

**COST CONTROL FOR MAJOR CONSTRUCTION PROJECTS**

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## ABSTRACT

## COST CONTROL FOR MAJOR CONSTRUCTION PROJECTS

Anil Dattaram Yelekar

This report deals with the cost control implications of major construction projects, from the project management viewpoint, its purpose being to aid the development of a cost control system for large scale projects. The emphasis has been placed on the cost control program as a whole, including the organization, responsibilities, functions, planning background, problems, possible solutions and the cost control methodology. A more detailed description of the report is included in Chapter 1 (Section 1.1). The report format is as follows:

- Chapter one includes general information about the report including assumptions and an introduction to project management as it relates to construction;
- Chapters two to five deal with the cost control implications (of major construction projects) in a generic form;
- Chapter six is in the form of a case study of the cost planning and control system used by the SNC Group of Consultants, Montreal, Canada;
- Chapter seven includes observations and conclusion.

DEDICATED TO  
MY GRANDFATHER  
AND MY LATE GRANDMOTHER

v

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CHAPTER ONE  
INTRODUCTION AND GENERAL



## Chapter 1

### 1.1 Introduction and general information about the report:

Title: Cost control for major construction projects

The theme and objectives -

The cost control implications covered by this report are primarily for 'superprojects' involving multiple disciplines, long schedules (over three years) and large cost budgets (over 75 million dollars), e.g. hydro electric projects, airports, etc. thus requiring a sophisticated cost control methodology and organization which may not be justified for small projects.

The prime objectives of the report are:

- To establish the organizational principles and the methodology for developing a cost control system, as applicable to the project category mentioned above, from the project management viewpoint;
- To review some of the significant problems leading directly or indirectly to cost overruns, and to discuss how the cost control system detects them and measures their cost impact;
- To examine a cost control system currently in use in relation to the criteria established, with a view to elaborate the practical applications of the methodology developed earlier, and to derive conclusions.

The scope:

This report may be of interest mainly to project management personnel, the main purpose of the report being to aid the development of a cost control system for major construction projects. The first part of

the report deals with the organizational aspects, the methodology for developing and using a cost control system, and a review of some major problems as well as the possible solutions. The sixth chapter is in the form of a case study of the organization, the cost planning and control methodology and techniques used by the SNC Group of Consultants, Montreal, Canada. The emphasis has been placed on establishing the principles and the methodology for cost control including control standards and parameters. As such, this report is oriented towards the control problems, how control is exercised, what information is required for support and how the data is used rather than the details regarding data transmission, accounting, etc. Most of the cost report specimens illustrated, therefore, are those generated at the project level, as they are, in effect, the comprehensive cost summaries of the project under way. More information on the formats used for physical performance reporting and worksheets may be obtained from some of the sources mentioned under references at the end of the report.

An attempt has been made to identify most of the significant problems related to project cost control and to discuss the possible solutions if any. In general, the problems related to cost control system development and use are discussed in detail. Problems related to resources and the resulting costs are discussed in brief to point out how they are detected, and their causes traced, by using the cost control system.

The case study covers cost control of the professional services and contract control. It does not cover direct hire work. Similarly, the case study is organization and system oriented, and does not imply

the cost control requirements of any specific project. It establishes the organizational aspects and the overall system along with the methodology for dealing with some of the commonly encountered problems. In general, the objective of the case study is to give the reader some insight into the practical applications of the cost control principles and methodology covered in the first part of the report, thus aiding the development of an effective cost control system from the project management point of view. The terminology encountered in the case study may differ from the one used in the rest of the report, although the issues remain similar. An attempt has been made to explain any terms or expressions which may be peculiar to the SNC system. As construction projects can differ considerably from one another (by way of size, environment, the role of project management and other disciplines, contractual arrangements, financing, etc.) it is important to define the project organization, the contractual arrangements among the parties involved and the role of the project management company. The organizational structure for the project as a whole is assumed to be as shown in Figure 1.1.1.

