MANAGEMENT OF PROCUREMENT FOR MAJOR INFRASTRUCTURE AND EQUIPMENT PROJECTS

Stanley J. Zwierzchowski, M.Eng, P.Eng.

Zwierzchowski Associates Inc.

Calgary, Alberta

Canada

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Part A Introduction

1. Introduction and Overview

1.1 Course Perspective

This course deals with the management of the high level procurement process in major projects that concern the construction of plant and infrastructure and the acquisition of equipment. Commonly, this is referred to as "project procurement" which is the term we will use for this high level procurement process. The actual purchasing, contract administration and accounting functions in the procurement of materials, equipment and services are but a small part of the overall process. What is important for us in this course is the interaction between and management of various groups and the functions involved in the procurement process. We are concerned with responsibilities of these groups, inputs and outputs from these groups, and the functions of these groups. We must consider the process as a whole. Many different disciplines are involved in the procurement process. Project procurement is an important activity that project managers oversee.

Definition of *project procurement*:

> "Project procurement concerns the organization, activities, practices, conventions, information and documents used in the procurement and construction/manufacture of major plant and equipment."

1.1.1 Management of the Procurement Process

What this course is concerned with is the management of the procurement process. We will look at it from the perspective of project managers – or upper level business managers. Hence this course does not look in any great detail at the day to day operations and management of the procurement group. We look at the big picture in this course as related to procurement.

This course is presented under the assumption that the student has an engineering background, but this background is not necessary.

1.1.2 Course Context – Infrastructure Development

The focus of the course will be on project procurement related to building infrastructure items such as plants and procurement of complex engineered equipment. Procurement in support of (repetitive) manufacturing operations will not be discussed

1.1.3 Industry Context

In discussion project procurement, we will attempt to relate the discussion to projects in the oil and gas industry. The principles and processes presented, though, can apply to many other industries where complex systems, infrastructure, and equipment is to be procured – one example would be the aerospace industry, where the processes discussed in this course are very rigorously applied.

1.1.4 Issues, Concerns, Exceptions

In presenting this course, we will try to identify and address issues and study the way these issues are managed. We will attempt to go beyond just memorizing processes and try to apply analytical thinking to procurement issues in projects.

1.2 Terminology

Often there is inconsistency in terminology and terminology may vary from one organization to the next – a universally used term may not exist. Sometimes the same phrase will be used by two different organizations with different meanings. This will be highlighted when ever it occurs.

Part B Project Procurement Overview

2. Procurement Perspectives

2.1 Issues and Underlying Principles – Opening Discussion

Does the procurement process vary according to the nature of the industry or business?

Does the procurement process vary relative to what is being procured?

How does complexity and cost of the item being procured impact the procurement process?

What is the effect of the amount of engineering and design required on the procurement process?

Is the manner in which procurement is done suitable for the objectives, business requirements and operations of the organization?

What are the variations in the procurement processes corresponding to the acquisition of major capital assets versus the procurement of parts, subassemblies and materials used in manufacturing versus purchase of products sold in retailing?

2.2 Categorizations of Procurement Perspectives

The nature of the procurement process varies depending on the business context and the industry in which the procurement process resides. The approaches, methods and management expertise required are strongly dependent on what is being procured. The approach taken for the procurement of large capital infrastructure is different from the purchasing operations required to feed a computer manufacturer with the parts and materials required to assemble computers.

For the purposes of studying procurement the different approaches to procurement can be categorized broadly as follows:

- Procurement of parts and materials for product manufacturing.
- Procurement of products for retail sale.
- Procurement of services.
- Procurement of major capital infrastructure – project procurement.

2.3 Product Manufacturing

Procurement in product manufacturing entails the purchasing of the raw materials, parts, and the subassemblies from which a given product is manufactured. In such an operation the concepts of inventory and inventory management are important. A primary goal of the procurement function is to ensure that the inputs to manufacturing are available when needed.

Product manufacturing is characterized by continuous operations sometimes spanning years in which repeated delivery of the same items is required. Given the nature of this business, alliances with suppliers have significant importance. Competitive bidding has a role in procurement for manufacturing but many other approaches are used to procure the inputs that a factory requires and in establishing relationships and alliances with suppliers.

Procurement for manufacturing may or may not have a strong engineering and technical dimension.

2.4 Retail

Procurement for retail has many similarities to procurement for product manufacturing. Variations exist in the extent to which technical and engineering contributions are required to the procurement function. Procurement for retail also is concerned with maintaining inventories in many different locations. The goal of procurement for retail is to have products available for purchase by consumers when they want them and where they want them. Again, inventories and inventory management play a key part in retail procurement.

By combining procurement for manufacturing and procurement for retail the concept of the supply chain emerges.

2.5 Services

A business is concerned with the procurement of services when it desires to outsource a given function to some other organization. Functions that can be outsourced include things such as subcontract manufacture, call centers, engineering, payroll. Additionally, services such as banking, legal, accounting, and insurance are also required by a business. The procurement of services is done in many different ways.

2.6 Project Procurement

Project procurement is concerned with the construction/manufacture of major capital assets – plant and equipment. The idea of procurement arises from the fact that an owner is purchasing/procuring the major capital asset.

Project procurement supports and is integrated the with the project management function required to build major capital assets. Engineering and construction are significant components of projects to which the principles of project procurement are applied.

2.6.1 Inputs and outputs

The inputs required to build a major capital asset are engineering, manufacturing, construction services, the supply of equipment and the supply of materials. The output is the completed plant, factory, or infrastructure item.

2.6.2 Project Procurement Approaches

A hierarchy of design, manufacture, and construction can exist in a given project procurement. The procurement process can be nested for several levels between the owner, the prime contractor, EPC firms, a project management consultant, engineering

consultants, suppliers, subcontractors, etc. The project procurement function is responsible for integrating from a business perspective the required inputs (as identified above) into the project in support of project management. The essential role of the project procurement function within the project is the formation and management of all the contracts with suppliers, manufacturers and contractors required to create and supply the inputs for the project. There are several approaches that can be used to acquire the inputs required to execute a given project.

2.6.2.1 Formal Competitive Bidding

Much of the procurement for major infrastructure projects is done through a formal bidding process that entails an RFP, sealed bids from contractors/suppliers and a formal evaluation process. Selection of a winning bidder is based on an evaluation against enumerated criteria. It is a competitive process which strives to achieve fairness amongst the bidders. For the owner it has the advantage of optimizing the best price relative to contractor/supplier capability, quality and performance.

2.6.2.2 Negotiated Supply

For various reasons there are times when a formal competitive bidding process is not desired or cannot be pursued. In such a situation what is often done is negotiations are undertaken directly with a desired supplier without conducting a formal tender. An obvious reason for such an approach would be when only one supplier exits that provides the desired product or capability. Another reason could be the cost of the item being procured is too small to warrant the time and expense of a formal bidding process.

2.6.2.3 Catalogue/Standard Items Purchased from Qualified Vendors

For certain items and materials the elaborate steps and methods associated with project procurement are not justifiable. Typically this would concern the purchase of standard items and consumables. In such a case a purchase order is issued without the application of any elaborate methodology.

2.6.3 Issues to consider relating to Project Procurement Approaches

Given the large prices for equipment and materials typically dealt with in major project procurements, fairness and consistency in procurement practices is essential. An approach could be taken whereby procurement was done with favourite contractors and suppliers with other bidders used just to refine pricing. Upon developing a reputation for doing this, future potential contractors and suppliers will develop the opinion that they have no chance of being successful on a given bid and hence will not bid on future work. This could result in uncompetitive pricing in the future for the owner.

2.7 Issues and Underlying Principles – Closing Discussion

Does the procurement process vary according to the nature of the industry or business? *Yes as elaborated above.*

Does the procurement process vary relative to what is being procured? *Yes.*

How does complexity and cost of the item being procured impact the procurement process? *The more expensive than item is, the more elaborate and formal the procurement process is.*

What is the effect of the amount of engineering and design required on the procurement process? *Again, the more engineering required the more elaborate and formal the procurement process becomes.*

Is the manner in which procurement is done suitable for the objectives, business requirements and operations of the organization? *It must be otherwise it is highly likely that the objectives of the organization will not be achieved.*

What are the variations in the procurement processes corresponding to the acquisition of major capital assets versus the procurement of parts, subassemblies and materials used in manufacturing versus purchase of products sold in retailing? *Briefly touched on above, this will be studied in further detail in these course notes.*

3. Project Procurement Process

3.1 Issues and Underlying Principles – Opening Discussion

For the construction of large complex systems and infrastructure how does an organization ensure that they get what they want, in the time that they want, at the price that they want?

For large complex systems and infrastructure many people are involved and many organizations are involved. How is work contracted and coordinated amongst all?

Does the project procurement process require any effort?

What can go wrong?

3.2 Project Procurement Process Steps

The steps in a typical project procurement process can be grouped under the following headings:

- Planning and organization
- Development and definition of requirements
- Generation of RFP documents
- Conducting the bidding process
- Contractors generating and submitting bids
- Receipt and evaluation of bids
- Contract award and contract formation
- Operation/execution of the procurement contract
- Close-out activities

These steps are briefly summarized below in this section and elaborated upon in later chapters.

3.3 Planning and organization

Planning and organization is probably the most important step in complex projects that involve many people and many organizations. Without proper planning and organization, chaos can develop and project execution can become inefficient and ineffective.

In any project the capabilities of the people and organizations that will work on the project must be evaluated. The responsibilities for executing the project must be divided amongst people and groups based on capabilities and cost to the project. Given that many people and organizations are involved in the project they must be organized as to when, where and what they are to do. This requires the development, formalization and communication of a project plan. Timelines must be identified; methods to manage and perform the work must be defined; a high level project scope is required.

Project planning and organization is an ongoing process. It is critical to the management of the project. It is an interactive process that starts at a high level then works

through lower levels of greater and greater detail in defining the activities, deliverables, and schedules for the people and organizations involved in the project.

3.4 Development and Definition of Technical and Commercial Requirements

Defining what is required is probably of equal importance to planning and organization. The scope and objective of the work must be defined; technical specifications must be established for function and performance; process details must be worked out. If requirements are inadequately specified then it is highly likely that suppliers and contractors will not supply what is needed for the project. Inadequacies, poor performance, operational problems, delays, and other such difficulties will develop – all of which requiring corrective actions such as change orders and rework leading to increased costs.

Technical requirements are established using drawings and specification documents. Specification documents can be single page data sheets or elaborate multipage documents. These documents originate from engineering analysis and design.

Commercial requirements are incorporated into the contracts established with suppliers and contractors. These commercial requirements arise out of the business needs of the corporation. They originate from the business management perspective.

3.5 Generation of RFP Documents and Activities Prior to Issuing the RFP

With the project plan in place and technical requirements defined, RFP's are generated and used to engage suppliers and contractors into the project.

The Request for Proposal (RFP) contains information and instructions to bidders – the prospective contractors and suppliers for the project. These prospective suppliers and contractors to the project base their proposals concerning work required and desired price on what is contained in the RFP. What is communicated in the RFP must be accurate and complete otherwise problems and disputes can arise in execution of the project.

Often, an important activity undertaken prior to issuing the request for proposals (invitation to bid) is to prequalify potential bidders. Bidders can be qualified based on a number of criteria including financial strength, technical expertise, management capability, quality systems, capacity, etc. The intent of prequalifying bidders is to make the bidding process more efficient by directing the invitation to bid to only those companies/organizations that are likely to successfully perform the desired work.

A note on terminology: in addition to referring to the actual "bid documents" issued, "RFP" in some practices is also used as an encompassing term referring to the bidding process.

3.6 Conducting the Bidding Process

The bidding process involves issuing the RFP (invitation to bid), communicating with bidders, and receiving the bids. Conventions have been established with regard to a public formal bidding process concerning the conduct and expectations of both the owner and the bidders. Typically a deadline is established for the submission of bids beyond which late bids are not accepted. All bidders expect to be treated fairly and equitably relative to the other bidders. The best compliant bid with the lowest price is expected to win a contract and this bidder is expected to undertake the work if they have the winning bid. Bonds are used in the bidding process to ensure that if the winning bidder does not undertake the work,

the owner is compensated for costs resulting from having to use an alternate bidder or from having to do the bid process again.

An elaborate bidding process is normally not used for procurement of standard materials and products that require little customization or the procurement of items and services of relatively low cost.

3.7 Contractor's Bid Generation

Upon the issuance of an RFP, a contractor/ supplier must decide whether to bid or not. Technical requirements must be evaluated against the capability of the contractor/supplier and the specifications of the products that the supplier produces. Schedule requirements must be evaluated against the availability and magnitude of the contractor's/supplier's resources. A contractor/supplier must also determine whether they will earn a profit in doing the work. If the contractor/supplier decides to bid then personnel must be assigned to generating and submitting a proposal. The generation of a proposal requires time and effort, which is a cost to the contractor/supplier.

3.8 Evaluation of Bid's

Once the deadline for receiving bids has passed, the owner opens and evaluates the bids were received. A systematic approach is required to evaluate the bids. Price is but one of many factors that must be evaluated in order to determine the winning bid. Other factors include the bidder's capability, their quality program, their expertise, their safety records, past performance history, their size, their financial strength, conformance to technical requirements, key personnel, and on.

3.9 Contract Award and Formation

Once the successful bidder has been selected, a contract must be formed between the contractor/supplier and the owner/purchaser. Contract documents must be created, reviewed and executed.

3.10 Operation/Execution of the Procurement

Having finalized the contract, the contractor/supplier begins the work. There will typically be significant interaction between the owner, or their representatives, and the supplier/contractor in managing and performing the work. A number of reviews will be required, numerous inspections and tests will have to be performed, progress reporting and verification will be done, progress payments will be issued upon the achievement and verification of milestones.

3.11 Close-out activities

To close out a contract, it must be verified that all work has been completed and all requirements have been met. Final payments can then be made. If the project plan, work scope, technical requirements, and commercial requirements are not sufficiently detailed this may be difficult.

Invariably for large complex projects errors, omissions and problems will arise. These will require rework and corrections. The source of these difficulties could be errors in the

specifications and requirements, design errors, misunderstandings related to technical or contractual obligations and responsibilities, incompetence, and on. This can lead to claims which must be addressed and resolved in order to close out the contract.

3.12 Issues and Underlying Principles – Closing Discussion

For the construction of large complex systems and infrastructure how does an organization ensure that they get what they want, in the time that they want, at the price that they want?
By developing, defining and documenting requirements – both technical and commercial.

For large complex systems and infrastructure many people are involved and many organizations are involved. How is work contracted and coordinated amongst all?
Through the planning and organization function.

Does the project procurement process require any effort?
Determining, defining and communicating the owner organization's objectives and conducting a competitive bid process requires a lot of effort; but if an investment is not made in this effort problems can arise and the success of the project is undermined.

What can go wrong?
The facility does not work or has operational problems. Failures occur. The project goes over budget; is overdue; is abandoned.
The steps and methodology of the project procurement approach are meant to minimize the chance of this occurring.

4. Contracts and Pricing Arrangements

4.1 Issues and Underlying Principles – Opening Discussion

At a basic level how is it ensured that the owner and the contractor/supplier perform their obligation and responsibilities?

What contract pricing arrangement minimizes the financial risk to the owner?

What contract pricing arrangement minimizes the financial risk to the supplier/contractor?

What contract pricing arrangement provides the best incentive for contractor/supplier performance and quality?

Does the type of contract price arrangement affect the number of bidders for a given project procurement?

4.2 What Is a Contract

A contract is a set of promises and obligations between two or more parties that is enforceable under the law. A contract can be oral or written - in other words the promises and obligations are defined in writing or are given verbally. Complex contracts are generally always written but may contain some verbal promises and agreements. Because of the potential for misunderstands based on verbal agreements, complex contracts normally require that all promises, revisions, undertakings and such be in writing in order to be binding. Complex contracts are often comprised of multiple documents as would be the case for major procurements.

When one party does not fulfill a promise or obligation required under a contract then that party is in breach of the contract and the aggrieved party under the law can seek enforcement of the contract and/or recovery of any financial loss. Through the courts, the non-defaulting party can recover damages incurred because of the breach or obtain other remedies to mitigate the breach or to obtain performance of the contract.

In order to form a valid contract a number of elements must be present. Depending on the jurisdiction these include mutual intent, legal capacity, consent, legality, and valuable consideration.

A contract can be brought to an end – terminated – in a number of ways. Contracts can be terminated through performance, mutual agreement, frustration, breach and operation of the law.

4.3 Project Procurement Contracts

Projects concerned with the construction of infrastructure and the procurement of plant and equipment tend to have high values and a large degree of complexity. For such projects the methodology of project procurement is applied. The contracts used for procurement in these projects have a corresponding high degree of complexity and extent. Typically the promises and obligations comprising these contracts would be defined in many documents – with all documents forming the “contract”.

Project procurement contracts typically would be structured such that a master agreement document establishes the foundation of the contract. The master agreement would describe the general scope of work to be performed, the price and price arrangement for the work, payment terms, overall schedule and key schedule milestones along with general terms and conditions.

In support of the master agreement, a project procurement contract would be comprised of many additional documents. Supplementary documents forming a project procurement contract would include datasheets and documents defining technical requirements, drawings, correspondence, change orders, inspection reports, meeting minutes, and on. Unless explicitly stated otherwise, even the documents, correspondence, and meeting minutes used in the bidding process form a part of the procurement contract.

4.4 Contract Pricing Arrangements

There are several methods of defining the price to be paid for the work or equipment to be supplied under a procurement contract. There are advantages and disadvantages to each method, both from the purchaser's point of view and the contractor/supplier's point of view.

