of options being considered. It must however be noted that any halt or delay to the work on the project will in itself almost certainly add to costs.
- **Abandonment of the project**
If the project appears to be no longer attractive then abandonment may need to be considered. If the project is at the design phase then the financial commitment is likely to be relatively low (relative to final cost) and abandonment may well be the appropriate action. If however significant materials have been ordered and even more so if construction has commenced then the cost of abandonment is likely to be high. In any case a detailed analysis of the final cost of an abandoned project should be made before the decision to abandon is made.

- **Make scope / specification reductions to contain costs**

Many (but by no means all) projects contain elements of the scope / specification which could be removed or modified to reduce costs without major impairment to the essential project objectives and deliverables. These fall into several categories:

1. Nice to have items. Things which have been included which are not essential but were included usually to meet the desires of senior personnel within the client, often in order to ensure their support for the overall project. Equally this applies to specifications which may be more onerous than needed simply because it matches previous client preference. Whilst in an ideal world all such extra cost items would have been eliminated during development phase project value management reviews, in reality many projects still retain them.
2. Items which add value but their removal will only result in limited devaluation of objectives and deliverables. This may include
 - Elements of the project included to provide for future expansion, future increased functionality (e.g. possible future different product production).
 - Limited reduction in performance specifications.
 - Elimination of need for custom specified items as opposed to industry standard items where the latter is adequate.
 - Finishes within buildings.
 - Specifications of fixtures, fittings and furnishing.
 - Deletion or reduction of expensive costs such as landscaping, opening ceremonies etc. (or transfer to another budget).

However when considering making such changes account must be taken of the cost of making a change, especially in the latter stages of a project.

Extend project duration

There are two possible reasons to consider this.

1. To reduce premium costs being incurred in order to achieve the existing schedule. Overtime and shift working are very expensive as can be premiums paid to vendors for accelerated delivery of materials. However if the project schedule is extended then certain other time related costs are likely to increase, so it is essential to carry out an assessment that a worthwhile net cost benefit will be achieved.
2. To improve the cash flow situation for the client (and others) who are funding the project. In some cases a client may be willing to accept an increased project cost but cannot meet the additional cash flow required. As per a) above the overall project cost is likely to increase.

Obtain additional funding

A request for additional funding to the client (and/or others providing funding) must be made if the projected cost is expected to exceed the project budget including any contingencies already provided for. In order to properly consider such a request the client will reasonably require the following,

- Explanation as to why the costs have risen.
- What measures have been taken to minimise the increase in costs.
- What options have been considered and why the proposed option is preferred.
- Advice re the current cost expectations (range possible of outcomes).
- Explanation of amount of additional funding now requested. In particular how much is a firm requirement and how much is contingency.
- Updated schedule for project completion.
- Updated cash-flow forecast

It is important to note that a Client is (almost) never happy to be faced with a need to provide additional funding or otherwise to revise the project strategy. Most clients will however accept that provided the reasons are sound and well presented a single request for additional funding and/or strategy modification is a risk which can occur on most complex projects even with the best project management team. Clients will however be much less supportive of repeated requests for additional funding or other strategy changes. It is therefore very important when making such a request, that it addresses all foreseeable future requirements. This may of course be presented as a range of scenarios, but at least the client has been advised. Client must also continue to be kept informed.

Checklist and Guidance Notes

3.3.10 Cost Management of Precommissioning Works

Budget detail & scope

Guidance

- It is typical that during project development precommissioning needs have been addressed only in very general terms and so it is common that project budgets contain a provisional value for precommissioning based upon little or no definition of the work required.
- As the project progresses the requirements for precommissioning (and commissioning) will be better defined both in terms of the scope, scheduling and the contractual arrangements for the work. Based on this detail it will be sensible to provide a budget in some considerable detail to allow comparison with actual costs as they arise.
- Where it appears that the original budget for precommissioning is adequate it may be reasonable to simply sub-divide it into elements which reflect the elements of the work as now defined.
- Where the budget appears to be potentially insufficient then it will be necessary to prepare a detailed review estimate for this phase of the project. The estimate should account for:
 - The low productivity of workforce doing this work. This is caused by both the nature of the work (lots of individually small tasks) and that it often must be carried out concurrently with final stages of construction works
 - Emerging works and rework
 - Overtime costs, shift work costs

- Supervision costs. Level of supervision required is typically much higher than for general construction

Contractual basis of this phase of the works

Guidance

- Precommissioning works may be wholly or partly included in the scope of work of the main construction contractors, or contracted for separately (with the construction contractors and/or others), including in some cases being partly carried out by clients own employees. Hopefully there is clarity as to who does what and who supervises and manages what.
- Given the nature of precommissioning works it is common that it is carried out on a partly (or even wholly) reimbursable basis even if using the construction contractors who have executed the main construction works on a lump sum basis, or unit cost (schedule of rates) basis.
- An important contractual requirement should always be to require the contractor to provide a regularly updated projection of his costs to the extent that they are reimbursable. The client / managing contractor must then rigorously chase the provision of such data and having received it, review its accuracy.
Note: Caution should apply when relying on contractor forecasts in this area of work, they are notoriously poor at assessing the required man-hour content of such work.
- If some work is covered by lump sum / schedule of rates and other work is reimbursable provided by the same contractor, considerable effort will be needed to ensure as far as is possible, that charging is done accurately. There is great potential for the contractor to over-allocate costs to the reimbursable elements so regular auditing as the work proceeds is highly desirable.

Planning Scheduling & issues

Guidance

- The planning and scheduling of precommissioning works typically requires a level of detail considerably beyond that for general construction work. Furthermore the scheduling is very vulnerable to requirement for revision, due to interaction with outstanding finalisation of construction and the actual progress of the precommissioning itself.
- The extent of planning and scheduling may in itself generate an additional cost if the resource requirement had not been foreseen in the original budget.
- Changes in scheduling are a significant source of additional costs and hence require close monitoring from a cost management view.

Management of Costs

Guidance

- It is vital that a reliable flow of actual cost data is established for the precommissioning works. The nature of the work is such that typically there will be a large number of individually relatively small costs arising from many sources and some of these will be vulnerable to considerable revision as the work progresses. It is most important that data is regularly updated.

- Project cost management must be pro-active in gathering actual costs and cost forecasts related to precommissioning works.
- It is essential that the project cost management addresses the significant risk that works and services which should be covered within the main construction contracts and costs are transferred (accidentally or otherwise) to precommissioning costs, effectively double charging the project. Before the start of precommissioning a plan should be developed for audit of the incoming costs.
- Commonly the precommissioning team will carry out some of the remedial work and omissions discovered as a result of check-out of construction works. Where this is charged to the project, the project management must be proactive in recording such costs and recharging them back to the party responsible for the deficiency.

Checklist and Guidance Notes

3.3.11 Insurances and Liability

For the majority of projects (possibly excluding some small value projects) it will be appropriate to provide project specific insurances. However insurance can be a significant cost item and so the exact scope of coverage of such insurances should be carefully considered by both the client and by contractors. Equally the liabilities of all parties involved in the project must be identified. Following are some guidelines.

- Client (in conjunction with his PMC or managing contractor where applicable) should decide upon overall requirements addressing liabilities of parties and who is expected to provide needed insurances. This should be written into the terms of every contract and purchase order
- Identify what general ongoing business insurances will cover. Virtually all asset owners and contractors have such insurances which may well be sufficient to address potential liabilities in respect of smaller projects, provided always that the client and other contractors indemnify them against (low risk of) very large liabilities.
- Ensure that, so far as is practicable, insurances provided by one party do not significantly overlap that provided by others. This simply adds to overall costs and not only does not provide extra cover but also leads to potential dispute as to which insurance should pay.
- There is as need to identify who will insure for loss or damage to the following:
 - The Works (i.e. the assets directly related to the project)
 - Other assets and materials at or adjacent to the project construction site owned by the client, contractors or others associated with the project.
 - Third party assets.
 - Death or injury to employees of the client, contractors or others engaged in the provision of works or services related to the project.
 - Death or Injury to other individuals as a consequence of the provision of works or services related to the project.

- Provider of insurances may in some cases provide coverage for liabilities of others. Indeed it is common that the Client or turnkey contractor will insure the works and that insurance will cover any loss or damage regardless of who caused the said loss or damage.
- Consider accepting that small value losses are excluded in order to reduce premiums. This can have a significant impact upon insurance cost, and in Practice small claims are often more trouble than their value. i.e. accept a deductible.
- Do not aim to place unlimited or a very high limit of liability on small contractors or suppliers. The cost to them for insurance (if they can get it at all) will be prohibitive. In particular do not impose liability for large consequential losses on such parties.
- Insurance for business interruption is expensive. In the case of a project this would relate to delayed availability of the facility into service. It is not usual Practice to tie such insurance to projects. The typical means to address such concerns is to include liquidated damages for delay into relevant contracts where appropriate.
- When an event occurs which is likely to result in an insurance claim, it is vital that the following steps are taken.
 - Inform the insurers (there may be more than one involved) as soon as is practicable of the event and request they advise their information requirements.
 - Take steps to mitigate the cost of the event
 - Collect detailed cost data in a manner that allows clear segregation of costs related to the insured event from other costs.
 - In most cases insurance will only cover for immediate making safe and reinstatement to situation as was before the event. It will not cover for improvement (even where this is essential to provide a long term safe / secure situation). Equally insurance will not cover for additional cost of “fast track” remediation. Hence where either of these apply it is necessary to be able to segregate costs accordingly.
 - Significant insurance claims will require considerable management, it is unlikely that all such costs will be recoverable and so they are likely to become a cost to the project.

Checklist and Guidance Notes

3.3.12 Force Majeure

Force Majeure is the occurrence of an event which is considered to be both wholly outside the control of the party concerned and one which it would be unreasonable for that party to take into account when planning and pricing a contract. Whilst the exact terms of a Force Majeure provisions may vary, nearly all purchase orders and contracts within the project construction industry contain a clause to address this issue. Typically Force Majeure will cover new government laws and regulations, war and other hostilities, civil unrest and terrorism, physical disasters, inability to use transport facilities, strikes and other industrial actions carried out employees other than those confined to the contractor and / or his subcontractors.

The consequence of a Force Majeure event is that there is a possibility that several parties associated with a project will be affected and that the resulting costs incurred are in many cases significantly greater than initially estimated.

The objective of Force Majeure provisions is to protect the party directly affected from any claims from others (usually the other party to the contract) arising as a result of delay or failure to supply the works or services under the contract. The result is that each party must themselves bear the cost (and other consequences) which are imposed upon them as a result of the Force Majeure event. The implications of this are that an event which directly affects one contractor, supplier or the client may well have cost and other consequences for other parties associated with the project.

In many contracts, there is also a provision that if a Force Majeure event continues over an extended period, then the contract may be terminated.

It is incumbent upon all parties concerned to take all reasonable steps to minimise the impact of a Force Majeure event.

Within the Law of some countries there is in effect some degree of Force Majeure provision regardless of whether there is an explicit provision within a contract. The Law requires that the provisions of any contract are not unreasonable and to make a party liable to others for events considered to be Force Majeure may well be considered unreasonable.

It must be noted that one of the common consequences of a Force Majeure event is that contractors must be granted an "Extension of Time" for the completion of their works or services. Whilst they will not be automatically entitled to any additional payment as a result, they will be entitled to additional payment if they are then required to accelerate their programme in order to regain lost time.

3.4. Project Commissioning & Financial Close out

- 3.4.1 Cost Management of Commissioning Works and other outstanding works
- 3.4.2 Management of Outstanding Accounts and Claims
- 3.4.3 Financial Close Out and Final Reporting

Checklist and Guidance Notes

3.4.1 Cost Management of Commissioning Works and other outstanding works

Many issues relating to commissioning work are essentially similar to those for precommissioning (See section 3.3.8)

Identification of Commissioning Works

Guidance

- It is common that the requirements for commissioning works (as for pre-commissioning) were not identified in any detail at the time the project budget was developed. If commissioning is to proceed efficiently it is essential that a detailed schedule of tasks and responsibilities is prepared well in advance of the time at which this work is to start.
- Planning and management of precommissioning and commissioning are substantial tasks in their own right and may well require dedicated staff. Identifying potential costs should be a fundamental part of the preparatory work.