The role of the project management team:

The project management team is responsible to plan and execute the project which is assumed to be of the Engineer-Procure-Construct type. The functions of the project management company include engineering, procurement and construction management, as well as project co-ordination and control. The efforts of the project management team will be supplemented by external specialists/consultants if and when necessary, the specialists/consultants being appointed by the project manager with the

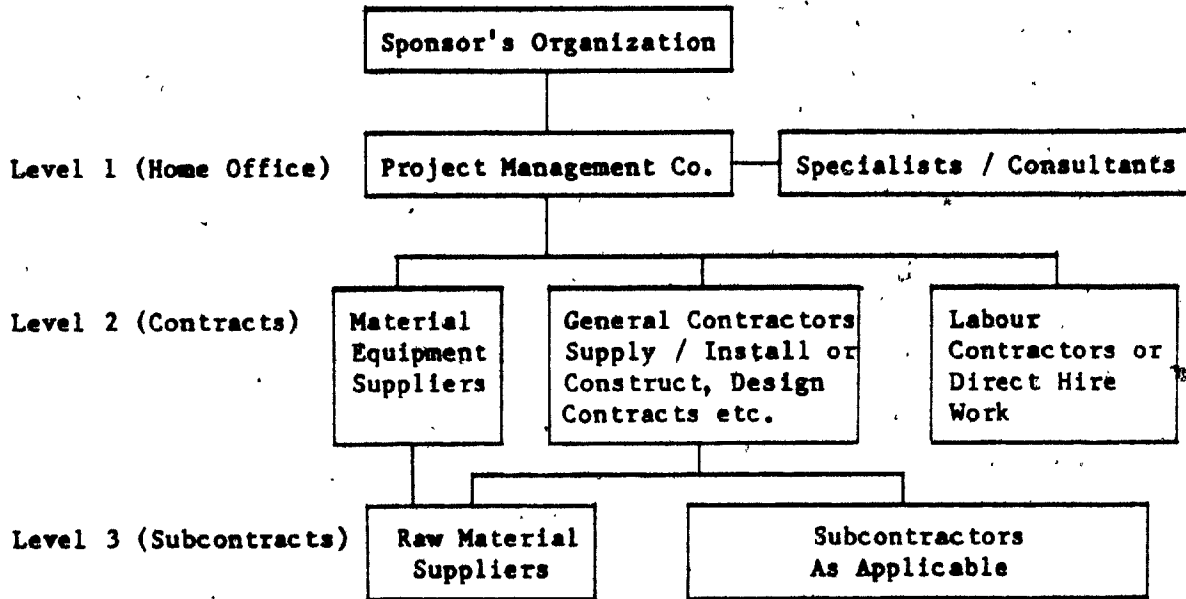


Figure: 1.1.1 Project Organization

sponsor's approval. The control functions include progress, quality and cost control over the work undertaken by the parties in Levels 1 and 2 of the project organization (shown in Figure 1.1.1). The subcontracts (Level 3) are entirely the responsibility of the related parties at the contract level (Level 2) as parts of their contracts. As such, the contractors will incorporate the progress and cost status of the subcontracts, as it relates to their contracts, in their progress claims to the project management company. The project management team will verify the claims and ensure compliance with the control standards at the contractual level (Level 2). In summary, the cost control functions of the project management team in this report apply mainly to Levels 1 and 2 shown in Figure 1.1.1. In general, cost plus contracts require more control data and a greater degree of control due to the possibility of overclaiming of the reimbursable costs by the contractors. Thus in order

to make the cost control system most 'general', for the purpose of this report, the contractual arrangements between the various parties are assumed to be as follows:

- The project management company is assumed to have a 'cost plus' contract with the sponsor for the project management and other services;
- The external specialists or consultants, if any, are assumed to have lump sum contracts with the project management company, for their services;
- The parties shown in the contractual level (Level 3) are assumed to have 'cost plus' contracts with the sponsor who will be assisted by the project management personnel in the bid evaluation and contract award process;
- The contractual agreements between the related parties in Level 2 and Level 3 (subcontract level) will be negotiated by the parties involved, the project management personnel being responsible for assessing the feasibility of the arrangements;

The responsibilities related to financing are assumed to be as follows:

- The sponsor will be responsible for obtaining the funds for financing the project. The project management team will be responsible for project cost and cash flow planning as well as control;
- The project management company is assumed to recover its reimbursable costs and its fees to date (based on the progress to date) from the sponsor through monthly billing procedures.