4.4.1 Fixed Price

In a fixed price contract the contractor/supplier is paid a set amount for a defined scope of work or a defined equipment specification. The intent of the fixed price that is established is to cover the contractor/supplier's costs plus overhead and to provide a profit. The contractor/ supplier will incur a loss under such a contract if the contractor's costs actually turn out to be greater than the contract price.

In such a contract the scope of work must be accurately and completely defined. Changes and additions beyond the original scope of work are done through a change order process and normally result in extra charges by the contractor to the purchaser. The price charged for each change would have to be negotiated between the purchaser and contractor using rules defined in the contract. If there are too many changes to the scope of work or to the design, a contractor could take advantage of this with the result that the project suffers a serious cost overrun. The owner must put more time and effort in to developing the scope of work, design and technical requirements for such a contract pricing arrangement, relative to the other types of arrangement, in an attempt to minimize the number of changes required in the work.

With such a contract price arrangement the contractor assumes the risk associated with the price of the work. Variations in labour and material costs, the need for extra labour beyond what was estimated, technical difficulties in meeting defined work scope and technical objectives, can all lead to an increase in the cost of the work to the contractor. This additional expense would reduce or eliminate the contractor's profit. Recognizing this risk, many contractors/suppliers add a contingency to the price they bid for the work.

In a fixed price contract the contractor is motivated to reduce costs. By doing this contractor's profit is increased. Given this, the contractor has no incentive to incur additional costs such as schedule acceleration through overtime or for providing greater quality in the work or equipment than the minimum required to meet contract requirements.

4.4.2 Lump Sum with Price Adjustment

This contract price arrangement is similar to straight fixed price except that adjustments can be made to the price over time if some of the contractor/supplier's costs change. Usually contracts that span long time periods where uncertainty in future input costs exists would incorporate this pricing scheme. For example, this price arrangement could be used to offset the effects of inflation on the contractors/suppliers costs for labour and materials. The contract price would be adjusted to cover cost changes using a method or formula defined in the contract along with published statistics for inflation and other input costs. Such a pricing arrangement reduces the contractors/suppliers risk when inflation is a concern. This pricing arrangement could also be used when the contractor/supplier uses a commodity that has high price volatility.

4.4.3 Unit Price

In a unit price contract the contractor/supplier agrees to provide each unit of work/equipment at a fixed price. The exact quantity of units required is not specified and may not be known with certainty at the beginning of the project – an expected range, though, in the quantity of units needed may be stated. The price established for each unit will cover the contractor/supplier's direct costs plus overhead and profit. In this type of contract arrangement, the contractor/supplier assumes the price risk of cost variations/increases on a per unit basis; the owner/purchaser assumes the price risk for variations/increases in the quantity of units required. The difference between this contract arrangement and the fix priced contract arrangement discussed above is that the unit price contract arrangement is priced on a per unit basis with multiple units required while the fixed price contract discussed above is the price for the entire contract.

Examples where the unit price arrangement could be applied: supply and installation of racking on a per module basis; supply and installation of lighting on a per fixture basis; manufacture and supply of valves; manufacture and supply of pressure vessels; supply and installation of piping on a per length basis; excavation on a per volume basis. Note that for a unit price contract it is still important to accurately and completely define the requirements and specifications for each unit purchased. Otherwise, the need for changes in the design/scope of a given unit is more likely to occur resulting in price escalation.

4.4.4 Time and Materials/Unit Rate

In a unit rate contract, the contractor is paid for the amount of time required of labour and other resources to perform the work defined in the contract. Rates are established on an hourly, daily or weekly basis per labour category or per chargeable resource item such as equipment and tools. Examples of labor categories would include senior engineer; drafter; master electrician; journeyman welder; and so on. Equipment examples would include items such as cranes; excavators; scaffolding; and on. The rates charged by the contractor would include overheads and profits. These rates would typically be fixed for the contract. As such the contractor assumes price risk relative to the actual wages that the contractor must pay to its personnel, the actual rates that equipment is rented at, and the overheads incurred. The schedule of rates that the

contractor applies to the work is included in the contract. Cost of materials and other expenses that the contractor incurs would be passed on to the customer/owner usually at cost plus a percentage markup to cover administrative costs. This contract pricing arrangement can be considered as a type of reimbursable contract – the contractor's actual costs though do not directly determine the price paid. The price paid is based on the rates established when the contract is negotiated and as such the contractor's actual costs could vary over time affecting the profit the contractor earns.

A disadvantage with this pricing arrangement, as with all the reimbursable pricing arrangements, is that the contractor has no incentive to quickly complete the work. The longer the contractor must work on the project, the more money the contractor earns. An advantage is that the quality of the work provided by the contractor, though, can be high since there is no reason for the contractor to limit the amount of time devoted to the job to ensure high quality work. In entering into this type of contract arrangement the scope of work, technical requirements, and design do not have to be defined in detail at the beginning of the contract – changes in requirements will be handled in the normal course of executing the contract.

4.4.5 Reimbursable with Fixed or Percentage Fee

A reimbursable with fee contract is similar to a time and materials contract with the exception being that the contractor is paid for the actual costs that are incurred in a project by the contractor. In addition to the actual costs, the contractor is paid a fee to cover overhead and profit that is either a percentage of the actual costs or a fixed amount. Advantages and disadvantages of this pricing arrangement are similar to those of the time and materials contract, but in this type of pricing arrangement, the contractor bears no price risk whatsoever. Administration of this type of contract is very difficult because actual costs incurred by the contractor must be documented and verified thus increasing the management burden.

4.4.6 Target Price Contract Types

The target price contract is a form of reimbursable contract with an incentive based on total costs that the contractor charges for the work. If the costs charged by the contractor to the customer are below the target price, then the contractor is paid a percentage of the difference as a bonus. If the costs charged by the contractor to the customer are above the target price, then only a portion of the excess costs above the target price are paid to the contractor with the contractor responsible for the remaining costs. Costs charge by a contractor can either be rates as established in time and materials contracts or can be the actual costs incurred. Administratively set rates are easier to work with than trying to determine the actual costs.

4.4.7 Reimbursable with Incentive Fees

In a reimbursable with incentive fee contract, the contractor is paid for the actual costs incurred or according to rates established for the work provided. In addition the contractor is paid an incentive fee based on performance. Performance criteria can be associated with schedule, quality and cost, among other things.

4.5 Issues and Underlying Principles – Concluding discussion.

At a basic level how is it ensured that the owner and the contractor/supplier perform their obligation and responsibilities? *Through contracts and contract law.*

What contract pricing arrangement minimizes the financial risk to the owner? *Fixed price*.

What contract pricing arrangement minimizes the financial risk to the supplier/contractor? *Reimbursable with percentage fee.*

What contract pricing arrangement provides the best incentive for contractor/supplier performance and quality? *Reimbursable with incentive fee.*

Does the type of contract price arrangement affect the number of bidders for a given project procurement? *Yes, for example some organizations may not undertake fixed price contracts because of the risk of financial loss in performing the work.*

Part C Project Procurement Front-End Activities

5. Planning and Organizing the Procurement Process

5.1 Issues and Underlying Principles – Opening Discussion

How can large numbers of people, businesses and organizations be brought together to achieve a complex objective such as the construction of a major infrastructure item?

What is required to plan a project?

Should an organization do a project completely on its own or should it use outside services from contractors? How and why should the work be divided between the owner-organization and external contractors?

What organizational structure should be used for the project?

5.2 Organizational Structures – Division of Responsibilities

Upon deciding to procure a major infrastructure item, an organization needs to decide whether the work required for the project should be done internally or externally. That is, it must be determined which goods and services will be provided by the owner organization and which goods and services will be provided by suppliers and contractors. Upon determining the mix of internal versus external work, in depth project planning can commence. The following figures illustrate various ways of structuring project work and responsibilities between external organizations and the owner-organization for procurement/construction of infrastructure items.

Figure 5-1 *Owner undertakes all project work with its own personnel and resources.*

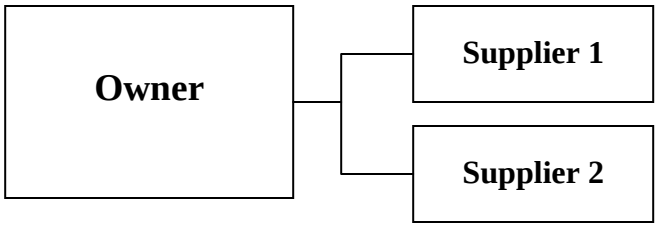

Figure 5-2 *Owner undertakes most project work with its own personnel and resources but uses a few external suppliers.*

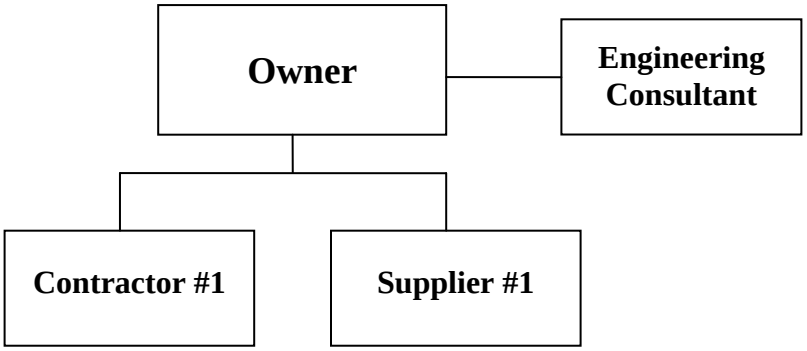

Figure 5-3 *Owner uses an external engineering firm to provide design and technical requirements. The owner performs project management and procurement management. Owner contracts directly with contractors and suppliers.*

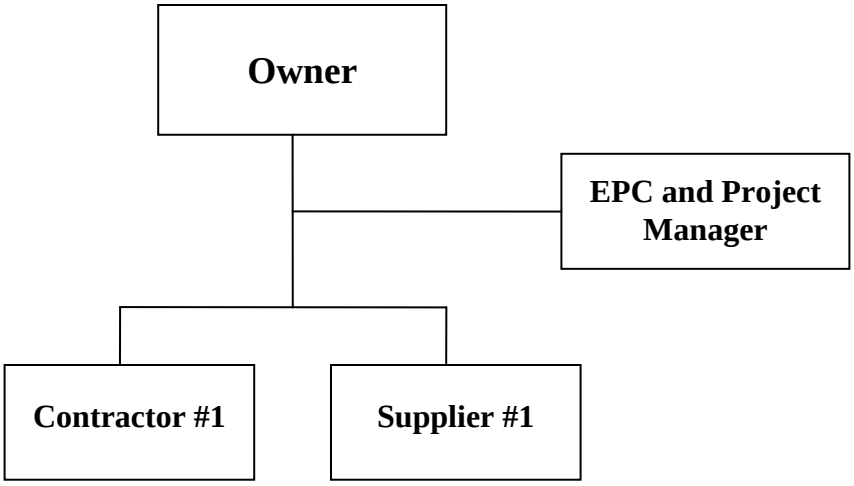

Figure 5-4 *Owner contracts with an external EPC (Engineering Procurement Construction) firm to provide design and technical requirements and to provide project management and procurement management for the project. Owner contracts directly with contractors and suppliers with the EPC/Project manager firm acting as the owner's agent.*

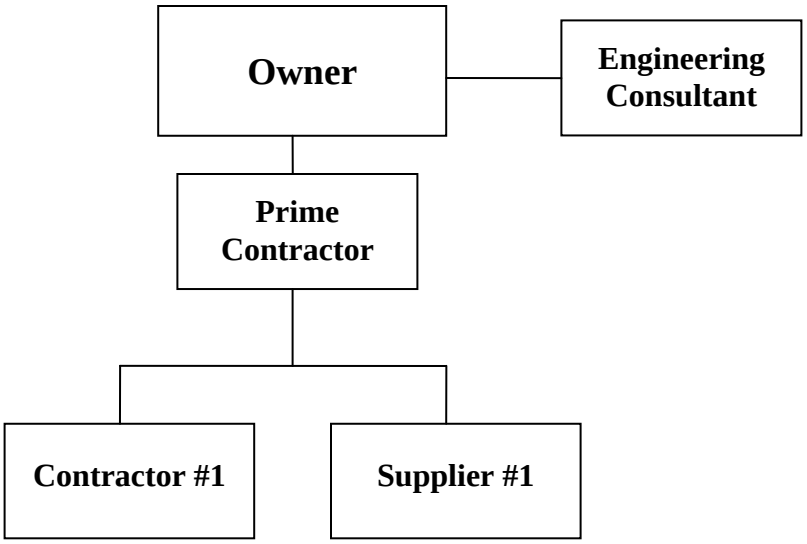

Figure 5-5 *Owner uses an external engineering firm to provide design and technical requirements. The owner contracts with a prime contractor who is responsible for performing all the construction and procurement work required. The prime contractor has its own project management and procurement management functions. The owner performs some project management and conducts the bidding process to engage the prime contractor. Prime contractor contracts directly with sub-contractors and suppliers. Sub-contractors and suppliers have no contractual relationship with the owner.*

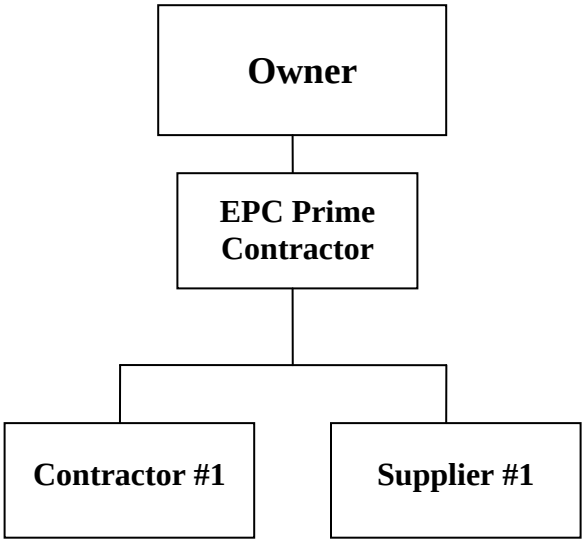

Figure 5-6 *The owner contracts with an EPC prime contractor who is responsible for performing all the engineering, procurement and construction work required. The EPC prime contractor has its own project management and procurement management functions. The owner performs very little project management. The owner's primary management activity is to select the EPC prime contractor – which may be done through a formal bidding process. The EPC prime contractor contracts directly with sub-contractors and suppliers. Sub-contractors and suppliers have no contractual relationship with the owner.*

Many factors must be considered in making the decision as to whether project work is done internally or externally. With respect to services such as engineering design an owner-organization must determine whether the expertise and capability exists amongst its personnel. Even if the owner-organization's own personnel have the capability to provide the services required the question becomes do they have the capacity. In other words are there enough personnel to do the work in the time required or are they too busy with other activities? If the owner-organization does not have enough available personnel to provide the manpower needed for the project, there is the option of hiring additional personnel. In deciding whether or not to hire additional personnel, the owner-organization must consider what these personnel will do once the project is completed. Further the owner-organization must compare the proficiency of its personnel versus that of external personnel. Proficiency can depend on the availability of appropriate resources and tools that the owner may not have.

Assuming that an owner-organization has available internally the necessary personnel and capacity, overall costs for the project will tend to be lower by using internal personnel. This is because much of the management, effort and activities related to using outside contractors is not required. For example the effort necessary to conduct a formal bidding process is not required. Also, the prices that outside contractors charge include a portion that covers the contractor's overhead and profit. By doing the work internally project overheads are reduced and the money spent on contractor's overhead and profit is saved.

There are advantages to using an outside contractor even if the capability resides in house. A contractor is often more proficient in performing the work required. Further, the contractor's business focus is on the provision of the services whereas this is probably not the case with the owner-organization. This fact will likely result in the contractor maintaining the current state-of-the-art in the services it provides whereas an owner-organization may lag behind.

Similar factors and considerations exist for the procurement of materials and equipment from external sources versus manufacturing and fabricating the materials and equipment internally. In deciding whether to manufacture and fabricate equipment internally it must be determined whether or not the owner organization has the capability, expertise and capacity to do this. Internal costs would be lower in terms of management overhead and not having to pay external overheads and profits; but doing the work internally may not have the same efficiencies as an external organization and hence the work may actually cost more.

After weighing all the factors as to whether to do the work internally or externally, it then often becomes an executive decision as to how to divide the work. Of course, if the owner-organization does not have the capability internally then an outside organization has to be used.

On paper Figures 5-2 to 5-6 may look fairly simple, but each line that connects two organizations may require significant effort to establish and manage throughout the project. At a minimum each line represents a contractual relationship that will require effort to establish – RFP generation, bid creation, bid evaluation, contract formation. Further, each line represents a logistical requirement for moving materials, people, and information between organizations. If the two organizations are in different countries on different continents, the logistical effort can be complex and expensive.

5.3 Defining the Procurement Program

A number of things need to be addressed and determined prior to and at the start of an infrastructure procurement project as discussed below. This is done in conjunction with project management and provides necessary inputs to the procurement function for its operation. The procurement function needs to know when to issue RFP's and the required timing for entering into contracts with contractors and suppliers. Budgetary estimates are required for the project, which are then used in evaluating the acceptability of bids. Division of responsibility and organization define who the procurement function must work with and the types of contractors and suppliers that must be sought after.

5.3.1 Project Birth – The Business Decision and Conceptual Design

All infrastructure projects start from the business perspective with the recognition of an opportunity for revenue or the requirement to fill a business need. To be able to analyze the viability of the project, a high level conceptual design is required. Process flow sheets or block diagram designs can be used to define the conceptual design. From the flow sheets/ block diagrams a capital cost analysis/estimate can be made. Additionally operational parameters can be estimated from which cash flow projections can be made. From the cost and cash flow estimates a profitability analysis is done for the project from which a go/no-go decision can be made.

