ARUP

Construction Management Manual

Volume 1

Guidelines

Ove Arup & Partners
Consulting Engineers

Construction Management Manual

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Guidelines

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CONTENTS – VOLUME 1

1. INTRODUCTION

1.1 Objectives of the Construction Management Manual (CMM)

To manage a project so that effort and resource is focussed efficiently and effectively to achieve the project objectives, it is necessary to define and implement procedures and/or systems to ensure control of our project responsibilities.

This manual has been prepared to provide a common method and approach to the Construction Management service on offer to our clients.

Although its origins are in Arup Manufacturing the manual has been prepared from contributions from various parts of the firm and is intended to provide a guide and best practice approach to many Construction Management activities. The manual will develop and it is hoped that Construction Managers will feed back comments and improvements.

A further aim is to establish an Arup identity to procedures, proformas and reports required under a construction management commission.

1.2 CMM Structure

The manual has been set out as a series of sections covering the principal processes involved in Construction Management.

The manual has been laid out as a series of sections covering the principal processes involved in Construction Management within Volume 1. Each section makes reference to outline procedures, proformas or recommended tools for tackling the activity covered. These are generally contained in Volume 2 – outline Procedures and Examples. It is hoped that this approach will make it easy to find the relevant topic in the manual and allow the speedy customisation of procedures and forms for specific projects whilst maintaining a common general format.

Section 2 provides a list of definitions for commonly used terms in the manual.

Sections 3 to 6 provide an overview of the Construction Manager's role and the documentation, organisational and communication arrangements and control systems that need to be put in place at the commencement of a project in order to move the project forward in a controlled and co-ordinated manner. These are pulled together in a document termed the Project Implementation Plan.

Sections 7 to 14 provide more detailed guidance and typical procedures for specific Construction Management activities.

The principal scope, objective and content of each section of the manual is set out in more detail in Table 1 - Manual Sections - Scope / Objective / Content:

1.3 Status of the Current Issue

Volume 1 – Guidelines – Draft 1 can currently be accessed via the APM Project Management Manual at http://69.144.5.1/ppm/.

Volume 1 has now been updated (June 2000) to version Issue 0 and will replace the above version.

Volume 2 – Outline Procedures and Examples Issue 0 is issued for the first time during July 2000.

1.4 Future Issues

Whilst hard copies have been issued to further the Arup internal review and concurrence, the intention is to permit access to both volumes via on Arup intranet site during July/August 2000.

For the projects where we act as CM in remote locations, it may be appropriate to copy the complete CMM onto a CD or other electronic media.

The manual will cease to exist in a consolidated hard copy form and shall continue to operate only in an electronic form.

1.5 CM Champions – Designated Experts

The long term aim will be to assign ownership of each section of the manual to designated Arup experts. The finalised list of designated experts has yet to be confirmed but is likely to mirror the APM list.

TABLE 1 – MANUAL SECTIONS - SCOPE / OBJECTIVE / CONTENT

SECTION HEADING	SCOPE / OBJECTIVE / CONTENT
1. Introduction	• Scope of manual • Target users • Layout of manual
2. Definitions	• Definition of terms used in the Manual
3. Construction Manager's Responsibilities & duties	• Overview of the CM's role. • List of primary responsibilities • Schedule of typical duties / activities to provide outline of manual contents
4. Project Implementation Plan (PIP)	• Objectives of a typical PIP (covers the principal objectives of a project and the principal management processes to be employed) • Guidance on typical issues covered by PIP • Guidance on the level of detail required in a PIP.
5. Control Procedures	• Identification of general project processes to which control procedures are typically applied • Guide to typical control procedures for the identified processes • Guide to available computer systems to support project controls
6. Communications	• Define forms of communication • Guide to typical procedures / systems adopted for managing specific types of communication
7. Management of Design Input	• Define aspects of design process that CM should manage / monitor • Guide to typical types of procedures / systems adopted • Guide to types of reports normally generated
8. Cost Management	• Define elements of project cost management • Guide to typical types of procedures / systems to be adopted for managing cost at a project level • Guide to types of reports normally generated • Guide to capability of Arup's PCS system
9. Programme Management	• Define types of programmes normally required • Guide to content of each type of programme • Guide to typical types of procedures / systems to be adopted for statusing and updating programmes • Guide to types of reports normally generated

TABLE 1 – MANUAL SECTIONS - SCOPE / OBJECTIVE / CONTENT cont…..

SECTION HEADING	OBJECTIVE / SCOPE
10. Documentation Management	• Define types of documentation • Guide to typical types of procedures / systems adopted for controlling the flow of documents • Guide to types of reports normally generated • Guide to archiving of documents
11. Procurement	• Define scope of procurement • Guide to alternative forms of Contract • Guide to developing a contract strategy / works package breakdown • Guide to pre qualifying contractors / designers • Guide to structure of typical tender and contract documents • Guide to tender and assessment process • Guide to types of reports normally generated
12. Contract Administration	• Define role & duties of the contract administrator • Guide to typical contract processes • Guide to typical types of procedures / systems adopted for managing contract processes • Guide to types of reports normally generated
13. Construction Support Services	• Define scope of construction support services • Guide to typical types of procedures / systems adopted for managing support services
14. Health & Safety	• Define scope of Health and Safety • Guide to complying with UK CDM regulations
15. Quality Management	• Guide to complying with Arup Quality Manual • Guide to auditing contractors and designers quality systems

2. DEFINITIONS

The following terms are used generally throughout this manual, emphasising that construction management is reliant on the clear identification of the key participants and their relationships.

Construction Management

The term Construction Management can have various meanings depending upon which part of the construction industry you come from and in which country the client or project is located.

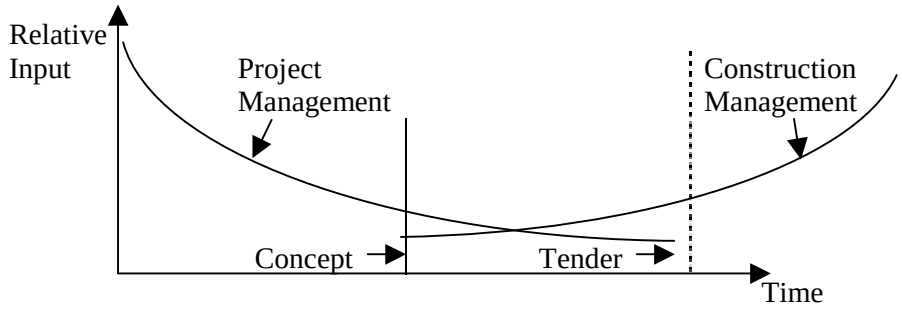
Within the context of this manual Construction Management covers the process of planning, implementing and controlling the design and construction of a project from conception through to commissioning and hand over. It does not cover the undertaking of design or construction work itself.

For the purpose of this manual Project Management and the Project Manager's role has been absorbed into Construction Management and the Construction Manager's role.

It must be remembered that on certain projects an Owner may choose to employ a Project Manager and a Construction Manager

Traditionally, construction management services have included overall responsibility for construction supervision and health and safety on projects. There are various levels of service that can be provided under the Arup version of Construction Management and as stated elsewhere it is important to confirm the level of service, responsibilities and corresponding fee for the appointment.

Several Arup projects have involved a transition in appointment from Project Management to Construction Management. In terms of input the roles of Project Management and Construction Management can be summarised as diagram below:



Owner (O)

The individual or organisation commissioning the project and directly employing the Designer, Construction Manager and Works Contractors.

Construction Manager (CM)

The individual or organisation employed to plan, implement and control the construction office project, it will include controlling the cost of the Owner's project, in co-operation with the Designer through a series of Works Contracts.

Designer (D)

The design consultant employed to lead the design team of all the project elemental parts. The design team may comprise specialist design consultants and where necessary specialist contractors.

Works Contractor (WC)

The organisations employed by the Owner to construct, fabricate, manufacture, install or supply parts of the project to the designs and specifications prepared by the Designer.

3. CONSTRUCTION MANAGER – TYPICAL RESPONSIBILITIES AND DUTIES

3.1 General

Construction Management is the management path of procurement in which the Owner enters into separate contracts with a Designer, a Construction Manager and Works Contractors. Construction Management presupposes the early appointment of the Designer and the Construction Manager, each of whom is responsible to the Client.

In Construction Management the Owner is able to maintain control over his project, without relieving the Designer and Construction Manager of any of their professional duties or liabilities. Roles are more clearly defined in construction management than in other procurement methods because the Designer designs, the Construction Manager manages and the Works Contractors produce the elements and the Owner directs the project for which he alone is ultimately responsible.

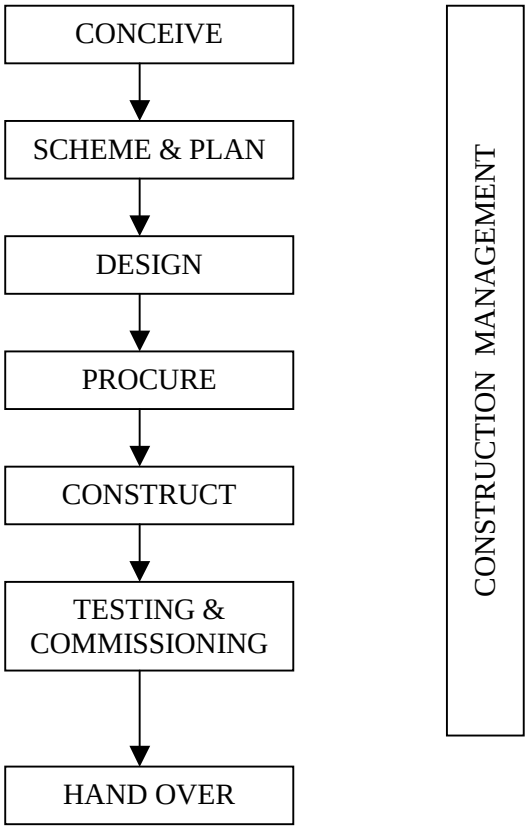
Construction Management covers the process of planning, implementing and controlling a project from conception through to commissioning and hand over. Typical project phases are shown in figure 3.1, in most projects there is a considerable overlapping of phases.

A Construction Management commission may include management of only some of these phases.

3.2 Construction Manager's Responsibilities

The Construction Manager is responsible for developing a plan, an organisation structure and control procedures for achieving the project objectives. This will entail developing, in conjunction with others, procedures and strategies covering the following:

- The overall planning, control and general management of the total project from inception to completion;
- The assessment of the design to ensure buildability, compliance with budget costs, programme and value for money;
- The provision of advice on construction costs and the establishment of cost budgets for the project, which may include lifetime costs.



PROJECT PHASES

Figure 3.1

- Identification of all statutory requirements, advising the Owner of their time and cost implications and suggesting alternative methods, if necessary, of meeting these requirements
- the establishment of a health, safety and security policy for the site;
- an evaluation of the site and the identification of construction support requirements;
- The planning, management and implementation of the construction phase of the project including the division of the work into appropriate packages; the obtaining of tenders for each work package and ensure that pre-ordering of essential long delivery materials or equipment is undertaken.
- During the currency of the project ensuring that the Owner is kept informed on progress, costs and levels of future expenditure; evaluating and issuing variations once they have received the Owner's approval, agreeing interim payments and final accounts with the works contractors and advising the Owner on contractual claims.
- Administration and supervision of Works Contracts.

This manual is intended to provide guidance on discharging these responsibilities.

3.3 Construction Manager's Tasks

The Construction Manager's responsibilities will be discharged by the performance of the following schedule of tasks which, for ease of reference, is listed under the section headings of this manual. The list of tasks is illustrative of a typical Construction Management Commission and will obviously vary depending upon the requirements of individual projects. Many of these duties will be carried out in co-operation with the Designer and other members of the professional team.

3.3.1 General management and organisation of the project (Sections 4 to 6);

- Prepare the Project Implementation Plan comprising;
  (a) Project Organisation;
  (b) Organisational Responsibilities;
  (c) Control procedures;
  (d) Communication procedures;
  (e) Meetings schedules;
  (f) Co-ordination / Interface Management procedures;
  (g) Reporting arrangements.
- Prepare and present budget costs and present feasibility studies to the Owner;
- Evaluate the site to identify construction constraints and opportunities;
- Advise on the need for preparatory works, e.g. service diversions;

- Monitor the process of obtaining the approvals from statutory authorities to enable construction to commence;
- Liase with Owner and Designer for the appointment of Specialist Contractors for design;
- Design the overall project organisation structure and produce clear descriptions of all the required roles and responsibilities. Check that competent people are employed to fill each role and that they fully understand their responsibilities;
- Maintain records of meetings and all other activities;
- In discussion with Designer and Owner, establish a mechanism for effective industrial relations;
- Produce monthly reports for the Owner giving forecast final costs and forecast completion dates;
- Ensure the co-ordination of the production and assembly tasks with the Designer and Works Contractors;
- Receive occupation certificates and clearance from Health and Safety and Fire Officers.

3.3.2 Management Of Design Input (Section 7)

- In conjunction with the Designer present and review Design Reports with the Owner for agreement;
- Discuss buildability and technical design with the Designer and Works Contractors;
- Agree with Designer the use of construction technologies including particularly the extent of off-site prefabrication;
- Contribute to the preparation and development of the Brief in conjunction with the Designer and issue amendments as necessary.

3.3.3 Cost Management (Section 8)

- Prepare budget costs and present cost studies to the Owner;
- Prepare and maintain a Cost Plan.

3.3.4 Programme Management (Section 9)

- Plan the construction method including on and off-site fabrication systems;
- Prepare Owner's commissioning and equipping programme;
- Prepare and maintain a Project Master Programme;
- Monitor progress and prepare monthly status reports.

3.3.5 Documentation Management (Section 10)

- Establish and manage an information system, which ensures that everyone involved with the project knows what work they must do, and how it fits into the total project;
- Establish and manage a document control system.

3.3.6 Procurement (Section 11)

- Discuss alternative forms of contract with the Owner, evaluate each option for suitability of meeting the Owner's requirements and, where necessary, identify special conditions of contract which need to be prepared.
- Prepare and discuss work packages with the Designer and Specialist Contractors, identify a suitable split of activities and arrange procurement of each package (including soil investigations, surveys and the like).
- Draw up list of qualified tenderers, identifying resources and labour;
- Send out tender documents;
- Receive tenders and obtain clarifications as required;
- Prepare tender award recommendations to Owner;
- Arrange orders for long delivery components.

3.3.7 Contract administration (Section 12)

- Assemble contract documents, approve bonds where necessary and obtain Owner and Works Contractors' signatures;
- Prepare valuations and final account;
- Issue payment certificates;
- Obtain approval to cost of variations and claims when the Construction Manager's limit of authority is exceeded;
- Issue variation orders and instructions;
- Deal with insurance claims;
- Issue certificates of extensions of time;
- Issue Practical Completion Certificates;
- Ensure that defects are remedied;
- Obtain maintenance manuals and as-built drawings;
- Monitor the Designer and Works Contractors in the performance of their duties and the discharge of responsibilities as set out in their respective Schedule of Duties;
- Issue directions to Works Contractors where their work does not comply with the contract documents;

- Maintain a site diary to record the progress of each Works Contractor's design, construction noting delays, weather conditions, site visitors and other significant facts;
- Ensure that the Works Contractor protect the works in accordance with contract documents.