The internal financial planning of the project management company will be the responsibility of the project management team itself;

- The contractors/suppliers (Level 2) are also assumed to recover the reimbursable costs and fees/profit to date from the sponsor (through the project management company) based on monthly progress claims certified by the project management authority. The contractors' internal financial planning is primarily their own responsibility, although the contractors' financial position and cash flow planning will be examined by the project management personnel before contract award, in order to ensure financial feasibility.

As cost control is an integral part of project management, it is important to examine the project management methodology briefly, and hence sections 1.2 and 1.3 deal with some key issues in project management which reflect on project cost control.

1.2 Project management: The problems and the management approach

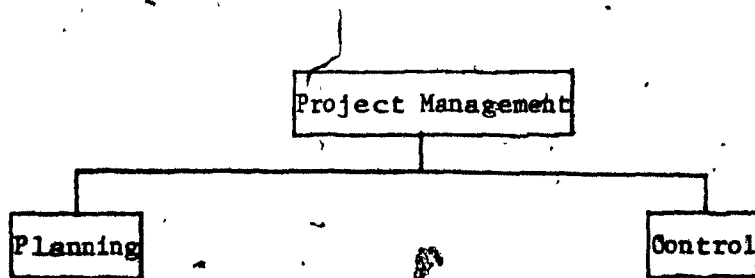
Project management is relatively more complex than the management of commercial enterprises, and the main differences can be summarized as follows (1):

A commercial enterprise is normally of an ongoing nature. The main objective of the control system here is to provide information to manage slow changing operations such as inventories, production, sales, billings, revenues, etc. Due to the ongoing nature of commercial enterprises the collection and processing of data can be regularized, and control standards can be established, and used, relatively easily. The decisions are normally based on an identified set of policies and procedures, based on predetermined guidelines, which are a result of past experience as well as ongoing research for improving the operations. As a result the information required and provided by any part of the organization can be specific and well defined. The time frame for planning and control is normally limited to cyclic events such as annual and periodic budgets and budgetary control. The cost accounting is normally of a static nature as time analysis is not always required. It enables cost calculations for products manufactured by a process which may be regarded as known, but it may have its limitations for forward looking control. Commercial organization is normally in the form of well defined departments carrying out well defined tasks every period and responsible for the predefined departmental outputs. The management team is used to working together using the established procedures, the results being judged by the financial performance.

A project, in sharp contrast, has a beginning, a middle and an end, the main objective of the control system being to provide information for managing projects in a rapidly changing environment. The data handled is of many types and each type normally affects several functional areas. The main time constraints are the planned date of project completion, and the dates of completion for individual construction contracts, which in turn depend on the timely completion of all the critical activities. Thus the schedule has to be monitored constantly. A project requires a dynamically oriented method of cost planning and control because most projects are unique in themselves, their development process being relatively difficult to predict. Due to its complex functional interrelationships project control has to be of a highly integrative nature, the results being judged by the physical development in relation to time as well as cost. The single major problem with construction projects is the nature of the construction industry and project organizational structure itself. Projects of the magnitude being examined here can be located in remote areas, thus making it necessary to collect a large amount of planning data specifically for the project in question. This data can vary from rumours, to subjective matters, to quantitative issues, and can relate to anything from supply and demand of the resources, to local practices and laws, manpower productivity, local inflation, currency exchange rates, weather and so on. Added to this is the fact that there may be a new team of professionals, contractors, suppliers, clients personnel, etc. their attitudes and/or requirements being different also. In general, the advantage of familiarity with the people and the surrounding environment is significantly less for a major construction project.