Upon the decision to proceed, front-end planning commences for the project. The conceptual design is a key input to this planning. It provides the initial scope of the project and allows for an initial high level breakdown of the work required and the equipment and materials to be procured. Using this breakdown, decisions can be made regarding how to structure and conduct a project.

5.3.2 Procurement Approach and Division of Responsibilities

With an understanding of the scope of the project and a breakdown of the work required decisions as to whether the work should be done internally or externally can be made. If it is determined that the work must be done externally then the procurement approach for outside contractors and suppliers is defined. That is, for the different work elements it must be decided whether a formal competitive bidding process with RFP's and bid evaluations will be used; whether sole source negotiated contracts without a competitive bidding process will be used; whether off-the-shelf purchases of standard items based on simple quotations will be used. It must be understood that a formal competitive bidding process requires time, effort, and expense. The method of obtaining bidders must also be determined – unrestricted through advertising or from a qualified list. Depending on the contract pricing arrangement to be used, much effort will be required to define technical and commercial requirements prior to the commencement of the bidding process.

5.3.3 Number and Scope of Individual Contracts

From the division of responsibility that has been determined for the project, work to be done by external organizations is divided into individual contracts. With each contract effort is required to form the contract and manage and administer the contract. Thus the more contracts that are used in a project the greater the amount of work required to just manage and administer the contracts. There are a number of additional factors to consider in determining how many contracts to use in a given project.

If the owner-organization has insufficient or no internal engineering staff, then one or more external engineering contractors will be required. With more than one engineering contractor the requirement for establishing design interfaces arises. This will require specific work devoted to developing interface specifications. Further, if there is more than one engineering contractor, there will have to be a strong engineering group coordinating all the engineering work. In establishing the scope for the engineering contracts, it should be determined whether the engineering contractor will be involved in inspection and test and whether the engineering contractor should have direct interfaces with construction contractors and suppliers.

Similarly with more than one construction contractor there is the management issue of coordinating all of the contractors. Since all contractors tend to be on-site at the same time this is not a trivial task. The coordination effort required may be minimized by using a prime or general contractor. In determining the scope of work for contractors consideration may be given to having the contractors do detailed design work and procurement of equipment and materials. Often contractors will have the capability to do this.

5.3.4 Budgets/Cost Estimates

Budgets/cost estimates are used to monitor and manage the project. The acceptability of bids received is determined by comparison with the budget established for the work. The control of reimbursable contracts is done through comparison of actual charges with the budget for a given contract. Whenever any element of the project is over budget, this raises a flag that requires the attention of project management. Whenever a project element is significantly over budget, or if many elements are over budget, the viability of the project is put into question.

Budgets/cost estimates are generated from a work breakdown developed from the conceptual design for the project. The work breakdown identifies all the work elements/activities required to carry out the project. For each work element identified costs are estimated for labour, materials, equipment and overhead. Both internal costs to the owner-organization and external costs must be identified. At the beginning of the project the accuracy of the estimates will be weak since the scope of work is normally not defined in detail. Past experience in similar projects can be used to generate cost estimates at the beginning of a project when detailed work requirements are not known. As the scope of work becomes more detailed, the accuracy of the cost estimates can be improved through a bottom up approach. That is, estimates are done for small packets of work and then added together to get an estimate for the overall activity.

Given that engineering design work is done at the beginning of a project, accurate cost estimates can be difficult to obtain for the engineering work. As mentioned this is because the scope of work is normally not detailed at this time. In fact, it is the engineering design

work that leads to details in the scope of work. Given this, engineering contracts are often established on a time and materials or cost reimbursable basis. To reduce price uncertainty and risk in the engineering work, the up-front engineering work can be confined to just defining performance specifications. Detailed design work could then be done by contractors and suppliers under a fixed price basis when the scope of work is better defined. Given that the cost of construction contracts can likely be accurately estimated using a bottom up roll-up, a fixed price contract is viable for construction/fabrication work.

In all estimates, a contingency may be required to cover the possibility of cost escalation/inflation, to cover inaccuracies in work scope, and errors caused by under estimating costs.

5.3.5 Activities, Phases and Schedule

From the work breakdown that was obtained from the conceptual design, work elements are ordered in a logical sequence in time. Expected or desired durations for each work element are assigned to the elements. Working backward from the desired completion date or forward from the start date, a schedule is developed for the project. Important activities, milestones, and deadlines to include in the schedule are:

- Conceptual design
- Technical specifications and requirements (assign completion date)
- Detailed design (assign completion date)
- Division of responsibility determination
- Determination of management, commercial and RFP requirements
- Quality requirements
- Generation of RFP (assign deadline)
- Issue RFP
- Contractor bid preparation
- Receive and open bids (assign deadline)
- Bid evaluation
- Contract preparation and signing (assign deadline)
- Carryout contract
- Excavation
- Construction (assign start date)
- Close-out contract
- Commissioning
- Start-up (assign deadline)

5.3.6 Organization – People and Resources

Many functions and skills are required from the people involved in a procurement project. Project personnel must know their functions, responsibilities, authority, and the reporting interfaces and communication lines with other personnel and other organizations. An important activity at the beginning of a procurement project is therefore to assign, appoint and organize the people involved in the project to the various roles and responsibilities necessary to carry out the project. Organization involves

defining the reporting and communication links between people. A key person to appoint for the project is the project manager. The project manager has total responsibility for the procurement project. Supporting the project manager would be various personnel providing the following functions:

- Project engineer/ engineering manager
- Engineers
- Construction manager
- Contracts and procurement manager
- Program planner
- Cost controller
- Accounting
- Legal support
- Operations liaison
- Maintenance liaison
- Quality Assurance

The size of the project team is of course proportional to project size. In larger projects many of the above roles will be broken out further and assigned to additional personnel. In smaller projects many of the above roles will be combined and undertaken by one person. Further, the division of responsibility between the owner-organization and external organizations will affect the composition and structure of the project team. Figure 5-7 shows a typical organizational structure.

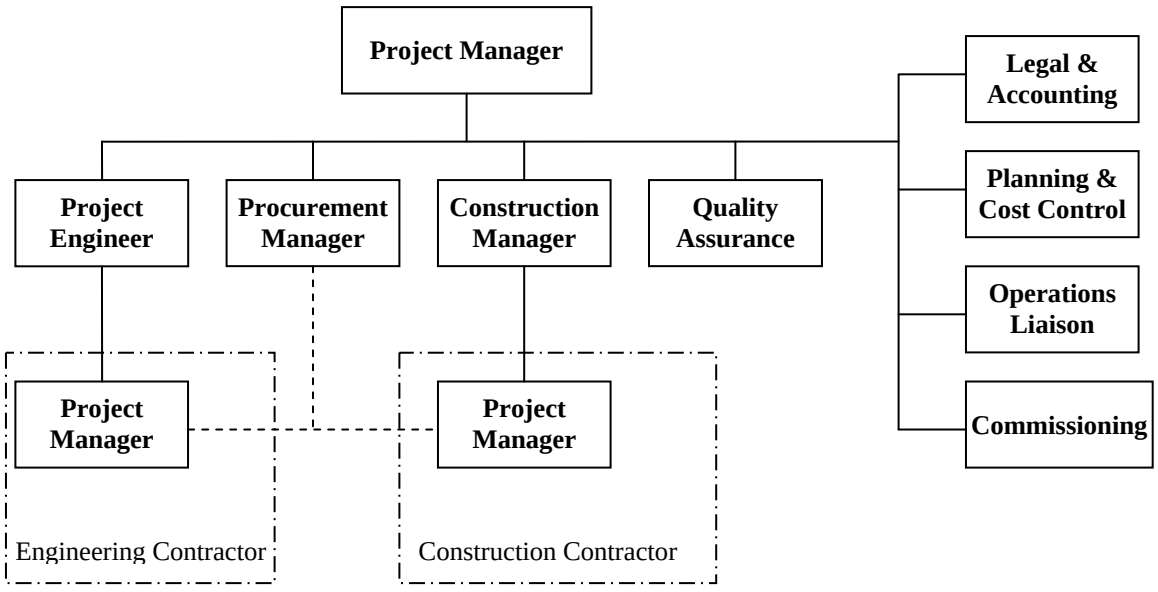

Figure 5-4 *Procurement project organizational structure.*

An important organizational and operational process to define concerns the reviews and approvals required in the project. If an engineering consultant is used in the project, the owner-organization may desire to approve specifications and designs before these are given to a construction contractor or issued to a supplier. The degree of approval and control that the owner-organization exercises over a contractor will depend on the contract pricing arrangement with the contractor. For fixed price contracts, relatively little review and control will be exercised – it is the contractor's responsibility to meet technical requirements. In a reimbursable contract, the owner-organization would exercise greater control through reviews and approval requirements.

5.3.7 Deliverables/Scope

The overall project objective and the work scope and deliverables of individual contracts are defined through requirements. The project requirements – technical, quality, schedule, and commercial – are developed through the efforts of the various groups involved in the project.

5.3.8 Information and Documents

A project runs on information. Information is created by one group and passed to another group for use by that group. Technical designs, drawings, specifications, contract requirements, scheduled dates, RFP's, bids, inspection and test results, change orders, and on, are all various types of information that make the project work and are needed to achieve project objectives. In order to be useful and manageable this information must be embodied in documents. Key documents include:

- Drawings
- Technical specifications documents
- Equipment data sheets
- Analysis reports
- Contract documents
- Request for proposal (bidding) documents
- Contractor's proposal (bid) submissions
- Quality plans
- Inspection and test plans
- Progress reports
- Detailed work instructions
- Low level work plans/shift plans
- Accomplishment summaries
- Operating and maintenance manuals
- Correspondence

5.3.9 Determine Bidding and Selection Methods

For contracts that have a large monetary value and for other reasons, a competitive bidding approach using a formal tendering process is desirable. This requires the development of a Request for Proposal (RFP) package which is then issued in an *Invitation to Bid*. The formal tendering process requires significant effort. Evaluation criteria must be established with which to assess the bids submitted – bids received are then evaluated against these criteria. For various reasons, a sole-source negotiated contract approach may be pursued.

5.4 Carrying Out the Plan

A great plan is of no value unless it is acted upon and carried out. Some topics related to carrying out the plan will be discussed below – others will be left to later courses.

5.5 Issues and Underlying Principles – Concluding Discussion

How can large numbers of people, businesses and organizations be brought together to achieve a complex objective such as the construction of a major infrastructure item? *Through effective planning, organization, and management – this entails the division of labour and responsibilities.*

What is required to plan a project? *A top level project scope/conceptual design. A work breakdown. Scheduling of work elements. Identification of contracts required.*

Should an organization do a project completely on its own or should it use outside services from contractors? How and why should the work be divided between the owner-organization and external contractors? *Considerations related to this were discussed above.*

What organizational structure should be used for the project? *Considerations were discussed above.*

Part D Defining Requirements and Contract Terms

6. Technical Requirements

6.1 Issues and Underlying Principles – Opening Discussion

How does an owner/purchaser ensure that they get what they need and want?

6.2 Purpose of Technical Requirements

The procurement/construction of infrastructure depends on engineering design. A potential contractor/supplier bidding for a contract to undertake construction/fabrication work in the project needs to know the design in order to determine the price and to do the work. This information is communicated through the technical requirements that are provided in an RFP. The extent of detail and completeness in these technical requirements is a factor in determining the type of contract pricing arrangement to be used. If the technical requirements/specifications/design cannot be thoroughly defined then a reimbursable type of contract pricing arrangement is more likely to be used. For this reason contracts for engineering design are more likely to be of the reimbursable type since it is the engineering function that creates the detailed technical requirements and design in the first place. Fixed price contracts are more likely to be used for construction and fabrication provided sufficient engineering has been done before the start of the bidding process.

6.3 Creating Engineering Specifications and Designs

The technical requirements provided in an RFP can be detailed and include all design information; or the technical requirements can be given at a higher level as performance specifications that define high level requirements and interfaces only. If the technical requirements in the RFP just provide performance and interface requirements then detailed engineering design would be expected to be done by the contractor/supplier and would be part of the contract. This approach would allow an RFP to be issued sooner and hence accelerate the contracting process. But with this approach the owner/purchaser has less control over all the design details and hence it may be more difficult to resolve interface problems and issues when they arise.

If detailed specifications and design are to be provided in an RFP package then the design burden is placed on the owner/purchaser. The owner has to complete the detailed design with its own staff, or use an engineering contractor, prior to issuing the RFP for construction/supply. With this approach the owner has complete control and knowledge of the design, which may be beneficial in complex projects having large numbers of equipment to interface together. This approach, though, does not take advantage of a supplier's design expertise and may delay the awarding of contracts since the design must be completed for issuing the RFP. For the owner to complete detailed design, the owner must have the necessary engineering expertise. Maintaining engineering staff may not be desirable to the owner if this is not related to the owner's usual business focus – if so an engineering contractor would have to be used.

6.4 Reference Standards, Codes, and Regulations

Reference standards are created by industry associations, national standards authorities, and certification bodies. These standards establish such things as; material requirements and properties; test methods; interface specifications; protocols; design requirements and practices; welding codes; safety practices; quality requirements; and on. Examples of different bodies/organizations that create standards include:

- International Electrotechnical Commission (IEC)
- International Telecommunciations Union (ITU)
- International Organization for Standardization (ISO)
- Canadian Standards Association (CSA)
- British Standards (BS)
- Institute of Electrical and Electronic Engineers (IEEE)
- German Standards (DIN)
- American Society for Testing and Materials (ASTM)
- American Society of Mechanical Engineers (ASME)
- plus many more

Codes are typically standards that must be applied by law. These standards would be developed by bodies such as those identified above and made mandatory by regulatory authorities. For example, the Canadian Electrical Code is developed by CSA and made mandatory by the provincial governments in Canada.

Technical specifications for a procurement can be defined in detail through fundamental engineering design work, or the specifications can reference standards to establish and control details of the design. Basic safety considerations can be addressed by applying the standards developed by the standards bodies identified above. These standards are normally developed with safety issues in the mind and since any engineering work required to create the standard has already been done, using a standard avoids redundantly doing the engineering work again. Another consideration is that issues concerning liability for design failures will be mitigated by using accepted industry standards that define accepted practices and the state of the art. If it is possible to misinterpret an industry standard, clarification must be included in the RFP technical requirements.

6.5 Standard Specifications and Products from Suppliers

The use of standard specifications and products can greatly reduce the engineering work required in a procurement project. Off-the-shelf products have already had their engineering design work done and through actual use have had any deficiencies or problems corrected. Therefore, using standard products can potentially increase project quality, decrease project cost, eliminate custom manufacturing and fabrication, and reduce the project schedule. Even if some modification/customization is required, this may still be more cost effective than designing from scratch.

Examples of standard products and specifications include:

- Piping, valves, and fittings
- Electric motors, transformers
- Platforms, walkways, ladders, stairways
- Painting, insulation, material application
- General noise control
- Electronic and electrical devices
- Pumps and compressors

Off the shelf systems can also be used which can greatly save engineering time. Examples include:

- Communication systems
- Turbine and generator systems

And of course, duplicating a previous project will have significant cost benefits. For example, designing a compressor station once and then repeating the design many times.

6.6 Interrelationships in Design and Requirements

In developing the specifications and designs, the engineering group must consider the interests and needs of the other functional groups involved in the project. To achieve this the engineering group must receive input from these groups. Some of other groups involved in a project and their needs are as follows:

Procurement group – in order to get a competitive price the procurement function desires that there are enough potential contractors/suppliers interested in bidding and that potential contractors/suppliers will have the capability to realize the design.

Construction/manufacturing group – desires that the designed can be realized (constructed/manufactured) in a practical way.

Project management – desires that creating the design and realizing the design does not adversely affect project schedule and cost. Project management is concerned with overall project success and desires that engineering processes and resulting designs lead to this success.

Test and quality control – desires that the design can be tested and verified and the provisions are included for testability.

Operations – desires a problem free design that is efficient to operate.

All of these groups must be included in the design process in some manner. This can be achieved through consultations with these groups; having representatives from these groups as part of the design team; conducting design reviews that involve participants from these groups. It is also worth including contractors/suppliers in the design process if these have already been contracted with.

6.7 Document Formats for Conveying Technical Requirements

Several different formats for documents are used in conveying technical requirements and designs. Normally all formats will be included in an RFP.

6.7.1 Written Specifications

Written specifications are used when words and text are required to best convey technical requirements. The specifications would be a document much like these course notes.

6.7.2 Data Sheets

Data sheets are used when tabulation of data he is best for conveying technical requirements.

6.7.3 Drawings

Drawings will of course be used when technical requirements and design are best conveyed through a graphical representation.

All the documents must be listed and indexed in some manner within the RFP in order to ensure that they are recognized as forming a part of the RFP.

6.8 Issues and Underlying Principles – Closing Discussion

How does an owner/purchaser ensure that they get what they need and want? *Through detailed and elaborate defining of requirements and through the use of industry standards.*

7. Quality Assurance Requirements

7.1 Issues and Underlying Principles – Opening Discussion

What needs to be done to ensure that the product provided by suppliers and work performed contractors meets the requirements of the technical specification/design?

7.2 Quality

Obviously the owner/purchaser wants the procurement project to deliver an end result of goof quality relative to the price paid. The question arises as to what is meant by quality because it can mean many different things to different people. Formal definitions of quality used by various standards organizations and references (ISO 9000, others) tend to be as or similar to the following:

> "Quality is the totality of features and characteristics of a product or service that bear on the ability to satisfy stated or implied needs. It is the degree to which these requirements are met."

Less formal definitions commonly used by lay people are based on ideas such as: freedom from defects and deficiencies; superiority to other products (relative quality); meeting or exceeding expectations; fitness for use; ease of use; reliability; and so on.