Identification of budgets for Commissioning Works

Guidance

- As indicated above it will be necessary to identify in detail the potential costs of commissioning works well in advance of the start of such works. This can only be achieved by having a detailed scope and schedule for this work, however in most cases this detail will not have been available at the time of preparation the overall project budget and hence it is common that a simple unscoped allowance has been allowed.
- It is common, though by no means universal, that precommissioning works are the responsibility of the project manager and his construction team whereas commissioning is handled separately by the organisation responsible for use (operation) of the facility. It is essential that there is clarity as to who is responsible for what and equally which budget is responsible for the costs of each element of the works. Too often this identification of cost responsibility is left until the work is in progress (or even later) and a dispute arises, which due to pressure of events is not satisfactorily resolved.
- It is not unusual for a contractor to be involved both in work which is covered by the main project budgets and work covered by separate commissioning or pre-operational budgets. In such cases it is vital to ensure that the contractor is required to clearly separate the various costs in an acceptable manner.

Identification of other outstanding works within project scope

Guidance

- It is almost inevitable that at the time when the facilities are handed over from the construction team to the end user (operator) that a myriad of mostly minor items of work remain outstanding. These will include identified omissions and defects, other items (not clearly within the original scope) which are now considered necessary and works which inherently could not have been done earlier.
- It is essential that (just as for the precommissioning and commissioning works) all of these are reviewed and identified who is responsible for their completion and what budget is responsible for the costs.
- In order to control costs and ensure value, this group of works there should be subject to a rigorous review carried out jointly by the project manager and the client addressing:
 - Whether each item is considered essential (even if within the original project scope). i.e. can it be excluded?
 - For items not clearly within the project scope, identify the budget from which they will be funded.
 - Clarify exactly what is needed, e.g. site clearance and restoration can be done to a wide range of levels. Typically whilst the project should be responsible for general clearance, it may well be that landscaping / beautification should be handled and budgeted separately.
 - Who will manage execution of each item, and if necessary transfer of budget to match or arrange for future correct allocation of costs when they arise.

Agreeing budget for outstanding works

Guidance

- It is essential that there is clarity as to what the budget(s) are for and hence the outstanding works need to be itemised and allocated to the relevant budget.

Cost recording of commissioning and other outstanding works

Guidance

- The nature of these works is that the costs will accumulate mostly as individually fairly small amounts from numerous sources. It is also likely that some of these costs will take some considerable time to be received, with considerable scope for costs to be temporarily miss-allocated in accounts.
- It is important to clearly advise each potential cost source of the requirements for providing cost advice both in terms of updated forecasts and invoicing requirements.
- The recording and monitoring of costs arising after project physical completion will take disproportionately a high effort by the cost manager relative to the absolute value of such works.

Checklist and Guidance Notes

3.4.2 Management of Outstanding Accounts and Claims

Confirmation of outstanding accounts and claims

Guidance

- At the time of project physical completion and handover (to the owner / operator) it is quite normal that a number of the purchase orders / contracts have not been financially finalised. This may be due to a variety of reasons including:
 - Confirmation of acceptance of the work has not been given
 - Invoices not received
 - Invoices which are incomplete, erroneous or disputed
 - There remain outstanding works to be completed
 - There are outstanding claims and possibly counter-claims
- It is sensible at this time to carry out a complete review of the financial status of every order / contract which is not as yet financially closed. This review should aim to:
 - What is outstanding, in terms of delivery of required works and services?
 - What payments (or return of performance bonds) remain outstanding against performance guarantees?
 - What payments or credits remain to be agreed in respect of incentive schemes? An assessment of the likely value of these should be made.
 - What is outstanding in terms of financial information such as invoices and other documents?
 - Who must provide and how will outstanding information be obtained. Check with suppliers and contractors that they have (or will within an agreed timeframe) submitted their final accounts.
 - What claims for additional costs have been received and additionally may be expected. Assess both the maximum credible cost and the most likely cost.
 - Identify costs (or other diminution of value) which might be recharged to contractors / suppliers.
 - What additional costs are likely to be incurred for ongoing management of outstanding works and for ongoing project financial management, including where needed support from external consultants / lawyers.

Strategy for finalisation

Guidance

- In the majority of cases there will be no fundamental dispute over the amount due or the dispute is in respect of a small sum of money. In such cases the strategy should be to achieve finalisation as quickly as practicable, there is no value (and potentially considerable administrative cost) in dragging matters out over minor non-compliances or minor monies. Equally in almost all cases the

supplier or contractor is equally also keen to finalise his account. Some steps to facilitate this include:

- Formally request a statement of final account; at the same time indicate any outstanding deliverables and if acceptable indicate a willingness to forgo them in return for an appropriate credit.
 - If a statement of final account is not readily forthcoming, prepare a draft one and send to the supplier / contractor.
 - If there are incentive schemes with payments to be resolved make a proposal for their settlement. (This does not apply to an overall performance guarantee for a complete process plant or manufacturing facility, where performance will only be able to be assessed by specific performance tests and/or many months of in service operation).
 - If there are retention monies, which contractually are to be held over an extended maintenance period, consider whether these are really necessary. The contractor may well be willing to give a small credit if payment is made early. Similarly for outstanding Performance Bonds.
 - If there are disputed costs of small value make a reasonable offer (without prejudice) for settlement without going into all the fine detail of the merits of the claim. This is not to suggest paying against claims which have no merit whatsoever, but simply pragmatism for those small items which have merit in principle, but where there may be disagreement as to exact value.
- Notwithstanding the above it is essential to ensure that any vital outstanding deliverables are provided, e.g. it may not be vital to get “as constructed” drawings of piping systems, but it will be vital to get the operating and maintenance manual for a compressor.
 - Where there is a significant dispute in respect of the value of an account then a resolution strategy should be carefully developed and agreed. The agreement of the strategy must include the client at senior level (i.e. not just the client’s project manager, but those who will be eventually able to authorise a payment) If another party has a liability in respect of any payment then they must also be involved. Steps to developing a strategy should typically include:
 - Ensuring that the final value of any accounts including claims for additional costs is provided by the contractor as soon as practicable. In most cases the terms of contract will include a requirement to provide details within a specified time. This should be enforced so far as is reasonable.
 - Carry out a detailed review by all relevant individuals within the project team of the claimed value. This review should:
 - Involve the engineers within the project team responsible for the interface with the supplier / contractor.
 - Review each element of any disputed amounts, firstly to determine whether they have any merit in principle and then to assess what their true value may be.
 - When reviewing potential value of claims it is important to avoid being optimistic without a sound basis for such optimism. It is useful to aim to identify both a maximum credible value and a most likely (erring on the side of conservatism) value.

- Review and consider how well each element of the claims have been demonstrated, both the principle of the claim and the claimed value. In many cases this may at least in part be deficient.
- Review whether the claims include any “double dipping”. Where elements overlap and the monies have been claimed effectively twice.
- Are there any potential counter claims?
- Identify relevant documentation within the project team organisation.
- Review and consider the likely attitude of the supplier / contractor. In many cases this may be determined by the attitude seen during the course of his work. Will he be reasonable in any negotiation, will he be keen to resolve quickly?
- If claims are large and complex, it may be useful to get an independent opinion. This could range from a qualified individual within the client or managing contractor organisation (but not otherwise involved in the project), to project management consultant to lawyers specialising in engineering construction contracts. Recognise however that such a step will in itself be a cost to the project.
- Are there any issues related to long term relationships
- Develop a strategy for resolution based upon all of the above.
- Claim resolution strategy needs to be agreed by all key parties including the clients senior management, project manager and where applicable the managing contractor / project management consultant. Where an external finance provider has been used, then depending on terms of his agreement, he may also need to be involved.
- In almost all cases it is recommended that a resolution strategy should be progressive, rather than moving rapidly to confrontation. There should always be a recognition that a resort to litigation or formal arbitration is likely to be very costly (even for the nominally “winning” party) and carry a risk of an outcome not aligned otherwise considered merit. In some countries the legal procedure is likely to be very prolonged, and impartiality not always guaranteed.
- Some issues to be considered are:
 - Who will “lead” the claims negotiations and who else is likely to be involved?
 - If information provided to support claims is considered deficient, whether to point out deficiencies prior to start of real negotiations.
 - Should counter claims be presented?
 - What is the initially considered time frame for resolution?
 - Are there outstanding issues (e.g. works or services not yet fully completed)
 - Are long term relationships an issue?
 - Is the use of an independent adjudicator an option to achieve settlement?
 - Is the attitude of the supplier / contractor basically realistic or are his stated aspirations radically beyond anything he has reasonably justified. If the latter is the case the approach may well be to meet with the aim of convincing him of the deficiencies of his claims and then making him a considered “take-it or leave it” offer together with a statement that no further negotiation is intended.

- Will the involvement of a lawyer (internal or external) be of value to clarify the legal position and the perceived probability of success in the event of litigation?

Resources

Guidance

- Based upon the review of outstanding accounts and claims an assessment of resources needed to manage these can be made. This is valuable as typically there is a (usually false) belief that when a project is physically complete the project team can quickly carry out any project closure tasks and then disband. In reality for most, medium sized and larger projects finalisation of accounts and claims will take many months and in some cases years to achieve.
- In reality the ongoing responsibilities need so far as is possible the continued, albeit on an intermittent basis involvement of key individuals who have the relevant knowledge and skills to efficiently handle the required tasks.
- Where the client is using a managing contractor or PMC it is important that he gets the relevant assurance from them that the required personnel will continue to be available as and when needed. Equally the client must recognise the need for ongoing involvement of his own staff. Inevitably some changes in personnel cannot be avoided, but when this is to occur there should be strenuous steps to ensure an orderly handover, including a review of current position and of all relevant documentation.
- Where use of external resource is contemplated, it is essential to identify the terms and scope of their proposed involvement and to ensure that there are funds available for their payment. It should always be assumed that the project (or other client budget) will end up paying for such a resource.

Agreeing payments related to incentive schemes

Guidance

- Some purchase orders / contracts may include schemes which are aimed at incentivising suppliers / contractors to achieve or exceed specific targets within the overall performance of their obligations. In many cases it is impracticable to assess the extent of achievement until the completion of the works and in some cases related to in service performance it will be even later.
- In many cases the extent of achievement and amount of payment (or deduction) due can be determined readily from data collected relevant to the terms of the scheme. In such cases where there is no dispute the payments should be made without delay.
- In other cases (most commonly relating to schedule performance) there is potential for disagreement as to the extent of achievement, where the supplier / contractor believes that failure to achieve is partly or wholly as a result of causes outside his control. In such cases it is likely that this is simply one element of a larger group of claims related to a request for contractual extension of time and will need to be considered as a part of these claims.

- Payments against incentive schemes related to the overall performance in service of the facility will often only be able to be agreed once performance tests and / or a more general assessment of in service performance has been carried out. Where deficiencies are evident it is normally necessary to first give the supplier / contractor the opportunity to carry out remedial works. If he fails to do so the client may then:
 - Notify that he intends to carry out remedial work himself and recharge the cost
 - Suggest a settlement to reflect the diminution in value of the facility provided based upon the incentive scheme.

Additionally the client may wish to claim for losses related to non-performance over the period up to when the issue has been resolved.