This also makes it necessary to have a high degree of flexibility (of applications) in the control system. Due to these inherent problems it is necessary to establish well defined objectives and the strategy to achieve them for each project. Therefore "Management By Objectives" (MBO) can be a very useful approach for project management and it can be summarized as shown in Figure 1.2.1 (2).



- What must be done?
- Why must it be done?
- When must it be done?
- Where must it be done?
- Who will do it?
- How will it be done?
- How much time will it require?
- How much should it cost?
- Performance criteria in relation to plan;
- What progress is being achieved?
- Are there any significant variations from the plans, schedule, budget?
- Is a corrective action necessary?
- If a corrective action is needed, when and how should it be taken?
- Feedback to revise and update plans.

Figure 1.2.1 Management By Objectives (MBO)

This is in agreement with the classic concept of establishing a plan, performing against the plan, analyzing and evaluating the performance and taking corrective action when necessary (3). This is, in fact, the essence of project management and control, and applies to every project operation that needs to be actively controlled. The project management strategy can be summarized as shown in Figure 1.2.2.

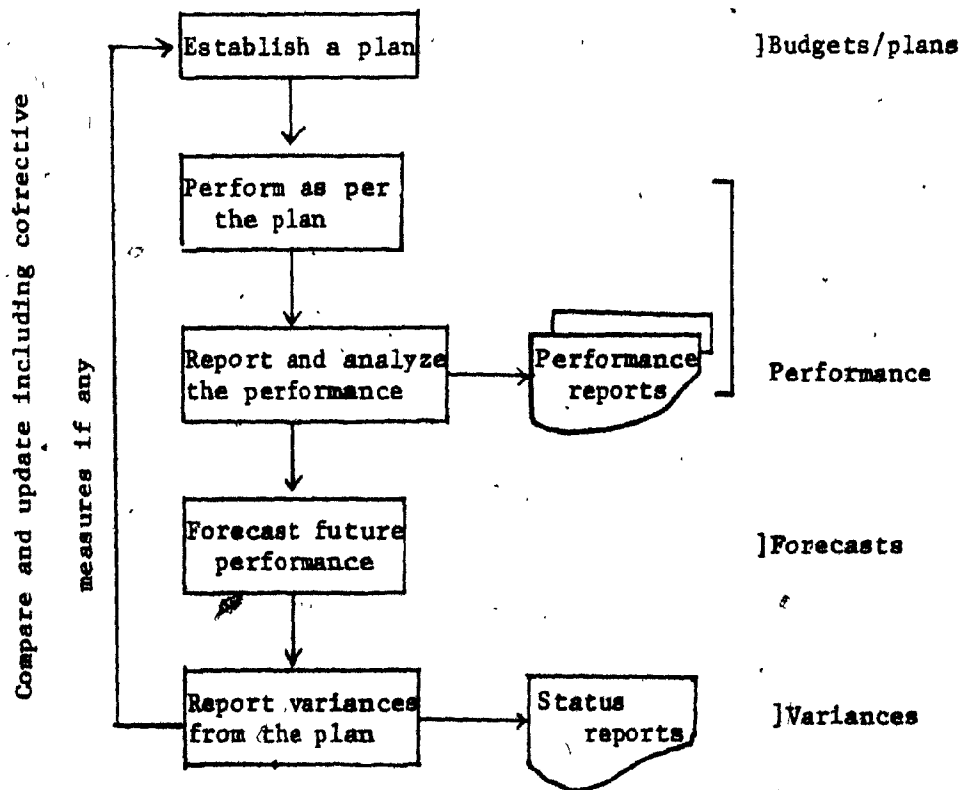


Figure 1.2.2 Project Management Strategy

Source: 'Managing Capital Expenditures for Construction Projects' by Kenneth M. Guthrie, p. 71.

This strategy can be applied to both the professional/home office services and the field services to develop an integrated project management system, including cost, schedule and quality control.