3.3.8 Construction Support Services (Section 13)

- Provide site services if required.

3.3.9 Health & Safety (Section 14)

- Discuss health and safety requirements on site and develop and implement appropriate policies. For projects in the UK, these should embrace the requirements of the Construction (Design and Management) Regulations 1994.
- Obtain the health and safety file in the UK.

3.3.10 Quality (Section 15)

- It is also possible to extend the role of the construction manager to be responsible for quality control, but this must involve the whole project team to establish the initial standards for works contractors and the subsequent quality monitoring. The responsibility for quality control must be established before construction contracts are awarded.

All of the above responsibilities are typical of services on offer and should be read in conjunction with the Responsibilities Matrix in Volume 2, Section 2.2.

4. PROJECT IMPLEMENTATION PLAN

4.1 General

In order to manage a project and reassure the Owner that the project will meet its defined objectives it is necessary to define those objectives and implement procedures and systems to ensure control of all aspects of the project.

The Project Implementation Plan (PIP) is the document that defines the principal project objectives and sets out the principal procedures and systems to be adopted to control all aspects of the project. The Construction Manager, at the commencement of the project, should prepare this document.

The PIP will assist in the co-ordination of the management processes with the Owner, Designer, Construction Manager and Works Contractors. It will provide a common basis for all parties through the project life. The PIP will need to be updated as the project develops.

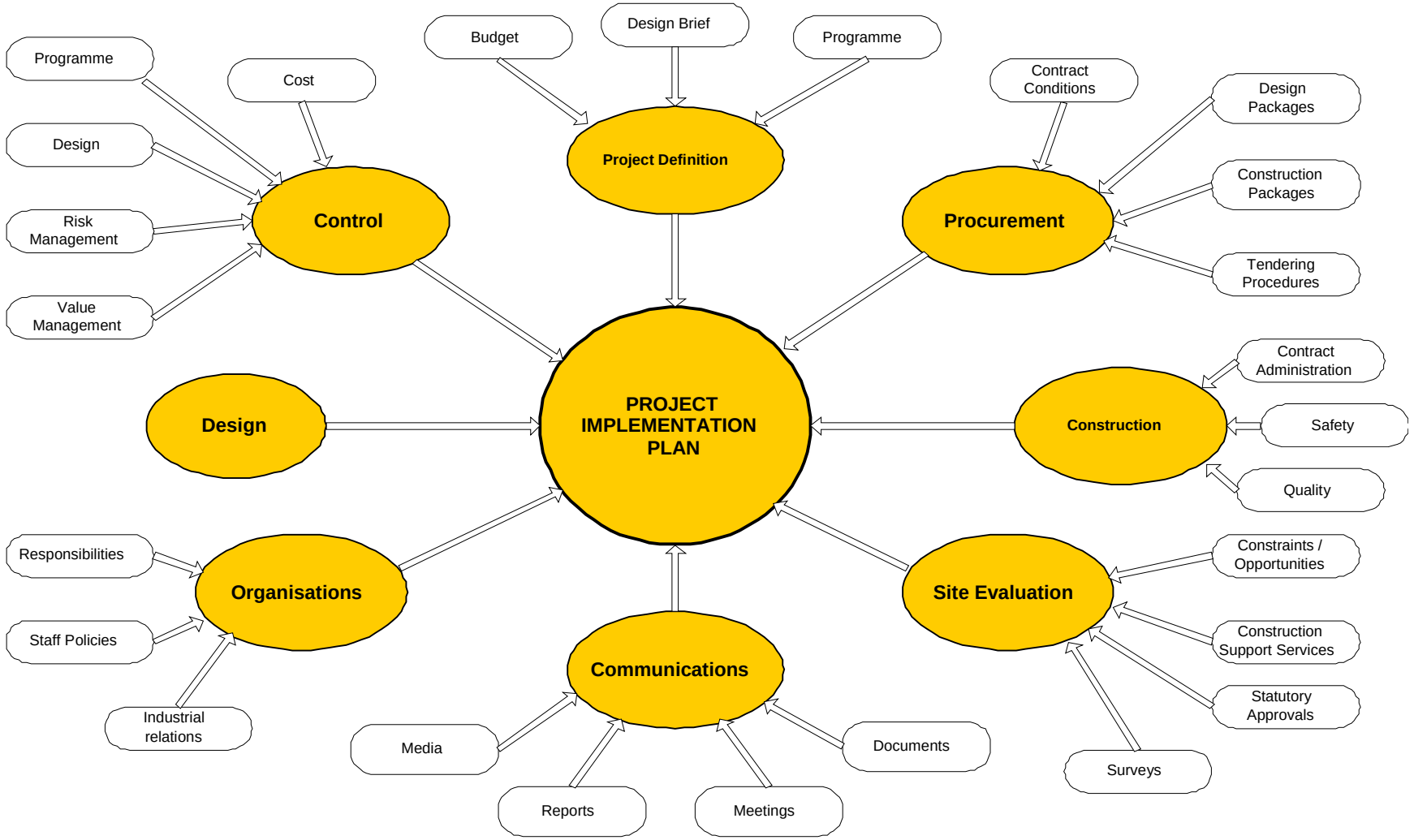
The PIP should be drawn up as a single document and circulated to all members of the project team as a controlled document.

The PIP should typically contain sections on the following:

- Project definition in terms of objectives, requirements and acceptance criteria;
- Control procedures and systems;
- Organisational responsibilities and arrangements;
- Communication procedures and arrangements;
- Site Evaluation;
- Procurement Strategy;
- Design Management; and
- Construction Management

The content of the PIP is illustrated in Figure 4.1 and the various components are discussed in the following paragraphs.

The PIP will identify a number of sub-plans, reports and papers that will need to be prepared to progress the project through its various stages.



PROJECT IMPLEMENTATION PLAN **Figure 4.1**

4.2 Project Definition

The PIP should define the project in terms of the Owner's requirements with respect to the facilities to be constructed, the required programme and the budget allocated. An example is given in Volume 2 Section 4.2.

4.2.1 Owner's Requirements - general

These should be defined in a way that communicates to the project team in as concise a way as possible the fundamental practical and aesthetic needs of the Owner. It should include a statement of the general functional purpose of the facilities in sufficient detail to indicate their main requirements. Any acceptance criteria should be stated.

A general description of the project should also be prepared. This should include the location of the project, a general description of the buildings, the intended usage of the completed works, and any other relevant data necessary to describe the scope of the project.

Statements should be included on:

- quality - indication of general standards, environmental control standards, acceptable life to first maintenance.
- approvals - statutory approvals known to be needed.
- planning - factors known to have a bearing on implementation such as site availability, vehicle access, existing services, environmental concerns, neighbours .etc
- flexibility - adaptability, expansion, phasing.

4.2.2 Programme

The PIP should contain an outline programme for the project indicating the Owners requirements.

The programme should typically identify the following project phases:

- Start Date
- Design — Design the works to the standard required for procurement and construction.
- Surveys — Topographic, geotechnical etc.
- Tendering — Preparation of tender documents, bills of quantities and other information required for the selection of suppliers and contractors. Selection by negotiation or competitive tendering, evaluation of bids and completion of contract document.
- Construction — Supply of materials, fabrication and testing of elements, construction and installation on site.

- Commissioning — Test of the complete project section by section. Adjustment of all plant and equipment to optimise overall performance. Staff training, start-up and monitoring over first phase of operation.
- Completion — Phased requirements

4.2.3 Budget

The PIP should contain an outline budget for the project broken down into the project's major elements together with an indicative cash flow forecast.

The limitations and assumptions made should be clearly stated.

4.3 Organisational Arrangements

The PIP should set out the organisational arrangements for the project team members in terms of:

- Responsibilities
- Reporting lines for communication
- Reporting lines for contractual matters

4.3.1 Responsibilities

It is essential that the responsibilities of each of the organisations involved in the project are clearly defined.

The primary tasks of each Organisation during each phase of the project should be identified and stated. Any omissions should be noted.

The actual responsibilities allocated to each party will depend upon the scope of the project and the allocation of work by the Owner and should broadly be based on the Responsibilities Matrix in Volume 2, Section 2.2.

It is recommended to specify a "signing-off 'procedure by the Owner to be implemented during the project at pre-determined stages.

4.3.2 Reporting Lines

An overall project organisation diagram of the principal participants in the project should be prepared. This should typically include the following:

- Owner
- Construction Manager
- Designer
- Other Professionals

- Works Contractors

The diagram should illustrate the reporting lines and hierarchy of the various organisations and their contractual relationship with the Owner. Figure 4.2 shows a typical arrangement.

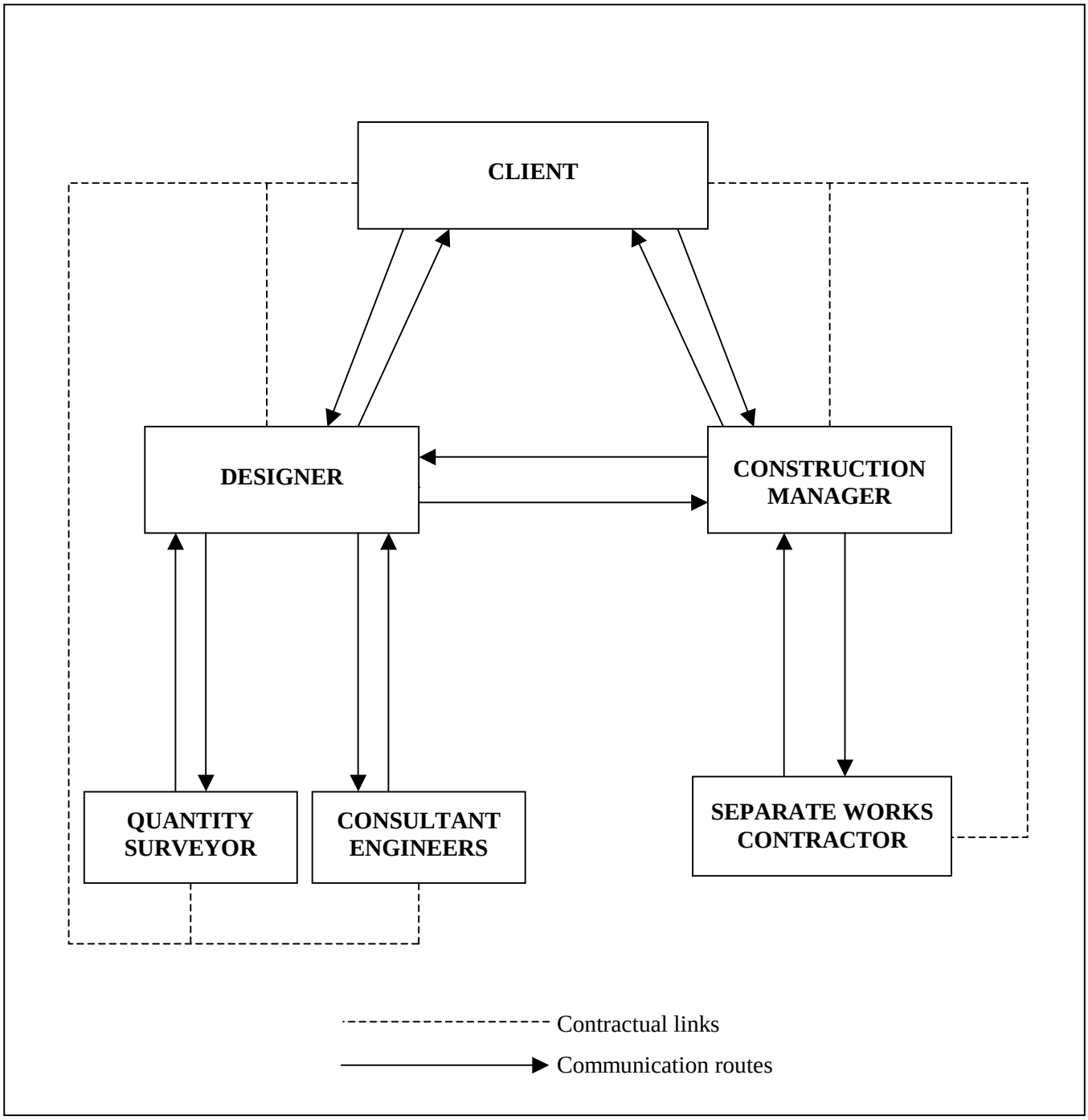
Organisation charts for each organisation involved in the project should also be obtained so that the responsibility and authority of individuals involved can be identified.

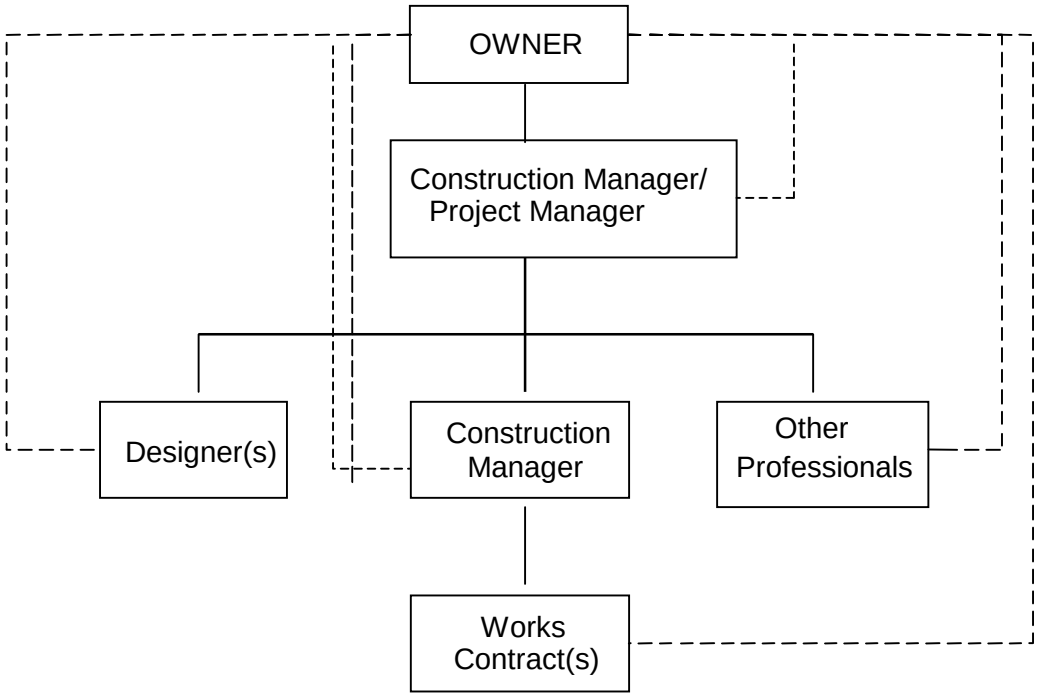
A typical organisation chart for a Construction Manager's organisation is shown in Figure 4.3. A brief description of the key players and their roles should be provided. Typical examples of recent Arup CM project organisation charts are shown in Volume 2.