Claims for damages resulting from non-performance

Guidance

- It is not uncommon that when the supplier asserts that he has completed all of his works and /or services there remain, in the opinion of the client (or his managing contractor or other agent) some outstanding deficiencies and omissions. Most commonly this is issued to the supplier / contractor as a outstanding works list with a request that they are remedied as quickly as is practicable and in most contracts it is a requirement that the supplier / contractor is given this opportunity.
- By agreement alternative solutions may be appropriate:
 - That the deficiency can be excluded, with in some cases an adjustment to reflect diminution in value.
 - That the outstanding works / services will be carried out by others and the client will recharge the cost.
- In cases where non-performance has resulted in additional costs to the client, (e.g. additional costs from other contractors) he may decide to make a counter-claim on the supplier / contractor.
- A further category of non-performance is emerging defects, i.e. defects which only become evident (and which could not have reasonably been identified earlier) after acceptance of the facility. If this occurs before settlement of the final account with the supplier / contractor is can be handled like any other defect (see above). However a defect may appear many months or years after acceptance in which case it will have to be treated as an entirely separate issue. Note under many legal systems acceptance of the work does not preclude legitimate claims for emerging defects at a later time. Some will identify a specific number of years under which such a claim can be made others will judge on the nature of the defect. In any case there will be a need to reasonably demonstrate:
 - The claim is not trivial
 - It does not relate to normal wear and tear or accidental damage
 - The item concerned has not been misused
 - That it has been properly maintained

Checklist and Guidance Notes

3.4.3 Financial Close Out and Final Reporting

Transfer of assets to business accounts

- A fundamental part of being able to close out a project is to finalise all accounts related to that project and to enable the client to incorporate the capital and revenue amounts into his overall business accounts.
- The business will often wish to do this as soon as is practicable for good management, statutory accounting and taxation reasons.
- Hopefully the required detail will have been identified at the time the project accounts were set up so that there is general compatibility.
- For reasons indicated above project accounts may not be wholly finalised for a considerable time after project physical completion, and it may therefore be necessary to carry out a transfer representing the whole of payments made plus any other firm uncontested commitments whilst retaining a residual project accounting system for outstanding items (outstanding works plus settlement of claims etc.)
- If it is intended to transfer data fully electronically then it is strongly recommended that some form of representative test transfer is first carried out to validate the system. Naturally if it is an already proven process this may not be necessary.

Claiming of grants etc.

- Grants from government agencies or others are often not paid in full until it is demonstrated that the facility concerned meets the agreed performance criteria. In such cases may well be necessary for a formally certified performance statement with supporting documentation to be provided.
- Clearly claims for any such grants should be made as soon as practicable and the needed resource provided and work to make the claim should be carried out.

Close out of project accounts

Guidance

- In Practice (for reasons stated above in 3.4.1 and 3.4.2) it may well require considerable time and resource to fully close-out all project accounts. A real effort should be made to close out each element of the accounts as soon as is practicable.
- There may well come a time when the project team is effectively disbanded some accounts remaining not finalised. It is important that whoever becomes responsible for management of those accounts has all the relevant information and also relevant contacts to be able to resolve issues which will arise.

Final cost Reporting

Guidance

- It is good Practice for all large projects to prepare a project report and a fundamental part of this will be the cost report.
- The cost report should be concise and focus on aspects which will provide learning and guidance for those who may be considering broadly similar projects in the future. Some cost management issues which typically should be addressed include:
 - Was the project budget estimate realistic? If not why not?
 - Was it simply based upon an inadequate scope?
 - Was the deficiency general or confined to a few specific elements? If the latter what were the root causes?
 - How accurate was the unit cost data used for the estimate?
 - Highlight major deviations between budget and actual outcome and briefly summarise the root causes.
 - What was the cost of any delays to the schedule?
 - What was the cost of major claims and why did they occur?
 - What was the overall cost (including indirect cost if it can be determined) of Scope Changes?
 - If scope changes had a significant impact on project outcome, how can a similar situation be avoided in future?
 - Did the Scope Change and Contract Change procedures operate effectively?
 - Did the forms of contract used provide the optimal means of managing costs for this project? (this is a judgement issue which will inevitably be a matter of opinion)
 - Was cost management adequate and what could be improved in this respect?

4. Estimating

- 4.1. Estimate Categories
- 4.2. Estimate Quality
- 4.3. Project Schedule influence on estimated cost
- 4.4. Estimate Scope
- 4.5. Study / Development Estimates
- 4.6. Estimates for provision of advanced funding
- 4.7. Estimate quality required for project authorisation
- 4.8. Estimating techniques
- 4.9. Location factors
- 4.10. Escalation
- 4.11. Currency fluctuations
- 4.12. Contingency
- 4.13. Cash flow

In almost all cases the development and definition of an engineering project will require cost estimates to be produced and in many cases further estimates will be required during project implementation. Estimates may be required to evaluate different options, to assist in assessing economic viability, to identify cash flow requirements, to obtain funding for next stages of the work and to seek final approval to implement the project. The aim of this section is to provide an extensive overview of the key aspects and issues relating to estimates, which form a key part of overall cost management. The parties that utilise the output data from the estimates must have a sound appreciation of the issues and hence the requirements and limitations of the various categories of estimate.

A plan for the preparation of estimates should be included within the overall planning for the project. When deciding what estimates should be provided the following should be considered:

- What detail of information is likely to be available at the time the estimate is required. It is unlikely that sufficient detail of scope for high accuracy estimates will be available until project definition is substantially complete.
- Improving estimate accuracy requires greater detail of the scope of the work/specification and the time schedule.
- For comparison of options, it is unlikely that more detailed estimates will result in a major change to the relative costs of the options: the inaccuracies are likely to be broadly similar for all cases.

The limitations of early estimates should always be highlighted to all parties, in particular business management who will later be asked to authorise the project against a more definitive estimate. There is a strong tendency for management to assume that first indicated figures will not be exceeded. This is often a wholly unrealistic aspiration, as usually these early estimates are based upon an incomplete scope of limited definition. It needs to be emphasised that, for a typical order of magnitude estimate, the eventual project cost can exceed the base estimate by more than 50% within the error limit, even if the scope does not change.

4.1. Estimate categories

Estimates can be broadly categorised as follows:

Type	Purpose	Accuracy Required
Order of magnitude	Early appraisal to assess fundamental economics. Initial review and ranking of options	±60% - ±30%
Study	More detailed economic appraisal. Final selection of best option, scope optimisation	±40% - ±25%
Advance funding	Approval of limited funding to allow further development/definition works, initiation of detailed design, ordering of long lead materials, execution of enabling works.	±30% - ±10%
Budget / sanction	Approval of budget to allow project execution	±20% - ±10%
Review / control	Cost review/control during the project execution	±10% - ±5%

The Accuracy figure stated above may be defined in a number of different ways. There is no right or wrong way, but it is always important that the definition being used is clear to all concerned.

An alternative presentation approach, particularly valuable for early estimates, is to assign levels of confidence to various figures. For example, three costs could be stated:

- 50% confidence - where there is a 50% probability of the figure being exceeded.
- 80% confidence - where there is a 20% probability of the figure being exceeded.
- 95% confidence - where there is a 5% probability of the figure being exceeded.

The three cost figures will differ, but this may give management a better appreciation of the possible overrun. It is essential that a proper evaluation of cost probabilities is carried out in order to ensure that confidence levels are realistic. In practice, this requires the preparation of cost probability curves as shown in chart 4.1

4.2. Estimate quality

The quality of any estimate is limited by:

The quality of the scope of work and specification

How well has this been defined:

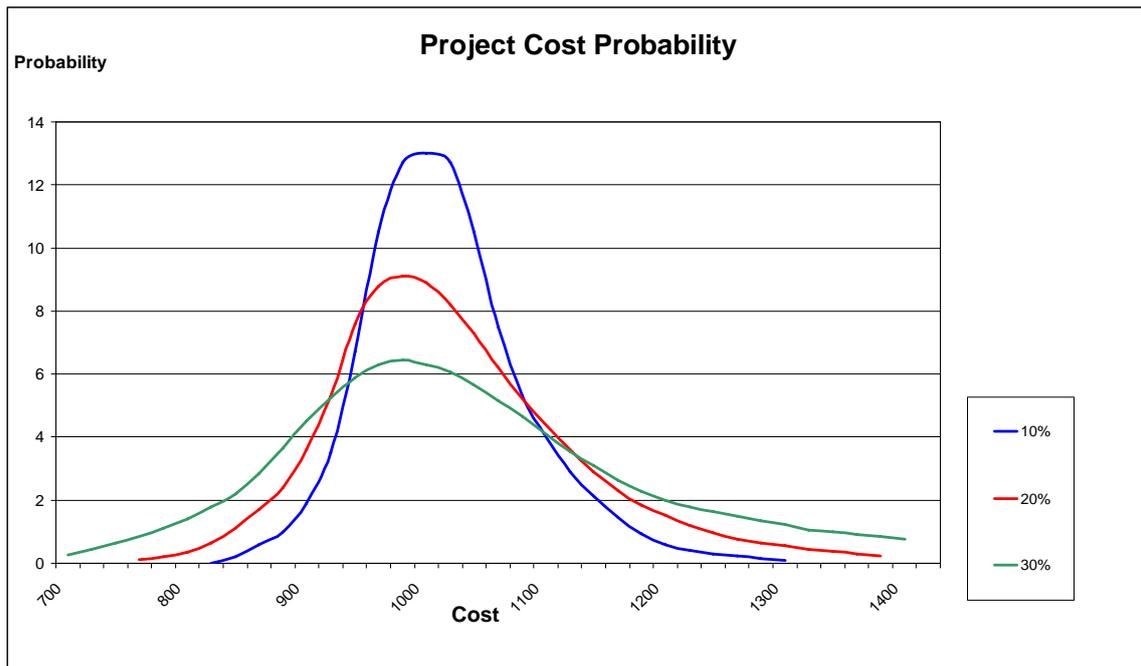
- The extent of design and engineering work needed.
- The physical content of the equipment and materials (quantities and specifications) to be supplied
- The construction work to be done.
- The circumstances under which the parts of the project will be implemented. Time pressures may require payment of premiums. Difficult working conditions may result in lower productivity.
- Identification of scope items (if they are to be included) such as temporary works, temporary facilities for construction labour and supervision, insurance, cleaning, waste disposal, spare parts, document updating, training, first fill process materials, transport, project team travel and other expenses, import duties, project-specific medical and security provisions.
- An assessment of the quantity of management required for the project to be developed and successfully implemented.

The quality of cost data available

- How accurate is the pricing data for each element of the identified scope? Is it based upon current data or historic data? If the latter, how old is the base data? Data which is 1 year old will usually provide a fairly good basis, but if it is 10 years old then it will be very difficult to accurately update the cost.
- What are the vulnerabilities to short term changes in rates and prices? Bulk materials are vulnerable to changes in the world prices for raw material commodities which in the recent past have been very volatile. Custom-made items and specialist services are likely to be priced at levels which reflect current market demand. For example demolition works pricing is dependent upon current prices for scrap metal, which can fluctuate significantly. Prices for engineering design may reflect how busy local engineering contractors expect to be in the near future.

The above limitations apply to all projects. The later in the overall development and design of the project that an estimate is carried out; the more accurate the estimate is likely to be as the data upon which it is based is more detailed and more likely to be accurate.

The following diagram shows the cost probability curves for a typical project.

Chart 4.1 – Typical cost probability for 10%, 20% and 30% estimates

The curves have been drawn to reflect common reality for typical projects. The following points should be noted:

- The curves are not exactly symmetrical. There is a distinct credible limit of possible cost at the low end, but at the high end there is a diminishingly low but still credible possibility of very high costs beyond the shown extent of the curves.
- The $\pm 10\%$ estimate shows that whilst there is no credible probability that cost would be less than 800, there is a small but entirely possible risk that the cost will exceed 1200. The same principle applies for the other curves.
- The $\pm 10\%$ curve shows that there is a distinct possibility, with some 10% probability, that the actual cost will exceed the median cost by more than 10%. That is, there is a 10% risk that project cost will exceed 1100. For the 20% curve, there is approximately a 10% risk that the cost will exceed 1200.
- The most probable cost for the project tends to increase as estimate accuracy increases. For the curves above it moves from 960 for the 30% estimate to 1000 for the 10% estimate. This reflects the most common typical outcome for estimates against a common overall scope. The reality is that the provision of more detail for the higher accuracy estimate usually, though not always, uncovers more items or specifications which increase cost versus those which decrease cost.