In summary, any control system related to the project performs three basic operations, namely <sup>(4)</sup>:

- Detect deviations from plans/standards;
- Analyse performance to identify the problem areas and their sources;
- Initiate control/corrective action as required;

The pre-requisites to execute these operations efficiently are <sup>(5)</sup>:

- Sensing devices to detect deviations;
- Traceability of project data, experience, information and technology to analyse the actual performance;
- Directives and predefined constraints/limits to exercise control and initiate corrective action whenever necessary.

1.3 The objective of project control and the integration of cost control:

Under the 'expected' conditions, the primary objective of project control is to complete the project within the time, cost and quality constraints defined during the planning stage and updated from time to time (as required) to incorporate changes in the project scope. In practice, however, it is not always possible to achieve this objective due to various internal and external influences affecting the performance on the project. While some of these influences can be controlled by the project management team, problems related to inflation, exchange rate fluctuations, weather, productivity, etc. are very difficult (if not impossible) to control once they have occurred. Some of them may be avoided through good planning and foresight, the others being unavoidable. So the major area of concern, from the project management viewpoint, is the net impact of these influences on the project in terms of time, cost and quality. The very fact that some time and/or cost overrun is to be expected (in comparison to the basic project cost estimate and schedule), allowances are made in the total cost estimate for contingencies, cost escalation, etc. (a similar allowance being made in the schedule), based on the available historical and forecast data from official information sources (such as the local Chamber of Commerce, Weather Bureau, etc.), in order to have a more realistic estimate and schedule. During the control phase, when the actual performance is being monitored for compliance with the control standards, the actual impact of these problems is measured for comparison with the allowances made (and to keep track of the operations requiring more/less time and/or money than allowed for), so that corrective action can be taken if necessary.

A realistic definition of a project control system, therefore, implies a system for monitoring the actual performance on the project against the pre-established standards for time, cost and quality, taking into consideration the impact of factors such as those mentioned earlier, so that corrective action can be initiated in time. The project cost control system, as an integral part of the overall project control system, covers the cost aspect of project control by using the cost budget as the standard.

The influence of project control is normally optimum during the early stages of the project, as shown in Figures 1.3.1 and 1.3.2. This is mainly due to the fact that most of the major cost related decisions are made during the planning and preliminary engineering stages, and they are still reversible until the project commitments are made. The control estimate is the point at which this transition begins, and the planning and engineering team can make or break the project before the transition begins. It is therefore necessary to emphasize that a cost control system is meant to 'control' costs so that they remain within the budget without violating the time (progress) and quality constraints, for the defined project scope. Even the most efficient cost control system and cost engineering personnel will not be able to 'reduce' costs, which are a result of previous design/engineering decisions, estimating errors, etc., during the construction phase. It is, therefore, imperative that the cost control system is backed up by:

- a) A sound planning, engineering, scheduling and estimating background;
- b) A control procedure for the technical and aesthetic aspects