The design team organisation chart should include the role and relationship of any specialist consultant.

Standard Forms of Contract

Construction Management





PROJECT ORGANISATION (TYPICAL)

Functional & Contractual Relationships

Figure 4.2

4.3.3 Staff policies

Any particular requirements of the owner with respect to staffing should be noted in the PIP.

4.4 Control procedures and systems

One of the principal tasks and responsibilities of the Construction Manager is to monitor and control the implementation of the project. To perform this task it is essential that procedures and systems be put in place to provide the information and control points necessary to manage the project. The control procedures need to cover changes in cost, specification or programme to all principal aspects of the project, namely:

- Design
- Approvals
- Procurement
- Costs
- Programme
- Interfaces
- Construction

The PIP should identify the procedures and systems to be adopted for monitoring these aspects of the project.

Where changes are identified they should be subject to a formal authorisation procedure in order that all implication of the change are identified.

Control procedures should also include application of the following techniques throughout the life of the project:

- Risk management
- Value management

The PIP should identify an appropriate strategy for operating value and risk management.

Further guidance on this subject is given in Section 5

4.5 Communication procedures and arrangements

The PIP should define, in principle, the lines of communication to be adopted for the project, the frequency of meetings and the type, style and format of reports to be prepared.

The PIP should identify the CAD and IT systems to be adopted for the project to ensure the compatibility of data exchange.

Further guidance on this subject is given in Section 6

4.6 Site Evaluation

The PIP should include assessments of the following:

- the physical condition of the site and its implications on the project;
- the need for additional ground surveys/investigations;
- the need for environmental measures;
- service provisions / requirements for the site;
- the availability of the site; and
- access arrangements for the site;

The requirement for enabling and construction support services should also be assessed.

4.7 Procurement Strategy

The PIP should identify the main parameters for establishing a procurement programme for the project.

These should include:

- alternative contract terms and conditions, payment terms and dispute arrangements that could be adopted;
- whether design and construction is an option that should be followed;
- Identification of long lead items that need to be ordered ahead of other elements on the procurement strategy; and
- The principals underlying arrangements and procedures for the pre-qualification, tender and award of contracts.

Further guidance on procurement is given in Section 11.

4.8 Management of Design Input

The PIP should identify the principal process to be adopted for defining the detailed scope of the facilities forming the project.

The PIP should also identify:

- the procedures to be adopted for reviewing and controlling the design process; and
- studies that should be undertaken to optimise the design and construction process, for instance the scope for modularisation and pre-fabrication.

Further guidance on this subject is given in Section 7.

4.9 Contract Administration

The PIP should identify the main parameters to be used in establishing administrative and supervisory arrangements for the management and control of Works Contracts.

This should in particular cover the authority of the Contract Administrator his reporting arrangements and the types of procedures that will be used to monitor and control progress, cost and quality.

Further guidance on this subject is given in Section 12.

5. CONTROL PROCEDURES

General

The following paragraphs give guidance on the application of change management, interface management, risk management, value management and available computer systems.

5.1 Change Management

It is a fundamental principle of project control that the design or construction of proposed changes should not, unless they are within authorised limits, be initiated until formal approval and sign off has been received from the Owner. The sole exception being during the construction phase of the work, where a change is deemed necessary to alleviate an immediate safety hazard.

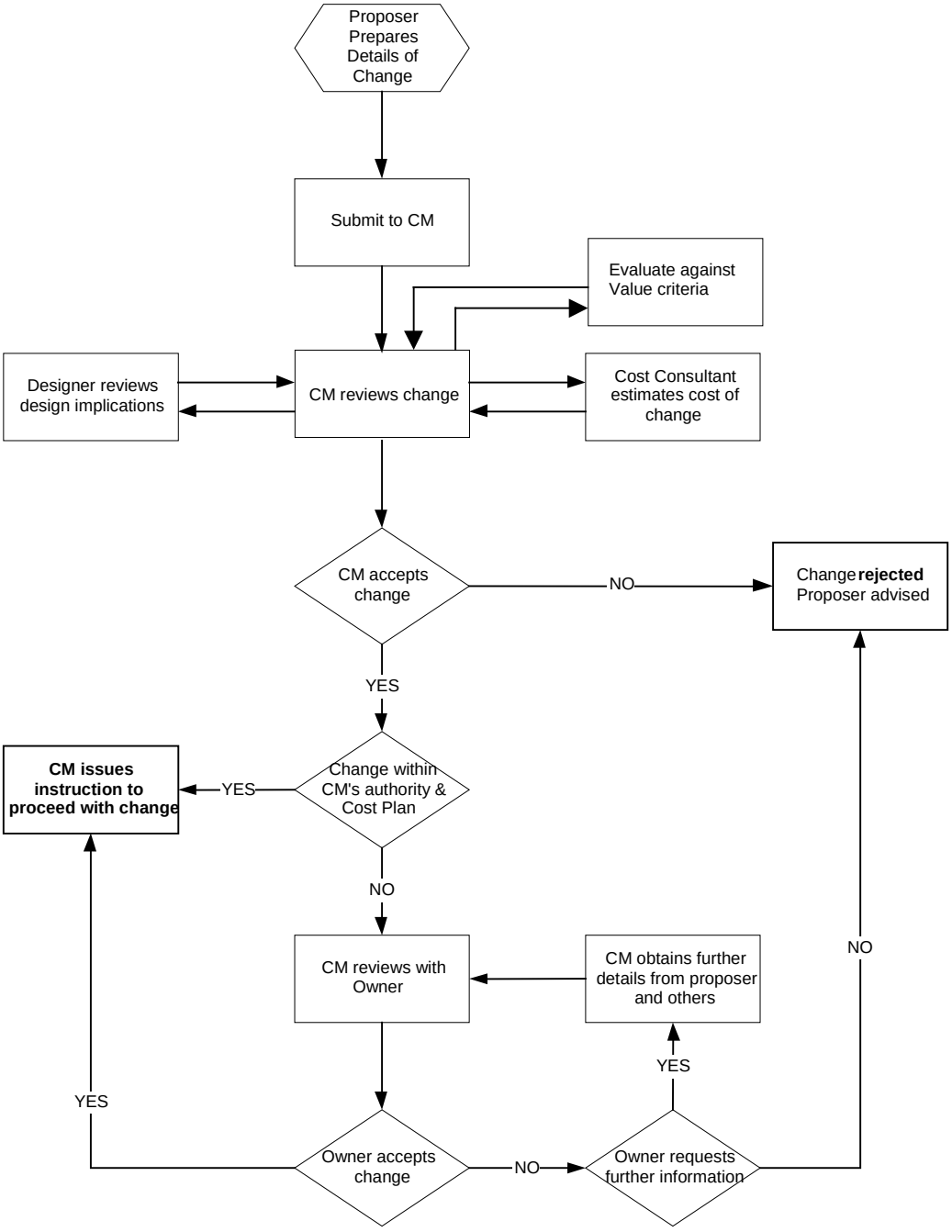
For an effective change control system to operate, a series of agreed benchmarks must be acknowledged, namely:

- An approved detailed project brief.
- An approved control budget based on the project brief.
- An agreed mechanism for identifying and quantifying the effects of proposed changes, together with mandatory response times for authorisation to proceed.
- Regular reporting of the status of change requests with cumulative cost and programme implications.
- An individual responsible for implementation of the process. This will be the Construction Manager.

The PIP should provide the initial bench mark for assessing change.

Any member of the project team may initiate proposals for a change. The mechanism for initiation of a change should be the same in each case. A change notification (CN) should be raised and logged with the Construction Manager. A Typical Example appears in Volume 2 Section 5.1.

A Typical change review and approval process is shown in Figure 5.1. Once a change has been approved the Construction Manager must issue a formal instruction which will initiate the formal update of project budgets and other data.



TYPICAL CHANGE MANAGEMENT PROCESS

Figure 5.1

The efficiency with which changes are reviewed and dealt with is very dependent on:

- the judgement of the Construction Manager in determining whether the change is essential;
- the completeness of the documentation supporting the change proposal; and
- the authority of the Owner's Representative to approve budget changes;

Whenever a change is proposed it is essential that the Construction Manager assesses the impact on ongoing work and determines the timescale within which the change should be reviewed and decided upon.

If a change is considered urgent or perhaps the need for it is uncertain the Construction Manager should quickly establish, following consultation with others, the order of cost, programme, risk and health and safety implications associated with the proposed change. The accuracy of cost assessments at this stage should be in the order of +/-20%. If the Owner is satisfied with the change request implications, he can then either authorise the change on the basis of the estimate, request further information or reject the request if it is considered unnecessary or too costly.

5.2 Requests for Information

At various stages from design to construction the scope of work that designers, suppliers and contractors undertake should be defined in the project documentation.

There will be occasions when the scope needs to be clarified or amplified.

A system of requesting information from the project parties, tracking the requests and tracking the responses should be instigated.

A Request For Information (RFI) procedure is an essential communication tool. It is a formal communication procedure that will provide order and traceability.

Volume 2, Section 5.2 illustrates a Request For Information procedure.

5.3 Interface Management

The Construction Manager should prepare a procedure for interface management, in conjunction with the Designer. The procedure should identify responsibilities during the design phase, which may require the production of interaction/interface documents.

The procedure needs to cover the following disciplines:

- Architectural
- Structural / Civil
- Mechanical systems
- Utilities
- Electrical

- Instrumentation and control
- Process
- Interior Design
- Landscaping

The description of the interface needs to be sufficiently detailed to allow it to be reviewed and released. All interface points need to be clearly marked and designated by an appropriate numbering system.

The Construction Manager should convene meetings during the design and construction phases to identify and resolve interfaces and interactions.

Formal co-ordination proformas should be instigated for certain interfaces, on which discipline design managers should confirm that they have co-ordinated their design with others. This procedure should formally record that each part of the team has conscientiously addressed the design interface with others.

The responsibility for the preparation of integrated services drawings, to combine the drawings prepared by the various works contractors, needs to be specified. These drawings need to be reviewed and released by the designer.

The Construction Manager should implement a system of area handover between the works contractors during the construction phase.

5.4 Risk Management

Risk Management is the planned and systematic process of identification, assessment, control and monitoring of threats to achieving the project objectives. It incorporates risk analysis for which a range of analysis methods are used ranging from simple qualitative analysis to a complex quantitative approach, depending on the demands of the functions to be analysed.

Risks can be categorised into commercial (including cost and programme), operational (impact on Owner's or facilities' operations), environmental, health and safety and property. The approach is to identify and assess the risks involved for options under consideration and then set procedures for the management of risks associated with the chosen option throughout the life cycle of the facility. This helps to achieve the objective of minimum life cycle costs.

The Risk Management process does not stand-alone and is closely allied to Value Management and similar techniques are used for both processes. This approach means that systematic examination of the threats to project objectives often result in new opportunities being revealed.

The Risk Management process is designed to ensure that as far as is reasonable:

- All significant uncertainties are identified and assessed.
- Opportunities are recognised and optimised.
- Risk exposure is understood and reduced to acceptable levels.
- Cost-effective risk control measures are implemented.
- Risk estimates are prepared for contingency.

- Control measures and risk estimates are reviewed and managed.
- Contingency plans are developed and reviewed.

The essence of the control of risk is the allocation of contingency and the subsequent monitoring of the drawdown. Risk assessments contribute to the allocation of appropriate contingency values to the base parameters of cost, time, quality and safety, based on risk estimates.

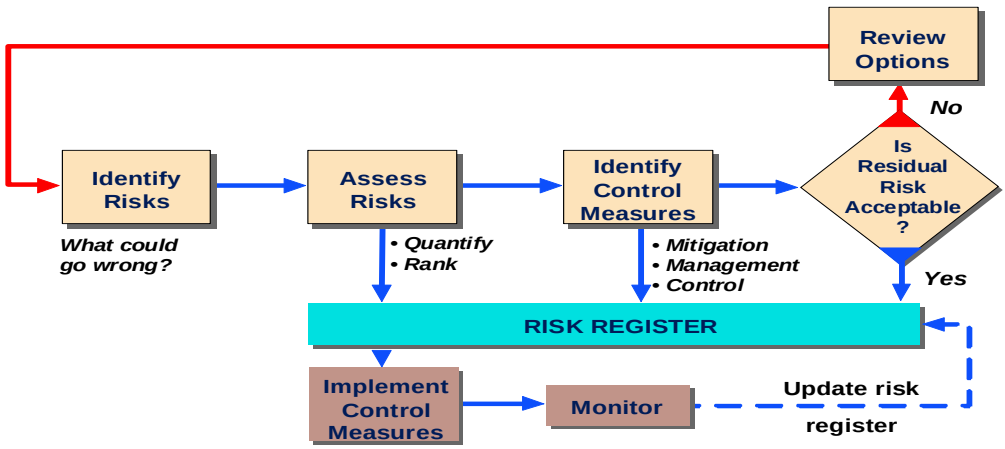
Experience has shown that the technique is most effective if it is aimed at specific risk minimisation targets, and if it is introduced at the earliest stages of the project with all members of the project team being involved. The process then continues throughout the design and construction with reviews at the key stages.

During the project initiation stage a detailed strategy, programme and procedures for Risk Management should be established. This should include the risk assessment methods to be undertaken, the identification of risk control measures and risk owners, and the format and intended operation of the risk register. The risk identification, assessment and control process continues throughout the design and construction with reviews being undertaken at key stages. In parallel with risk identification and classification, mitigation or control measures are developed in consultation with all parties.

Regular project hazard identification workshops should be established, where people work together to assess the associated risks and control measures. The workshops should be timed to coincide with key decision points in the project process. These should be recorded in the risk register, which is maintained by the Construction Manager, and regularly reviewed. The risk control measures should be regularly reviewed and monitored. Where appropriate, contingency plans should be developed in the event of a potential hazard becoming a reality.

The Risk Management process includes the preparation of the Risk Register and the methods to be used to manage the risks for all major aspects of the project, including Health and Safety, Cost and Programme.

The risk management process is illustrated in Figure 5.2 and described in further detail in Volume 2 Section 5.4.



RISK MANAGEMENT PROCESS

Figure 5.2

The Risk Register is a controlled document which lists the uncertain events, risk assessment, control measures, specific action plans and the risk ownership. Reference is made to contingency allowances incorporated in the cost budgets, programmes, specifications and safety plans where appropriate. It is a dynamic document, which changes under the direction of the Construction Manager as the Project develops.

An example of a typical Risk Register can be found in Volume 2 Section 5.4.

5.5 Value Management

Value Management is a structured approach to the identification and evaluation of project objectives and the means by which those objectives can be achieved over the life cycle of the project in order to achieve value for money. It incorporates value engineering which is a systematic approach to achieving the required project functions at least life cycle cost while maintaining quality, performance and reliability.

The value management and value engineering approach is illustrated in figure 5.3 below.