It is important that all those involved with the preparation and use of an estimate understand what the terms used to quantify it mean. For example, the commonly-quoted '10% estimate', which is often used as a basis for project authorisation, can have a number of different detailed definitions. It is not the case that one definition is correct and the others not; what matters is that all those using the estimate have a common agreed definition. The detailed definition needs to address:

- What 10% (or 20%, 30% etc.) means. A typical meaning is that there is an 80% probability that the actual cost will fall within 10% of the mode figure.
- What the mode figure represents. Typically this is the value at which there is a 50 per cent chance of over-spend or under-spend. This should include provision for those uncertain costs which have a probability of 50% or more of occurring.
- Whether the estimate includes any contingency. This may be provided for several reasons and it is necessary to identify which contingencies are included and which are excluded. See section 14.12 below.

4.3. Project schedule influence on estimated cost

An estimate is generally only valid for the programme against which the project has been estimated. If, as often occurs, the programme is substantially changed, then there is significant risk of incurring additional cost in order to achieve the revised programme.

- It is very common that the development phase takes longer than initially foreseen. Almost inevitably, this means that more work-hours will be consumed, resulting in higher cost. It may also result in the time for implementation being compressed, although this is usually a lesser cost risk than failing adequately to complete the development work.
- Repeated starting and stopping of project development causes inefficient working and hence higher costs. This is particularly the case in the implementation phase.
- Compression of project implementation (fast track) brings a significant risk of additional costs, arising largely from the requirement for more intensive management, premiums for shortened deliveries, overtime payments etc. Where the appropriate planning and fast track processes are in place additional costs may be offset by savings on time related costs. If, however, a fast track process has not been planned into the project at time of authorisation, but acceleration is later imposed, then additional costs will inevitably occur and there is a high possibility that the required earlier completion will not be achieved. This is often the situation when project authorisation is delayed but the original completion date is maintained.
- An overall delay to a project is likely to lead to unit cost escalation and to additional cost of time related elements such as project management.

4.4. Estimate scope

It is essential that the scope covered by an estimate is always clear to all referring to it. In many cases, the main budget estimate does not cover all activities associated with the project and if these are not clearly identified, it is probable that, during the later implementation, stakeholders will have differing views of what was included.

In all cases, there should be a statement of the basis of the estimate. This should typically include:

- A summary of the scope of with particular reference to boundaries (physical, work content and time).
- A statement of accuracy and whether the total estimated value represents a 50%/50%, 90%/10% or some other percentage for risk of exceeding the stated estimate.
- A statement of contingencies included in the estimate.
- Identification of the implementation programme assumed.
- A listing of known items specifically excluded and, if possible, how it is intended that these items will be funded. Appendix C provides a listing of items which may commonly be included or excluded from a project capital cost estimate, dependent upon the approach.
- Identification of any significant specific cost risks.

At a later stage it will be necessary to provide an estimate breakdown suitable for project cost control. So far as is practicable, the breakdown should be into cost elements which match the physical work breakdown structure.

4.5. Study / Development Estimates

For almost all projects, there is a legitimate requirement to provide initial estimates to allow a management assessment of the basic viability of a proposal and, if there are distinct options available, which one(s) should be pursued. If an organisation has a defined development process, then it is probable that these requirements are included. At this stage there is no need for high quality estimates, but it is imperative that the quality and limitations of the estimate provided are made clear to those who will make decisions based upon it. There is a tendency for businesses to remember figures stated in early estimates, but to forget the qualifications attached to them, with the result that when (usually higher) figures are presented as a result of later authorisation quality estimates, there is considerable discontent. Points of note are:

- When comparing options, provided that a similar basis has been used to assess each, it is unlikely that the relative ratio of costs for each option indicated by an early order of magnitude estimate will change significantly as a result of later, higher quality estimates. The inaccuracies will usually be broadly similar for each option unless the scope of an option has changed significantly. An exception to this is where one option is estimated based upon a recently completed very similar scope project, whereas other options are not.

- Commonly, early estimates tend, for a number of reasons, to understate the final cost. It is therefore vital that any financial evaluations of commercial return and reservation of funds in capital programme budgets recognise this. Viability should always be tested at project cost figures higher than the estimate. If the estimate is a $\pm 30\%$ figure, then there is probably a need to test at base estimate cost plus 50%. If the proposal cannot pass such a test, then there is necessary to review whether to proceed and, if so, whether specific cost reduction measures must be considered.
- Early estimates often only address the core project (i.e. items such as permit costs, off-plot facilities, temporary facilities, insurances, commissioning costs etc., may not have been addressed or at best a simple allowance has been included). This is acceptable given the purpose of the estimate, but should always be made clear.

4.6. Estimates for provision of advanced funding

There is often a requirement for funding for a project prior to the request for full authorisation. This may cover project development and definition works, certain permits, land acquisition, surveys, land improvement works, purchase of long delivery materials items, detailed design works, etc.

It is important that such early funding requirements are identified and notified to the business management as early as practicable within the project development phase. At this time, agreement should also be obtained on the requirements needed to obtain approvals of such funds. Advanced funding approvals should be an integral part of any stage-gate approval process. Key issues are likely to include:

- Who has the authority to approve advanced funding and what is the required process? This is likely to depend upon amount required.
- What quality of estimate is required for the funds to be applied for?
- What preliminary appraisal of the overall project is required to support the request?
- Why the funding is required at the given time and what are the likely implications if authorisation is not given at the requested time?

If a single application for advanced funding covers several discrete purposes, it is good practice to identify clearly the amounts required for each purpose.

4.7. Estimate quality required for project authorisation

There is a legitimate business need for a projected cost of sufficient quality for the project to be evaluated and authorised prior to irrevocable commitment of significant expenditure. It is essential that the project team, the business and those authorising the budget understand what the quality of given estimate is and appreciate there is a trade-off between quality (accuracy) and the extent of data and work needed to achieve that quality.

An agreement must be obtained as to the required estimate accuracy for project authorisation. The often-stated requirement for a '±10% estimate' may need to be challenged given the work and time needed to provide this for certain types of projects. This is a particular problem for those smaller projects, typically retrofit, which are scope unique, that is with little or no scope commonality with already-completed projects, and hence have a very limited ability to use historic data from similar scope projects.

It is always good practice to test the viability of a project proposal at cost levels higher than those indicated by the estimate. Even when the authorisation estimate is genuinely a ±10% figure it would be normal to test at +20% or even +30% for continued viability.

Authorisation estimates should always clearly state what contingencies have and have not been included. If there is any specific significant cost risk item which has not been included, this should also be identified.

4.8. Estimating techniques

Database of similar plants or structures

Where a proposed new process plant or structure will utilise a similar process / design parameters and have a similar capacity to others which have been constructed in the recent past, that is (up to 5 years), then, assuming accurate costs are available from the earlier projects, such data provides one of the best ways to estimate the core project. In particular, where there is an extensive database of multiple projects, the averaged data may be considered highly reliable. For example, there is extensive data for gas turbine electric power generation plant, for polyethylene and polypropylene plants, for liquefied natural gas plants for roads and road bridges as all of these are constructed fairly frequently around the world to a limited number of basic designs. This gives a valid basis for estimating new projects.

Care must of course be taken to account for differences including:

- Scale – larger scale projects cost more, but not proportionately to capacity (see below).
- Escalation – it may be necessary to address separately design and management, materials and construction, as escalation rates tend to differ significantly.
- Location – costs depend upon location due to a number of causes. Again, there may be a need to address separately design and management, materials

and construction, as the impact of location will vary significantly for different cost elements.

- Cost of infrastructure. Even basically identical plants will have different associated infrastructure (off plot utilities, roads, warehouses, offices etc), and these elements will have to be estimated individually based on scope.
- Financing costs, contractual terms. These may well influence the overall project cost.
- Scaling factors .
- Scaling is only valid for items which are closely similar except for scale. Two pumps of same power consumption but one rated for high head low flow, the other for low head high flow are not sufficiently similar.

Pricing individual cost items using current market data and judgement

Estimating by pricing each cost item within the scope of the project is usually the only means of achieving a high quality, high accuracy estimate. The downside of this approach is that it requires not only a detailed scope of work but also sufficient design details to enable an accurate take-off of sizes, specification and quantities for each element of the scope. The work involved in quantifying each element and converting it into costs is labour intensive, even with the use of computer based estimating tools.

Materials

Market data is readily available for most commodity items, such as standard building materials, structural steel, piping components, cabling, lighting, small tanks and vessels, small pumps, LV switchgear, standard instruments, insulation materials. Provided that the estimator ensures that data is up to date, then it can provide accurate guidance. However, the following must be taken into account:

- Significant discounts may be available for large quantities and/or against long-term supply agreements
- Where materials are sourced from outside the locality where they will be installed, provision must be made for transport costs and import duties.
- If materials are required for delivery in a shorter than normal period, there may be a significant premium cost.
- Some countries have local content obligations which may require purchase of materials at prices higher than free market levels.

For custom made items and those such as large vessels, reactors, heat exchangers, compressors, large pumps, special pumps, HV switchgear, special instruments, special valves, bespoke laboratory equipment or any item made from exotic materials, there is usually no readily available market data. So unless there is specific information from a closely similar item procured in the recent past, then the only reasonably accurate means of estimating cost is to obtain quotation(s). These must be treated with care as they are often obtained against a preliminary specification and this may result in significant deviation from actual costs when purchase is made.

Design and Engineering

Hourly rates for design and engineering (D&E) works are readily available and indeed most contractors are willing to provide their current guideline rates to a client considering use of the contractor. Contractors usually estimate the total cost for D&E by allocating specific work-hours against each material item in the scope, utilising norms from their database of experience on previous projects. Adjustments are then made for items such as complexity. Additional issues to be considered include the following:-

- Site visits will be required by the design team. If the location is remote, such visits may involve significant cost.
- Retrofit projects are not only complex, but may need additional work to review existing plant design, design of elements to be modified or removed and how to integrate new with existing. It may well be essential to employ a site design team for part of the work.
- Where elements of the design are to be sub-contracted, for example architectural design of a building, it is not only necessary to identify the costs of the sub-contract but also to make provision for co-ordination.
- Provision must be included for design team follow up to support design issues arising during construction works.
- If there is likely to be an extensive need for overtime, working, allowance must be made in the rates
- Contractors' openly quoted rates may not be the same as those they utilise when tendering on a lump sum basis.

Construction Contractors

Different approaches are often adopted for different types of construction works. These include:

- Building, civil and steelworks. The construction contractor normally supplies materials, and often carries out design detailing; so provision for those costs must also be made. Typically, the cost of such works is estimated based upon material content rather than work-hour content, for example cost per tonne of steel or per square metre of brickwork.
- Ground works, including piling, will require a specific design for the location. This type of work usually cannot be assessed on the basis of any norms, so often quotations against a preliminary scope are required.
- The costs of internal fittings for buildings are very dependent upon specification.
- The costs of temporary facilities must always be addressed. These include items such as temporary roads, hard standing for lay-down areas, fences, construction huts for labour and offices, site security, temporary utilities, etc. A specific assessment of requirements for the project will normally be required
- Piping fabrication and erection costs are extremely dependent upon material specification, design complexity and construction location congestion.
- The cost of installing equipment depends on the difficulty of access. If large cranes (>100T) are required, this can be a significant cost and is time related.