Achieving desired quality in the deliverables of a project is not guaranteed unless effort and resources are devoted explicitly and specifically to this objective – otherwise, obtaining the desired quality is left to chance. Responsibilities, processes, procedures, activities and resources must be defined and committed with the specific aim of achieving quality. These responsibilities, processes, procedures, activities and resources devoted to quality make up a quality management system. A quality management system does have an explicit cost, but of course the return related to ensuring quality justifies this cost. As such, quality system requirements must be considered within the project procurement process and be included in any RFP. Either the owner/purchaser or contractor/supplier, or both, must undertake responsibilities for quality.

7.3 Quality Assurance versus Quality Control

Quality Assurance – quality assurance refers to the management systems and business processes that an organization implements to ensure a high degree of quality in the products and services that it provides. These processes are directed towards ensuring that the activities necessary to ensure quality are undertaken.

Quality Control – quality control concerns the actual inspections, tests, reviews and reporting that are done in manufacturing a product or providing a service to ensure that requirements are met. Quality control is an element of quality assurance.

7.4 Quality Requirements

Effort is required to ensure quality in a project – time and money is required to carry out tasks and activities related to quality assurance and quality control. Nevertheless this is

an important aspect of a procurement project required to achieve success. Quality requirements must be included in an RFP.

The extent to which quality control requirements – inspections, tests, reviews, reports – are defined in the RFP depends on the pricing arrangement to be used for the contract. For fixed price contracts these requirements must be fully defined so that the contractor/supplier can accurately determine the associated price. For reimbursable contracts, these requirements can be established in the course of the contract if need be.

An owner-organization may have an established quality management system with quality processes that apply to a project. The owner-organization may wish that the contractor/supplier work within or at least interface with this quality management system. Documents referencing the owner's quality management system and the extent to which contractors/suppliers must conform to the requirements of this system should be included in an RFP.

In evaluating contractors and suppliers for the award of a contract, the owner's quality assurance group should perform an audit of a supplier/contractor's operations and quality system. The audit evaluates the contractor/supplier's documented quality procedures and processes (quality management system) as contained in manuals and documents; and then verifies that these procedures and processes are actually performed. If the contractor/supplier does not have a well defined quality program there is a risk that the equipment, materials and work supplied maybe of low quality. To award a contract, the owner must approve the quality procedures to be applied and must be satisfied that quality control activities will be performed as required. Meetings with supplier/contractor personnel and plant visits aid in quality audits. For contracts that have a strong design aspect and that anticipate the occurrence of changes, configuration management processes are important and must be satisfactory to the owner.

Technical reviews of designs are an important quality assurance task in contracts for the provision of engineering design services. These technical reviews must be worked into the project plan and significant reviews are often identified as key milestones. The design reviews can function as approval and progress payment milestones. The procedure for reviewing and approving designs, design changes, and controlling configuration must be defined in the RFP. In addition to reviews, prototype testing maybe required to ensure that the design works and meets requirements. As an alternative to physical testing, computer simulation may be used to verify design performance.

7.5 ISO 9000 and Quality Management Systems

Organizations achieve the desired quality in their products and services through a quality management system (QMS). If an organization has a formal and observable QMS to which effort and resources are devoted it would be expected that this organization would have a high degree of success and consistency in meeting the requirements desired of its products and services. Therefore, in the procurement of major infrastructure and equipment it is essential that suppliers/contractors have a QMS that is formal, well defined, implemented, and very importantly operating. To ensure that this is the case, the owner/purchaser will need to audit the QMS of suppliers/contractors – this can either be done by the owner/purchaser themselves or reliance can be placed on a 3rd party certification.

Worldwide there are a number of standards for quality systems published by various organizations. Internationally, the most dominant set of standards is the ISO 9000 family of quality management standards developed and published by the International Organization for Standardization (ISO). Collectively, the ISO 9000 family "represents an international consensus on good quality management practices. It consists of standards and guidelines relating to quality management systems and related supporting standards."(ISO 9000)

The focus of and the key standard in the ISO 9000 family is ISO 9001:2008. There are a number of essential features that are common to all quality management systems and these are enumerated and defined in ISO 9001:2008. ISO 9001:2008 sets out the requirements for a generic management system for assuring quality that can be applied to any organization and used in any type of industry. A given organization would tailor the requirements of ISO 9001:2008 in application to its business. ISO 9001:2008 is the only standard in the ISO family to which organizations can be certified.

An organization can be independently audited and confirmed as being in conformity with ISO 9001:2008 by various independent (3rd party) certification bodies. If found to be in conformity, the organization will be certified and registered as conforming to the requirements of ISO 9001:2008. Therefore, selecting a contractor/supplier that is certified to conform to ISO 9001:2008 can save an owner/purchaser the effort of having to audit the contractor/supplier's quality system in the evaluation of a bid.

7.6 ISO 9001:2008 QMS Requirements

A very basic understanding of quality management systems can be obtained from a summary of the main sections of ISO 9001:2008. The main sections are:

Section 4 – General Requirements (of ISO 9001:2008)

which is then followed by four sections of specific requirements for a QMS:

Section 5 – Management Responsibility

Section 6 – Resource Management

Section 7 – Product Realization

Section 8 – Measurement, Analysis and Improvement

Further discussion of the requirements given in these sections is given below.

Section 4 – General Requirements

The organization shall establish and maintain a documented quality management system. The QMS consists of processes implemented to achieve quality requirements and objectives. QMS documentation shall include a quality manual; documented plans, procedures, and instructions; and records. The quality manual is the primary document of the QMS that integrates all the elements of the QMS. The content of the quality manual must be implemented and evidence that the QMS system is operating as stated in the manual must be provided. The QMS system operates through the detailed processes and associated procedures and instructions referenced in the quality manual. Records must be kept of the activity and outcomes associated with the organization carrying out these processes. These records generated by the activity and tasks associated with the process procedures and instructions provide the evidence that the QMS has been implemented and is operating.

All documents relating to the quality system and its operation must be controlled with respect release, identification, distribution, revision, access and storage. Similarly all

quality records must be controlled for identification, maintenance, storage, retrieval, retention, and disposition.

Section 5 – Management Responsibility

Management must commit to establishing and operating a QMS for their organization and must commit to ensuring that the QMS is effective. The customer is of ultimate importance to a business. Therefore the objectives of an organization and its QMS must be directed towards fulfilling the needs of the organization's customers.

First management must establish a quality policy for their organization and define the objectives of the QMS. Communicating the policy and objectives and ensuring that the organization is aware and motivated to achieving the objectives are important responsibilities of management.

Effort must be devoted to planning and defining the QMS and its objectives. This is underscored by creation and maintenance of the quality manual. Planning identifies the processes required, the infrastructure needed, the resources necessary to implement the QMS. The responsibilities of personnel for the QMS and their roles within the QMS must be defined and authority must be given. Lines of communications and reporting must be established.

Management must ensure the necessary resources are available for the QMS. A management representative with responsibility for the overall QMS must be designated and this representative must have the authority to ensure the effectiveness of the QMS. Regular reviews of the effectiveness of the QMS must be conducted.

Section 6 – Resource Management

The organization shall provide the necessary resources to implement, operate, and improve the QMS. Personnel shall be assigned to roles and responsibilities within the QMS. These personnel must be educated and trained in QMS processes and they must be sufficiently skilled, experienced and competent. The organization is responsible for training its personnel. It must evaluate and maintain the effectiveness of the training and keep records of this training.

The necessary infrastructure for the QMS must be provided and maintained. Infrastructure consists of facilities, workspaces, equipment, software and services. A good work environment must be established and managed so that people can properly carry out their roles in the QMS.

Section 7 – Product Realization

Many organizations are not involved in designing and/or manufacturing products and therefore the QMS requirements of product realization will not apply to all organizations. But these are of particular importance to procurement projects for major infrastructure and equipment because of the significant engineering, design, manufacturing and construction aspects of such projects.

First of all there are many processes involved in product realization: design and development; purchasing; manufacturing; inspection and test. For an effective operation these must be planned and detailed. Inputs, outputs, activities, and records for all processes must be identified and formalized within the QMS. With this resources can be applied to the processes and the business can meet its objectives.

Customer focus and interaction is very important. The process of reviewing contracts and entering into contracts with the customer must be figured out. Identifying, defining, understanding and reviewing requirements for the product and those of the customer must be done. These requirements must be formalized and documented to ensure they are met. Documented requirements are the inputs to many of the product realization processes – especially the design and development process.

Design and development is a significant product realization process. This process starts with planning to identify the activities, resources, processes and organizing required. Reviews are an important part of the design process. Depending on the complexity of the product there can be many reviews at various stages of the design activity. These reviews ensure that the design is technically correct and capable of meeting product requirements. These reviews can serve as gates and milestones in the design process.

Verification activities must be defined and scheduled within the development process. The design and development process consists of many steps from product conceptualization through to product realization. For example: conceptual design, detailed design, coding, sub-module design, etc. would be steps in the design process of various projects. Verification concerns using various methods – such as prototyping and physical testing, simulation, inspection, etc. – to verify that the outputs of a given step in the development process meet the requirements defined as the inputs to the step.

Validation is done at the end of the development process. This activity is concerned with validating that the product meets its requirements (often referred to as high-level requirements). Product requirements are the input to the design and development process. These pass through several stages in the development process. At each stage, more detail and a greater breakdown of the requirements is done into subsystems and subassemblies. The last stages of the development process concern integrating all the subsystems and subassemblies back together in the product. Validation looks at the overall product relative to the high-level or overall requirements.

Since design changes often arise processes must be defined for controlling, approving and incorporating these changes – processes often referred to as configuration management. Throughout the design and development process the design must be properly documented, changes correctly incorporated and records must be generated and maintained of all activities and the results of the activities.

Purchasing must be addressed by the QMS. Information about purchased products and materials must be created and maintained. This information defines the required specifications of these products and materials. When received, purchased products and materials must be verified through appropriate methods such as inspections and test to conform to the required specifications. Suppliers must be evaluated, selected and regularly reevaluated as to their ability to meet requirements.

Production and service operations must be controlled and managed. The processes involved must be defined and documented in terms of methodologies, quality procedures, and work instructions. The processes must have available suitable equipment and qualified personnel. Validation of the processes is required especially when it is difficult to directly test or measure the outputs of the processes.

Measuring, monitoring and test equipment must be controlled and cared for. Regular calibration and traceability to standards is required to maintain the effectiveness of the equipment.

Section 8 – Measurement, Analysis and Improvement

A QMS cannot just be defined and implemented and then ignored. It must be regularly audited to ensure it is effective and operating properly and to improve it where possible. Quality processes should be measured and monitored to ensure they meet their intended purpose and satisfy customer requirements.

Similar attention must be given to the products of the business. These products must be continually monitored, measured and evaluated to ensure that they meet requirements. Customer satisfaction should also be measured and monitored.

Where items do not conform to requirements, the non-conforming products must be controlled so that they are not unintentionally used and so that rework and correction can be applied if feasible.

The basis upon which all this rests is data. The organization shall collect the appropriate data and implement methods to analyze the data. Where indicated, corrective actions, preventative actions, and continual improvements should be undertaken.

7.7 Quality Management System Documents

The types of documents that define and are required by a QMS include for example:

- Quality manual
- Quality plans
- Quality procedures
- Work instructions
- Design Documents and Specifications
- Inspection and Test Plans
- Inspection Procedures
- Test Procedures
- Records
  - Inspection and Test Results
  - Inspection and Test reports
  - Material Certifications
  - Training Records

7.8 Quality Plan – The Application of the QMS to a Specific Project

The quality management system requirements defined above are general and a supplier will likely have implemented a system that encompasses the entire business. The complexity and magnitude of a major procurement may require additional separate planning to that contained in the overall QMS specifically tailored to the requirements of the procurement. If this is the case then a separate quality plan should be developed and documented for the specific project. The quality plan would in essence be a mini-quality-manual tailored to the project that would define how the quality system requirements will be met in the specific project.

Key elements of a specific quality plan commonly developed for and used in major procurement projects include a Quality Inspection and Test Plan and a Factory Acceptance Test procedure.

7.8.1 Quality Inspection and Test Plan

Testing and inspections are required to insure that equipment supplied meets technical requirements and that the equipment basically works and performs as desired. These test and inspection requirements would be contained in the quality inspection and test plan specifically developed for the given equipment. The plan would identify what tests and inspections are required, the approval necessary to proceed at various points in manufacture of the equipment, what to do with non-conformances, and the schedule of significant test and inspection milestones. The quality inspection and test plan has important contractual significance and as such will be included in an RFP. Successful completion of the tests and inspections defined in the plan will often be used as criteria to release payment to the supplier.

Key issues in developing the plan are the amount and type of inspection and testing to be done and the owner/purchaser's involvement in this inspection and testing. Depending on the importance of the equipment, its complexity and challenge in design, inspection and testing can be very extensive with a high degree of oversight and witnessing by the owner/purchaser. The involvement of the owner/purchaser can range from little or no participation through to having an owner's inspector resident at the manufacturer's/supplier's facility for continual monitoring of the manufacturing process and witnessing of tests. The range of variation in the degree of owner/purchaser involvement could be as follows:

- No inspection involvement
- The final inspection only
- Scheduled inspections – inspections only at predefined points in the manufacturing schedule
- Regular inspections – repeated visits and inspections done on a regular basis
- Resident inspection

In defining what inspections and tests to do, the owner/purchaser will often have standard inspection and test procedures that are defined in the RFP and included in the contract. Depending on the complexity and nature of the tests, the personnel conducting the tests may need engineering expertise - a representative from engineering may then be required to be involved in testing. What to do with nonconforming items and equipment must be defined – this can entail rework or scrapping the item. Often a non-conforming item will require engineering involvement in determining its disposition.

Construction work also requires inspections and tests to ensure that reasonable workmanship is being applied and that technical requirements are met. In construction contracts inspection plans will also have to be established. Many of the principals discussed above also apply to inspection plans for construction. Additionally, hold-points need to be defined to provide an opportunity for the owner or their representative to inspect the work. Construction would not proceed past the hold-point until approval is given by the owner or their representative.

7.8.2 Factory Acceptance Test (FAT)

For equipment often an elaborate set of tests is required to be performed on the equipment when manufacturing has been completed and prior to shipment of the equipment from the manufacturer's facility. On successful completion of these tests the owner/purchaser accepts the equipment. In considering what testing is to be done in the FAT, it should be noted that resolving and correcting problems in the equipment is easier at the manufacturer's facility.

7.8.3 First Article Testing - Type Acceptance

When multiple units of a given product or equipment are required, often the first article produced will undergo a more rigorous set of tests which in essence comprise validation testing of the design. Subsequent units produced would not be subject to this set of tests. The owner/purchaser would often either participate in this testing or look to 3rd party test agencies to conduct the testing.

7.9 ISO 14000

The ISO 14000 family of standards addresses the environmental impact of an organization's operations. As ISO 9000 defines a quality management system (QMS), ISO 14000 defines an environmental management system (EMS). The purpose of the EMS is to reduce or prevent pollution by identifying and controlling the ways in which an organization's activities impact the environment. An organization's EMS will set acceptable environmental objectives; measure and monitor to ensure these objectives are achieved; and strive to improve the organizations environmental performance. ISO 14001:2004 provides the requirements for an EMS. For a given procurement, the owner/purchaser's EMS may have requirements that must be included in any RFP's.

7.10 Issues and Underlying Principles – Closing Discussion

What needs to be done to ensure that the product provided by suppliers and work performed contractors meets the requirements of the technical specification/design?
Quality system requirements must be included in a procurement project and associated RFP's. These requirements can range from specific testing plans and activities through to ensuring that suppliers/contractors have implemented effective and operational quality management systems within their organizations.

What needs to be done to ensure that the work performed by suppliers and contractors meets the requirements of the technical specification/design? *Through ensuring that the contractor/supplier has the corporate philosophy and management systems that lead to better quality products and services – Quality Assurance. By ensuring that the contractor carries' out appropriate inspections and tests – Quality Control.*

8. Detailed Schedule Requirements

The scheduling considered earlier pertained to the high level procurement activities. A more detailed schedule is required to manage the execution of the project. This topic will be covered in other courses in the MEng program.

8.1 Issues and Underlying Principles – Opening Discussion

8.2 Milestones

8.3 Recognizing and Allowing for Interdependencies

8.4 Creation of the Schedule

8.5 Monitoring the Schedule

8.6 Issues and Underlying Principles – Closing Discussion

9. Commercial Requirements and Contract Conditions

9.1 Issues and Underlying Principles – Opening Discussion

9.2 Terminology and Jargon

A number of different words and expressions are used with respect to contracts and contract conditions. Sometimes this is confusing, but most of the time all of these words mean essentially the same thing. A contract is a set of obligations and promises between two parties. These obligations and promises are outlined in the *terms and conditions* of the contract. The word *term* can be interchanged with the word *condition*, these words are equivalent; they mean the same thing, that is, they mean the obligations and promises of the contract. *Term*, though, is often used to describe date and time period obligations while *condition* is used to describe other obligations and promises – but this isn't strictly applied.

The *requirements* of the contract is another way of saying the *conditions* of the contract. Thus the technical requirements are *contract conditions* – the supplier/contractor promises to provide equipment/services that meets the technical requirements. Likewise, commercial requirements form contract conditions.

Sometimes a differentiation is made between g*eneral conditions* and *supplementary conditions or commercial terms*. *General conditions* are standard contract conditions applicable to all contracts while *supplementary conditions* or *commercial terms* are contract conditions specific to a given contract and will vary from contract to contract. The *commercial terms* define the business relationship for a given contract. The term *boilerplate* is often used to refer to *general (standard) conditions*.