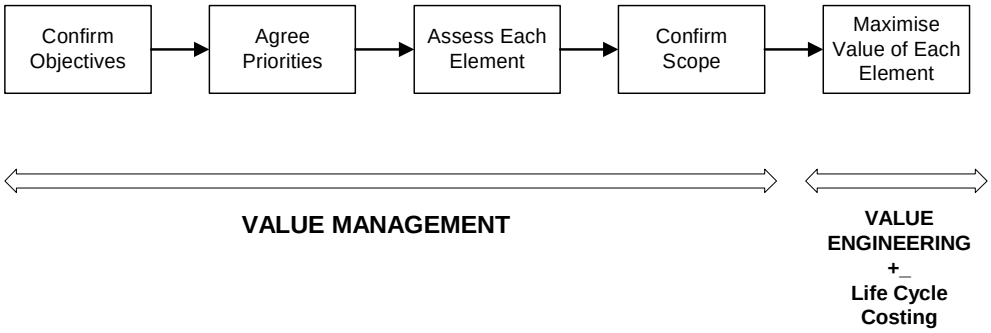


Figure 5.3

Value management should be used from the very earliest stages of a project and the preferred approach is to host successive workshops with the Owner and project team. Initially clearly identifiable requirements and money available for the life cycle of the project should be established. Design solutions can then evolve in accordance with agreed objectives. Workshops should then be held at key stages of the project to develop the best value for money solution.

A set of creative problem solving techniques within a team should be used to evaluate rigorously the key project decisions. The basic stages of creative problem solving are widely recognised as follows:

- Define the problem.
- Identify different options for resolving the problem.

- Evaluate the options.
- Select the option offering best value for money.

The methods used by Arup are all based on these stages. Indeed, good design practice should also follow these stages, but the advantage of Value Management is that each of the above stages are identified and performed separately. This ensures that the creative process of identifying possible solutions is kept separate from evaluation. This is important because it is necessary to consider a wide range of possible solutions to ensure value for money - the first solution to appear workable does not always provide the best value for money. Creativity and imagination are key ingredients in finding the best value for money solution for any project.

It has been found to be beneficial for workshops to be multi-disciplinary to enable account to be taken of all the engineering and design criteria and their interaction. All disciplines have an equal and simultaneous role in this process.

Key features of such workshops are that they:

- Are timed to coincide with key decision points in the project process.
- Intervene in the design/construction process.

Workshops should be held at appropriate stages of the project which typically include:

- At the earliest appropriate stage, to help identify the key project objectives and constraints, and to evaluate the broad project approach outline design.
- During scheme design, to evaluate developing design proposal.
- During detailed design, to evaluate design proposals.
- During procurement and construction, to evaluate alternatives offered by the works contractors.

During the project initial stage a detailed strategy programme and procedures for Value Management should be established. Whatever frequency of workshops is considered appropriate such a strategy shall establish procedures to ensure that value is foremost in the development of the project throughout the project life cycle.

Whilst the emphasis of Value Management is on achieving maximum value for the resources available, cost savings are nearly always possible. Typically, capital cost savings of ***between 10% to 25% are achievable*** on works projects. Whilst these savings should more than offset the additional costs of Value Management, it is just as valuable to confirm that original design proposals are effective as to discover better alternatives.

Value Management incorporates Value Engineering to minimise costs and maximise value and performance. Its aim is to produce a cohesive and successful solution for the whole for this, the input and close collaboration of the full project team is needed. Value engineering studies should be carried out during and at the end of, the design process, to ensure that economical facility has been produced. These studies should ensure that lowest costs are achieved over the life of the new facility (i.e. least life cost to meet function requirement), and that excessive

(i.e. redundant) performance is not paid for by the Owner. Value Management should take account of life expectancies in comparative evaluations, and the data and the assumptions on maintenance requirements etc should be retained after the exercise, to feed forward to the facilities manager.

Life cycle management looks at each critical element of the new project and selects a design solution on the basis of least cost over the life of the facility including the cost of any provisions for safe maintenance and replacement. Life cycle management is a holistic approach involving the Owner, the design team, and manufacturers and contractors in the procurement stage, and the user and facilities managers once the facility is in use. Low capital and low maintenance costs can be achieved by designing explicitly with that intention, but this must be balanced with the associated excessive replacement costs due to inadequate or uncertain performance and reduced durability. Where the life of the item is less than the intended life of the building, the design should make suitable provision for easy and safe removal and replacement.

The approach to the process of life cycle management should be based on BS7543, which describes a procedure for dealing with life expectancies and the causes and effects of failures. The procedure for dealing with these issues is shown below:

- Set design of the facility.
- Set design life of components and assemblies.
- Set maintenance levels.
- Complete design life data sheets.
- Evaluate effects of failure and risk control measures.
- Prepare outline performance data plan.
- Prepare financial forecasts of likely expenditure over time with associated cash flows.

Involvement of suppliers and users in particular should provide useful information about design life, reliability and maintenance requirements.

6. COMMUNICATIONS

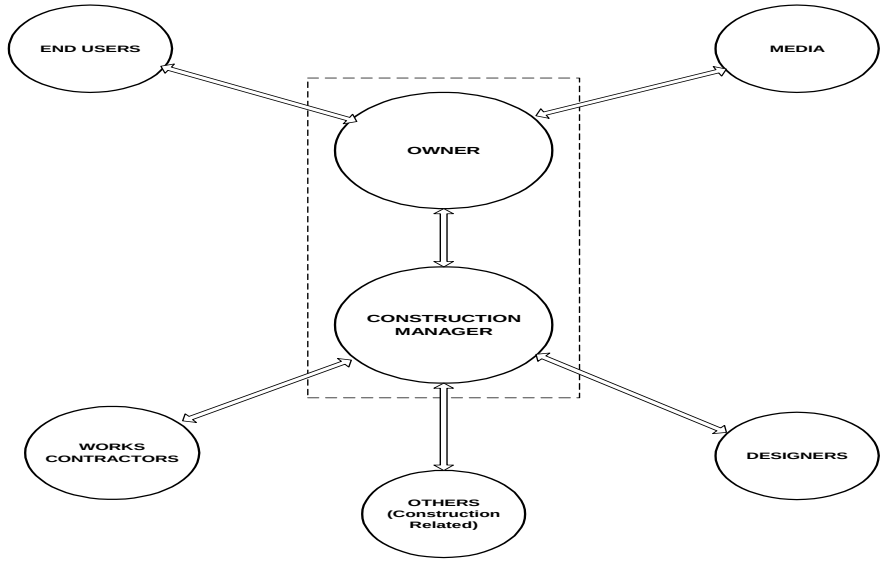
6.1 General

Sound management of a project depends on good communication between all the project participants. This can only be achieved by having clear and unambiguous lines of communication between all parties covering written and verbal communications.

The Construction Manager is responsible for defining the lines of communication and ensuring that they operate efficiently. To achieve this objective the Construction Manager should develop and issue procedures covering the following:

- Project contacts;
- Project correspondence;
- Project meetings; and
- Reporting formats and requirements.

The lines of communication should be based on the project organisation structure and the contractual relationship between the various parties. A Typical arrangement is shown in Figure 6.1



TYPICAL LINES OF COMMUNICATION

Figure 6.1

6.2 Project Directory

The project directory should identify all the principal participants from each party and provide their contact names, addresses, telephone and facsimile numbers.

The directory should be distributed to all parties involved in the project.

The directory should be updated as the project progresses and re-issued to all parties to ensure that the current status is always available for reference.

6.3 Project Correspondence

The Construction Manager is responsible for ensuring an efficient flow of project correspondence that is compatible with the project control philosophy adopted.

The Construction Manager should develop procedures that encompass the following:

- Nomination by all parties of their representatives to whom project correspondence should be addressed;
- Identification of the flow path of documents between parties. For instance the Construction Manager should issue all design documentation from the designer to a Works Contractor.
- Identification of the distribution list for all project correspondence whether originated by the Construction Manager or not. All correspondence and documentation should be copied to the construction management office, where the project documentation filing system should be maintained.

6.4 Meetings

6.4.1 General

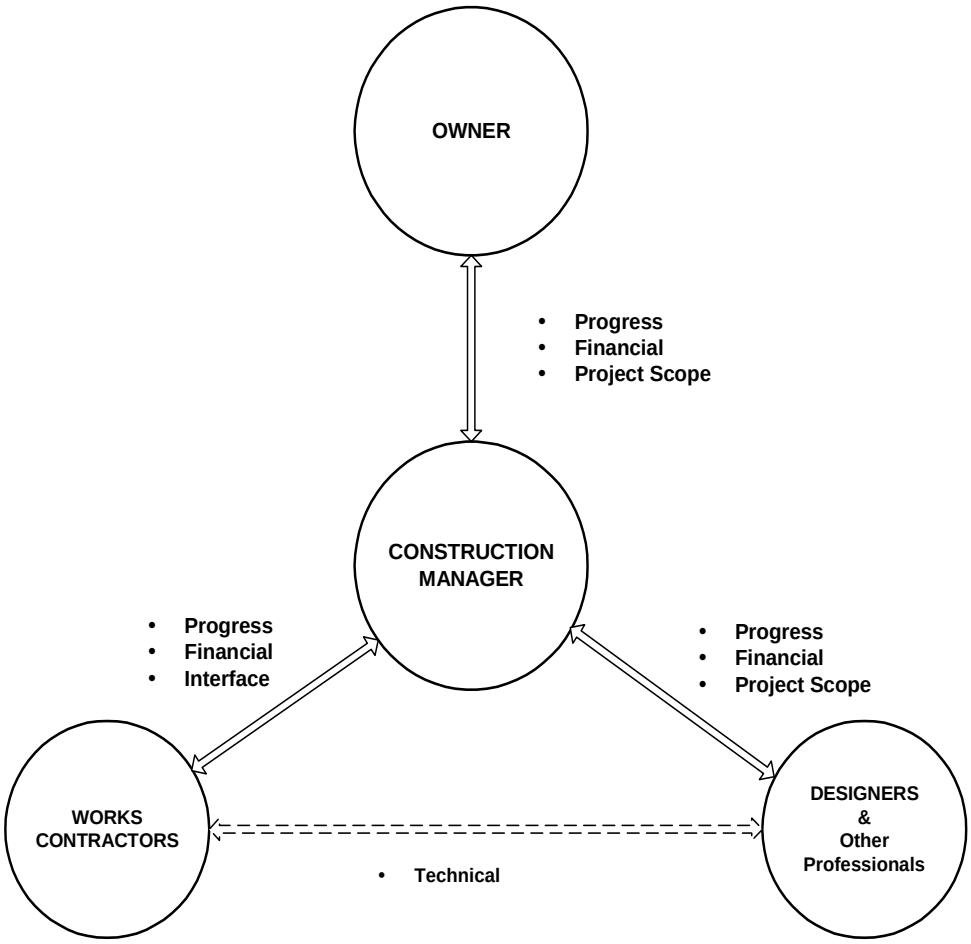
The Construction Manager is responsible for developing a schedule of meetings to enable the progress of the project to be reported, reviewed and discussed and also to assist in the management of interfaces between project participants.

Separate meetings will be necessary with the following project participants to discuss project progress, technical and commercial issues:

- Owners
- Designers
- Works Contractors

Co-ordination and interface meetings would involve a number of project participants.

A typical schedule of meeting types between project participants is shown in Figure 6.2.



TYPICAL MEETING TYPES

Figure 6.2

The Construction Manager should chair all meetings and prepare and issue all minutes of meetings or nominate a party to do so.

Meetings should be structured with an agenda that will be followed in each successive meeting.

Action lists should be prepared for review at each meeting, and the topics closed-out or carried forward to the next meeting. "Required by" dates for responses to actions should be included.

Notes of meetings should be concise with actions clearly identified. Notes should be prepared and issued within three days of a meeting

A meeting schedule should be prepared and updated on a weekly basis, showing all meetings that will be held on the project together with a list of attendees.

6.4.2 Interface Meetings

The Construction Manager should arrange interface meetings as and when required. These may address design or construction issues. The appropriate parties should be invited to attend.

To resolve some issues it may be necessary to assemble task forces to investigate and resolve the particular issue.

It will be necessary to co-ordinate the construction interfaces by reviewing the work areas and methods of Works Contractors. This should also have a planning and safety function.

6.4.3 Meetings with the Owner

Regular meetings should be held with the Owner, generally monthly, to review the status and progress of the project during the preceding month. This would normally follow the issue of the monthly progress report by the Construction Manager. At critical points in the life of the project more regular meetings may be required.

The purpose of the meeting would be to discuss any items raised in the progress report. This would include any deviations in progress from the Master Programme and the effect of any recovery measures proposed, variations from the Cost Plan and cash flow forecast and any corrective measures considered necessary.

6.5 Reporting formats and requirements

6.5.1 Reports from Designers and Works Contractors

All project participants, designers and works contractors, should be required to submit monthly progress reports.

The format and content of the reports should be specified by the Construction Manager to ensure that he has the information necessary to mange the project

reported to him in a consistent and compatible format. Reporting requirements should be stated in contract documents whenever possible.

A typical report should contain the following:

- a statement of progress;
- a marked up schedule showing progress relative to programme;
- Expenditure to date;
- Unresolved issues;
- Outstanding information;
- Interfaces;
- Quality; and
- Health and Safety.

6.5.2 Reporting to Owner

The Construction Manager should submit a formal progress report to the Owner on a monthly basis. The purpose of the report will be to satisfy the Owner that his objectives will be met, or if this is not possible, to offer the optimum alternatives. The report should be predictive, indicating the likely completion date and the expected total cost. Any significant variations to the forecast rate of expenditure should also be highlighted.

A typical report should contain the following**:**

- executive summary generally describing the status of cost and progress;
- a section stating any areas of concern effective cost or programme, with a recommended action to address and rectify the situation;
- a general description of activities in progress during the reporting month on a contract by contract basis;
- a review and statement on the progress of each contract relative to the master programme;
- a cost report, which should take into account all known factors at the time of the report, resulting in a project, forecast final cost relative to the budget.
- a cash flow report;
- a statement on health and safety; and
- a statement on quality

7. MANAGEMENT OF DESIGN INPUT

7.1 General

The Construction Manager whilst not being directly responsible for the design of the Works needs to ensure that there is a proper structure and control to the design development process. The Construction Manager also needs to ensure that the design deliverables/packages required to meet the project programme are identified and delivered on time.

The Construction Manager should provide, to design teams, the leadership, management systems and support necessary to achieve the Owner's objectives with respect to quality, value for money and timeliness, as set out in the PIP. Effective management enables the design team to work in an efficient and orderly manner.

The approach to be adopted should rely on the identification of clear design briefs and stages in the design process, accurate assessments of design progress and rigorous forecasts of project costs.

The Construction Manager should ensure that procedures covering the following are in place:

- Design Team Organisation and Communications
- Design Stages and Reviews
- Review of Contractor's Design Submissions
- Value Engineering Assessments
- Document Control
- Design Change Control
- Deliverables and Progress Monitoring
- Co-ordination and Interfaces

The Design Team should have in place their own procedures, the Construction Manager needs to ensure that these procedures incorporate project level requirements.

7.2 Design Team Organisation

The Design Team should prepare and maintain an organisation chart that clearly shows the structure and reporting lines within the design team. The relationship with other project team members should also be shown.

The organisation chart should be accompanied with a narrative stating the responsibilities of all posts shown on the organisation chart.

On behalf of the Owner the Construction Manager should satisfy himself that the designer has the resources available to meet the design programme.