- Scaffolding costs are notoriously difficult to assess and are very commonly under estimated. Whilst the major scaffolds can be identified, there is always a requirement for additional smaller scaffolds and numerous scaffold modifications.
- Assessment of likely productivity must be made. This varies significantly from country to country and even regions within countries. If significant overtime and/or double shift work are foreseen then unit productivity will decrease.
- Overtime working on construction results in additional cost, both directly due to the higher rates payable and indirectly due to resultant loss of productivity.
- Retrofit projects by definition involve construction within existing plant, and this results in lower productivity than on a 'new build' construction site. The extent of lower productivity and hence higher cost depends upon a number of factors.
- Assessment of unit labour cost must be made. If the site is in a region where there is regular work of a similar nature, then rates are likely to be well established, though if there is a shortage of skilled labour due to high workload there may be a need for premium payments. For remote locations, it will be difficult to assess rates not least as it is likely that labour will need to be imported and provision included for a labour camp or lodgings.
- Provision must be include for work associated with testing, punch listing, handover and precommissioning. This work is labour-intensive and must often be carried out on a shift work basis. Additionally, certain specialist contractors may be required, for example chemical cleaning, and at the time of the estimate it will be difficult to quantify such work with accuracy.

Project and construction management

- These include the costs of the owner's project staff, of any PMC contractor/consultant and the management costs of any EPC contractor. To some considerable extent it, must be expected that tasks carried out by one party will not have to be duplicated by another. For complete new plant projects, major contractors will normally have statistical data to assess what percentage of total costs will be required for management. The following points are of note:-
- In general, small projects require proportionately more management than large.
- Retrofit projects will require proportionately more management.
- Contracting and procurement strategy will influence the amount of management required.
- Fast-track projects will need more management for the period they are in execution, but cost may be reduced by shorter durations, assuming the fast track strategy succeeds.
- The size, and hence cost, of the owner's project team in the project implementation phase will depend upon the extent to which the owner requires to audit the contractor's work.
- Where expatriates from high-income countries are involved, costs will be very significantly higher than for local staff.
- It is necessary to identify whether any owner's senior management costs will be charged to the project in respect of their occasional involvement. The same applies for the owner's plant operations management.

Commissioning

Such costs are difficult to estimate as the detailed procedures, activities and resources required are rarely well defined at the time of the estimate. Commonly, commissioning requires more effort and time than initially anticipated, especially if the project is a one-off (that is not a repeat of a plant/facility previously constructed to similar specification). For well-established processes, it may be possible to estimate on the basis of statistical data from other similar plant. It is essential to identify and agree what elements of commissioning will be charged to a project budget. For many smaller projects related to existing facilities, commissioning costs may either wholly or partly be absorbed within the plant operating budget. Commissioning costs may include:

- Cost of labour (operators and technicians) carrying out the commissioning and their supervision. These may be the owner's existing employees at the site, owner's employees brought in from other locations, contractor employees, licensors' employees or a combination of these.
- Equipment commissioning engineers, provided from vendors and contractors.
- The cost of materials and utilities consumed in the commissioning work.

Other elements

In addition to the above, a number of other elements may require inclusion in the estimate. These may embrace:

- Costs associated with project development and definition. By the time that an authorisation-grade estimate is to be produced, these costs should be reasonably accurately known as a significant portion will have already been expended, and others should be well identified to the extent of detailed forecasts for each element of outstanding work and other costs.
- Cost of any permits required.
- Cost of project financing. If this requires borrowing money from banks or others, there will be interest payable and possibly an arranging fee.
- Insurance, where provided by the owner. Insurance provided by suppliers and contractors will be included in their tender prices.
- Spare parts to be provided.
- Computer hardware and software, including the costs of installation, data loading and training. These can be significant.
- Travel costs for the owner's project team and contractors' engineers visiting vendor premises.
- Cost of financial and technical auditors.
- Public affairs costs. Certain large high profile projects will need to publicise what is going on, hold events to keep local authorities and others positively disposed; there may be a desire to support certain local organisations, including charities, as a goodwill gesture.

4.9. Location factors

The unit cost of many elements within an estimate will depend upon the location at which the project is to be constructed. In other words the cost of two technically identical plants is likely to be different as a result of their being differently located. There exists published data (in industry journals and within industry organisations) providing location factors for overall project cost for process plant which can be used as a means of adjusting the known cost based upon existing plant to fit a new location. Use of this technique is reasonable for preliminary estimates. However its use is constrained by a number of limitations:

- In reality, the location factors are different for the various elements of a project. (design, materials, construction etc), so the overall factor is dependent upon how much of each element make up the total cost.
- Costs may vary significantly within one country, so for a factor to be useful it must apply to the specific location.
- Location factors change over time as a result of differential escalation of costs and movements in currency exchange rates. Hence, any data which is several years old must be treated with considerable caution.
- Patterns for procurement of materials and services are changing rapidly with a major increase in international purchasing. This will certainly influence location factors.

4.10. Escalation

It is always essential to identify the time validity of the data used for an estimate. Most commonly, estimates are prepared on the basis of price levels valid at the time of the estimate and then a provision for future price escalation is added. Recent (2003 onwards) significant mostly upward movements in prices for basic commodities have caused an increase in the volatility of material costs, including manufactured items, and therefore the issue of cost escalation has become more important and difficult to assess.

The difficulty in identifying an appropriate provision for escalation is that the rate of price change for the cost elements which make up the estimate may differ from one another considerably. Some recent trends are as follows:

- Design, engineering and project management staff costs are rising on a work-hour cost basis faster than general wage rates due to shortage of experienced personnel. Overall D&E costs may also be affected by the following:
 - For major projects some work is now being carried out in lower wage cost centres, mostly in South and East Asia. This generates lower costs, though not on the scale of the difference in wage rates as productivity is usually lower: in addition, there is a requirement for additional co-ordination between the contractor's offices.
 - Productivity gains have been achieved by the introduction of CAD and CAE systems over the last 15 years. It appears that the rate of gain for process plant design is tapering off.

- Some lowering of design and engineering cost may occur as a result of the engineering contractor sub-contracting detail work to vendors and construction contractors. Only a portion of this is a real gain as the balance appears as a cost elsewhere.
- Materials costs. Prices overall were slowly declining until 2003, but this trend has been dramatically reversed with rapid, though uneven increases in many commodities. There are presently (2008) real difficulties in predicting the future cost of many commodities and there are considerable differences for particular types of material.
- Comparative costs for instrumentation and control systems are difficult to track due to the rates of change of technology and the levels of automation, safeguarding and data handling specified.
- Construction costs. Construction cost levels and changes in those levels are dependent on location. Cost levels are also significantly affected by the balance of supply and demand. In construction there is a slow general improvement in productivity, but construction costs are increasing much faster than general inflation (2005-08). This appears to be generally true worldwide, but with variance as to the degree.
- In high wage economies and for remote locations, there is a trend towards modularisation with more work carried out offsite. This can reduce overall costs and will tend to move costs towards the materials component of the estimates.
- Costs for process plant demolition works are significantly influenced by the short term value of scrap material, especially steel and copper

Where an estimate relies on historic cost data, especially if the cost data is more than 5 years old, then the level of escalation to be applied should be considered very carefully as it is unlikely that a simple application of a published price index will provide an accurate result.

4.11. Currency fluctuations

For many projects it is likely that a significant portion of the actual costs will arise in a number of currencies different from the host country. Additionally, for major projects, if the owner is an international company then it is probable that the estimate provided for project authorisation and subsequent use as a budget for cost control will be denominated in that company's main accounting currency.

It is difficult to predict accurately currency movements even for a few months ahead, so any estimate which has significant exposure to currency fluctuation must clearly identify the exchange rates assumed and what, if any, contingency has been included.

Currency risk can be managed by the owner in various ways:

- Accept the risk and make a contingency provision.
- Hedge the risk by purchase of currency options at fixed rates.
- Move the risk to contractors and vendors by requiring contracts priced in the owner's accounting currency. The contractor/vendor will assess the risk and try to build it in to their prices.

4.12. Contingency

No estimate can precisely identify the cost of each of the individual elements which will eventually make up the overall project cost. There are four basic uncertainties and hence causes of a need for contingency. These are:

- Cost uncertainty covering the exact unit cost to the project of a known item.
- Scope uncertainty: - how many/how much of an item or service will be required?
- Specification uncertainty - what are the detailed technical requirements for an item or service?
- Schedule uncertainty

For most projects, all of the above will apply to some extent. Clearly, the more detailed the definition of the project scope, specification and certainty of the required schedule, then the amount of contingency required is reduced. Hence, in almost all cases, a $\pm 10\%$ estimate will need a lower contingency provision than a $\pm 20\%$ estimate.

For any estimate, a clearly-identified approach to contingency provision should apply and be agreed by those authorising the project. Issues will include:

- Provision for items with a $>50\%$ chance of occurring. Usually, this provision is categorised as growth and is included within the base estimate rather than as a contingency. Not including it would condemn the great majority of projects to overspend their budget.
- The provision of a general contingency added to the base estimate in order to reduce the risk of overspend to a more manageable level. Typically, this will reduce the risk of overspend to 10% (that is 90 / 10% under-spend/over-spend confidence). Usually, this contingency is released, wholly or in part, for use by the project manager as they see fit. It is unrealistic to require separate approval/release for the numerous, mostly relatively small, requirements for use of contingency which will almost always arise during the execution of a project.
- Provision of specific contingency for a particular significant cost risk item. Typically, such a contingency is identified and a 'risk fund' established. This money is only released in the event that a request is made as a result of the identified risk(s) occurring.
- Schedule maintenance contingency for fast track projects, to provide for additional expenditure which may be needed to safeguard a critical schedule, for example premium delivery payments, additional overtime payments. Premium payments which are identified as required or probably ($>50\%$) required at the time the estimate is prepared should be included in the base estimate, not as a contingency.
- Provision for minor scope changes. Such a provision may be appropriate especially for new technology and retrofit projects where the detailed design, inspections or even early operation may result in a need for changes. This should not be confused with scope growth which occurs as the design and engineering of most process plant project progresses.
- Provision for currency risk.

The last four of the above contingency requirements are often not included in the project budget under the control of the project manager, but are retained by the owner's management, for release in the event of the specific event(s) occurring.

4.13. Cash flow

For all but the smallest of projects, the owner's business will wish to know what the predicted cash requirements will be. Depending on the scale of the investment, this may need to be included in the overall corporate capital budget forecasts or, if smaller, included within the location's general annual provision for small project expenditure.

Typically, an initial forecast is provided at the time the proposal is placed on the project development list (that is it has been accepted in principle as an item to be developed). At that stage, the cost is usually no better than an order of magnitude and expenditure timing is identified only on an annual basis. In some cases, inclusion of the project proposal may have a 'knock on' effect on other project proposals, as many organisations impose limits on total annual project capital expenditure.

At the time of request for project authorisation, it is likely that, other than for very small projects, the business will require a more detailed forecast of cash flow timing. The need will be for quarterly figures (or even monthly for major investments) and may include both:

- Identification of timing of financial commitments
- Timing of cash requirements

The timing of cash requirements is normally derived by addressing the individual elements of the estimate, looking at the terms of payment for each and then identifying when payments would be made taking into account the timings in the project schedule. From this, an overall cash flow for the project can be constructed. It is important to take a realistic view based on experience, as cash flow is of major importance to businesses.

In some cases, the identified cash flow may present a problem for the business. In such cases, it may well be possible to change the expected cash flow by changing terms of payment. Of course, changes in terms of payment may well influence the absolute cost of an item. Changing terms of payment should only be done, other than in truly exceptional circumstances, before placing an order and preferably before obtaining a quotation. Changing terms of payment after order placement is usually a highly contentious step with negative impact on relationships.

Retention monies, performance bonds etc. can have a significant impact on cash flow for both the client and for contractors. Their use should be considered carefully as they can result in an increase in the total cost of a contract.

5. Project Financing

When considering options for financing, the potential costs associated with that financing need to be addressed including whether these costs will be borne by the project or more generally by the clients overall business.

5.1 Internal financing

Almost all small projects and some larger ones are financed internally by the owner(s). This may involve an increase in general borrowing, but not directly linked to the project. Whilst internal financing removes a significant task and uncertainty from the project development, it does not diminish the need to demonstrate its financial soundness. The owner's overall business management and finance department will wish to be advised of both the total anticipated funding requirement and also its timing in order to manage the overall business finances.