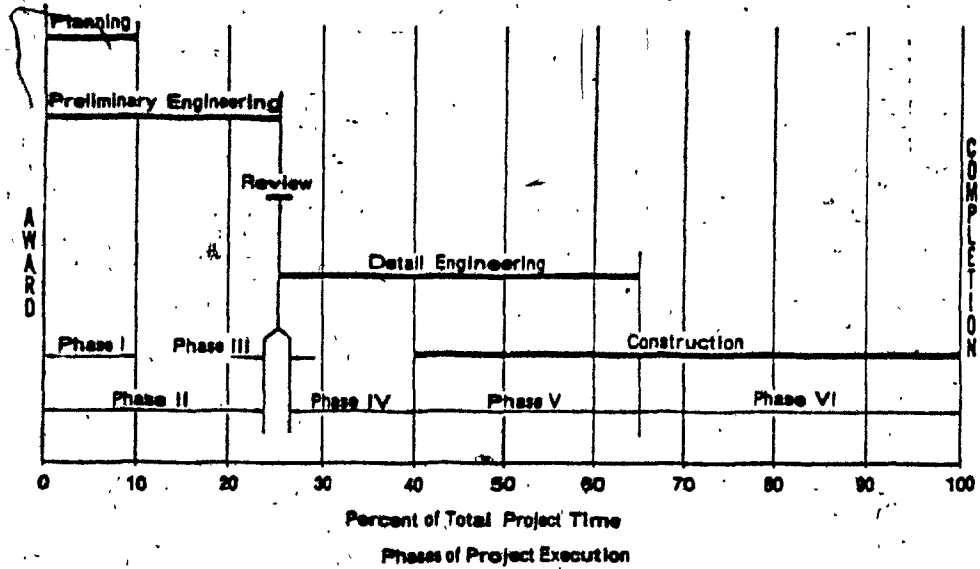
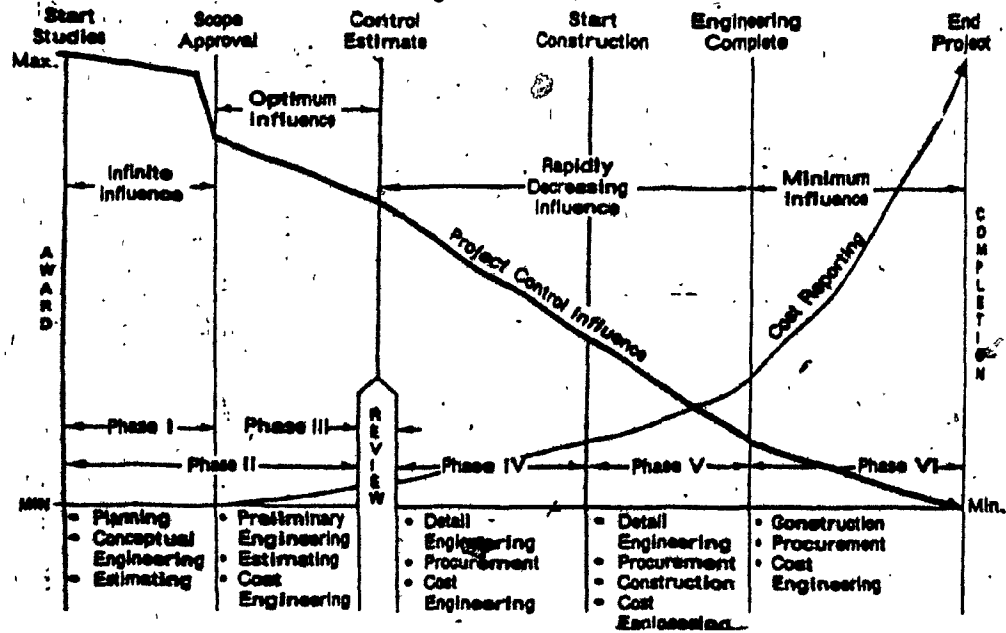


Figure 1.3.1



Note: Although the above profiles may differ from project to project, the general trend remains similar.

Figure 1.3.2

Source (1.3.1 and 1.3.2): "Managing Capital Expenditures for

Construction Projects", by Guthrie, p. 80.

of design and engineering such as a 'design to cost' approach, or 'value engineering' procedures, to give the client value for his money within his global budget.

Even with an efficient cost control system, for the project category being considered here, it is unlikely that the final paid cost of the project will be within the original budget due to its large size and long schedule. It is extremely difficult, if not impossible, to define the exact scope of such a large scale project in advance, and it will normally have to be revised several times during the implementation of the project as more and more data becomes available. In such cases the cost control system cannot reduce the additional costs, but it is responsible for participating in the scope change procedures and for updating the budget, based on the revised estimates, after the sponsor's approval. On the other hand there may be a schedule slippage, requiring a time cost trade-off in order to meet deadlines. Similarly, although the external influences such as inflation, escalation, foreign exchange rate fluctuations are at times difficult to predict beforehand for estimating their impact on the project can be monitored through the cost control system to initiate corrective action whenever necessary. These issues, and others, are examined in some detail under cost control overview, methodology and the case study.