7.3 Design Stages and Reviews

To facilitate review of the design by the Owner, where appropriate the Construction Manager should ensure that the design process is broken down into an appropriate number of stages. Formal sign off of each stage should occur before proceeding to the next stage. The stages would normally comprise:

- Inception
- Feasibility
- Scheme Design
- Tender Design
- Detail Design

The recommendations / conclusions from each stage would normally form the basis for the next design stage and also the reference document for assessing changes.

As work progresses formal buildability studies should be carried out to ensure that the design is right for efficient construction.

7.4 Reviews of Contractor's Design Submissions

The Construction Manager should establish a document review procedure for each stage of a contractor's design. This should be applicable throughout the design and construction phase of the project and should include any documentation, samples or equipment submitted by Works Contractors.

The procedures should identify the role of the designer in reviewing contractor's submissions.

All documents submitted for review should be through the Construction Manager who should control and record the status of all documentation.

7.5 Value Management

The Construction Manager should implement and manage value based assessments throughout the design process.

7.6 Document Control

The Construction Manager must ensure that there are clear procedures in place covering the control and distribution of design information.

Guidance on appropriate types of procedures can be found in Section 10.

7.7 Design Change Control

The Construction Manager must ensure that there are clear procedures in place covering changes to the design.

Guidance on appropriate types of procedures can be found in Section 5.1.

7.8 Deliverables and Progress Monitoring

The Construction Manager should ensure that procedures are in place requiring designers and contractors to:

- produce and maintain a schedule of design deliverable.
- update schedules of deliverables on a regular basis.
- Produce and status regularly a design programme

These schedules should form the basis for monitoring progress in the production of deliverables.

Progress meetings should be held at regular intervals, normally monthly, to review the status of individual design contracts.

The schedules should contain due and forecast dates for deliverables at each stage of the design process.

A Design Programme should be established to achieve the requirements of the Project Master Programme or Contract Requirements should they differ.

Where slippage is identified, a recovery plan should be implemented, and monitoring frequency increased if necessary.

7.9 Co-ordination and Interfaces

The Construction Manager must ensure that there are clear procedures in place covering the co-ordination of design interfaces.

Interface meetings should be held regularly to review interfaces between different design organisations, notably between building services and the structure and building services and the process equipment.

8. COST MANAGEMENT

8.1 General

Successful execution of projects depends upon the appropriate and effective management of cost.

The Construction Manager should ensure that appropriate procedures and systems are put in place to cover the following:

- Preparation of preliminary comparative budget estimates for project options
- Agreement of project budget with the Owner
- Project cost plans identifying project budget in elemental and/or work package format including identification of contingencies.
- Costing of project changes and authorisations of budget changes.
- Cost comparisons of alternative design solutions/forms of construction.
- Value analysis procedures and cost-in-use.
- Tender evaluation and reduction (where required)
- Periodic cost reporting identifying forecast final cost, budget changes, valuation reports and actual cashflow versus forecast cashflow.

An effective Cost Management System should be deployed.

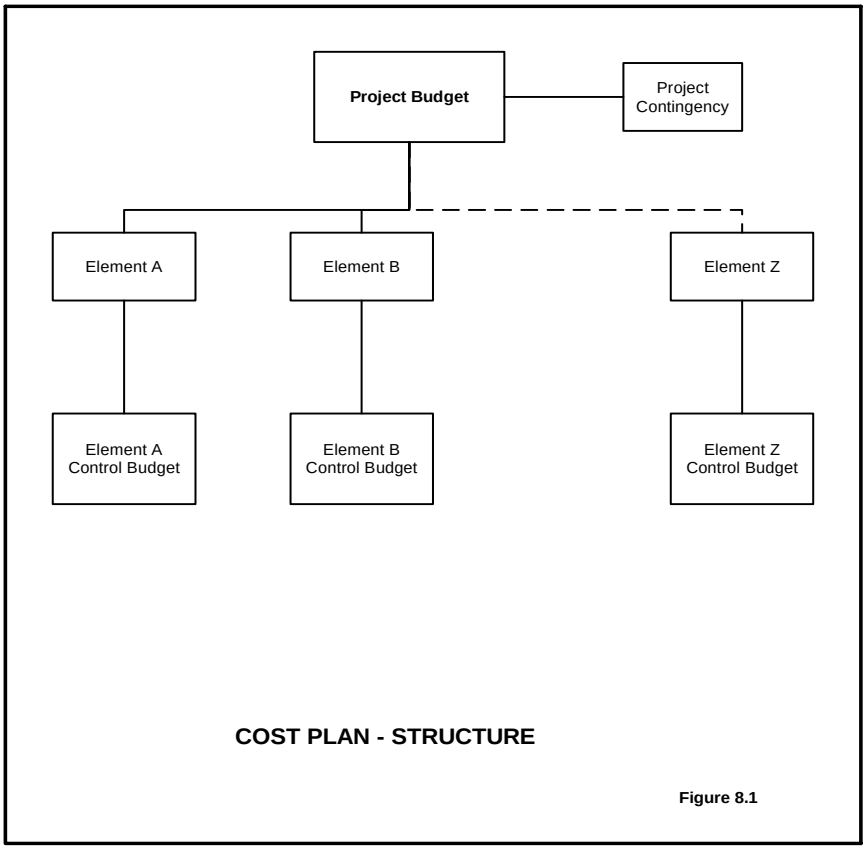
Cost administration of individual Works Contracts is covered in Section 12.

8.2 Project Cost Plan

The Cost Plan is a breakdown of the Owner's Project Budget. The budget may have been prepared and authorised by the Owner prior to the appointment of the Construction Manager.

The Construction Manager is responsible for preparing and maintaining the Cost Plan in order to control the project costs.

The basic structure of a Cost Plan is shown in Figure 8.1 which also shows the terminology adopted in this Manual.



COST PLAN - STRUCTURE

Figure 8.1

A Cost Plan should be prepared for each of the design stages of the project; namely:

- Inception
- Feasibility (- leading to an approved budget)
- Scheme
- Tender
- Detail / Construction

The accuracy and detail of the Cost plan at each stage should be appropriate to the level of design information available.

The Cost Plan at each design stage will define the Element/Work Package Control Budgets for the next design stage. The cost plans should be updated regularly to reflect the evolving design.

The Construction Manager should develop procedures for identifying and dealing with deviations from the agreed Control Budgets. Where deviations are identified the following actions are normally considered:

- If an estimate of the cost of a proposed decision exceeds the allowance in the Control Budget, the decision should be reconsidered to find a cheaper, satisfactory alternative.

- If an estimate falls significantly below the Control Budget, the saving should be referred to the Owner, and may be transferred to contingency.
- If it is impossible to contain costs within the Project Budget, the Owner must be asked to increase the budget or accept amendments to the Design Brief.

It may, in some cases, be possible to effect budget transfers between different Element Control Budgets without affecting the overall Project Budget.

The Cost Plan should include a contingency allowance consistent with the status of the design. The contingency should only be used to pay for events which are unforeseen and unforeseeable. The residual sum in the contingency shall be constantly reviewed against contingency provisions calculated from the Risk Management policy. Where the contingency is considered more than sufficient consideration shall be given to using the contingency to fund changes; subject to the usual authorisation procedures for implementing changes. In all other circumstances changes shall constitute a change to the Project Budget.

A typical Elemental Cost Plan Report is shown in Volume 2, Section 8.3.

8.3 Cash Flow Forecast

A cash flow forecast should be prepared for the project based on Project Master Programme. This should be updated at intervals to reflect the progress of the works and any amendments to the project Cost Plan. The cash flow forecast shall be used as a programme monitoring tool by recording actual cash flow and indicating any potential overspend and any areas of delay or likely problems.

8.4 Authorisation of Expenditure

Levels of authorisation of expenditure should be established the Construction Manager and the Owner.

Changes in the Design Brief, which affect levels of costs, should be authorised by the Owner. This is described under Section 5.1.

The Owner should authorise the Construction Manager to issue Site Instructions up to a predetermined level.

8.5 Cost Reports

A cost report should be prepared and submitted to the Owner on a regular basis, at intervals agreed with the Owner. The cost report is essential in ensuring that the Owner is well informed of the current budgetary and financial situation of the project. The cost report should identify:

- The approved budget (including any changes to it)
- The forecast final cost of the project
- The actual cash flow versus forecast cash flow and the implications on future cash flow
- Schedules of variations and their status

All those responsible for a Budget should be required to submit cost commitment records to the Construction Manager on a monthly basis. These should be incorporated into a monthly cost report to the Owner, which should demonstrate how targets are being met relative to the Control Budgets.

The forecast final cost should be calculated on an elemental/work package basis to take account of orders placed, orders not placed, agreed variations and estimated variations.

Typical Project Cost Breakdown and Potential Cost Liability reports are shown in Volume 2 Section 8.3.together with a typical report for an Elemental Cost Breakdown.

9. PROGRAMME MANAGEMENT

9.1 General

A primary responsibility of the Construction Manager is to plan construction of the Project and monitor implementation of the project against the plan.

To co-ordinate and plan all the activities that make up the project the Construction Manager must develop a Project Master Programme. This should be developed using proprietary project management software packages such as:-

- MS Project
- Project Scheduler
- Primavera Suretrak
- Primavera P3 Project Planner

All of these packages have the following basic capabilities:

- Can identify critical paths
- Allow the project to be broken down into Works Packages
- Allow the programme to be broken down into sub-programmes
- Allow the project to be summarised in a number of ways
- Allows interfaces between Works Contracts to be identified
- Allow project progress to be input and compared with the plan
- Allow the impact of delays to be assessed
- Can be linked to provide information on costs and resources

Selection of the appropriate software depends on the size and complexity of the project and the familiarity of potential project participants with the software and specific client needs/requests.

To facilitate the exchange of programme information between project participants it is desirable for all project participants to use the same or compatible programme software.

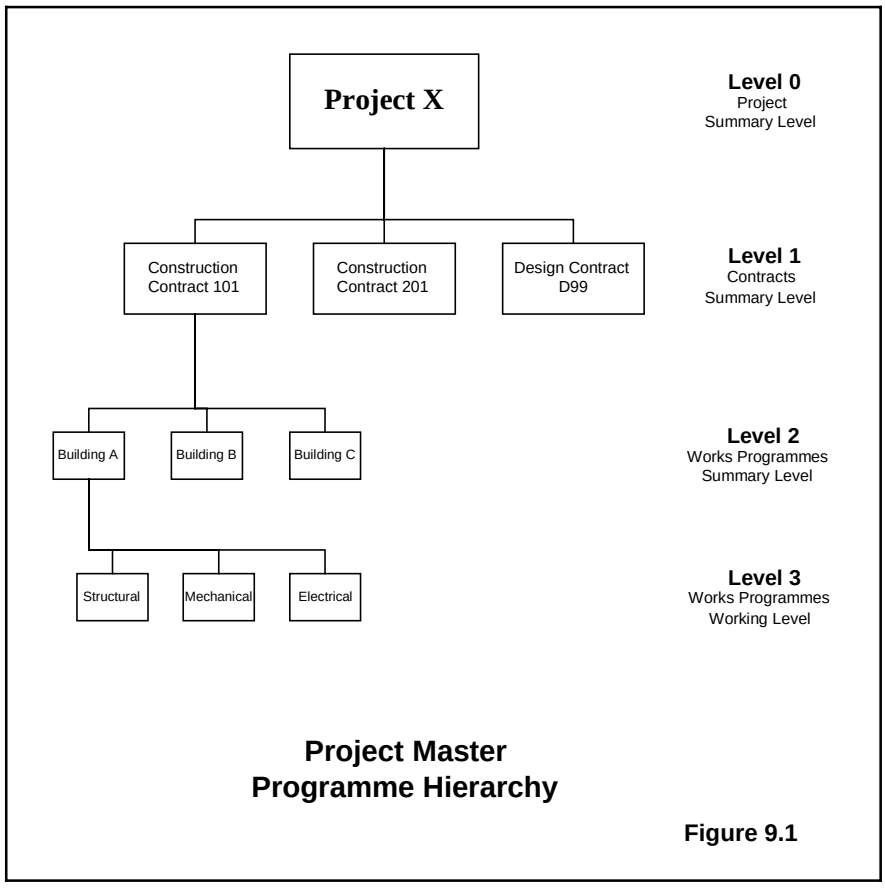
9.2 Project Master Programme

The Construction Manager should develop a Project Master Programme (PMP) at the commencement of the Project. This should be a comprehensive critical path network (CPN) programme in precedence diagram (PDM) format covering all activities relating to the planning, design, procurement, construction and commissioning of the project.

The PMP should have a hierarchy that takes account of the complexity and scope of the project, the number of participants and the reporting requirements of the Owner.

The PMP must be capable of being summarised at a number of levels of detail to assist in management of the project.

A typical hierarchy for a PMP is shown on Figure 9.1.



Project Master Programme Hierarchy

Figure 9.1

The level of detail in the programme should increase at each level down.

The content of the various levels of the PMP is typically as follows:

Level	Description	Content
0	Project Summary Level	Summary level programme in bar chart format showing all major components of the project for presentations and reports.
1	Contracts – Summary Level	Summary of all Contracts forming the project showing major dates and interfaces.
2	Works Programme – Summary Level	Summary of individual elements of a Works Contract in sufficient detail to determine completion, stage or interface dates for tender purposes. Programme by individual Cost Centres or major components.
3	Works Programme – Working Level	Detailed programme with a maximum activity duration of 4 weeks. This would be the level of detail expected in a Works Programme.

The format of some CPN programmes does not provide sufficient flexibility in format styles to support high level presentations and report. To overcome this deficiency a separate bar chart summary programme to the PMP is often prepared using a more graphically based software.

The Work Breakdown Structure (WBS) and coding arrangements for programme activities must be carefully considered at the outset. This is to ensure that programme information can be summarised in the form required.

The programme structure needs to be sufficiently flexible to allow the development of separate programmes or reports covering the following:

- Individual Organisations
- Individual Works Contracts
- Individual Structures / Facilities
- Individual Systems
- Resource Utilisation
- Costs

The structure of the programme should also facilitate the production of graphical representations of progress for incorporation in progress reports.

The Construction Manager needs to develop a set of procedures to manage the development of the Project Master Programme and its subsequent control and updating to take account of progress and new information or requirements.

9.3 Design Programmes

9.3.1 General

The Construction Manager should develop a level 2 programme which identifies the major phases, deliverables and due dates for design contracts.

The Design Consultant should develop a Level 3 design programme, breaking the design process down into a detailed list of tasks and deliverables for individual facilities and disciplines.

At this stage, possible areas of risk in the programme are identified and strategies for overcoming them developed.

Review and verification of the programme interfaces are a vital check to ensure the smooth progress of the work.

The level of programming effort required will depend on the size and complexity of the project but it should be in sufficient detail to identify design interfaces and critical path(s).

9.3.2 Design Deliverables

The schedule of deliverables prepared by the designer should include studies, reports, specifications and drawings.

At key stages of the design process, the schedule should be regularly reviewed and updated.