Often the term *Purchase Order* or *PO* is used to describe the agreement with a supplier for the purchase of an item. A *purchase order* is a contract (for the purchase of an item). A purchase order typically consists mostly of standard (general) conditions with a few supplementary conditions that define, among other things, the item to be purchased, its cost, and the desired quantity.

9.3 Overview of Terms and Conditions

The contract conditions define the promises and obligations of the owner/purchaser and the contractor/supplier. As such they can have significant financial consequences and it is therefore important that all groups which are affected by these conditions understand and agree to them. Given the complexity of infrastructure procurement, all components of contracts should always be in writing. Both parties may propose contract conditions, but of course both parties must agree to the inclusion of the condition and to the writing used to define the condition. Standard contracts and contract conditions are available from some industry associations which can be used for certain situations and thus save time and effort in writing the contract - but of course they should be reviewed and understood by project management.

Contracts for infrastructure procurement tend to be made up of a master agreement plus a large number of other documents. The documents that make up the contract should always be listed within the contract. The different documents within the contract also tend to be generated by different groups. Given all this, there is the potential for conflicts to

occur between requirements defined in different documents. To resolve this, there is often a contract clause that defines the priority/precedence of the documents – which document will be used in the event of a conflict.

9.3.1 Index of General Conditions

General conditions that are included in a contract include:

- Definition and interpretation of words used in the contract
- Compliance with the laws
- The language and jurisdiction to be used to interpret the contract
- Identification of representatives and addresses
- Notices
- Rights, duties, and responsibilities of the purchaser
- Performance of the work - obligations of the contractor
- Assignment
- Subcontracting
- Compliance with codes, standards, laws, and regulations
- Patents, copyright, and other intellectual property rights
- Confidential information
- Use and priority of contract documents
- Errors and omissions in documents supplied by the purchaser
- Contract variations
- Change orders and extra work
- Delays and extension of time
- General terms for shop inspection, tests, and rejection
- Owner's right to inspect
- Right to audit
- Deficient work
- Passing of ownership and property
- Title and responsibility
- Liens
- Accidents and damage - damage to owner's or others' property
- Completion of tests, taking over, and rejection of equipment
- Completion and acceptance
- General terms for equipment warranty.
- Certificates authorizing payment
- Certificates identifying completed work and the meeting of requirements
- Limitation of contractors liability
- Security for performance
- Force majeure
- Insurance
- Indemnity
- Independent contractor
- Termination at owner's option
- Default
- Owner's right to assume control
- Owner's right to supplement

- Insolvency
- Arbitration – resolution of disputes
- List of schedules and appendices
- Safety
- Worksite conditions and operations
- Materials management
- No other understanding

9.3.2 Supplementary Conditions – Commercial Terms

Supplementary conditions that are included in a contract include:

- Contract price structure
- Contract price adjustments for cost variations
- Terms of payment
- Contract program/schedule of payments
- Liquidated damages
- Incentive payments
- Specific indemnification requirements
- Specific insurance requirements
- Progress control and reporting
- Application for payment
- Claims procedures
- Change order procedures

9.3.3 Specific Information

Often specific information for a contract is contained in a schedule (appendix) to the contract. This schedule can be given to the bidders to review and fill in with their bid submission which can make evaluation and comparison between bidders easier. Information included in the schedule can include:

- Names of the purchaser and of the contractor
- Addresses for notices
- Applicable law (country/province)
- Price and price schedule
- Language for communications
- Time for delivery
- Place for delivery
- Time period required for purchaser approvals
- Time period required for payments and claims
- The amount of security to be provided
- Contractor's limit of liability
- Liquidated damages for delay
- Liquidated damages for not achieving required performance
- Limit of liquidated damages
- Holdbacks
- Amount of insurance to cover equipment
- Amount of insurance to cover public liability
- Identification of the arbitrator

- Procedures and place for arbitration

9.4 Discussion of Some Key Contract Conditions

9.4.1 Arbitration

Arbitration is the settling of a contract dispute, should one arise, by using a neutral third party to make a decision for resolving the dispute. The use of arbitration is simpler and less costly than taking a dispute to a court of law. The parties to the contract should agree to accept the arbitrator's decision as final. Normally, the desired arbitrator should be identified in the contract. An example of an organization that can be selected as an arbitrator is the International Chamber Of Commerce. The parties can still resort to using a court of law if necessary.

9.4.2 Assignment of the Contract

The assignment of a contract means transferring the obligations and promises contained in a contract by one party to a new third party. For example a contractor that discovers they have insufficient resources to perform the contract could potentially assign a contract to another contractor that has spare capacity. This new contractor would then have to assume the obligations and promises contained in the contract and in return would be paid under the terms of the contract for the work performed.

An important conditioned to establish in a contract is that assignment of the contract by a contractor can only be done with the owner/purchaser's written approval. Likewise, the contractor may want to approve assignment of the contract by the owner/purchaser.

9.4.3 Subcontracting

Many contractors will subcontract out a good portion of a contract with an owner. Subcontracting will be done to obtain trades, skills and manpower needed to perform the contract. The contract should state that the owner/purchaser must approve subcontracting by the contractor. The contract should also state that the owner/purchaser will not withhold approval unreasonably. The contractor will normally provide in the contractor's bid submission a list of subcontractors to be used.

9.4.4 Completion and Acceptance, Taking Over, and Certificates

These contract conditions define milestone events and requirements which are important in establishing the completion of the work and transfer of ownership and responsibility to the owner/purchaser. Various criteria that can be used to indicate completion of the work include:

- None of the technical requirements have been overlooked
- The work has finished on time
- Performance and acceptance tests have been successfully completed or commissioning has been completed
- The owner/purchaser starts normal operation
- Warranty periods have expired
- Final documents (as-built drawings) have been delivered

- Clean-up completed
- Final deliverables have been provided

Procedures for documenting the occurrence of the above events and fulfillment of the requirements above should be defined in the contract.

For transfer of ownership to the purchaser there are a number of precise procedures and documentation required to evidence that ownership has transferred to the owner/purchaser. Upon transfer of ownership, the owner/purchaser becomes responsible for care, operation, normal maintenance, and safety of the equipment or plant. Various certificates can be used to identify the completion of various steps/items for transfer of ownership to the purchaser/owner. These include:

- Acceptance certificates for FAT, Commissioning, Inspection
- Taking over certificates
- Final Certificate
- Final Certificate for Payment

A typical ordering of events for in the transfer of ownership of equipment from a manufacturer to the owner/purchaser could be as follows:

- Factory acceptance test
- Take-over certificate issued
- Shipping of equipment
- Installation
- Site acceptance test/ commissioning / performance test
- Acceptance certificate (with deficiencies noted)
- Corrections/ warranty repairs
- Final certificate (used for final payment)

In the above order of events, the precise locations and events for the transfer ownership would be established by referencing Incoterms 2000. In issuing a certificate there may still be minor deficiencies and defects in the equipment which should not stop the above flow of events. These deficiencies should be noted on the certificate. It is then the responsibility of the supplier/manufacture to correct these deficiencies; otherwise the owner can correct the deficiencies and deduct the costs from payments to the supplier.

9.4.5 Owner Approvals

The contract should specify those things that require approval from the owner. These things could include designs, inspections and tests, plans, schedules, worked methods, and other such things that are determined in the normal course of the contract. The contract conditions should specify how the approval is given, the length of time needed to provide the approval, and what happens if the approval is not given on time.

9.4.6 Force Majeure

Force majeure concerns the occurrence of events or circumstances that are unforeseen and beyond the control of the contractor or owner that make performance of some or all of the contract obligations impossible. Such events would include breakdown of plant, fire, explosion, war, rebellions, strikes and lockouts. A force majeure clause should specify the consequences if such an event occurs. These consequences could include

settlement of additional costs incurred because of the force majeure event, extensions of time for completion of work, and/or a release from some or all of the obligations in the contract.

Should the contractor claim that a force majeure event has occurred; the owner/purchaser may disagree and contest the contractor's claim. In this situation the dispute would have to be referred to arbitration.

9.4.7 Inspection and Test

The right of the owner/purchaser to conduct inspections and tests should be stated in the contract conditions. Further, the owner/purchaser's right to reject any part or all of the work that fails an inspection and test and that the supplier should fix or replace any such work that fails should be stated. Commonly inspection and test plans form part of the RFP or are required to be submitted by bidders in their tenders.

9.4.8 Liquidated Damages

Liquidated damages are pre-estimated/pre-determined amounts that are agreed to cover the owner/purchaser's losses if the work is not completed on time or does not perform to requirements or if the contractor fails to perform other obligations which are specified. In many countries liquidated damages must be a true estimate of the loss incurred and cannot be greater than this loss, otherwise the liquidated damages could be interpreted as a penalty. In such countries penalty provisions are not enforceable.

9.4.9 Changes to the Scope of Work

Design changes and changes in the scope of work can be a source of grief in a contract. They can result in cost overruns and schedule delays and if not managed properly can result in disputes and claims – this is especially of concern if the contract is on a fixed price basis. A formalized change order process with documentation must be defined and adhered to.

The contract should include a condition stating purchaser reserves the right to make changes in the scope of work and that the contractor agrees to this. Also, it should be stated that the contractor has the right to be paid for any changes and additional work. When a change is required to the scope of work, negotiations will be required to determine the additional price (or price reduction) to be paid to the contractor. Both parties should attempt to limit the length of time for negotiations to minimize any impact on project schedule. A contractor could proceed with the work associated with the change without a price being established, but this could result in a dispute later on. One method to avoid disputes and reduce the time necessary to establish a price is to perform work associated with a change order on a cost reimbursable basis.

9.4.10 Schedule Changes

In a complex project with many activities, contractors, and suppliers, there is a high likelihood that delays will arise. For example a delay by an engineering contractor in developing a design may result in the delay of work to be performed by a contractor. Another example would be a delay in the owner/purchaser obtaining financing for the project which would then delay the start of the project. The contract should state that

the owner can suspend or extend the project schedule if necessary. If this is done, the contractor must be compensated for any costs incurred as a result of the schedule change.

9.4.11 Default

A contractor can be in default of the contract for several reasons: poor performance, inadequate quality of work, failure to provide sufficient personnel and resources, inability to meet schedule deadlines, failure to perform obligations in the contract. The contract should state that if a contractor is in default, the owner/purchaser may cancel and terminate the contract (except of course if Force Majeure applies). Also, if the contractor becomes insolvent or bankrupt or if bankruptcy proceedings are instituted against the contractor, the contract should allow the owner to cancel and terminate the contract. In the event the contract is terminated under this condition, cost recovery by the contractor should be limited to that for work already performed.

9.4.12 Supplier/Contractor Caused Delays

The contract should define the actions that should be taken if the contractor/supplier is the cause of project schedule delays. These actions could include increasing the number of personnel, working overtime, and working shift work. If the contract is on a fixed price or unit price then the contractor would be responsible for these extra costs.

9.4.13 Limitation of Liability

Contractors are normally concerned with the possibility that if they breach a contract condition or are negligent in some manner, they could be held liable for any resulting damages or loss incurred by the owner/purchaser. Contractors normally desire to limit this liability and include a contract clause that set the limit of liability equal to or less than the value of the contract. Owners would of course desire that the limit for liability be as high as possible. The limitation of liability must be addressed in the contract.

9.4.14 Indemnification

The purpose of indemnification is to protect the owner against liability for negligent acts committed by the contractor since the owner will typically be included in any lawsuits resulting from the contractor's negligence. A contract clause should be included that requires a contractor to indemnify and hold harmless the owner. The contractor must be considered an independent contractor for indemnification to work.

9.4.15 Bonds

The requirements for bonds to be provided by the contractor should be stated in the RFP and in the contract. Bonds essentially guarantee that the contractor performs its obligations. A bond is a guarantee underwritten by a third party that if the contractor does not perform a contract obligation, then the underwriter will pay to the owner an amount that covers the owner's loss - up to the value of the bond. Bonds are used for several purposes in the contract as follows:

Bid bond – guarantees that the contractor will undertake the work, or at least arrange performance and payment bonds.

Performance bond – guarantees that if the contractor fails to complete or to do the work then the underwriter will compensate the owner for this or will arrange to have the work completed.

Payment bond – guarantees that if the contractor fails to pay suppliers and subcontractors that they will be paid by the underwriter.

Maintenance bond – protects the owner against deficiencies and defects that are not identified until much later after completion.

The contract clauses will specify which bonds are required and their amount.

9.4.16 Contract Program

This information, usually contained in a schedule (appendix) to the contract, defines the significant milestones in the performance of the contract. Some of the key milestones are:

Contract date – the date the purchaser notifies the successful bidder of acceptance.

Effective starting date of the contract – the date that work actually commences.

Contract completion date – this date can be defined in various ways and therefore must clearly be defined in the contract conditions.

9.4.17 Terms of Payment

For fixed price contracts payments are typically tied to the contract program milestones. For reimbursable contracts, payments are often done at regular time intervals.

9.4.18 Contract Price Structure

The contract price structure is typically defined in schedules (appendixes) attached to the contract. Included would be rate sheets if the contract is a reimbursable type. These schedules are often included in the RFP for bidders to complete in their bid submissions. For equipment procurements information as to the point where ownership transfers and which party is responsible for freight and insurance would be included. Incoterms would be used to specify this information.

9.4.19 Documentary (Letter of) Credit

If required, terms associated with any documentary credit or international performance guarantees would be included in the contract.

9.4.20 Insurance

Insurance required to be provided by the contractor should be identified.

9.4.21 Quality deficiencies

For fixed price contracts, the contract should state that the contractor is responsible to correct these deficiencies at the contractor's expense.

9.5 Issues and Underlying Principles – Closing Discussion

Part E Tendering and Bid Process

10. RFP Creation and Bidder Selection

10.1 Issues and Underlying Principles – Opening Discussion

When should a formal tendering process be used?

What must be conveyed to prospective bidders to enable them to respond?

What is considered ethical conduct of owner personnel when companies seek to be added to a bidder list by giving gifts to the owner personnel?

10.2 Contract Formation Approach

For contracts with large monetary values an owner/purchaser typically uses a formal competitive bidding process. This is typically done regardless of the contract pricing arrangement to be used.

For some contracts a formal competitive bidding process may not be warranted or justified. A sole source negotiated approach to engaging a contractor can be used provided certain criteria are met. The criteria can include:

- a relatively small monetary value for the contract;
- the complexity and requirements of the contract are such that only one contractor has the ability to do the work.

If the contract is for the purchase of standard off-the-shelf products and materials a formal competitive bidding approach would typically not be used. Nor would the contract require any elaborate negotiations. Typically, a contract (purchase order) would be issued based on quotations received from prospective suppliers.

10.3 Selection of Qualified Bidders

To ensure the greatest likelihood of success for a project it is desirable to contract with the best qualified company. When using a formal bidding approach this requires qualifying the bidders with respect to the likelihood of completing the work properly and with good quality. Given that potentially a large number of bids could be received it is often desirable to restrict bidding to only pre-qualified companies in order to reduce the complexity and effort needed to evaluate all bidders.

In order to create a list of pre-qualified bidders, candidate companies must first be identified for the list. Candidates for the list can be identified by looking at past contracts that the owner/purchaser has had; using suggestions from the owner's personnel; suggestions from other owners; suggestions from contractor's already engaged; from supplier/contractor sales and marketing information; advertising.

Once potential candidates are identified they must be pre-qualified to determine if they should be invited to bid on the project work. This can be done using a criteria sheet which tabulates the desired abilities of the contractor. The sheet would be filled in to obtain the

prequalification evaluation. Factors to consider in qualifying a potential bidder would include:

- *Financial strength, size and status* – this information could be obtained from public financial statements and from credit reporting and rating agencies.
- *Technical capability* – this information would be based on past projects and current projects of the company and on the background and resumes of the company's personal.
- *Manufacturing capability* – this information could be obtained the company's literature and an assessment of its facilities.
- *Quality program* – the company's literature and its quality assurance manuals would provide this information.
- *Safety record* – can be obtained company's information plus organizations such as the Worker's Compensation Board.

In conducting the evaluation to pre-qualify a company as a potential bidder, visits to the company's facilities and meetings with its personnel are of value.

In considering the addition of a company from a different country to the bidder's list there are a few questions to consider:

- Will the language and cultural differences result in potential misunderstandings?
- Is the required capability and technology not available locally to allow for competitive bidding?
- Are there significant cost savings?
- Will the distance add extra time to the schedule?
- Will the costs of shipping and travel be high?

Once the list of pre-qualified bidders has been generated, the invitation to bid and RFQ package would be sent to the companies on this list.

10.4 Content of the RFP

A Request for Proposal – consisting of the bidding documents – is issued to the selected bidders for the contract work. The RFP contains a number of sections/documents which are identified below. Different organizations may identify these sections/documents with different names but the content as described below will tend to be present in all RFP packages.

10.4.1 Invitation to Bid

The Invitation to Bid is the cover letter to the RFP package. It provides a brief introduction and description of the desired contract work. It also requests the bidder to immediately inform the purchaser/owner as to whether the bidder will submit a bid or

decline the invitation to bid. If the bidder declines then the bidder is requested to return all the documents in the RFP package.

10.4.2 Instructions to Bidders

The Instructions to Bidders provides information and guidance to assist the bidder in generating a bid. These instructions are not intended to be conditions of the contract – they only have effect during the bidding process. An important purpose of instructions to bid is to describe the purchaser's policy with regard to evaluating bids and dealing with bidders during the bidding period. This policy should reflect local practices and legal requirements.