Where projects are carried out under the provisions of a joint venture, it will be necessary to ensure that all the joint venture partners (owners) are advised of funding requirements. In some cases the share of funding for a project may not be in the same proportions as the overall ownership of the joint venture, and in such cases it is vital that the different financial obligations of the joint venture partners are clearly stated and agreed. This should be agreed as early as is practicable in the project development.

5.2 Financing of project development works

Even where projects will be wholly or partly externally financed, it is unlikely that such financing will be available for the development phase. Hence, the owner(s) will need to finance this work themselves. The following decisions will be needed:

- To what extent will development costs be charged to a project budget or to normal operational budgets?
- If operational budgets are to be charged. It is essential that these costs, if of any significance, are provided for at the time the budget is set. However, some development costs relate to the time of individuals who may well have been provided for in the operational budget in any event.
- If a discrete budget is provided, normal practice is that the costs charged will eventually be included in the overall project costs if the project proceeds through implementation. However, in the event that the project is not sanctioned or is abandoned as incomplete, it is usually not possible, for fiscal reasons, to capitalise expenditure and costs must be written off in current year business accounts.

5.3 External financing

Many high-value projects are financed wholly or partly by parties other than the owner(s). Financing routes include loans from banks, venture funds, loans or grants from government agencies and occasionally from customers or suppliers. It is beyond the remit of this handbook to address the full detail of the terms upon which this financing is provided, but certain aspects are likely to impact directly upon the development and definition of the project and these are identified below. In order to get an application for financing into detailed consideration it will usually be necessary to prepare a project information memorandum. This should set out the key aspects, in particular the preliminary commercial appraisal and details of the amounts and timing of financing required including preferred arrangements for repayments. Such a memorandum is only the starting point for what may well be lengthy and complex negotiations.

5.4 Banks & Venture Funds

Banks and Venture funds will require considerable information concerning the proposed project in order to assess and limit their risk. Negotiating the terms of a loan will be a significant activity which may extend over many months. The project manager responsible for project development will require support from the owner's finance and legal departments. Typically, banks may require:

- A detailed economic appraisal of the project, usually with review by a third party.
- Prior to final commitment of the loan, a firm cost estimate based upon a detailed scope and/or a fixed price tender for project implementation.
- Banks are unlikely to release funding until the project is fully authorised for implementation and may well link releases to achievement of specific milestones.
- Banks are often very keen that major contracts are entered into on a fixed price (lump sum) basis in the belief that this provides improved cost certainty. Whether this is truly the case, will depend upon a number of other issues, not least the quality of project definition.
- Banks are likely to require either their own staff or an independent party regularly to audit the validity of payments and cost projections. This work may well be an additional charge against project cost.

5.5 Government grants and loans

Governments may be prepared to support projects if they are complementary to their policies. This may relate to the creation of new employment or securing existing employment, support an industrial policy or the achievement of significant environmental benefit. In some cases, even quite small projects may be eligible for government grants, particularly if they are delivering environmental benefits. However, payment of such grants is usually only made on completion of the project.

Almost inevitably, obtaining financial support from government is likely to be a lengthy process requiring considerable presentation of detail concerning the proposed business and how it fits with the government's policies. It is of great

advantage when applying for such support already to have gained the support of those, such as local political representatives, who will have influence on the government department(s) that will provide the support.

Government may provide land for the project and carry out or support any needed upgrading of infrastructure such as water and power supplies and roads to the project site. If government funds these items then they represent a direct reduction in project cost which will improve its economics.

Government may also offer an advantageous fiscal regime for the business on completion of the project. Whilst this does not affect investment cost; it improves the business economics upon against the project will be assessed.

Government support may be contingent upon provisions for enhanced local content. Utilisation of local content where it is not competitive provides an extra burden on the project in terms of cost and ensuring acceptable quality. It may also require training of local personnel and the need to demonstrate in detail why certain elements of the project cannot be executed locally.

Whilst government may be an enthusiastic supporter of a project from its inception and indicate in principle its willingness to offer financial help, it is unlikely that actual payments will be forthcoming until the project is fully authorised and even then only against achieved milestones. Government will also usually demand a 'claw back' of any grants if the key parameters against which they were awarded are not fulfilled.

5.6 Contractors

Contractors almost always indirectly provide some limited financing of a project by default, in that they receive payment for their work and services some time (sometimes the delay is considerable) after they have made payments to their employees and suppliers. In some circumstances for major projects, a contractor will agree to terms which will require them substantially to fund the work in progress and they in turn will often look to banks to support this. In some cases, payment by the owner may be in the form of product from the finished project. Such an approach is attractive to an owner who is setting up a new venture but is in a poor position to gain acceptable terms from banks for financing.

5.7 Suppliers

Though not particularly common, suppliers to the owner may financially support a project. This occurs when the outcome of the project will deliver a specific benefit to the supplier. A typical example would be the upgrading of the incoming electrical system needed to provide additional electric power, which may be funded by the electric power supplier if the project outcome involves a significant increase in electricity demand.

5.8 Customers

A customer may financially support a project if it arises principally as the result of demand from them. Clearly, any such support will only be provided if it is also beneficial to the customer. Examples of this may include modification to a plant to make a special customer-specified product or the provision of a facility to dispose of hazardous waste. The customer will usually require some long-term guarantee of supply and pricing.

6. Vulnerable Projects

Certain types of projects have a higher than normal vulnerability to cost uncertainty (usually significant cost growth). Some examples and outline of the reasons are given below.

Mega-projects (Projects with value >€2Bn)

- Desire to announce a cost early in the development for “political” reasons. Such figures are either deliberately low to provide an “acceptable” figure to those who will need to provide support, or at best are aspirational in that they are not based upon a scope which is in any way detailed.
- The actual time frame for development and implementation is often far longer than originally assumed.
- The long overall time-frame makes accurate estimating of unit costs extremely difficult.
- The detailed scope when eventually finalised often is more extensive and /or complex than originally foreseen.
- Peripheral costs such as cost of public enquiries, land purchase, compensation of parties who are disrupted by the project can be far higher than foreseen.
- Construction skilled labour shortages (due to sheer quantity required) can raise unit labour costs.

Retrofit projects (Modifications and extensions to existing facilities)

- Difficulty in identifying the full scope of work required. Vulnerability of both emerging works during implementation and of work being more complex than foreseen in order to connect with existing facilities
- Lower productivity due to working within or immediately adjacent to existing facilities. Congestion, requirements for safe working, etc. Difficult to quantify productivity loss in advance.
- Need for premium time working to achieve targets for return to use of the facility.
- Risks relating to hazardous materials in existing facilities.
- Amount of planning and management required is proportionately much greater than for a normal “new build” project.

New Technology projects

- Uncertainty that the technology will work as required, even when it has been tested in a pilot facility. Outcomes can range from need for minor changes to major rework or, in worst case, complete project failure.
- Technology develops as project progresses. Leads to reworks delay and additional costs.

- Scale up from lab, pilot plant or prototype to commercial scale is not straightforward. May well involve some “best guess” for detailed design requirements, with associated risk of not being valid.
- If technology is purchased from a third party, then there may be claims for impaired performance.

Sub-surface works

- Uncertainty as to what is below the ground, even for projects located on a green-field site. This can be mitigated by extensive soil surveys during project development. However for large sites it is often impracticable to carry out a sufficiently detailed survey to eliminate all risks.
- For green field sites risks include unexpected ground conditions e.g. running sand, level of water table, boulders obstructing piles, variable depth and type of underlying rock, discovery of faults in sub-surface rock. All of these can impact upon both the design and method of construction of sub-surface works.
- An additional risk is discovery of ancient relics which can cause significant delay whilst agreement is reached as to how they will be removed.
- Excavations must be both prevented from collapse and suitable barriers installed to prevent falls of personnel or equipment into the excavation. If located near to public access, requirements for safe separation may need to be extensive.
- For brown-field sites (i.e. those which have been subject to earlier constructions or industrial use) there are additional unknowns These may include –
 - Drawings and documents indicating existing sub-surface obstructions may provide an indication but rarely can they be relied upon in detail.
 - Contaminated water table. Water cannot then simply be pumped to a nearby storm drain. But must first be treated.
 - Contaminated spoil will need to be removed to an authorised disposal site, which typically will impose a significant charge for accepting such material.
 - Underground piping needs to be checked to confirm what it is and it contains any hazardous material. The pipe will then need removal or relocation by suitable method or ensure that new constructions are compatible with pipe remaining in place. This may to disrupt general progress or the works in the immediate vicinity of the piping.
 - Underground cabling needs to be checked to confirm what it is and whether it is still live. It will then need removal / relocation or checking it can remain.
 - Old foundations. Usually will require removal which may involve excavations far greater than originally foreseen. Excavated area will then require backfill and compacting.

Projects in emerging markets (e.g. E Europe, Asia)

- Uncertainty as to unit costs for these locations
- Uncertainty as to productivity and skills of local construction labour
- Requirements for local sourcing of materials.
- Unforeseen peripheral costs related to local legislation and customs.
- Interference from government agencies throughout the project. Delays to approvals, changing the rules and unexpected interpretation of rules. Conflicts between local and national agencies over authorities.
- Unethical behaviours.

Projects in remote locations

- Uncertainty as to unit costs for these locations
- Uncertainty as to availability productivity and skills of construction labour which may have to be imported.
- Costs associated with staff and labour working in remote location.
- Cost of bringing materials and construction equipment to location. This could require the construction of temporary harbours and access roads.
- Impact of extreme weather conditions on design of facility, working techniques and construction productivity.

Projects requiring significant regulatory validation (e.g. Pharmaceutical, Nuclear)

- Longer duration of project development and implementation to comply with regulatory requirements.
- Uncertainty as to how long required approvals will take.
- Additional testing and documentation requirements and associated management of same.
- For nuclear likely very long period for regulatory approval to proceed.

Contaminated Demolition

- Applies to many demolitions such as. nuclear, onshore and offshore oilfields, oil and chemical processing and storage, asbestos contaminated buildings, hydrocarbon and chemical pipelines, ship breaking.
- Extent of contamination is often difficult to assess before work commences.
- Regulatory approval to do the work may require extensive method statements and response / approval may be prolonged.
- For some cases the technology required (e.g. nuclear plant disassembly) is only presently being developed.
- Recording of every consignment leaving site will be required.
- Special security measures for transport of hazardous and toxic materials.

- Depending on type of contamination special containment may be needed for transportation.
- Location of where the contaminated material can be removed to is sometimes not apparent.
- Pre-training of workforce may be needed for the specific project.

Fast Track Projects

- Additional cost is not a certainty, but there is much higher cost risk due to a number of factors:
 - Project will probably have been authorised at a stage where development work was significantly incomplete, hence budget estimate will be less accurate and the implementation work is commencing with an incomplete project definition.
 - Risk of rework due to greater overlapping of design, procurement, construction.
 - Need for overtime working may be greater than foreseen.
 - Risk of contractors exploiting any lack of clarity in requirements.
 - Risk of additional time related costs if schedule is exceeded.

Projects with an absolute time imperative (e.g. Olympic games facilities)

- Most related to fast track projects are likely to apply.
- Knowledge of fixed completion date will allow contractors and construction labour force to exploit the situation to gain a premium price for their work.
- Risk of quality deficiencies due to time pressure requiring later remediation.
- Risk that elements of the work will be deleted to allow focus on schedule achievement. These may later have to be reinstated at higher cost.

7. Accounting for Joint Ventures

For any joint venture there should be a Joint Venture Agreement which sets out the shares of ownership of the project and funding (which may be different from ownership). The agreement should also set out how the project will be developed and managed including what the roles, responsibilities and authorities of the project manager will be. This Joint Venture Agreement should be in place as early as is practicable in the development of the proposed project, but in any event before any significant contracts for project implementation are placed.