9.3.3 Design Progress Monitoring

Progress of the design should be assessed against the planned activities at regular intervals, typically monthly, for design periods of a significant duration. The procedure for conducting progress measurement should be tailored to the type of work being done and the phase of the project. It can range from a simple gathering of progress estimates on given tasks from individual designers in relation to the activities planned for the period in question, to a summation of individual progress estimates for each identified deliverable.

Productivity should be assessed at the end of each reporting period according to the actual manpower input and progress made. This information should be used together with any agreed changes to revise future projected progress forecasts. Regular, objective and systematic measurement of progress in this way ensures that any delays are identified early and can be corrected before they become significant.

9.4 Construction Programmes

9.4.1 General

The Construction Manager should develop a level 2 programme to include the prequalification, tender, contract award and construction activities. This should be used for tendering of Works Contracts.

Following award of a Works Contract the Contractor is normally required to submit the following programmes:

- Works Programme.
- Design Programme
- Interface Programme
- Testing and Commissioning Programme
- 3-week rolling programme (Lookahead Schedule)

The timing and format of programme submissions should be stated in the Contract Documents.

9.4.2 Contractor's Works Programmes

Following award of a Works Contract the Contractor should provide a detailed level 3 Works Programme together with a programme narrative and method statement giving details of assumptions used in preparation of the programme.

The Works Programme should be reviewed for compliance with all the date and interface requirements of the Contract and for the provision of adequate resources. The Construction Manager should, where necessary, update the Project Master Programme to reflect the logic and sequence of each approved Works Programme.

A typical procedure for reviewing Works Programmes is shown in Volume 2 Section 9.3.

9.4.3 Contractor's Design Programme

This should be a sub-network of the Works Programme and should specifically address any design work, design interfaces and supplier approvals required by the contractor.

The design programme should identify requirements for offsite factory inspections of equipment.

9.4.4 Contractor's Interface Programme

This should be a sub-network of the Works Programme and should specifically address the construction interfaces between the contractor and other contractors or other parties.

The Construction Manager would use this programme to assist in management of project interfaces.

9.4.5 Contractor's Testing and Commissioning Programme

This should be a sub-network of the Works Programme and should specifically address the testing and commissioning phase of the project, this would also include the production of Operation and Maintenance Manuals.

The Construction Manager should use this programme to assist in the arrangements for witnessing tests by specialist personnel and the Owners staff.

9.4.6 3-week rolling programme (Lookahead Schedule)

This should be a detailed programme showing all activities that are in progress or due to start within three weeks of the date of issue.

Contractors should submit lookahead schedules on a weekly basis. The lookahead schedule should be used at a working level to monitor daily progress and manage interfaces.

9.5 Construction Progress Monitoring

9.5.1 Statusing of Programmes

Throughout the construction period the Contractor should regularly, normally monthly, status the Works Programme to give forecasts for achievement of completion and interface dates. Recovery plans should be proposed to overcome delays.

The Construction Manager should status the Project Master Programme regularly, normally monthly, based on the reported status of each Works Programme or his own assessment where this differs from that of a Works Contractor.

Statusing of the PMP should be supported by schedules of milestones showing the planned and due date for achievement of major activities. The status of each activity should be established on a monthly basis.

Deviations from the programme should be identified and assessed by the Construction Manager to determine the need for remedial measures or advancing construction.

9.5.2 Task Lists

The Construction Manager should prepare Task Lists to show those tasks, which must be completed by each party - Owner, Designer, and Contractor at the beginning of each month. There should be a specific completion date for each task. These should be organised so as to be limited to 4 - 8 tasks to be achieved each month. All overdue tasks should be reported as such until they have been completed. The Construction Manager should check the status of tasks on the

task lists each Monday. Thus no participant should lose more than 1 week on the programme without knowing he has done so and therefore considering how he can correct the delay.

9.5.3 Offsite Activities

The Construction Manager should check the status of off site activities by periodic visits to fabrication yards and manufacturing workshops. The status of these activities can thus be verified directly, and any necessary actions can then be taken to ensure that deliveries to site meet the programme requirements.

9.6 Progress Reporting

On a monthly basis the Construction Manager should produce a progress report which summarises the current status of each activity in the Project Master Programme.

The report should identify the due date, the current status and the forecast completion date of all major components of the project. The report should identify the current critical path and any problem areas and propose corrective measures.

The report should consist of bar charts, histograms, schedules and narrative to describe in as succinct a manner as possible progress of each contract and the Project overall.

A typical progress monitoring report is shown in Volume 2 Section 6.5.

10. DOCUMENT MANAGEMENT

10.1 General

Although the majority of information is now created electronically, for legal and convenience reasons, paper is still the preferred method of communicating and using such information.

The complexity and scale of many projects, together with requirements for Quality Assurance requires the implementation of good information management practices.

Each distinct piece of project information (such as drawings, reports, specifications and written correspondence) can be conveniently termed a "document". The components of a document management system encompass:

- clear procedures and responsibilities of team members for issuing and receiving documents;
- a means of recording details about project documents;
- a filing and document storage system appropriate to the sophistication of the project; and
- principles and responsibilities for the archiving of project documentation.

10.2 Document Control System (DCS)

The system used to record information about documents and their movements is termed the "document control system". Such a system needs to encompass procedures for:

- the distribution and recording of documents issued
- the distribution and recording of documents received
- the efficient referencing and labelling of all documents
- storage and retrieval of data about documents
- the tracking of documents and monitoring of follow up actions
- the archiving of documents.

The document control system must be capable of producing accurate and informative reports. To achieve this objective it will be necessary to utilise an electronic database to record appropriate information about each document. Typical report requirements are:

- What information has been issued and when.
- The status of information issued.
- What information has yet to be issued.

Each project has its own particular needs and requirements, which may develop as the project develops. However, many of the requirements will be clear at the start of the project. The key issues to be addressed during the planning stage are:

- What documents need to be tracked - for example on a large project it may be felt necessary to log all incoming correspondence, or correspondence from a particular source. It would for instance be necessary to track all documents relating to a Works Contract.
- How documents are to be referenced - i.e. a document numbering system needs to be developed for all project documentation, irrespective of origin.

The procedures should be set out in a written and flow chart form. They should clearly define the flow of information through the project team, and the responsibilities of the members of the team.

10.3 Issue and Receipt of Documents

Procedures with accompanying flow charts should be developed covering the issue and receipt of documents. These should identify distribution lists for documents.

10.4 Filing and Storage of Project Documents

10.4.1 Documentation Identification

Dependent upon the type and size of the project, it may be considered advantageous to impose a project wide standardised document identification system to be implemented by all parties.

Typically the standard set-up includes standard attributes for:

- standard discipline codes
- standard status codes and revision suffix
- standard document type
- standard document media
- standard media sizes

10.4.2 Documentation Format

All parties to the project may adopt a common layout of documentation.

10.4.3 Existing Data

The data to be used by all project parties during the design and construction of the project should be identified, recorded, and filed by the Construction Manager. This should include, but is not necessarily limited to boundary surveys, topographic surveys, geotechnical data, utility surveys, surveys of adjacent structures.

10.5 Archiving of Project Documents

Procedures with accompanying flow charts should be developed covering the archiving of documents.

11. PROCUREMENT

11.1 General

Procurement covers the process of defining work packages, selecting appropriate firms for tendering, preparing, issuing and assessing tenders. Procurement covers both design and construction packages. The generic processes involved in procurement are shown in Figure 11.1

Before procurement can proceed it is necessary to develop a procurement strategy this needs to take account of:

- Contract terms and conditions
- Capability and size of available contractors
- Contract package size
- Interfaces between packages
- Available information
- Programme
- Contract award criteria

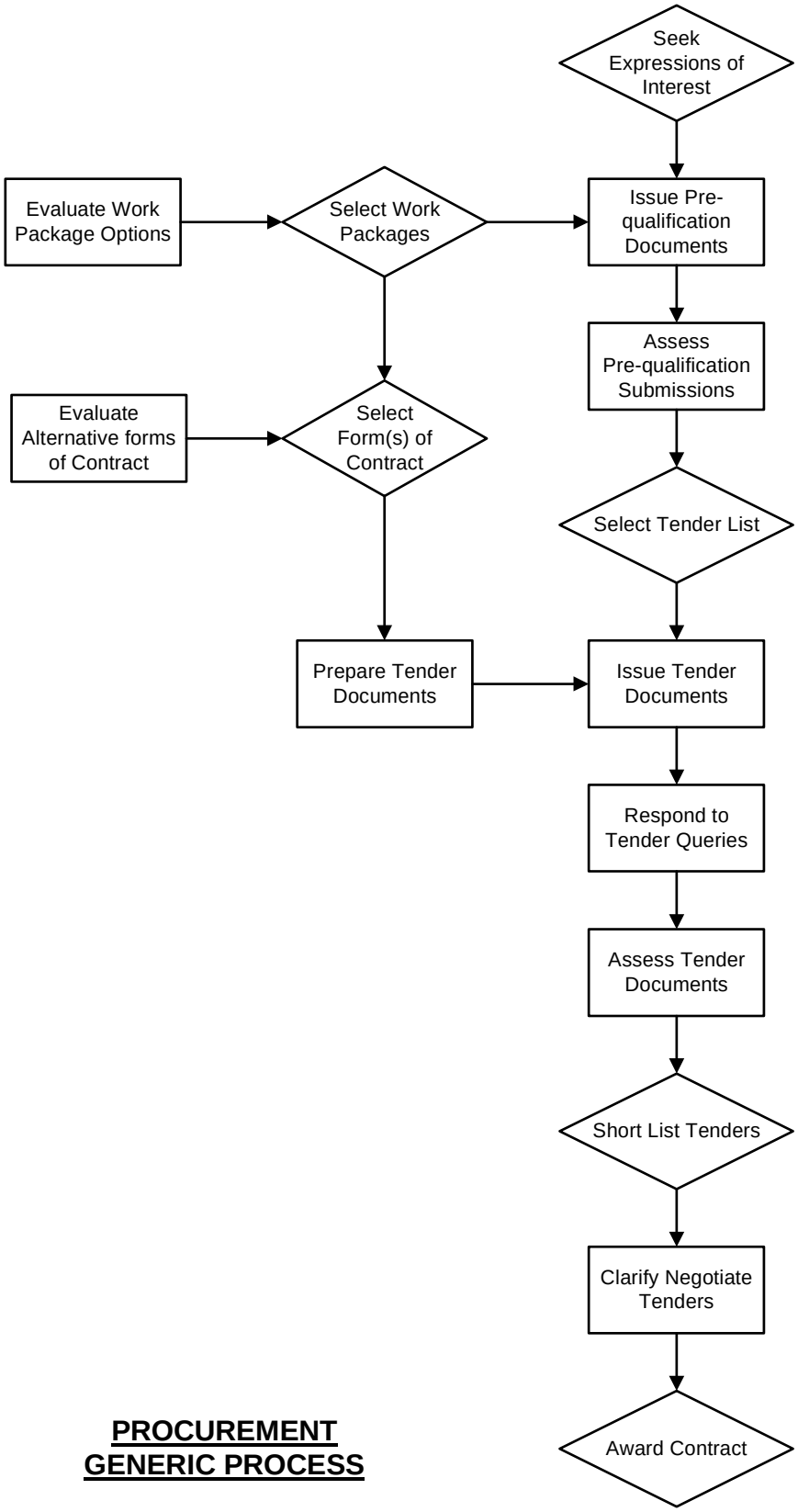
Ideally before tendering a Works Contract the design concept should be frozen and the detail design well advanced. Subsequent changes in the work can have serious implications on cost and programme.

11.2 Contract Terms and Conditions

Selection of the appropriate contract terms and conditions is an important task of the Construction Manager. There are a number of organisations producing standard forms to choose from, including the following:

- FIDIC
- ICE 6
- NCE
- JCT

In addition to the above standard terms and conditions some clients have their own terms and conditions or special requirements.



PROCUREMENT GENERIC PROCESS

Figure 11.1

Selection of the appropriate terms and conditions will be influenced by:

- The type of construction or supply
- The country of work or source
- The owners financial risk exposure
- The required degree of control over design or construction
- The information that is available at the time of contract tender/award
- The information required at tender/award
- The organisational requirements

It is not within the scope of this manual to provide detailed guidance on this issue and specialist advice should be sought.

11.3 Contract Strategy

A contract strategy should be developed from the list of tender packages formulated. A clear strategy is the basis for a successful and cost effective project.

Choice of appropriate payment terms should be determined by the nature of the works and the relative degree of risk to be carried by Owner and Works Contractor. Several alternatives are available and these are listed in ascending order of risk to the Owner.

- Lump Sum
- Add and omit
- Measure and value
- Schedule of Rates
- Cost Reimbursable

The Construction Manager should evaluate these alternative arrangements and recommend to the Owner the preferred arrangement(s).

11.4 Work Package Breakdown

The project should be broken down and listed by individual work elements. This can be by

- building
- discipline
- system

This should be used for planning, cost estimating and should be the basis for a document identification system and a component identification system.

11.5 List of Tender/Contract Packages

Based on the work breakdown, packages of work should be identified of compatible scopes, which will be the basis for tender/contract packages.

The work can be subdivided into two categories:

- Product orientated, such as piling, curtain walling.
- Systems orientated, such as heating and ventilating, lighting and power.

This should also identify the needs for any specialist contractor.

Key factors affecting the selection of contract packages are listed below:

- Design
- Project programme
- Project size
- Site geography
- Owner's requirements
- Specialist technology
- Project financing strategy

An example is included in the appendix to this section.

11.6 Tender/Contract Package Descriptions

The scope of the various tender/contract packages should be described in sufficient detail to form the basis of the tender documents

11.7 Contractor Pre-qualification and Selection

To ensure that Works Contractors meet the Owner's objectives for quality, safety, and timing it is necessary for contracts to only be awarded to properly pre-qualified contractors. This should be achieved by implementing a prequalification procedure requesting specific information in a formal manner.

A pre-qualification procedure should also provide advanced information to the eventual tenderers on the scope of the project and also on the scope of the works for which they will be invited to tender. This should enable a shorter tendering period and a quicker mobilization time.

Depending upon the scope of work and other circumstances, the procedure could be in one or two stages.

The initial list of potential tenderers should be prepared from knowledge of the scope of work and the availability of contractors known to do the type of work in the project locality.

For the first stage, each contractor may be requested to send information on their financial status and work experience.

Following an evaluation of the first submissions, a preferred list of contractors should be requested to submit further detailed information on personnel, resources, quality systems etc.

A further evaluation should take place and a report submitted which should provide a short list of selected contractors to be invited to tender for the works.

For the pre-qualification, the potential tenderers should be issued with

- a letter explaining the procedure
- the project description
- the tender package description
- the pre-qualification questionnaire

A sample of a pre-qualification questionnaire follows, and this may be modified to suit any particular requirements of the Owner or the Project. Further detailed information may be requested on particular aspects of the work or the company. The submissions from the contractors are then reviewed and evaluated. It would be suggested that a weighting factor is allocated to the various criteria, and an example is shown below:

CRITERIA	MAXIMUM	SCORE
Structure/Organisation	40	(10%)
Financial Statement	40	(10%)
Resources: Personnel	80	(20%)
: Plant	80	(20%)
Product Assurance	80	(20%)
Similar Experience	60	(15%)
Additional Information	20	(5%)
	400	(100%)

11.8 Tender/Contract Documents

The Tender document should be structured in a consistent format.