Cost control may be visualized as a three-dimensional operation as costs have to be controlled along with the elapsed time and the physical progress achieved. As such, it is necessary to integrate progress or schedule control with the cost control operations, and a project can be said to be within budget only if it is on schedule as well as within the

budgeted cost. To this end it is normally not sufficient to compare the expenditures and commitments to date with the planned expenditures to date. For a truly forward looking control it is important to compare the projected final cost of the project with the project budget, and the projected completion time with the scheduled completion time, thus establishing baseline control rather than trying to control every detail individually. The essence of project cost control, therefore, can be found in the terms 'Costs and commitments to date', 'Forecasts to complete' and 'Forecast cost at completion'. These terms summarize the actual costs (and commitments) incurred to date, the forecast of the cost of work left to be done (based on actual progress and cost trends), and a realistic forecast of the final cost of the project at completion. The accuracy of these figures, found in most cost summaries, is instrumental in the success of the cost control system as they are the key figures used by the management to exercise control and initiate corrective action whenever necessary. The costs (and commitments) to date can be collected through the data collection and accounting systems, the actual work progress being measured simultaneously. The forecast to complete is a co-operative effort of the project team as it requires 'accurate' physical data on work yet to be done, as well as the applicable cost data. Therefore it is important to note that the success of even a good cost control system depends not only on the efficiency of the cost control personnel and system, but also on the supervisory staff (responsible for progress, performance and other feedback data reporting) during field operations. Thus project cost control, as a whole, is a co-operative effort on the part of the whole project management team. The cost control



department can be viewed as the co-ordinator of the effort, using the cost control system as a tool for generating comprehensive periodic cost summaries of the project for management review, thus establishing baseline control.