Some of the information contained in the Instructions to Bidders includes:

- *General Description of the Work* – This is provided for convenience only as other documents/sections in the RFP define the scope of work for contractual purposes.
- *Location of the Work*
- *Closing Date, Time and Location for the Submission of Bids* – The policy for late bids and requests by bidders for an extension of time must be stated. If an extension of time is granted to one bidder, it should be granted to all bidders. Normally late bids are not accepted.
- *Expected Date of Contract Award*
- *Pre-Bid Meetings* – Pre-bid meetings are meetings of all interested bidders with the owner/purchaser where questions are answered and requirements are clarified. The dates, time, and locations of any such meetings would be stated.
- *Ethical Standards* – The policies and rules governing interaction between owner/purchaser personnel and bidder personnel during the bid period are included in the instructions.
- *Information and Data to be Submitted with the Bid* – Normally this requires the completion of schedules included with the RFP package. A key purpose for these instructions and schedules is to have consistency in the information provided by the bidders to allow for easier comparison between bidders.
- *Proposal Format* – It is often necessary that a bidder elaborates, beyond the basic information entered in the schedules of the RFP, about the technology and services that they will be providing. This would be done in a detailed proposal included with the bid. Instructions as to the format of this proposal must be given.
- *Basis of Bid Evaluation and Award of the Contract* – In addition to price, the other factors and their corresponding weightings for selection of the successful bidder should be described. This includes the weighting given to technical, quality and other requirements.

- *Acceptance of Bids* – It should be stated that the owner/purchaser can accept any bid, reject any bid, and reject all bids. Also, it should be stated that the lowest (priced) bid will not necessarily be accepted.

The above list is just a brief summary of the common items typically included; there are of course many other items of information and instructions that should be included in the Instructions to Bidders.

10.4.3 Scope of Work

For large or complex procurements, the scope of work is normally defined in several specifications and many drawings. This section of the RFP would be a summary of the scope of work and would include a tabulation of all the specifications and drawings included with the RFP.

The division of responsibilities between the owner/purchaser and the contract would also be done here. What the contractor is to do and what the owner is to do can sometimes be enumerated as a checklist. This is a useful approach in construction contracts.

10.4.4 Specifications and Drawings

All pertinent specifications and drawings are included in the RFP package. A listing of these must be tabulated and indexed in some manner so that the bidder will not overlook any of them and to ensure that they are linked into and thus included as part of the subsequent contract.

10.4.5 Special Conditions

Special conditions are requirements in support of the scope of work – typically the management, quality and schedule requirements. Some of these may have already been addressed in other sections of the RFP – for example, quality and schedule requirements may have been discussed in the scope of work section.

10.4.6 General Conditions and Contract Agreements

This section provides the desired substance/wording for the contract conditions discussed earlier in Chapter 9 of these course notes. What is often done is the purchaser/owner attaches a copy of their Contract Agreement to the RFP package.

10.4.7 Content of the Bid – Bid Form – Proposal Form

It is desirable that bidders provide the information and details about their bid in a format that makes evaluation easy and allows for side-by-side comparison of information from different bidders. This is achieved by requiring bidders to tabulate their bid information in a common format on prepared schedules to the RFP. These schedules would contain blanks where a bidder would write in their data. Typical items to be completed by the bidder on these schedules include:

- *Price breakdown*

- *Schedule dates*
- *List of subcontractors*
- *Contract price variation and escalation formulas*
- *Terms of payment*
- *Delivery and logistics information*
- *List and price of spare parts*
- *Contractor's personnel*

The bid form is a summary of the key information that comprises the bidder's bid. It is signed by an authorized representative of the bidder which results in the bid being legally deemed as an offer and binds the bidder to undertake the work, if awarded the contract, under the terms and conditions established in the RFP and bid submission.

10.5 Issues and Underlying Principles - Concluded

When should a formal tendering process be used?
The formal tendering process has overheads associated with it and therefore it is generally not appropriate for small value contracts; but when there are a sufficient number of qualified bidders, the formal tendering process is desirable because of the competitive nature of it leading to optimal pricing for the owner/purchaser.

What must be conveyed to prospective bidders to enable them to respond? *The bidding documents of the RFP package – instructions to bidders and requirements.*

What is considered ethical conduct of owner personnel when companies seek to be added to a bidder list by giving gifts to the owner personnel? *In order to treat all bidders equally and fairly, the owner personnel should decline these gifts.*

11. Bid Period Activities and Process

11.1 Issues and Underlying Principles – Opening Discussion

Can an owner/purchase treat one of the bidders more favourably?

If an owner/purchaser answers a set of questions for one bidder, should they let the other bidders know about the questions and answers?

If all bids are over budget what should the owner do?

11.2 Issuing and Initiating the Bid

The bidding process is initiated by sending an RFP package to each bidder. Depending on the complexity of the bidding package this may require the contents to be printed on paper and physically delivered to the bidders. Printing the bid package on paper has the advantage that all bidders will have the capability to read the documents.

An alternate approach is to use an Internet web-site from which bidders can access all documents – the advantage of this is the reduced cost of publishing and distributing the RFP. The web-site should be password protected and secure. One potential difficulty of using this approach is that all bidders may not have the software to read the different formats in which documents can exist electronically – for example drawings. By careful selection of formats, this issue can be overcome. Consideration must also be given to documents which are required to have signatures – such as the bid form and invitation to bid. These documents could be couriered separately or facsimile transmission could be used.

11.3 Ethical Practices and Liaison with Bidders

11.3.1 Treat all Bidders Equally

In formal competitive tenders, especially those that use bid bonds, it is an expectation of all bidders to be treated equally. To ensure that this occurs, there should be one individual designated by the owner/purchaser through which all communication with the bidders should be conducted. Individual discussions with bidders should be avoided unless all bidders are apprised of the substance of a given communication.

11.3.2 Answers to Bidders Questions

Bidders should submit questions in writing and answers should be communicated in writing. The advantage of this is that the questions and answers can then be easily, accurately, and fairly distributed to all other bidders. If a website is used, these questions and answers can be posted on the web site. All questions should be directed to the designated representative of the owner/purchaser – directly contacting other owner personnel should be discouraged.

11.3.3 Pre-Bid Meetings

For projects with complex and highly technical requirements, clarification and elaboration to ensure understanding of the requirements may be required through a pre-bid meeting. Face-to-face discussion often aids in clarification since it is often easier to explain things verbally than in writing. A pre-bid meeting can be done with tele-conferencing. The scheduling of the meeting should allow time for bidders to become familiar with the requirements and allow time for the results of the meeting to be incorporated in the bidder's bids. The questions, answers, and discussion in the meeting should be recorded in minutes and distributed to all bidders. These minutes become supplemental information to the RFP.

11.4 Changes Associated with the RFP

11.4.1 RFP Modification

If the need arises to correct errors or omissions in the RFP, or to provide clarification to the RFP, this should be done by issuing a *Supplemental Notice* to all bidders. Significant changes to requirements should be avoided by proper preparation of the RFP in the first place. It must be remembered that bidders are expending time and cost for the preparation of their bids and any changes that negate their efforts are not well received.

11.4.2 Extension to the Period

Extensions to the bid period should be given careful considered. If an extension is given to one bidder, all bidders must receive the extension. Extensions will of course likely delay the project start.

11.4.3 Bid Withdrawal

Bidders should be permitted to withdraw their bids prior to the date and time of bid closing. The request for withdrawal must be formally documented. It is standard convention to not allow bids to be withdrawn after bid closing.

11.4.4 Bid Modification

Bidders should be allowed to modify their bids prior to bid closing. In some jurisdictions, though, this is not permitted.

11.5 Receiving and Opening Bids

11.5.1 Late Bids

Late bids should be rejected. This is to avoid the possibility of a late bidder learning the price information contained in competitor bids or gaining any other advantage.

11.5.2 Opening of Bids

A formal process should be implemented for opening bids. A record should be kept of the people involved and of pertinent information about the bids. All information in the bids should be kept confidential; it is unethical to allow competitors to learn competitive details of a given bidder's bid. Some tendering processes, though, open bids in public and

in such situations, some basic information such as perhaps pricing will be made known to other bidders.

11.5.3 Mistakes, Corrections and Request by Bidder for Withdrawal

In certain countries, legal considerations do not allow the withdrawal of bids, even if errors are discovered in a bidder's bid. If a serious mistake has been made in a bidder's bid, the owner/purchaser should reject the bid in their own best interests since it is unlikely the bidder will provide satisfactory performance in carrying out the contract. Even if the law permits a bidder to withdraw, correct and resubmit their bid due to errors in the bid, this should still not be permitted because it could give that bidder an unfair competitive advantage.

11.5.4 Rejection of Bids Prior to Award

In the RFP, the owner/purchaser must state that they have the right to reject any and all bids. Rejection of a bid, or all bids, can be done for a number of reasons, some of which have been defined above. Other reasons include: lack of sufficient number of bids received; project cancellation for various reasons; no bid being within the project budget.

11.6 Issues and Underlying Principles – Closing Discussion

Can an owner/purchase treat one of the bidders more favourably?
No. This would not be ethical and for some procurements in certain jurisdictions would not be lawful – bidders who were not treated fairly might have recourse through the law.

If an owner/purchaser answers a set of questions for one bidder, should they let the other bidders know about the questions and answers?
Yes. Again the issue of fair and ethical treatment of all bidders arises for this situation.

If all bids are over budget what should the owner do?
Reject all bids. The owner reserves this right when issuing the RFP.

Can an owner/purchaser treat one of the bidders more favourably? *This is not desirable since it undermines the bidding process. For certain procurements, i.e. government, the other bidders could have a cause for legal action if one bidder is treated preferentially to the other bidders.*

If an owner/purchaser answers a set of questions for one bidder, should they let the other bidders know about the questions and answers? *Yes, for fairness.*

If all bids are over budget what should the owner do? *Reject all bids.*

Why use a formal bidding process? *To obtain a competitive price and the best contractor/supplier available.*

12. Contractor/Supplier Bid Generation

{Given the time constraints for the course, we will not study this topic.}

12.1 Issues

12.2 Decision to Bid

12.2.1 Joint Venture

12.3 Organization and Work Scheduling

12.4 Bid Contents

12.4.1 Technical Section

12.4.2 Quality Section

12.4.3 Schedule Section

12.4.4 Other Management Sections

12.4.5 Commercial Section

12.4.6 Pricing Section

12.5 Issues Concluded

13. Bid Evaluation and Contract Award

13.1 Issues and Underlying Principles – Opening Discussion

Is price is the only factor in determining which contractor/supplier to award the contract to?

What other factors should be considered in deciding which the best bid is?

From all the bids submitted, how is the best one determined?

13.2 Organizing for Evaluations

In evaluating bids, personnel with various responsibilities will be required. The bids must be analyzed and evaluated. Methods and tools must be implemented to analyze and evaluate the bids and present the results in comprehensible formats.

13.2.1 Responsibilities

Normally procurement personnel do not have the wide range of expertise needed to fully evaluate a procurement bid. Therefore several organizational groups such as engineering, quality assurance, operations, and so on, are required in a joint effort to undertake bid evaluation. This can be a significant effort in and of itself requiring detailed scheduling and coordination.

13.2.2 Bid Analysis Sheets / Requirement Cross-Reference Matrix (tables)

Typically bid analysis sheets or requirement cross-reference matrices are used to evaluate bids. These are tabulations of the RFP requirements and conditions against which bids are checked. For each requirement listed in the table, a bidder's response is noted and indicated as conforming to requirements or not. Bid analysis sheets can be paper based or computer based. A simple example is shown below. The specifics of format and information contained will of course vary depending on the conventions and processes of the owner/purchaser.

Contract or Bid:	**Bidder:**	
Requirement	**Conforms (Y/N)**	**Bidder's Reference**
(*Requirement reference*		(*Reference to where this*
from RFP documents)		*requirement is addressed*
		in the bidder's documents or
		the bidder's response.)

13.2.3 Score Based Evaluations

At a higher level in assessing bidders score based evaluations can be done of bidders. Given a list of factors to be evaluated relative to various criteria (eg. personnel, quality

program, etc.) weightings are assigned to each factor. Against each factor a bidder is scored. The bidder's grade is determined by summing the scores multiplied by the weights for all the factors. The bidder's can then be rated against each other based on their grades. A simple grading table example is shown below. The specifics of format, information contained, and grading scheme will of course vary depending on the conventions and processes of the owner/purchaser.

Criteria: (*eg. Technical design capability*)			
Contract:	**Bidder:**		
Factor	**Score**	**Weight (%)**	**Grade**
Factor 1	*a*	*b*	*a x b*
Factor 2			
Factor n			
Total Grade		**100**	*Sum of factor grades*

13.3 Evaluation of Bids

The first step in evaluating bids is to determine if a bid is responsive – conforms to requirements – or is non-responsive. Bids that obviously do not meet requirements – nonconforming bids – should be rejected. This is because the bidder may gain a cost advantage in not meeting requirements and also project success could be jeopardized. For bids that do conform, the bidder's information should be assessed critically to ensure that the information is true and not exaggerated.

In evaluating the bids that have been received, what is sought is to optimize the price for the work with the technical merit of any proposed design along with the overall capability of the bidder. Price is not the only factor to be considered. A successful project is the objective and this depends on many criteria besides price. Thus, the lowest priced bid may not be the best choice for contract award.

The bid evaluation can take place at various levels of detail. Higher level tables that summarize scoring can be considered as roll-ups of a more detailed analysis. This detailed analysis can be taken to the point where a line-by-line review of requirements is done using a requirements matrix or bid analysis sheet. This makes the evaluation more quantitative. For each requirement a yes/no is given as to where the bidder's proposal meets the requirement or not along with possibly an assessment of the bidder's capability of meeting the requirement. Computer databases and spreadsheets aid in this evaluation. Additionally, a bidder can be asked to provide a *requirements cross-reference matrix*. In such a matrix, every "*Shall"* of the requirements is listed and for each of these "*shall's"* the bidder provides a cross-reference to the section/clause in the bidder's proposal documentation that addresses how the requirement will be met.

13.3.1 Overall Evaluation

This is a rollup of the major criteria a bidder is assessed against. Each criterion can be weighted at this level against the others. The bidder with the highest score would likely be the choice to award the contract to. Some of the criteria that can be considered at this level include:

- Product performance – degree to which requirements are exceeded
- Ability to undertake design work / engineering capability
- Managerial capability
- Personnel
- Financial strength
- Quality management system
- Price
- Environmental management system
- Cost and schedule control capability

13.3.2 Engineering Capability

If the contract will allow much freedom in the creation of a detailed design, that is the requirements are specified at a performance and interface level, then the bidder's proposed conceptual design and the bidder's engineering capability must be evaluated. There is great potential, especially with new advanced technologies, that errors in design might occur which are not discovered until commissioning or operation. This could result in cost and schedule overruns and even in project failure.

For contracts where a detailed design will be provided to the contractor/supplier of bidders engineering capability is not as critical.

Factors to consider for technical evaluation include:

- Engineering design processes and procedures
- Personnel – experience, number, competence
- Engineering management
- Design tools – computers, software, CAD, test equipment
- Configuration management process

13.3.3 Product / Design Performance

Factors here would include:

- Degree to which the product or design exceeds requirements
- Life cycle costs
- Ease of maintenance
- Operator interface

13.3.4 Quality Systems Evaluation

At a basic level in the evaluation of quality, a key factor is: does the bidder have a formalized management system for quality assurance? If not then there is good potential that the quality of work may not be satisfactory or that the owner/purchaser will have to interact to a greater degree with the bidder to ensure satisfactory quality.

For engineering design work, key factors to consider include:

- Design reviews planned
- How are design reviews conducted
- Configuration management systems
- Verification and validation programs

These issues are quality issues but also address engineering capability. Many other factors were presented and considered in Chapter 7 in the discussion of quality management systems. The evaluation would rate the bidder's performance and capability in the various quality system requirements.

13.3.5 Schedule Related Evaluation

Factors include:

- Schedule length
- Schedule control and tracking capability – software and systems used
- Adequacy of scheduling information
- Reporting
- Management and personnel responsible for schedule control
- Project status analysis methods

13.3.6 Organization and Staffing Evaluations

Factors include:

- Staffing levels
- Project management techniques
- Key personnel
- Functional capabilities

13.3.7 Safety and Environmental Evaluations

Factors include:

- Safety history and performance
- Environmental history
- Training
- Procedures

13.3.8 Price and Cost Evaluations

Price evaluations for fixed price and unit price contracts are reasonably straightforward. What is required is to make sure that the bids contain no exceptions and that the bids present pricing in a consistent manner for comparison between bidders. Also, for these contract types it is important to review how work scope changes are to be priced.

An important factor to evaluate is a bidder's cost control and reporting capability. This has a significant impact on project cost and management for reimbursable and target price contracts and on the costs associated with work changes in fixed price and unit price contracts.

In evaluating equipment and designs it is important to consider lifecycle costs. These should be estimated by the evaluation group; or the bidders can be asked to include these

estimates in their proposals. The estimated lifecycle costs should be converted to present value to allow for comparison between the bids. Lifecycle costs to consider include:

- Operating costs
- Maintenance costs
- Energy and fuel costs
- Spare parts costs
- Training costs
- Equipment and system reliability – direct costs of repair and indirect costs of lost production.

13.3.9 Risk Assessment

Cost and schedule overruns and project failure can have very great financial implications in infrastructure procurement. Therefore, the risks associated with awarding the contract to a given bidder must be assessed relative to cost overrun, schedule overrun and project failure. Some factors to consider include:

- Will the contractor have technical design difficulties;
- Will the bidder meet schedule dates;
- Will the bidder's subcontractors meet their required commitments;
- Is the bid price so low that the bidder may run into financial difficulties;
- Is the bid a loss leader – that is has the bidder bid a price below cost with the intent of making up the loss on charges for work scope changes and future contracts;
- What is the bidder's history in cost and schedule overruns?