This may be modified to suit any specific requirements of the Owner, but would generally follow the format of.

- Invitation to Tender
- Instructions to Tender
- Form of Tender
- Contract Agreement
- Conditions of Contract
- Design Drawings/Scope of Work/Specifications

- Interfaces
- Technical requirements/submissions
- Pricing section
- Planning statement
- Project procedures
- QA statement
- Health and Safety statement

It is important that any requirements for compliance with specific project procedures are included in these documents in order that any cost and time implications can be incorporated in the Form of Tender.

11.9 Invitation to Tender

The Invitation to tender should be issued simultaneously by the Construction Manager to all the selected contractors.

The covering letter shall clearly state the requirements for:

- Number of copies of the tender.
- Place, time and date for the submission.
- Sealed tender requirements.

11.10 Tender Instructions

The instructions to tenderers shall explain exactly what is required from the tenderer and shall include:

- arrangements for site inspections
- arrangement for meetings relating to the tender documents
- method for written questions on the tender documents
- method of pricing validity of tender
- method statements
- planning statement/submissions
- issue of tender bulletins

All tenderers shall be treated fairly and equally.

Tenderers shall be given the opportunity to tender on identical information.

11.11 Tender Bulletins

During the tender period, it may be necessary to issued revised or additional documentation to the tenderers.

It may also be necessary, following a question received from a tenderer, to issue a revision or clarification to the documentation.

A Tender Bulletin should be prepared, which should have contractual status, and issued to all tenderers.

11.12 Tender Submission Requirements

Tenderers shall be instructed to submit tenders in a predetermined format.

Alternatives maybe submitted separately, provided a compliant tender is also submitted.

Tenders must be compliant.

Tenders may comprise of separate technical and commercial submissions.

Tender forms may be prepared to ensure consistency of submissions. These may include:

- pricing section
- lists of construction equipment
- manpower schedules/resume of key personnel
- lists of subcontractors, sub-consultants
- method statements
- temporary works
- current works

11.13 Tender Assessment and Recommendation

Tender assessments shall be carried out under controlled conditions.

A nominated committee shall open all tenders at a predetermined time and place.

A Tender Opening Record Sheet should record the participants and the tender prices.

The Record Sheet and the original tender, bound if necessary, shall be locked in a safe place.

Copy tenders shall be used for assessment purposes and shall only be made available to nominated reviewers. They shall be controlled in circulation and be safe from unauthorised inspections at all times.

Arrangements may be made to review the technical and commercial sections separately.

Evaluation forms for the commercial submissions shall be prepared to enable the submissions to be reviewed and compared in a tabular format. This assists to identify any errors, omission or anomalies.

Evaluation forms for all other submissions shall be prepared to cover all other submissions required from the contractor as stipulated in the Tender forms, Instructions to Tenders, and Technical Requirements. These can be evaluated on a point scoring method.

Alternatives shall be evaluated from a technical and commercial point of view.

Any non-compliant tender shall be referred to the Owner. This may be rejected or reviewed with a view to removing the non-compliance.

Tender review meetings shall be held with the tenderers to confirm the scope and discuss any potential errors, omissions or anomalies.

A Tender Report shall be prepared which should summarise all tendering activities. This should include a comparison of technical and commercial submission, any deviations or non-compliances still unresolved, an evaluation of proposed alternatives and resulting in a recommendation of contractors in order of preference.

11.14 Award of Contract

A meeting shall be arranged between the Owner, the Construction Manager and the recommended Works Contractor. The Designer shall also be invited as necessary.

At the meeting all commercial details shall be finalised and any open issues shall be resolved.

Notes of the meeting shall be made and agreed, and signed by all parties.

At this stage the Owner may, in anticipation of contract signing, issue a letter of intend to the Works Contractor.

All final agreements shall be incorporated into the contract documents.

Three identical sets of the complete contract documents shall be prepared, and bound.

A letter of Acceptance shall be prepared.

A Contract Signing Ceremony shall be arranged. The Owner and the Contractor shall sign all three sets of documents, also initialling each page/drawing. The documents are then issued to the Owner, the Contractor with one set for the project filing system.

The unsuccessful tenderers shall be notified. This notification may or may not include an unnamed list of the conforming tender prices.

11.15 Contract Insurance

The Construction Manager should advise the Owner on the scope of insurance to be provided for the project as a whole.

12. CONTRACT ADMINISTRATION

12.1 General

Each Works Contract requires the appointment of a Contract Administrator to act on behalf of the Employer (Owner) under the Contract.

The role of the Contract Administrator is to see that the Works Contractor fulfils his obligations under the Contract and that the Owner is provided with the intended facility. This requires a good understanding of the Owners requirements and a sound knowledge of the terms and conditions of the Works Contract. It should be remembered that the Contract places obligations on both the Owner and the Contractor. The Owner's obligations include the timely provision of design information and approvals of submissions, the making of payments on time and the timely issue of Instructions and Certificates. The Contractor's obligations are obviously to complete the Works to the required quality, programme and cost. The Contract Administrator should endeavour to see that both parties meet their obligations. This is best achieved by a proactive rather than reactive approach to events.

The precise responsibilities of the Contract Administrator will be defined in the Contract Documents and his level of authority to issue instructions under the Contract should be advised to the Works Contractor and Contract Administrator by the Employer.

The authority of the Contract Administrator to issue any Completion Certificate under the Works Contract without the agreement of the Designer should be decided by the Owner.

For the purposes of this Section a distinction is made between the Contract Administrator and the Construction Manager. The Contract Administrator is assumed to have responsibilities for a particular Works Contract from the point of award by the Owner. It has also been assumed that he would take direction from the Construction Manager acting on behalf of the Owner.

The principal issues to be dealt with by the Contract Administrator, for which he needs to have procedures and systems in place, are listed below and discussed in the remaining paragraphs of this Section:

- Insurances / bonds;
- Issue of drawings, specifications and other documentation;
- Review and response to submissions and queries from the Works Contractors;
- Documentation control;
- Site Records;
- Meetings
- Approval of sub-contractors and suppliers;
- Issue of Instructions and Variations;
- Dayworks

- Valuations and issue of Payment Certificates;
- Disputes and claims
- Programme and progress
- Contract Administrator's Monthly Report
- Commissioning
- O & M manuals
- As Built Drawings
- Guarantees
- Completion and Defects Liability

To undertake the above tasks the Contract Administrator will need the support of a team for which he will assume management responsibility. The size and makeup of the team will vary from project to project but will need to encompass all necessary skills.

12.2 Formal Contract Agreement

The Construction Manager should prepare the contract agreement for signature by the Owner and the Contractor.

12.3 Insurances / Bonds;

The Contract Administrator should collect and review all bonds to be provided by the Works Contractor under the terms of the contract.

The Contract Administrator should check the scope and validity of all insurance to be provided under the terms of the contract by the contractor.

If the Owner has a project global all-risks insurance policy the Contract Administrator should manage any claims made by the Works under this policy.

12.4 Issue of drawings, specifications and other documentation

The Contract Administrator should establish the programme for issue of all drawings specifications and other documentation to the Works Contractor and should communicate this to the Designer and Construction Manager

The Contract Administrator should maintain a record of all drawings, specifications and other documentation issued to the Works Contractor and their status.

12.5 Contractor's submissions and queries

The Contract Administrator should establish a document review procedure for the contract. This should formalise the review process of any documentation, samples and equipment to be submitted by the contractor.

All documents submitted for review by the Works Contractor should be through the Contract Administrator who should control and record the status of all such documents.

A typical contractors document review form is included in Volume 2 Section 12.5.

Typical reports on submissions are listed below:

- Document received and not returned;
- Status of contractor's documents received and reviewed.

12.6 Documentation control

The Contract Administrator should develop and maintain the project filing system. This should include all correspondence, design documentation and drawings, and site generated documentation and records.

Guidance on this subject is given in Section 10.

12.7 Site Records

The Contract administrator is responsible for ensuring that accurate records are kept of the progress and construction of the works.

These records are normally in the form of site inspector's reports, diaries, surveys, test results and photographs.

These records would be used for evaluating claims and disputes and in checking as built records.

12.8 Meetings

The Contract Administrator should draw up and maintain a meeting schedule for the contract. This should encompass:

- a pre-construction meeting
- safety meeting
- progress meetings
- technical meetings
- commercial meetings

12.8.1 Preconstruction Meeting

The Construction Manager should convene a pre-construction meeting with the Works Contractor to:

- Introduce all parties and individuals of the project.
- Review the project procedures, which are applicable.
- Clarify the Works Contractor's requirements for site establishment.
- Emphasise the requirements for health and safety, and quality standards.
- Request the contractor's submissions under the terms of the contract.

12.8.2 Progress meetings

The Contract Administrator should chair and minute regular meetings, normally monthly, with the Works Contractor to review progress and payments but not to provide a forum for the debate of all the contentious issues on the contract. This meeting should provide an overview of the current status. The current status of contentious items, or those requiring detailed discussions, should be recorded rather than debated. Detailed discussions to be referred to separate meetings.

Preferably the Works Contractor shall have a statement of progress which has been previously agreed with the Contract Administrator, relative to the master programme. The meeting should concentrate on key issues such as:

- The current prediction for completing the works, or sections of the works.
- Major problems faced by the Contractor, with a discussion in principle on how the problems may be solved.

12.8.3 Technical Meetings

Meetings should be held regularly, generally weekly, together with the site supervision team to review technical topics and the progress of submissions and site queries. The designer should be requested to attend as necessary.

The meeting should review all technical aspects of the scope of work, and discussions should be held to resolve questions and problems wherever possible. It may be necessary to refer some topics to a specific meeting to address that topic individually.

12.8.4 Commercial Meetings

Meetings should be held regularly, generally monthly, to review commercial and contractual items. Discussions should be held on any items in dispute with a view to reaching agreement.

Instructions and variations should be reviewed to reach agreement on the associated costs.

The basis for the monthly valuations should also be agreed.

12.9 Sub-contractors and suppliers

The Contract Administrator should develop a procedure for the review of sub-contractors and suppliers proposed by the contractor.

This should include a review of the company's technical and financial status, together with an appraisal of their quality and safety standards.

12.10 Variations and Instructions

The Contract Administrator should issue all variations and instructions under the contract. These will be subject to any limitations on financial authority.

12.10.1 Variations

A Variation would normally alter the scope, specification or timing of the Works and have cost implications. The contract would normally define what constitutes a variation.

Any Variations exceeding the Contract Administrator's authority would be subject to approval by the Construction Manger / Owner prior to implementation. Approval would normally be through a change order procedure as described in Section 5.1.

The format will depend upon the form of contract, and examples are included in the appendix to this section. The Contract Administrator should issue, and keep a Register of all Variation Orders/Instructions.

12.10.2 Site Instructions

Site Instructions would usually clarify the scope, specification or timing of the Works.

Site Instructions should be issued during the construction period to contractors to clarify and modify the construction works. The Contract Administrator should issue, and keep a Register of, all site instructions. A typical format is shown in volume 2, Section 12.9.

12.11 Dayworks

Where work is to be carried out on a "Dayworks" basis the Contract Administrator should issue a Daywork Order.

The Works Contractor should submit a force account report on a daily basis, listing all labour, plant and materials used on each. Daywork Order.

The Contract Administrator should check and agree these records which will then form the basis for the evaluation and reimbursement of the work.

12.12 Valuations and Payment Certificates

The contract documents will define the method and timing of payments to the contractor. It is the Contract Administrator's responsibility to value and certify payments in accordance with the contract.

The Contract Administrator should carry out regular valuations of work completed under the contract; this is normally carried out monthly. The Contract Administrator should then issue a Certificate of Payment authorising payment by the Owner to the Works Contractor.

The Contract Administrator should agree a procedure for this activity with the Construction Manager / Owner. The procedure must comply with the contract and time scales given in the contract.

The method of valuation will depend upon the payment terms of the particular contract; these could typically be either:

- Remeasurement;
- stage payments based on key events /milestones;
- reimbursable on a "cost plus" basis;

Examples of typical payment certificates are shown in Volume 2, Section 12.7.

The Contract Administrator is responsible for agreeing the Final Statement of Account with the Contractor.

Procedures developed by the Contract Administrator relating to payment should also ensure that any prerequisites for payment, such as bonds or guarantees, have been received and are acceptable.

12.13 Disputes and Claims

The objective is to avoid disputes. In order achieve this, the Construction Manager should develop a project strategy, in conjunction with the Owner, the Designer and Contract Administrator. This should consider the following:

- Create an alliance between all parties.
- Frozen design.
- Changes to be clearly instructed in scope.
- Clear planning requirements should be given.
- Variations should be priced before work commences.
- Changes to be agreed fairly to achieve a "win-win" agreement.
- Incorporation of an adjudication process into the contract documents.

The Contract Administrator should assist in the evaluation of all contractual claims, and support the Construction Manager / Owner on how to proceed.

12.14 Programme and Progress

The contract documents will define programme and progress submissions to be made by the contractor. It is the Contract Administrator's responsibility to review and assess these submissions. Typically these submissions would include:

- Initial works programme;
- Works programme;
- Method statements
- Weekly schedules/lookaheads
- Interface programme;
- Testing and commissioning programme;
- Submissions schedule; and
- Monthly progress reports.

The Contract Administrator should provide the Designer with a schedule of dates for design deliverables to meet the contractors programme.

These should be recorded by the Contract Administrator, and should be monitored to ensure that the deliverables are issued according the requirements of the programme.

12.14.1 Works Programme

The Contract Administrator should review the works programme for compliance with the contract dates, the contractor's method statement and interface requirements with designers and other contractors.

12.14.2 Weekly schedules /lookaheads

The Contract Administrator should use these schedules to monitor the progress of the works and also to co-ordinate interfaces with other contractors.

These schedules should show all programmed activities and durations for the forthcoming three weeks, plus one week of history, which should include explanations for variances to the previous week's schedule. This should include all subcontracted activities.

12.14.3 Contractor's Monthly Progress Report

The Contract Administrator should use this report as the basis for progress discussions at the monthly progress.

The Works Contractor should submit a statement of progress and a statused copy of the Works Programme showing any changes to completion and interface dates. The report should include supplementary charts and diagrams to provide concise data on progress of the contract.

12.15 Contract Administrators Reports

The Contract Administrator should arrange for reports to be forwarded to the Construction Manager on a regular basis; typically these would include weekly and monthly reports.

12.15.1 Weekly Reports

These should be in tabular and diagrammatic form to a format agreed with the Construction Manager.

These reports should cover progress and quality of the various elements of the Works.

12.15.2 Monthly Reports

The monthly report should be in a concise format agreed with the Construction Manager; typically it would have the following sections:

- Summary and Comments
- Progress
- Programme
- Safety
- Quality System and Quality Plans
- Design Progress and Information
- Contractual & Financial Matters
- Interfaces
- Staff

12.16 Commissioning

The Contract Administrator should prepare a commissioning programme based on the contractor's construction programme. This should show the pre-commissioning and commissioning activities, an example of which is shown in Volume 2, Section 12.11. The programme should show the various phases of pre-commissioning which lead to the commissioning phase.