Where Partners have shares in the whole project then accounting should be relatively straightforward only needing to indicate the percentage of costs for each partner. However for some projects the ownership share may differ for various elements of the overall project and indeed the funding shares may be different from the ownership shares. In such cases there will need to provide

- A detailed definition of where the boundaries between the various elements are.
- A system whereby cost as they arise can be accurately allocated to the correct element of the project.
- An agreement for the allocation of project general costs to each of the partners (i.e. those such as project management, temporary facilities, permits etc. which relate to the overall project rather than a particular element)
- Ongoing accounts for each of the partners share which is auditable in demonstrating how the share of costs has been developed.
- Cash flow projections for each partner

Individual partners may lay different emphasis on different objectives / deliverables and it will be necessary to reconcile these to gain overall project requirements and priorities.

The partners will wish to be kept informed of the project and its financial position. They may demand the right to approve major financial commitments. Typically the partners will set up a “steering committee” of sponsors from each partner to review the project as it progresses. Normally the project management team will report to this steering committee on a regular basis (Written reports and / or meetings) and where appropriate see authorisation for proposed actions.

It is important that there is clarity in respect of authority delegated to the project manager and his team. This must be sufficient to allow him to sensibly manage the project. Hence whilst the steering committee may retain certain financial authorities these should be confined to major commitments only. Similarly there must be clarity as to how claims from suppliers and contractors will be addressed and approved.

The partners will almost certainly require the right of audit of project accounts and in particular the process by which the shares of the costs have been allocated.

There is need for clarity as to how payments to suppliers, contractors and other parties will be funded. The cash must be available from the partners when required. This can be achieved by various means; one common approach is for the project

manager to advise each partner of his projected requirements for the coming month and the partners placing these monies into a project funding account from which payments can subsequently be made.

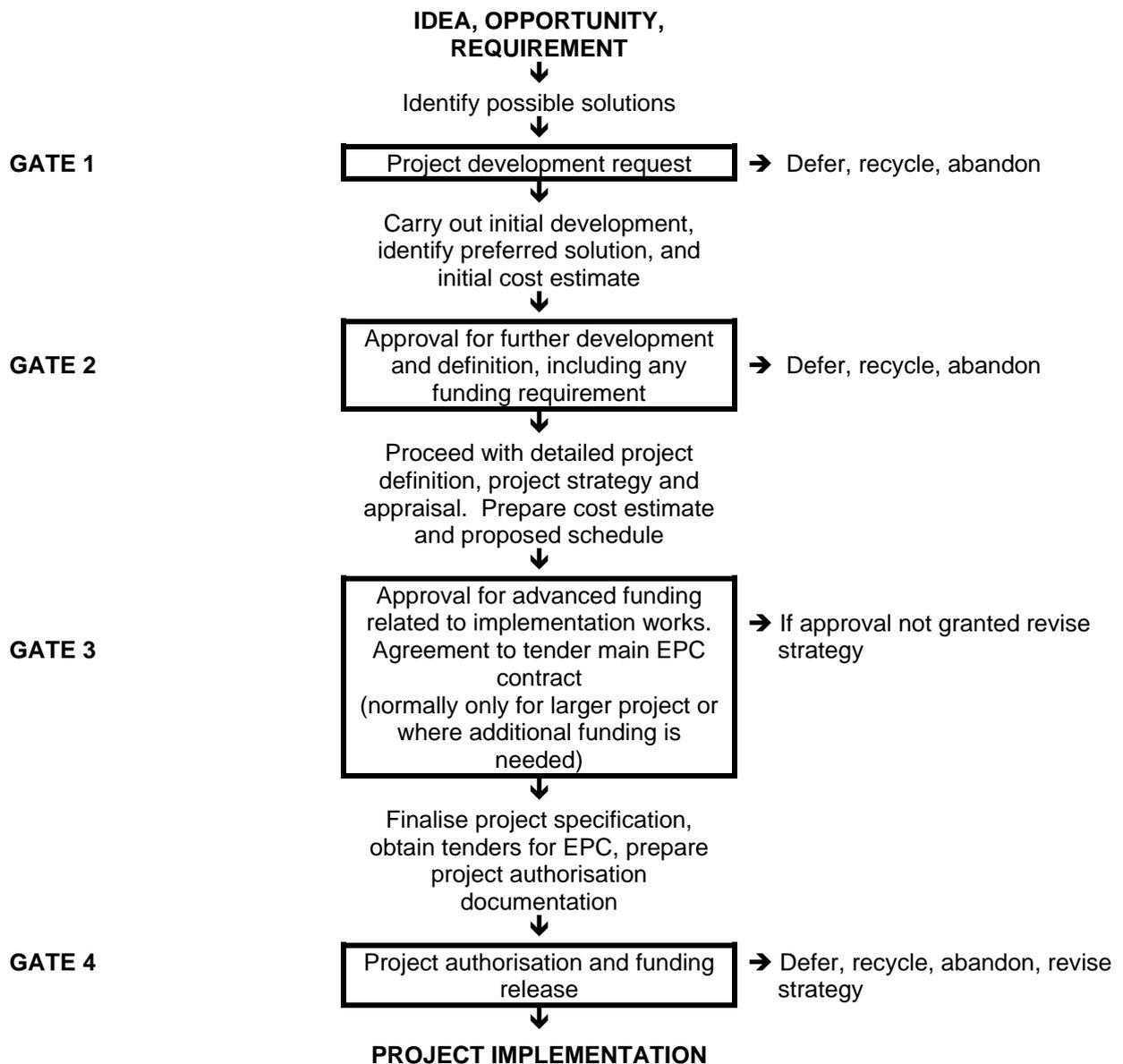
There is a requirement to clarify to how the parties will be responsible for any additional costs which may arise.

Appendix A

- Typical Stage-Gate Process for Project Development

The following is a typical process suitable for medium and large projects. Very large projects, such as construction of new site complex or major new joint venture, would usually require a more extensive process; small projects a simpler process

At each of the gates shown below there would be a management review of the development up to that point and of the proposed next steps. The level of management involvement would be dependent upon the scale of the project and the business authorisation requirements. In any event, the final asset owner must support the proposal at each gate.



The above shows only steps up to project authorisation. Some organisations extend this process, especially for large projects, through project implementation and to a final post implementation review.

Appendix B – Risks associated with Estimates

Common risks associated with cost estimates

Almost all risks associated with engineering projects have potential impact upon project cost and hence could be considered to generate a risk related to the cost estimate. The list below confines itself to those which are more closely related to the issues around estimate generation.

- General sufficiency of scope and specification detail
 - Accuracy of quantities
 - Sufficiency of specifications
 - Clarity of scope boundaries and deliverables
 - Identification of preparatory works
 - Identification of temporary works and facilities
 - Identification of any dismantling / demolition works
- Sufficiency / accuracy of project schedule detail
 - To allow assessment of any special requirements (and hence costs) needed for schedule achievement
 - To allow provision for escalation
- Vulnerability of process design to change, especially for new technology projects.
- Provision for scope growth (not scope changes)
- Accuracy of price levels in database, especially in times of rapidly changing prices.
- Ability to predict future commodity prices and impact on material costs.
- Complex equipment must be fully specified to yield accurate budget quotations, e.g. compressors, reactors, HVAC systems, process control / safeguarding systems, special valves, power generators, special requirements for buildings (e.g. blast resilience) special finishes on buildings, lab equipment, etc.
- Emerging works, especially for retrofit projects and new technology projects.
- Extent of overtime / shift working required.
- Productivity loss working in/on existing facilities. It is very difficult to assess this accurately unless there is relevant recent experience.
- Shortages of skilled labour. May require imported labour and / or additional skills training and / or use of overtime working and / or schedule extension.

- Cost of scaffolding and other access equipment. Very difficult to quantify.
- Discovery of unforeseen ground conditions / unforeseen objects in the ground.
- Estimating scope and cost of precommissioning & commissioning is difficult.
- “Allowances” to fund influential third parties to expedite permits, import of goods etc. (A fact of life in certain countries)
- Lack of common understanding of estimate (quality) definition, e.g. What does 10% estimate mean? Is a 50/50% estimate inclusive or exclusive of any contingencies? How are items which are not definitely required but have a significant probability of requirement addressed in the estimate?
- Lack of clarity / common understanding of what contingencies are intended to cover.
- What scope does the estimate include / exclude? – Development costs, land costs, permit costs, training costs, commissioning costs and restoration costs etc. (see also separate Appendix – Estimate Scope)
- Insufficient time for execution of the estimate.
- Difficulty in assessing future escalation. It appears that different elements of work and materials are subject to very different rates of escalation which are also becoming more difficult to predict.
- Vulnerability to exchange rate fluctuations.

Some Mitigation Measures

- Clearly state the definition of the quality of estimate to be provided, e.g. Articulate clearly and in some detail what you mean in stating 10% (or whatever stated quality) estimate to all those who will be utilising that estimate for authorisation and future cost control.
- Be very clear as to what pricing levels the base estimate (before any contingencies) has been based upon.
- State clearly the estimate scope boundaries (physical and other).
- Be realistic as to the quality of estimate which can be achieved based upon the quality of scope, time and specification data available.
- Clearly state the project schedule against which the estimate has been prepared. What authorisation date and what duration for implementation additionally any other key dates and durations which have been assumed.
- Agree the basis on which contingencies are calculated and provided

- A 50 / 50% base estimate will need a greater contingency than a 90 / 10% estimate
- Lower accuracy estimates will require greater contingencies
- How are price uncertainty, quantity uncertainty and quality uncertainty addressed?
- Consider discrete contingency for specific “high cost” risks, especially if the risk of requirement is fairly high
- Fast track projects will generally require greater contingencies to address:
 - Estimate probably prepared on limited data so less accurate
 - Higher risk of abortive works
 - Potential need to pay premiums for shorter deliveries and for premium time working
- Where an estimate is based upon a previously executed similar project, ensure that all the differences between the two are thoroughly identified and costed. If the earlier project was in another country and / or more than a few years earlier proceed with considerable caution.
- Clearly state what has been assumed for escalation, and what risks are attached to these assumptions.
- Clearly identify vulnerability to currency exchange rate changes. If these may have a significant impact consider a separate discrete contingency or forward hedging of the rate or agreement that they will be provided for outside the project budget.
- Where there are many cost risks each with different risk profiles, consider using a Monte Carlo type risk simulation tool to obtain an overall profile for the cost risk. However remember that the output is only as good as the input data for each risk element.

Appendix C - Estimate Scope

It is vital that for any project estimate there is a clear statement of the scope covered by the estimate and also other pertinent factors which have been assumed in the preparation of the estimate.

It should be noted that for most large capital projects the scope of the project and the scope of the (main) capital budget(s) are not the same.

List of items often omitted from estimates

The following is a listing of items which may or may not be included within the main capital budget for a project. Lack of clarity concerning the scope and hence the extent of inclusion or otherwise of these (and other) items should be avoided.

Their inclusion or otherwise is entirely a matter of policy for the client(s), but in every case there should be clarity and preferably identification for those items not within the main budgets as to how they will be funded.