13.4 Rejection of All Bids

It should be remembered that the purchaser/owner has reserved the right to reject any or all bids. Thus, if after evaluating the bids received, if there are too few compliant bids to allow for a competitive price; or if all compliant bids are priced above the budget for the project; or if there are no bids that are compliant or pass evaluation criteria; or if the project has been cancelled or changed for some reason; then the purchaser/owner should reject all bids.

It must be remembered, that to generate a bid, a bidder must assign personnel to this task and it will take some time and effort from these personnel to create the bid – it costs a bidder money to generate a bid. Hence, in cancelling an RFP, the bidders may not look favourably on this and may not submit bids on future dates or for future projects.

13.5 Negotiations with Short-Listed Bidders

It is accepted practice to negotiate and make adjustments to a short-list of bidders who have received the best evaluations, including price, for their bids provided the work scope and requirements are not substantially changed. If the work scope or requirements have substantially changed, in fairness all bidders should be given the opportunity to negotiate new bids.

13.6 Issues and Underlying Principles – Concluding Discussion

Is price is the only factor in determining which contractor/supplier to award the contract to?
No.

What other factors should be considered in deciding which the best bid is?
Other factors include financial strength of the bidder; expertise and capability; quality management systems; safety; personnel; proposed technical solution; proposed schedule; and on.

From all the bids submitted, how is the best one determined?
Through evaluating all bids against selected criteria. This entails scoring each bid against the criteria and then combining the scores using selected weightings. The bid with the best overall evaluation is chosen for award of the contract.

Is price is the only factor in determining which contractor/supplier to award the contract to?
No

What other factors should be considered in deciding which the best bid is? *Bidder's capability – performance evaluations on technical, quality, schedule, personnel – and the merits of the design the bidder is proposing.*

From all the bids submitted, how is the best one determined? *A weighted combination of scores for technical, quality, schedule, personnel, and price evaluations. The bidder with the best overall score is selected for award of the contract.*

Part F Contract Management

14. Contract Management

{Given the time constraints for the course, we will not study this section. This material will actually be covered in a later course in the MEng program.}

14.1 Issues and Underlying Principles – Closing Discussion

Inadequate technical requirements and suppliers contractors who are inadequately qualified make it difficult to manage the contract.
The better the contractor the easier project management is
Function to function interfaces versus cross functional interfaces

14.2 Owner contract management responsibilities

Owner is responsible for ensuring that supplier fulfills its contractual commitments- that the supplier performs to expectations with regard to technical quality schedule and cost and commercial requirements.

14.2.1 Technical management

14.2.1.1 Engineered equipment and materials contracts
14.2.1.2 Engineering contracts
14.2.1.3 Construction contracts

14.2.2 Quality management

14.2.2.1 Engineered equipment and materials contracts
14.2.2.2 Engineering contracts
14.2.2.3 Construction contracts

14.2.3 Schedule management

14.2.3.1 Engineered equipment and materials contracts
14.2.3.2 Engineering contracts
14.2.3.3 Construction contracts

14.2.4 Cost and commercial management

14.2.4.1 Engineered equipment and materials contracts
14.2.4.2 Engineering contracts
14.2.4.3 Construction contracts

14.3 Contractor/ supplier responsibilities

14.3.1 Engineered equipment and materials contracts

14.3.1.1 Engineering management
14.3.1.2 Production management

14.3.2 Engineering contracts

14.3.3 Construction contracts

14.4 Quality program

14.4.1 Quality procedures and Manual

Documented procedures are applicable to equipment manufacturing through to construction contracts. Responsibility to satisfy themselves that the Contractor/supplier has satisfactory quality procedures

14.4.2 Audits

14.4.3 Technical documentation

14.4.4 Review meetings

14.4.5 Inspection and test

14.4.6 Incoming inspection and test

14.4.7 The quality inspection and test plan

14.4.8 Factory acceptance test

14.4.9 Quality documentation and records

14.4.10 Site testing

14.4.11 Turnover and Commissioning

14.5 Schedule control

14.5.1 Detailed plan

14.5.2 Special reports and progress meetings

14.5.3 Milestones and gates

Go no-go points, rework
Progress payment release
Quality inspections and tests validate progress payment points

14.6 Cost control

14.6.1 Change on fixed price contracts

14.6.2 Time and materials contracts

14.7 Issues and Underlying Principles – Closing Discussion

Part G Logistics and Topics of Interest for International Trade

15. Bonds and Guarantees

A basic overview of bonds and guarantees and their role in project procurements is given in this section. There are many details regarding how bonds and guarantees are arranged, issued, and undertaken. Further conventions and rules can vary regionally though the International Chamber of Commerce has some publications that attempt to standardize some of the rules. Also, many terms have synonymous meanings, at least at a high level, and the terms used could also vary regionally and between industries. The purpose of this section, therefore, is to outline the principles concerning bonds and guarantees and leave an exhaustive discussion to other references.

15.1 Basic Principles and Terminology

Given an underlying contract between two parties, a bond or guarantee is a separate undertaking arranged to protect one of the parties from the default of the other party in performing its obligations under the contract. Typically this undertaking is arranged with a third party such as a bank, insurance company, or surety company. With respect to project procurements, normally it is the purchaser/owner whose interests are to be protected. In this case should a contractor/supplier default in their obligations as covered by a bond or guarantee, the owner/purchaser will be compensated for this by the bank or company providing the bond or guarantee.

The bond or guarantee is therefore a contract between three parties – separate from the underlying contract. The party whose interests are protected by the bond/guarantee, and therefore who would benefit from the bond/guarantee, is called the *beneficiary*. The party whose obligations are covered by the bond/guarantee is called the *principle*. For the bonds/guarantees that are typically used for project procurement contracts, the bonds/guarantees cover the obligations of the contractor/supplier and thus the owner/purchaser would be the beneficiary and the contractor/supplier is the principle. Occasionally though, the contractor/supplier may seek to have a bond/guarantee in place that would cover the obligations of owner/purchaser to pay the contractor/supplier resulting the roles of beneficiary-principle being reversed.

The following summarizes the terminology that is used related to the three parties for bonds/guarantees that are arranged to cover the obligations of a contractor/supplier to the owner/purchaser in project procurement.

- The owner/purchaser
  Referred to either as the *beneficiary, obligee* or simply *buyer* or *purchaser*.

- The contractor/supplier
  Referred to as the *principle* or simply *seller, contractor, or supplier*

- The company providing/issuing the bond/guarantee
  For surety bonds (discussed below) referred to as the s*urety* otherwise just bank, insurance company, bonding company, issuer or guarantor depending on the context.

A bond/guarantee does not constitute insurance for the principle (contractor/supplier). If the contractor/supplier is in default resulting in a payment to the owner/purchaser under the bond/guarantee, the issuer of the bond/guarantee can and will seek to recover its costs and outlays from the contractor/supplier.

15.1.1 Bond versus Guarantee

Fundamentally there is no difference between a bond and a guarantee – the distinction in terminology arises only based on the issuer. A guarantee is issued by a bank whereas a bond is issued by an insurance company or surety company.

15.1.2 Standby Letter of Credit

For our purposes, a standby letter of credit (L/C) is the same as a bank guarantee. A standby L/C is issued by a bank and it is in a "*standby mode*" until and if certain conditions occur. If these conditions occur (eg. contractor default) then the standby L/C becomes much like a commercial L/C.

15.1.3 Conditional Guarantees and Demand Guarantees

Bank guarantees can be classified as either being conditional or demand guarantees. A conditional guarantee is related to an underlying contract and is therefore also called a *contract guarantee*. A conditional guarantee is only paid to the beneficiary (owner/purchaser) if the principle (contractor/supplier) is in default of obligations covered by the guarantee. Should the default be in dispute between the contractor/supplier (principle) and the owner/purchaser (beneficiary), payment under the conditional guarantee is withheld until the dispute is settled.

A demand guarantee is payable 'on demand' by the beneficiary without the need to establish that the principle is in default of any obligation or for the principle to approve of payment – payment on a demand guarantee is unconditional and the issuing bank is obligated to pay. For project procurements, this has the advantage for the owner/purchaser (beneficiary) of receiving payment in spite of any outstanding dispute with regard to contractor/supplier performance. There is additional risk with a demand guarantee for the contractor/supplier in that the potential for a false or unfair call exists with a demand guarantee.

15.1.4 Surety Bonds

Surety bonds are issued by insurance companies and surety companies. The issuer of the bond is referred to as the *surety*. Under a surety bond, should the principle (contractor/supplier) be in default of a contractual obligation, the surety has the option of either paying the beneficiary (owner/purchaser) for any loss suffered due to this default up to the face value of the bond, or alternatively arranging to have the work covered by the bond completed. A surety company normally has the expertise to manage the completion

of the work covered by the bond and would arrange alternate contractors or suppliers to complete the work if it so chose. The owner/purchaser must still pay the originally contracted price for the work to the surety. The surety is responsible to pay any difference above the original price required to fulfill the obligations in default.

15.2 Surety Bonds and Contract Guarantees Used in Project Procurements

Some of the types of bonds/guarantees that are used in project procurements are discussed below. These tend to be the main types used. There are additional types which are often incorporated with the main types.

15.2.1 Bid Bond or Tender Guarantee

A bid bond/guarantee is used in tendering to ensure that the bidder selected for a contract will carry through with undertaking the contract. That is, the contractor/supplier that is awarded the contract must enter into the contract (undertake the work) and if required, arrange for performance bonds and any other bonds. If the contractor/supplier does not do this, then the surety/guarantor must pay an amount to the owner/purchaser to cover the owner/purchaser's loss. In such a case, the owner/purchaser's loss is equal to the difference between the price of the selected bid and the price of the next best bid. Alternately, the loss would be the costs required to establish a contract with another contractor/supplier including conducting a new RFP. The owner/purchaser is only paid up to the face value of the bond. A bid bond/guarantee lapses when the contract for the work is accepted by the contractor/supplier and required performance bonds/guarantees are provided; or when the contract for the work is awarded to another party.

15.2.2 Performance Bond/Guarantee

A performance bond/guarantee will cover the losses of the owner/purchaser in the situation whereby the contractor/supplier defaults in performing obligations in the contract. Default can include bankruptcy and insolvency of the contractor/supplier and/or failure of the contractor/supplier to meet technical, schedule and commercial requirements of the contract. A performance bond/guarantee only applies to a specific contract and the surety's/guarantor's obligations are limited to the terms stated in the bond. The amount of the bond is limited to either the full contract price or to some fraction of the contract price.

Upon default by the contractor/supplier, the surety is only responsible for paying the extra costs of completing the work. The owner must still pay the stipulated contract price for the work. As an option with a surety bond – but not for a bank guarantee – the surety may undertake or arrange to complete the work instead of paying the owner/purchaser. Often bonding companies (sureties) will maintain expertise on staff related to the types of work that these companies provide bonds for.

If the owner/purchaser alleges default and the contractor/supplier disputes this, the issuer of the bond will not pay on the bond or take action until the dispute is resolved. The dispute would need to be resolved through arbitration or litigation in the courts. Bankruptcy by the contractor/supplier is an obvious default.

15.2.3 Labour and Material Payment Bond/Guarantee

Subcontractors and suppliers of a contractor/supplier do not have a contractual relationship with the owner/purchaser and hence the subcontractors cannot sue the owner/purchaser should they not be paid by the contractor/supplier. The subcontractors, though, can place liens against the infrastructure item should they not be paid by the contractor/supplier. It is therefore in the owner/purchaser's best interest to ensure that subcontractors are paid. In this regard, a labour and material payment bond/guarantee is used to guarantee that the subcontractors are paid. The owner/purchaser in this bond acts as a trustee for the subcontractors. This bond will result in the subcontractors and suppliers being paid should the contractor/supplier (the principle) not pay them.

15.2.4 Maintenance Bond or Warranty Guarantee

This bond ensures that the obligations under the warranty provisions of a contract are fulfilled and is often combined with the performance bond.

15.2.5 Advanced Payment Bond/Guarantee

In some contracts, the contractor/supplier is paid an amount at the start of the contract prior to commencement of any work. This advanced payment is typically used to cover start-up costs of the contractor/supplier and the risk of delays and defaults in receiving payment from the owner/purchaser. An advanced payment bond covers the risk of the owner/purchaser for the amount of the advanced payment in the event the contractor fails to perform the contract.

16. International Payments – Documentary Credit

16.1 Basic Terms of Payment

The international transactions considered here concern the sale of goods. To these transactions there are two parties – the seller and the buyer. There are four basic terms of payment that can be used between the buyer and seller. These are:

- Cash in Advance
- Documentary (Letter of) Credit
- Documentary Collection
- Open Account

These basic terms of payment will be discussed in this section. Only a brief overview of the various methods will be given – many considerations and details related to the methods are not presented.

16.2 Open Account

Under an open account term of payment, the buyer pays the seller for the goods some period of time after the receipt of the goods. This time period will be as agreed and could be for example 30, 60 or 90 days. Under this arrangement, the seller is providing credit to the buyer and as such is exposed to the highest degree of risk in the transaction.

16.3 Documentary Collection

A transaction that uses a documentary collection requires the participation of the buyer's bank and the seller's bank. The banks, though, only act as collectors and conveyors of payments and documents – no credit is involved in the transactions. This is essentially a cash-on-delivery (COD) transaction – the buyer does not receive the documents that permit the buyer to take possession of the goods until payment is made by the buyer. The buyer's bank (collecting bank) also does not guarantee payment as in the case of a documentary credit.

The parties involved in a documentary collection transaction are as follows:

- The Seller (*Principle*) – the exporter of the goods
- The *Remitting Bank* – the seller's bank
- The *Collecting* or *Presenting Bank* – the buyer's bank
- The Buyer (*Drawee*) – the importer of the goods

16.3.1 The Documentary Collection Process

The documentary collection process works as follows:

1) The seller ships the goods.
   In doing this, the seller obtains a negotiable transport document from the shipping firm/agent. The negotiable transport document can be a *negotiable bill of lading* or equivalent – this is a document that when presented to the carrier the goods are released to the bearer of the document. A bill of lading is associated only when shipping by sea. When shipping by other transportation modes, other arrangements would be required so that the buyer only obtains possession documents upon payment/acceptance.
2) The seller prepares and delivers a document package.
   This document package includes the negotiable transport document (or equivalent) plus other documents/certificates as required by the contract between the buyer and seller. The seller presents this package to the seller's bank (the remitting bank).
3) The remitting bank forwards the document package to the buyer's bank (the presenting/collecting) bank.
4) The collecting bank releases the documents to the buyer upon receiving payment (or acceptance of a draft bill of exchange) from the buyer for the goods.
5) The buyer takes possession of the goods by presenting the negotiable transport document to the carrier.
6) The collecting bank forwards the payment funds to the remitting bank (seller's bank).
7) The remitting bank pays the seller.

16.4 Documentary (Letter of) Credit

A letter of credit is a bank's promise to pay on behalf of a client. With a letter of credit, the bank's credit standing is substituted for that of the client. With regard to international payments, a documentary (letter of) credit is a promise by a buyer's bank to pay a seller for the purchase of goods by the buyer when agreed conditions have been met in the sale of the goods. [Note, the current formal term for this type of transaction is *documentary credit* but past convention is *letter of credit* which is still commonly used today.]

The parties involved in documentary credit transactions are as follows:

- The Seller (*Beneficiary*) – the exporter of the goods
- The *Advising Bank* – the seller's bank
- The *Issuing Bank* – the buyer's bank
- The Buyer (*Applicant*) – the importer of the goods

16.4.1 Documentary Credit Process – Issuance

Issuance concerns applying for and opening a documentary credit. The steps in the issuance process are as follows:

1) The buyer and seller agree on terms of the sale
   These terms would include the use of documentary credit for the transaction and the documentation required to execute the documentary credit transaction.
2) The buyer applies to the buyer's bank (the issuing bank) to issue a documentary (letter of) credit.
   Specific terms and conditions of the transaction are entered in the application including the documentation required to effect payment. The seller is named as the beneficiary in the application.
3) The issuing bank (buyer's bank) sends the documentary credit to the advising bank (seller's bank). The advising bank checks over the documentary credit to ensure everything is correct. The advising bank may or may not confirm the documentary credit. By confirming a documentary credit, the advising bank is adding their guarantee to the documentary credit. If the advising bank (or any other bank) doesn't confirm the documentary credit, then only the issuing bank guarantees the documentary credit.
4) The advising bank advises the seller of the receipt of the documentary credit and provides the details of it to the seller. The seller must check the details of the documentary credit and initiate an amendment if any of these details are incorrect relative to the trade contract with the buyer.

16.4.2 Documentary Credit Process – Utilization

Utilization refers to undertaking the sales transaction and then completing it using the documentary credit. The steps in utilizing the documentary credit are as follows:

1) The seller (beneficiary of the documentary credit) ships the goods and obtains a negotiable transport document that corresponds to the agreed delivery terms.
   An Incoterm 2000 can be used to specify where the goods are deemed to be delivered. The negotiable transport document can be a *negotiable bill of lading* or equivalent – this is a document that when presented to the carrier the goods are released into the custody of the bearer of the document.
2) The seller produces the required documentation package along with the transport document related to the shipment of the goods and delivers this documentation package to the seller's bank (the advising bank).
   The documentation package consists of the negotiable transport document plus other documents and certificates as required in the sales agreement. These documents could include inspection certificates, certificates of origin, invoices, and others.

3) The advising bank (seller's bank) reviews the document package to ensure everything is in order.