A guideline procedure should be prepared for the pre-commissioning and commissioning periods which should address the conditions necessary to commence the work, the sequence and scope of testing, and document organisation, and test data sheets.

The Construction Manager should manage the interfaces between the various works contractors on systems testing. The Construction Manager should advise the Owner on employee training requirements. This should be in collaboration with the recommendations of the works contractors.

The Contract Administrator should advise on the requirements for spare part holdings, following discussions with the works contractors' equipment suppliers. This would be applicable for the commissioning, initial operation, and full production periods.

12.17 O & M Manuals

The Contract Administrator should obtain the operation and maintenance manuals from the works contractors.

The due date for the issue and format of these manuals should be specified in contract documents. They should be available, albeit in a draft form, at the start of commissioning. These would form part of the Health and Safety file in the UK.

The content list would typically be as follows:

- Scope of systems
- Installation record
  - Schedules of plant and equipment
  - Component identification system
  - Manufacturers literature
  - Test certificates
  - Guarantees
  - Data sheets and performance data
- Systems operation
  - Operating instructions
  - Fault finding
- Systems maintenance
  - Preventative maintenance schedules
  - Maintenance manuals and procedures
  - Consumables
  - Spares

12.18 As Built Drawings

The Contract Administrator should obtain the as-built drawings and records from the works contractors. These should be in a standardised layout and in a specified software format.

The Contract Administrator should arrange for the Designer and site supervisor to check these for correctness and completeness.

These would form part of the Health and Safety File in the UK.

12.19 Guarantees

The Contract Administrator should obtain and review all guarantees required from the works contractors under the terms of the contract.

12.20 Completion and Defects Liability

The contract documents will define the procedure for issue of completion certificates and schedules of defects. It is the Contract Administrator's responsibility to issue these documents. Typically these documents would include:

- Practical Completion Certificates. These would identify when the whole of the works, or parts thereof, were completed and should also identify the Defects Liability Period.
- Schedule of defects and outstanding works.

The list of defects and outstanding works should be produced by the party carrying out the site supervision and agreed with the contractor.

A typical Completion Certificate is shown in Volume 2 Section 12.12.

The Owner assumes responsibility for the insurance of the works upon issue of a certificate. The issue of a Certificate may also release retention money previously withheld from progress payments

The Contract Administrator should prepare and implement a contract closeout procedure. This should generally take the form of a checklist and a typical example is included in Volume 2 Section 12.12.

13. CONSTRUCTION SUPPORT SERVICES

13.1 Construction Support

There is a requirement under the CDM Regulations in the UK to develop the Health and Safety Plan to incorporate the common arrangements, including emergency procedures and welfare, that may be imposed by the owner or developed by the principal contractor.

13.2 Site Establishment

The Construction Manager should manage and co-ordinate all contractors' facilities within the boundaries of the construction site. This should include:

- The allocation of an area for the Contractor's offices.
- The allocation of an area for contractor's laydown.
- The provision of utilities including power, water, sanitary, telephone.
- Areas for parking for contractors employees, both on and off the construction area.
- Standard site working hours should be established. A procedure, for notification of working outside these hours, should be established.
- A procedure should be established to permit and record contractor's material deliveries to site.
- The general cleanliness of the site should be enforced.

13.3 Site Services

If the Construction Manager is required to provide suitable and adequate site services then a schedule should be provided by the Owner identifying the items to be proved and the method of procurement.

This may include:

- Consumables including fuel, copying and printing, office consumables.
- Temporary site installations including management offices, catering buildings, first aid rooms, office furniture, computer systems, telephone systems, weatherproof storage areas, secure storage areas, guardhouse.
- temporary site infrastructure including site roads, fencing, power and lighting systems, water supply, sewage systems, hard standings, parking areas, fencing.
- Site equipment including site transportation, fire fighting equipment, photo equipment, first aid equipment, miscellaneous materials for maintenance.
- Site services including security personnel, site office cleaning, site catering services,
- waste removal services, driver/maintenance personnel.

13.4 Site Security

The Construction Manager may be requested to prepare and implement a system for site security. This should form part of his work associated with the provision of site services, and will require a contract with a specialist company providing security systems and personnel.

The following activities form a recommendation for a system to be implemented.

13.4.1 Personnel Access to Site

Ensuring that only authorised persons are allowed in construction areas is a requirement of the Health and Safety Plan under the CDM Regulations.

All personnel working on site should be required to wear an ID badge. This should include a photograph, state the individuals name, position and employer, and have a unique number. This immediately identifies unauthorised personnel on site, identifies contractor's supervisors, and identifies personnel requiring disciplinary action.

All contractors should be allocated a unique colour of safety helmets. This allows the construction to easily identify working areas and potential conflicts.

All visitors to site should be allocated a temporary visitors badge. They should be signed in and out and should be required to obtain the signature of the person that they were visiting.

13.4.2 Photography

Photography should not be allowed on site unless a permit has been obtained from the Construction Manager. No photograph may be published without the prior approval of the Owner.

13.4.3 Fencing and Gates

It should be recommended, wherever possible, that a security fence with manned gates be provided around the perimeter of the construction area.

13.4.4 Security Personnel

It should be recommended that company providing security services are employed. All gates would be manned, storage areas would be patrolled and site patrols would be carried out during all hours of non-working.

13.4.5 Vehicle Access to Site

A limited number of personal vehicles for management staff would be allowed on site. These vehicles would be provided with a badge to allow them onto site - All vehicles would be registered in and out of site.

Visitors' vehicles would be recorded in and out of site, and would be provided with a badge providing them with temporary access to site.

All delivery vehicles would be recorded in and out of site including the recipient and the cargo.

13.4.6 Vehicles Leaving Site

All vehicles leaving site would be visually inspected including the boot.

A procedure would be prepared to allow equipment and materials to be taken offsite. A form listing the articles would be prepared and authorised, with the form being retained by security.

13.5 Computing Resources

A variety of computer based tools are available to support the work of the Construction Manager.

13.5.1 CAD

The primary CAD tool used is AutoCAD. We use an enhanced version of AutoCAD called OvaCAD, which has been developed in-house over a number of years for use specifically on building engineering projects. OvaCAD provides tools for increased ease-of-use and enhanced productivity, in addition to normal AutoCAD facilities. It also includes libraries of symbols and typical details for all projects.

13.5.2 Programmes

Refer to Section 9.0

13.5.3 Cost Management

Refer to Section 8.0

13.5.4 Document Management

Refer to Section 10.0

14. HEALTH AND SAFETY

14.1 Overview

Health and safety on site is a subject of particular and increasing concern, which requires the co-ordination of duties and a clear definition of responsibilities by all parties. Liability for site safety is shared among all concerned, and therefore it is vital to develop a system of supervision, which emphasises this and provides a practical site safety policy.

In the UK, the framework for the health & safety management of construction projects is generally dictated by the Construction (Design & Management) Regulations, CDM. For the purposes of this manual the UK CDM requirements have been outlined but they can act as a reminder for Health and Safety considerations outside the UK.

The CDM Regulations require Owners, Designers and Contractors to take a co-ordinated approach such that health and safety is fully integrated into all stages of the project process from conception through design, construction and maintenance.

The specific objective is that the CDM process strengthens the management of the interface between design and construction through:

- designers' risk assessments.
- pre-tender health and safety plans.
- contractors health and safety plans.
- assurance of competence of designers and contractors.
- co-ordination of the parties.

The role of the Construction Manager needs to be established in the contracted scope of work. This should establish that the Construction Manager has control of operations on site and co-ordinates the activities of the various work contractors. It should also establish whether the Construction Manager ensures that health and safety is taken into account during the design.

It is recommended that the Construction Manager develop with the Owner the site safety policy tailored to the specific project. The requirements of the policy would be reflected in the contract conditions, and in the UK in the health and safety plan.

The Construction Manager may assume the role of principal contractor in the UK under the CDM Regulations. This would need to be specified in the scope of work.

The CDM regulations would be the basis for the management of health and safety topics of the project, even when the project is not located in the UK. The principles would be applied wherever possible.

14.2 CDM Regulations

The CDM organisation is included in the appendix to this section. A brief overview of the principal objectives and directives of the DCM Regulations are as follows.

The key objectives of the CDM regulations are:

- Early identification of hazards and risks.
- Co-ordination of Health and Safety across design and construction.
- Improved documentation throughout the life of a project.

The principal mechanisms of the CDM Regulations are:

- Appointment of a Planning Supervisor
- Appointment of a Principal Contractor
- Preparation of a Health and Safety Plan
- Preparation of a Health and Safety File

The requirements on the Client are:

- Appoint competent persons as Planning Supervisor, Designer and Principal Contractor
- Ensure that the Health and Safety Plan is prepared before
- construction begins
- Provide information to the Planning Supervisor
- Ensure that the Health and Safety File is available for inspection

The requirements on the Planning Supervisor are:

- Give notice of the project to the HSE
- Advise on the competence and resource adequacy of designers and contractors
- ensure that the design meets the requirements of the Regulations
- Ensure preparation of the Health and Safety Plan and File

The requirements on the Designer are:

- Ensure clients are aware of their duties
- Avoid foreseeable risks to the health and safety of persons at work
- Combat at source risks to health and safety
- Give priority to measures to protect all persons at work
- Provide adequate information about residual risks
- Co-operate with the Planning Supervisor and other Designers

The requirements on the Principal Contractor are:

- Develop and implement the Health and Safety Plan
- Co-ordinate and obtain co-operation between the Contractors
- Manage the implementation of health and safety measures on site
- Provide the Planning Supervisor with information for the Health and Safety File

The requirements on Contractors are:

- To co-operate with the Principal Contractor
- To provide the Principal Contractor with any information (including risk assessments) pertaining to health and safety
- To comply with any directions under CDM from the Principal Contractor
- To comply with the Health and Safety Plan

14.3 Health and Safety Plan

It is essential that the Health and Safety Plan complies strictly with health and safety legislation, including approved codes of practice and official guidelines which may not have statutory effect but which represent good practice.

It would be prudent to prepare a Health and Safety Plan, which would comply, or follow the guidelines of the CDM Regulations. This should be a live document, which should develop as the project progresses. The topics covered by the plan would be as follows:

The Health and Safety Plan for the Planing and Design Stage should include:

- Description of project and timetable
- Details of health and safety risks
- Information to contractors to enable them to show they are competent
- and able to allocate adequate resources
- Details of site constraints
- Details of precautionary measures and site rules

The Health and Safety Plan for the Construction Stage should include:

- Arrangements for management and monitoring, taking into account
- risks involve and activities of persons at work
- Details of welfare arrangements and emergency procedures
- Details site rules and procedures
- Details controls of risks
- Specify arrangements for training, communication and consultation

Site services must also comply with statutory requirements and good industrial practice.

Safety representatives must be appointed from all parties on site who will have a responsibility to ensure compliance with the Safety Plan relative to their designate responsibility.

The plan may also stipulate a mandatory common safety-training programme.

14.4 Responsibility

If the Construction Manager assumes the responsibilities of the Principal Contractor in the UK, then the responsibilities are as defined in the CDM Regulations, as previously summarised.

Otherwise, the Construction Manager would normally be responsible for:

- Short listing works contractors who may be invited to tender, taking account of their skills in managing health and safety.
- To draw up the Health and Safety Plan for inclusion in the contract documents with the works contractors.
- To consider site safety procedures, guidance notes and codes of practice, which should be referred to in contract documents with works contractors.
- To ensure that work contractors are briefed about the anticipated construction methods and the relevant hazards.
- To satisfy himself that works contractors have made plans to carry out the work safely, have the necessary resources and have priced their tenders accordingly.
- To manage health and safety on site by co-ordinating activities, ensuring that planned procedures are implemented.
- To create a joint safety committee operating on a site-wide basis and involving representatives of management and operatives from all parties on site.
- To make site wide arrangements for emergencies, safe access and lighting.
- To hold regular co-ordination meetings between the various work contractors to identify and resolve area of interface to maintain safe working conditions.
- The appointment of a health and safety officer.
- Review work contractor's health and safety programmes for compliance with the plan.
- Monitor the contractor's programmes and perform audits on the contractor's operation.

14.5 Health and Safety Plan Compliance

The Construction Manager should monitor the contractors health and safety programmes and perform audits on the contractor's operations. These audits can include a review of the contractor's performance of the following activities:

- accident and injury reporting/accident investigation report

- training programmes
- job hazard analysis/method statements
- medical facilities
- arrangements with local offsite facilities
- record keeping and reporting procedures
- enforcement procedures/notice of disciplinary action
- permit to work systems
- sanitary facilities
- fire protection
- environmental protection/reporting hazardous materials
- emergency procedures
- key personnel: emergency telephone numbers
- toolbox meetings
- safety meetings
- appointment of a site safety officer

14.6 Health and Safety File

The preparation of a health and safety file is a requirement under the CDM Regulations.

The health and safety file is a project summary document, which records aspects of the construction which have health and safety implications.

Any requirement for this document, for projects outside of UK, would need to be clearly specified in the scope of work for the various project parties.

The contents of the health and safety file can be summarised as:

- Contains basic design criteria
- includes the "As-built" structure details
- Details the construction methods and materials used
- Provides information on equipment and maintenance facilities
- Includes manuals with schedules of plant
- Information on emergency and fire fighting systems

15. QUALITY MANAGEMENT

15.1 Construction Manager's Activities

The Construction Manager must comply with the requirements of the Ove Arup & Partners Quality Manual which has been accepted by BSI as meeting the requirements of BS EN 150 9001.

The Construction Manager must, therefore, prepare a quality assurance plan in accordance with the Quality Manual and arrange for reviews of the tasks being undertaken and procedures being put in place at regular intervals.

15.2 CM's Project Quality Assurance Plan

The Construction Manager should develop a comprehensive Project Quality Assurance Plan. The Project Assurance Quality Plan records:

- The Codes of Practice, Standards, Regulations and controlled references against which the project will be verified.
- The principal activities into which the Project is divided.
- The staff responsible for principal activities.
- All parties involved with the project and their representatives responsible for their work.
- The briefing documents, surveys, reports and other information on which the project is to be based.

The planned outputs:

- A programme of the project activities.
- Verification requirements e.g.: the categories of checking, project review and approval to issue.
- Change control procedure.

15.3 Quality Assurance Plan – Others

Each party to the project should be required to prepare and implement a Project Quality Plan for their specific scope of work. This should include procedures to be followed.

These procedures should generally include:

- Project control
- Change control
- Subcontractors and purchasing
- Document and data control

- Identification of documents
- Verification and validation
- Inspection, measuring and test equipment
- Verification and approval
- Quality records
- Control of non-conformances
- Handling and storage
- Internal quality audits
- Training

15.4 Enforcement / Quality Control

Responsibility for enforcement of the quality control of the construction should be directed by the Owner.

Works Contractors should be responsible for establishing their own system of checks and inspections to control quality.

The quality control team should make every effort to inspect the works in such a manner that unacceptable work, materials and equipment are not incorporated in the works.

To maintain consistency and uniformity when multiple works contractors are involved, a standard set of documentation formats should be developed.