- Initial project feasibility/development costs (internal)
- Feasibility / option studies by consultants
- Development / definition works by consultants / contractors
- Topographic and sub soil surveys
- Cost of project financing
- Cost of currency fluctuations
- Cost of extra-ordinary fluctuations in commodity prices
- Allocation of shared costs (multiple budgets, multiple projects)
- Scope changes after project budget finalisation
- Emerging Works (additional or more complex work needed to fulfil original objectives. Particularly in retrofit projects)
- Costs associated with schedule changes
- Extra-over costs for expatriate staff
- Purchase and leasing of land
- Preparatory enabling works (site clearance, demolitions, access roadways site drainage etc)
- Temporary works and facilities. (incl. temporary relocation of existing facilities)
- Interconnecting utilities and other infrastructure
- Surrounding infrastructure such as roadways, area lighting, and fencing
- Time of staff such as operations, maintenance, management, HSE (outside the project team)
- Audit Costs (Technical, HSE, financial)
- Licence fees
- Costs associated with obtaining regulatory approvals
- Donations to local communities

- Legal fees.
- Import duties.
- 3rd Party Inspection and testing (Required by client, required by regulatory bodies)
- Project insurances
- Updating of existing documentation, including regulatory documents
- Provision or updating of IT systems such as stock control, maintenance management, accounting systems. (Production/process control is usually within the core project)
- Office and other furniture and equipment
- Fit out of medical facilities.
- Workshop equipment and maintenance tools.
- Portable laboratory and other testing equipment.
- Warehouse racking, fork trucks etc
- Spare parts
- Moving staff and existing equipment to new locations (temporarily and permanent).
- Training of staff to operate and maintain the new/modified facility
- Process materials and lubricants – first inventory
- Personnel protective equipment for plant staff
- Cost of utilities supplied to construction site
- Additional site security during construction
- Pre-commissioning works and its management
- Commissioning works and start-up
- Provision of vendor's engineers for commissioning works
- Performance testing
- Site clean-up, restoration and beautification
- Disposal of construction waste materials
- Facility formal opening event
- Demolition of redundant facilities
- Redundancy/redeployment of staff
- Provision for post completion project close-out
- External support for negotiation of disputes
- Contingencies (Usually some contingency is within the budget, but other is excluded)

Appendix D - Common Forms of Contract for Project Implementation Works

The following listing provides a listing of the more common generic types of contract used for project implementation. In reality, there are a huge number of possibilities many of which have similarities to others. It is not possible to indicate which types are better than others as this is a function of circumstances and project requirements. For nearly all types it is possible either to tender competitively for the contract or to negotiate with a preferred contractor or indeed a combination of both.

Type of contract	Comments
1. Reimbursable - project management consultancy (PMC)	<p>Used (usually on large projects) where the owner does not have the resource to carry out project detailed definition and the tendering for implementation works. In many cases, PMC is retained to act as owner's representative through the project implementation. They are not the EPC Contractor.</p> <p>Merits – Provides appropriate skills when needed.</p> <p>Demerits – Need to control cost of PMC to the project. PMC may not always act fully in owner's best interest.</p>
2. PMC with incentives	<p>Still essentially reimbursable, but incentives aim to align more closely PMC with owner's objectives. Incentives usually relate to achievement of key milestones in PMC work and to overall project cost. Incentives must be progressive and carefully structured.</p> <p>Merits – As above plus improved drive to achieve targets.</p> <p>Demerits – As above but incentives mitigate.</p>
3. Lump sum turnkey (LSTK) (Note this is one particular form of EPCM contract)	<p>Contractor is responsible for delivery of the whole project implementation (cost, time, quality) in accordance with the contract specification. The specification must identify all the owners' specific requirements (scope, quality, time) in detail. May or may not include commissioning. Especially useful in cases where contractor is also the holder of process expertise and/or supplier of main equipment.</p> <p>Merits – Most of project risk is given to contractor. Requires less supervision from owner. Can be very cost and schedule effective.</p> <p>Demerits – Time for preparing, tendering, and evaluation of contract tends to be long. Any changes to specification will be very costly and likely also to lead to claims for extra time. Compliance with specification requires to be closely monitored. Higher risk of contract disputes.</p>

Type of contract	Comments
<p>4. Engineer, procure, construct, and manage. (EPCM) Fixed fee for E&M, reimbursable for P&C.</p>	<p>Contractor has principal responsible for delivery of the whole project implementation but with some owner involvement and sharing risks related to vendor and sub-contractor performance. Contract specification must fully detail owner's specific requirements (scope, quality, time) in detail. May or may not include commissioning.</p> <p>Merits – Some of cost risk is taken by owner, so contractor, needs less contingency in tender cost. Tendering time is shorter than for LSTK. Impact of any owner changes is usually less severe than for LSTK. Contractor will better check quality of vendors and sub-contractors.</p> <p>Demerits - Time for preparing, tendering and evaluation of contract tends to be long. Requires more involvement of owner: in addition to checking compliance with specification, also needs to verify proper cost control of vendors and subcontractors</p>
<p>5. Engineer, procure, construct, and manage. (EPCM) Fixed fee for E&M, reimbursable for P&C. With target incentives.</p>	<p>Generally as 4 above but including incentives re overall project cost and possibly also re project schedule</p> <p>Merits – Generally similar to 4 above. Target cost incentive will drive EPC contractor to control costs of vendors and sub-contractors. Target schedule incentive will drive progress.</p> <p>Demerits – Generally similar to 4 above. Incentive schemes may make contractor more claims conscious for any perceived changes. Final payments of incentives likely to need negotiation.</p>
<p>6. Engineer, procure, construct, and manage. (EPCM) Fully reimbursable.</p>	<p>Contractor responsible for delivery of the whole project implementation but with owner involvement and significant risk sharing. In particular, owner takes main cost risk. Contract specification does not need to be fully detailed, although detail is still beneficial.</p> <p>Merits – Allows for fast tendering as work needed to tender is much reduced. Allows finalisation of specification without major claims arising. Allows owner to participate in design and engineering detail. Likely to lead to high quality outcome. Low risk of significant contract disputes.</p> <p>Demerits – Risk that owner continues to make changes. High vulnerability to escalating costs. Some vulnerability to extension of schedule, hence owner will need larger input for project control.</p>

Type of contract	Comments
<p>7. Engineer, procure, construct, and manage. (EPCM) Reimbursable with target incentives</p>	<p>Contractor responsible for delivery of the whole project implementation but with owner involvement and significant risk sharing, in particular, sharing of cost risk. Contract specification does not need to be fully detailed. Good detail is still beneficial and if significant changes arise, contractor may wish to revise targets.</p> <p>Merits – Generally as 6 above. Incentives will improve drive to control costs and schedule. Deters owner from making changes. Can be carried out as a project partnership.</p> <p>Demerits – Generally as 6 above. Some risk of sacrificing quality for cost and time.</p>
<p>8. Contract for engineering and procurement, owner manages separate contracts for construction.</p>	<p>Useful in the case of small and medium-sized projects, especially those involving substantial work within owner's existing facilities. Owner will contract construction with local contractors who have existing site knowledge or even use own labour for some of the work.</p> <p>Merits – Avoids the difficult aspect of retrofit construction management by contractor. Owner has knowledge of site established practices for retrofit construction. Owner's project management should have closer relationship to plant operations to facilitate handover and commissioning. May allow lump sum contract which would not be possible if construction were included.</p> <p>Demerits – Adds a major interface and splits project responsibilities. Not conducive to minimising overall schedule. May need contractor resources to resolve design queries and provide technical assurance.</p>
<p>9. Owner manages, procures. Contracts separately engineering and construction</p>	<p>Generally similar to 8 above. If owner considers they have procurement capability, then this can reduce project costs.</p> <p>Merits – Generally as 8 above. Owner may be more efficient at procurement for smaller projects.</p> <p>Demerits – As 8 above. Adds major interface between engineering and procurement</p>

Type of contract	Comments
<p>10. Owner carries out E&P Owner manages separate contracts for construction</p>	<p>For smaller projects where owner retains project engineering and management and engineering capability, but has insufficient design capacity.</p> <p>Merits – Often results in lower cost than using an EPCM contract for smallish projects. If project development has not been thorough, this route is more able to cope with changes. Owner’s design staff have inherent site knowledge of existing facilities, standards and specifications. Owner is often more efficient at procurement of small-quantity material requirements. Owner can select appropriate form of contract for each element of the project.</p> <p>Demerits – May stretch owner’s project capacity, resulting in delays to project and possibly to other works. Greater risk of preference engineering adding to the project scope. Requires owner to maintain significant project capability which may sometimes underutilised and hence not cost effective for overall business.</p>
<p>11. Design and build</p>	<p>Contractor is engaged to carry out detailed design on reimbursable or target cost basis. Procurement and construction then tendered on lump sum or guaranteed maximum price based on the completed design and specification. Not common in process industries.</p> <p>Merits – Allows owner to check design meets their requirements and adjust if costs appear excessive. Provides a high-accuracy project cost before final commitment to procure and construct. Low vulnerability to change after design completion.</p> <p>Demerits – Usually leads to a longer overall project schedule. Compliance to specification requires to be closely monitored.</p>
<p>12. Alliance contracts</p>	<p>Very useful if owner has an ongoing demand for contractor services related to project design and management. Contract is usually reimbursable, but with performance and profit sharing incentives.</p> <p>Merits – Alliance contractor develops detailed knowledge of owner’s technical and business requirements. Facilitates rapid mobilisation to start works; contractor can very effectively assist in project development. Contractor will be more efficient and hence cost effective. Allows for sensible risk sharing. Avoids repeated tendering.</p> <p>Demerits – Arrangement needs major effort and time to set up. Initial performance during learning curve likely to be disappointing. Must have continuity of work for the contractor. Difficult to objectively assess contractor performance versus their competitors.</p>

Other Incentives	
General comment re incentives	Incentives should only be considered where the contractor has real ability to influence achievement. Incentive schemes should be simple in their formulation and payments/penalties should be progressive relative to degree of achievement. Incentive schemes where the contractor is vulnerable to a large step change in payment as a result of marginal failure to achieve a target figure are likely to have an overall negative impact on performance.
Construction safety	Only useful if based on achievement of improved performance versus what are established norms. If the frequency of accidents is used, this must include those which result only in minor injuries, as lost time incidents (LTIs) are so infrequent as not to be statistically valuable. It is also possible to use outcomes of construction site audits – for instance the number of non-conformances found by joint owner/contractor audits. Consider whether incentives should go to the contractor or their staff.
Quality	This is a very difficult to incentivise as there are so many different elements to quality and it usually makes little sense to focus on only one or two. Overall design quality can be approximately measured by the percentage of design documents which must be revised post release as final, though even this must filter out causes not related to contractor performance. Such a measurement system is time-consuming. There is no simple way to measure overall construction quality. Performance guarantees, especially if they include reliability, are in fact a form of quality incentive (see below).
Schedule	Schedule is commonly the subject of incentive systems, but should only be so if schedule is of particular importance to the owner. Schedule incentives can result in a contractor becoming over-focused on achieving schedule at expense of quality. Also, a contractor will look to identify causes for delay outside their responsibility. Schedule incentives/penalties should always be progressive so that there is an incentive for the contractor to perform even under adverse conditions.

Other Incentives	
<p>Performance of the completed facility</p>	<p>There may be several measures by which performance is assessed such as output capacity, meeting product specification, percentage of feed converted into saleable product, energy efficiency plant on-stream factor. Provided the scope of contractor's work has significantly influenced these parameters, then it is usual that their contract includes guarantees for performance linked to achievement. The terms of the guarantee may either require remedial work and/or impose penalties for failure to achieve the specified performance. Penalties should be progressive, dependent upon the degree of non-achievement: a bonus should be considered in the event of exceeding specification, always providing that enhanced performance is of value to the owner. One problem is that carrying out valid performance tests can be difficult due to operating constraints. Items such as reliability/on-stream factor may take many months to determine and may be influenced by factors not related to the contractor's work.</p>

Appendix E – UK typical costs for overtime and shift working

Following data is indicative only of typical uplift in rates which may apply.

Type of Working	Increased Cost Increase over normal weekday rates
Overtime on working days	30–40% for additional hours
Saturday Working	40–50% for all hours
Sunday and Holiday Working	80–100% for all hours
Shift Working (8hr shifts)	20–30% for all hours
Shift Working, supervision	80–100% (additional personnel & premium rates)

Above figures do not account for loss of productivity, which is a further additional cost, see Appendix F.

Appendix F – Typical UK Loss of Productivity versus “New Build”

Table indicates reduction in productivity compared to normal weekday working on a “Greenfield” construction site

Type of Working	Productivity Loss
Existing off-plot facilities	10 – 20% loss
Ex. process unit in service	20 – 40% loss
Ex. process unit shutdown	15 – 30% loss
Difficult access areas	10 – 30% loss
Overtime up to 10hr/week	5 – 10% loss on all hours
Overtime >10 to 25hr/week	15 – 20% loss on all hours
Shift Working	15 – 20% loss on all hours

These loss categories may be cumulative one on another



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