4) If everything is in order, the advising bank sends the documentation package to the buyer's bank (the issuing bank). Also, if the advising bank has confirmed (confirmed) the documentary credit, the advising bank pays the seller the price arranged for the goods.
   Payment is according to the terms of the credit. Payment can either be done immediately upon presentation of the documents (at sight) or payment can be deferred a specified time period or done through a bill of exchange (also called and acceptance) according to the settlement terms.

5) The buyer's bank (the issuing bank) reviews the documentation package and if everything is in order the buyer's bank pays the seller's bank (the advising bank) and informs the buyer about the arrival of the documents.
   Payment is according to the terms of the credit.

6) The buyer reviews the document package and if everything is okay makes payment to the buyer's bank (issuing bank).
   If the terms allow, the buyer can defer payment for a specified time or accept a bill of exchange.

7) The buyer's bank releases the documentation package to the buyer.

8) The buyer takes ownership of the goods.

16.5 Cash in Advance

Under this payment term, the buyer pays the seller prior the seller shipping the goods. Payment is made using a cheque, a bank draft, or a bank transfer. The buyer assumes all the risk in with this payment arrangement and thus this payment term is not used very often. This payment term is used only in special situations such as when: a seller's goods are in such high demand that the seller does not want to be bothered with other arrangements and thus the seller is in a strong position to negotiate this arrangement; the seller is a small company and the buyer wants to provide some advanced financing to enable the seller to produce the goods; the buyer is in an unstable country and unknown to the seller.

16.6 Risk and Financing

The risk and financing costs associated with a sale transaction are allocated between the buyer and seller differently for each of the basic terms of payment. Risk is considered relative to the parties fulfilling their contractual obligations. This allocation of risk and financing costs will be discussed below for each of the basic terms of payment.

16.6.1 Cash in Advance

Of the basic payment terms, cash in advance exposes the buyer to the greatest risk and the seller to the least. After paying the seller, the buyer must trust the seller to ship the correct goods, of good quality and of the proper count. Should the seller not do this, the

buyer may have a difficult time rectifying the situation. The seller has the greatest security under this term of payment relative to the other terms of payment.

Under the cash in advance payment term, the buyer must finance the price of the goods during the period from payment until the goods are received.

16.6.2 Documentary Credit

Risk and security are almost equal for both the seller and buyer in a documentary credit transaction. The seller has a guarantee of being paid for the goods which is supported by the credit-worthiness of the buyer's bank and not of the buyer – thus making this payment arrangement better for the seller than a documentary collection. The buyer has the risk of whether the seller will ship the correct goods in good quality and correct quantity. This risk is addressed to some degree by the documentation package required in the transaction.

In this payment term, the seller finances the cost of the goods from completion of manufacturing until delivery of the documents related to the goods to either the advising bank, if it confirmed the documentary credit, or to the issuing bank if the credit wasn't confirmed.

16.6.3 Documentary Collection

Risk and security are almost equal for both the seller and buyer in a documentary collection. There are still at issue the concerns of whether the seller will ship the correct goods and quantity and whether the buyer will pay for the goods when they are delivered. A guarantee of payment from a bank is not given in a documentary collection and nor are the documents concerning the shipment of the goods carefully scrutinized by the banks – an error in the documents does not prevent the banks from passing the documents on or accepting and passing on payment for the documents.

In a documentary collection, the seller finances the cost of the goods from completion of manufacturing until delivery of the documents for the goods to the buyer.

16.6.4 Open Account

With an open account payment term the seller assumes the greatest risk and the buyer has the greatest security in comparison to the other types of payment terms. Under this payment term, the seller must finance the cost of the goods during the period from manufacture of the goods until receipt of the payment for the goods.

17. Incoterms 2000

In international trade, the sale and transport of goods requires a number of obligations, *trade terms,* to be established between the buyer and seller. Trade terms address:

- Where delivery (transfer of ownership) of the goods takes place. Delivery is normally used to trigger the payment process for the goods.
- Who assumes the risks in transporting the goods – that is, are the risks assumed by the buyer or the seller.
- Who arranges for and pays for import and export licenses, taxes, and duties.

The two parties in an international trade transaction, the buyer and the seller, would generally like the other to assume all risk, make all arrangements, and pay all costs. The seller would like to transfer ownership in shipping the goods and receive payment as soon as possible, while the buyer would like to delay transfer of ownership of the goods and make payment as late as possible. Obviously, misunderstandings can arise in what the agreed obligations and conditions are between the buyer and seller.

To address the above issues, the International Chamber of Commerce, has defined a set of trade terms referred to as Incoterms. Incoterms precisely specify the obligations and conditions for carriage, delivery and risk in an international trade transaction under various arrangements. By incorporating an Incoterm in the contract between the buyer and seller, the potential for misunderstandings is greatly reduced. The International Chamber of Commerce has revised the Incoterms at various times, hence, Incoterms 2000 refers to the definitions published in the year 2000 – the latest version available at the date of writing. (The Incoterms are currently under review and the new revision is intended to be released in 2011.)

There are 13 different Incoterms and these are grouped into four categories. These categories are differentiated by the obligations and risk assumed by the seller (or buyer). The four groups, in order by increasing risk and obligations by the seller, are as follows:

E term – In the E term, the seller's only obligation is to make the goods available at the seller's facility. The buyer must arrange and pay for transport and is responsible for loading the goods at the seller's facility. The buyer assumes all costs and risks associated with transporting the goods to the destination.

F terms – Under the F terms, the seller is responsible for delivery of the goods to a carrier designated by the buyer. The buyer assumes all risks and costs once the goods have been delivered to the carrier.

C terms – With the C terms, the seller's obligations include arranging and paying for carriage to a specified destination; but the seller does not assume the risk of loss or damage to the goods or any additional costs due to events or activities after shipment or dispatch.

D terms – Under the D terms, the seller bears all costs and risks in bringing the goods to the place of destination.

17.1 Summary of Incoterms

Only a summary of the Incoterms 2000 is given below for educational purposes. For details and interpretation please refer to the International Chamber of Commerce publications.

17.1.1 E Group

EXW

Ex Works (…named place)

Seller' Obligations:

The goods are delivered when they are placed at the disposal of the buyer at the seller's facility.

Buyer's Obligations:

The buyer is responsible for all carriage including loading the goods at the seller's facility. The buyer assumes all risks of damage or loss and is responsible for all costs related to shipping the goods.

17.1.2 F Group

FCA

Free Carrier (…named place)

Seller' Obligations:

The seller is responsible for delivering the goods to a carrier at the named place. The seller must arrange for clearance of the goods for export.

Buyer's Obligations:

The buyer is responsible for arranging carriage and the costs of all carriage from the named place. The buyer assumes all risks of damage or loss from the named place and is responsible for all costs after export.

FAS

Free Alongside Ship (…named port of shipment)

Seller' Obligations:

The seller is responsible for delivering the goods alongside a vessel designated by the buyer at the named port. The seller assumes all costs and risks until the goods are alongside the vessel.

Buyer's Obligations:

The buyer assumes all risks for damage and loss from the time when the goods are alongside the vessel. The buyer is responsible for all costs after the goods are alongside the vessel and clears the goods for export.

FOB

Free On Board (…named port of shipment)

Seller' Obligations:

The seller is responsible for delivering the goods onboard the vessel designated by the buyer at the named port. The seller assumes all costs and risks until the goods pass the ship's rail. The seller clears the goods for export.

Buyer's Obligations:

The buyer assumes all risks for damage and loss from the time the goods cross the ship's rail. The buyer is responsible for all costs after the goods pass the ship's rail.

17.1.3 C Group

CFR

Cost and Freight (…named port of destination)

Seller' Obligations:

The seller is responsible for all costs of delivering the goods to the named port of destination. The seller clears the goods for export.

Buyer's Obligations:

The buyer assumes all costs and all risks for damage and loss once the goods have been delivered at the destination.

CIF

Cost, Insurance and Freight (…named port of destination)

Seller' Obligations:

The seller is responsible for all costs of delivering the goods to the named port of destination including the cost of insurance. The seller clears the goods for export.

Buyer's Obligations:

The buyer assumes all costs and all risks for damage and loss once the goods have been delivered at the destination (passed the ship's rail). The buyer is responsible for import duties and taxes.

CPT

Carriage Paid To (…named place of destination)

Seller' Obligations:

The seller is responsible for the costs of carriage of the goods to the named place of destination.

Buyer's Obligations:

The buyer assumes all costs and all risks for damage and loss once the goods have been delivered into the custody of the carrier at the destination.

CIP

Carriage and Insurance Paid (…named place of destination)

Seller' Obligations:

The seller is responsible for the costs of carriage and insurance of the goods to the named place of destination.

Buyer's Obligations:

The buyer assumes all costs and all risks for damage and loss once the goods have been delivered into the custody of the carrier at the destination.

17.1.4 D Group

DAF

Delivered at Frontier (…named place)

Seller' Obligations:

The seller is responsible for the costs and risks of carriage to the named place before the customs of the adjoining country. The seller provides documentation for export.

Buyer's Obligations:

The buyer provides import documentation and covers import costs. The buyer assumes all costs and all risks for damage and loss once the goods have been placed at the buyer's disposal.

DES

Delivered Ex Ship (…named port of destination)

Seller' Obligations:

The seller is responsible for the costs and risks in delivering to the named port. The seller provides documentation for export.

Buyer's Obligations:

The buyer provides import documentation and covers import costs. The buyer assumes all costs and all risks once the goods have been placed at the buyer's disposal on board the ship at the port of destination and bears the costs of unloading.

DEQ

Delivered Ex Quay (…named port of destination)

Seller' Obligations:

The seller is responsible for the costs and risks in delivering to the named port on the quay including paying import duties and taxes. The seller provides documentation for export and import.

Buyer's Obligations:

The buyer assumes all costs and all risks once the goods have been placed at the buyer's disposal on the quay.

DDU

Delivered Duty Unpaid (…named place of destination)

Seller' Obligations:

The seller is responsible for the costs and risks in delivering to the named destination. The seller provides documentation for export.

Buyer's Obligations:

The buyer provides import documentation and covers import costs. The buyer assumes all costs and all risks once the goods have been placed at the buyer's disposal at the destination.

DDP

Delivered Duty Paid (…named place of destination)

Seller' Obligations:

The seller is responsible for the costs and risks in delivering to the named destination, including duties and taxes. The seller provides documentation for export and import.

Buyer's Obligations:

The buyer assumes all costs and all risks once the goods have been placed at the buyer's disposal at the destination.

18. Logistics

Only a cursory discussion of logistics will be done for this course. Hence the notes below will be given for the most part in point form. A basic consideration will be given of

- What logistics is
- Transportation Modes
- Warehousing
- Inventory management

Definition of Logistics

Logistics concerns the planning, organizing, implementing, arranging and controlling the transportation and storage of goods and related information from source location to the final destination where the goods are consumed. This involves integration of information, transportation, inventory, warehousing, material handling and packaging.

18.1 Transportation

18.1.1 The Transportation Modes

The basic transportation modes are as follows:

- Rail (Train)
- Motor (Truck)
- Water – Inland and Ocean
- Air
- Pipeline

18.1.1.1 Rail

- High fixed cost – low variable cost
  - Fixed: equipment, tracks, terminals
  - Variable: labour, fuel, maintenance
- Market focus
  - Long haul – benefits from low variable to fixed costs
  - Raw material extractive industries and bulk materials
  - Heavy manufacturing
  - Intermodal containers
- Characteristics:
  - Medium speed
  - Available to many locations
- Terminal to terminal with branch and spur tracks

- Capable of heavy loads
- Cheaper than motor or air

18.1.1.2 Motor

- Low fixed cost – medium variable cost
  - Fixed: roads provided by public
- Market focus
  - Short distances
  - High-value products
  - Distribution – warehouse to retail
  - Light and medium manufacturing
- Characteristics:
  - Second fastest to air
  - Available to most locations
- Point to point
  - Load weight capability is less than rail
  - More expensive than rail; cheaper than air

18.1.1.3 Water

- Medium fixed cost – low variable cost
  - Fixed costs are in between those of rail and motor – must build own terminals
- Market focus
  - Long distances
  - Bulk commodities
  - Large and heavy loads
  - Large tonnage long distances
  - Container
  - International trade
  - Distinction between deep water and inland
- Characteristics:
  - Slowest, other than pipelines
  - Available only between ports with required facilities – truck and rail is required beyond the port
  - Can carry the largest tonnage and heaviest items
  - Least expensive

18.1.1.4 Air

- Low fixed cost – high variable cost
  - Fixed costs – more than motor, less than the rest; airports are provided by the public
- Market focus
  - Long distances
  - Time critical shipments

- High value items
- Carries only a very small percentage of the freight market

- Characteristics:
  - Fastest
  - Available only between airports – truck to/from airport; rail generally not available; availability is not as good as rail
  - Most restricted (other than pipelines) on what can be carried
  - Most expensive

18.1.1.5 Pipelines

- Highest fixed cost – lowest variable cost
- Market focus
  - Restricted in the commodities that can be transported
  - Petroleum products
- Characteristics:
  - Slow
  - Source and destination very restricted
  - Very limited on what can be carried
  - Least expensive after accounting for capital costs

18.1.2 Transportation Service Providers

18.1.2.1 Operators

- Single-Mode Operators
- Specialized Carriers
  - Basic and premium package services
- Intermodal Operators
  - Trailer on flatcar; container on flatcar
  - Container ships
  - Coordinated air and truck

18.1.2.2 Nonoperating Intermediaries

- Freight Forwarders
  - Purchase transport services from carriers
  - Consolidate small shipments from several shippers
  - Domestic or international – surface or air
- Shippers' Association
  - Like freight forwarders – non profit cooperatives of shippers, usually operating in a specific industry
- Brokers
  - Coordinate transportation arrangements for shippers, consignees and carriers

- Third party logistics service providers
  - Outsourcing of large parts of logistics operations

18.2 Warehousing

Warehouse – A storage facility for goods at intermediate locations between origin (source) and use (destination)

18.2.1 The Role of Warehousing

The benefits and functions of warehousing:

- Consolidation
  - Goods are consolidated from a number of sources into one shipment to a given customer/destination
  - Lower transportation costs
- Break Bulk and Cross Dock
  - Break bulk – The warehouse receives a large shipment from one source/manufacturer, breaks this into individual orders and ships out the orders
  - Cross dock – Similar to break bulk except orders are received from multiple manufacturers and shipped to multiple customers. Several simultaneous break bulk operations with consolidation of shipments on the customer side
- Processing/Postponement
  - Some final processing and packaging operations can be done at the warehouse. Specific packaging and labelling is done at the warehouse and hence this commitment of the product is delayed
- Stockpiling
  - Collecting/manufacturing goods year round and using them in a small period or season of the year
  - Manufacturing goods during a short period and shipping/selling them year round.
- Production Support
  - Ensures steady supply of parts and materials to manufacturing
  - Safety stock levels will be maintained for items from outside vendors to ensure availability to operations
- Spot Stock
  - Dividing up inventory in smaller amounts and placing these small amounts in multiple locations closer to the customers. Reduces delivery time
- Assortment Warehouse
  - Stocks product combinations in anticipation of customer orders

18.2.2 Warehouse Facility Options

Within the logistics operation the warehouse facilities can be

- Private
  - Operated by the company whose products are stored in the warehouse
  - Advantages – Control, flexibility, (potential) cost, company image
- Public
  - The warehouse is operated by an independent company and provides warehousing services to multiple customers
  - Advantages – Financial flexibility, economics of scale, better operating and management expertise
- Contract
  - Long term relationship with a warehousing and distribution company
  - Advantages of both private and public

18.3 Inventory Management

18.3.1 Functions of Inventory

Functions of inventory are as follows:

- Balancing
  - Balancing supply and demand
    - Seasonal demand – year-round production
    - Year-round demand – seasonal production
- Buffering
  - Safety stock of buffer stock
  - Maintaining an inventory to protect against shortage or stock-outs due to
    - Demand exceeding forecasts
    - Longer replenishment lead-times than expected
- Decoupling (Economics of Scale)
  - Producing goods in a quantity that allows for efficiency in purchasing, production and transportation costs
    - Inventory includes work-in-process and finished items
  - Produced quantity exceeds current demand
    - Reduction in number of production changeovers

18.3.2 Cost of Carrying Inventory

Carrying cost is comprised of:

- Cost of Capital
  - Loss of earning power – Average return on investment of the corporation
  - Cost of acquiring equivalent invested funds in the money market
- Insurance

- Obsolescence, damage, shrinkage
  - Deterioration or changes in model design
- Storage
- Taxes
  - Some jurisdictions assess a property tax on inventory

18.3.3 Economic Order Quantity

$$X_C = C_O \frac{D_Y}{N_O}$$

$$X_I = C_C \frac{N_O}{2} P_U$$

$$N_{OE} = \sqrt{\frac{2C_O D_Y}{C_C P_U}}$$

X_C	Order costs per year
X_I	Inventory carrying costs per year
C_O	Cost per order
D_Y	Demand per year
N_O	Number of units per order
C_C	Carrying costs (%) per unit
P_U	Price per unit
N_{OE}	Economic Order Quantity

- Extensions to Economic Order Quantity
  - Volume transportation rates
  - Quantity discounts

18.3.4 Inventory Control

Inventory control concerns policies and methods aimed at maintaining a level in inventory to avoid stock-outs.

*Reactive methods for inventory contro*l – In these approaches, orders for replenishment of inventory are issued when the inventory level decreases below a given value (reorder point). Two types of reactive methods are:

- Perpetual review
  - Review inventory levels continuously (or at least daily)
- Period Review
  - Review inventory levels at regular time periods

18.3.5 Inventory Planning

- Combine forecasts of product demand with distribution process flow and production process flow
- Incorporate EOQ, delivery lead times, usage rates, inventory on hand
- Develop a material requirements plan
  - A detailed production schedule and material ordering schedule

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