CHAPTER TWO  
A COST CONTROL OVERVIEW

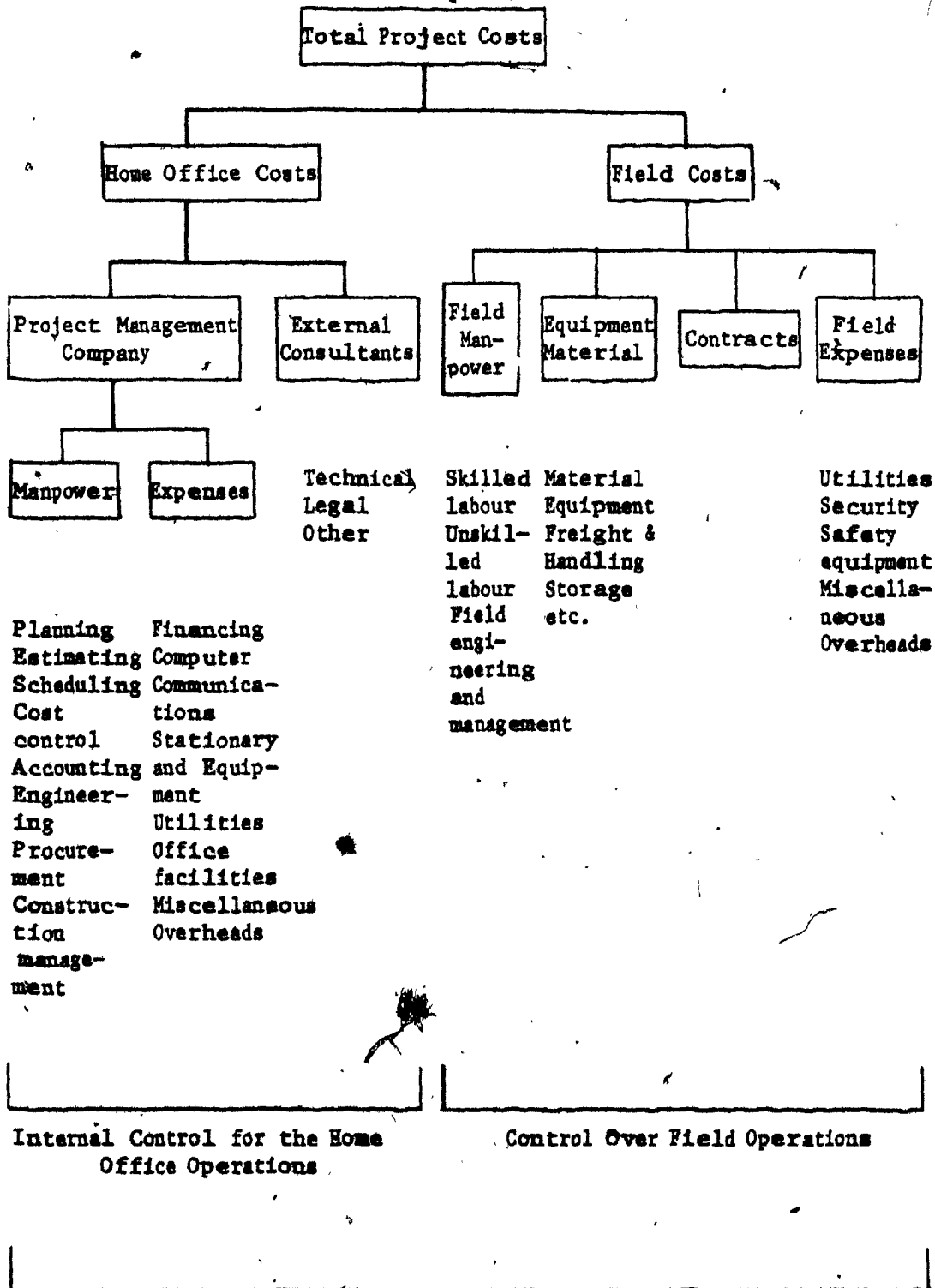
## Chapter 2

### 2.1 The project cost structure and the cost control implications:

Before developing a cost control system for a project it is important to understand how the various project costs are incurred and how they are affected by factors within or outside the project management jurisdiction, in order to avoid them or to generate timely solutions. All the costs incurred during the development of a project are related, one way or another, to the project resources of manpower, materials, machines/equipment, money and methods/systems. From the viewpoint of the project management company, these costs can be divided into two major categories namely the 'Home Office Costs' and the 'Field Costs'. The main cost sources can be summarized as shown in Figure 2.1.1.

#### Cost classification for projects:

The costs normally incurred on a project can be divided into two broad categories namely 'Direct' and 'Indirect' (6). There is no real uniformity in the identification (or interpretation) of costs as being direct or indirect, but in general, direct costs are considered to be those costs which can be associated in the field with work directly contributing to the physical completion of the permanent facility contracted for by the sponsor. The indirect costs include all the other costs (which cannot be classified as direct) contributing to the support of the project. The interpretation of this cost classification can vary



Total Project: Baseline Control  
 Figure 2.1.1 The Project Cost Structure

from project to project depending on the sponsor's requirements, the contract type, the project management company's operating methods, etc. For example: The costs of design/engineering and other professional services can be classified as direct or indirect depending on the agreement. Similarly for cost plus contracts all the 'reimbursable costs' recovered from the sponsor may be considered as 'direct' by him, the 'indirect' costs being the fees, general overheads, etc. The two major problems related to incorrect cost classification are:

- Controversies with the client over cost reimbursement;
- Incorrect cost breakdown for the project resulting in inconsistent and incorrect cost analysis which is required for problem detection and to update the company's database for future use.

These problems can be avoided by taking the following precautions (7):

- The decisions regarding categorization of costs should be thoroughly studied and deliberated. They should recognize the specific needs of the organization and its projects, taking into consideration the sponsor's standard requirements at the same time;
- Once the decisions are made, they should be documented and incorporated as standard policy to be applied uniformly wherever possible. Exceptions should be thoroughly justified and approved by higher management. This is important, as otherwise comparisons of costs between two projects will be meaningless;
- During control the costs should be segregated at their source

and assigned to their proper accounts as direct or indirect costs, based on the standard policy or as decided during planning, depending on the contract reporting requirements.

Figure 2.1.2 shows the typical cost breakdown for major construction projects, from the project management viewpoint, assuming that all the contracts related to the project are on a cost plus fee/profit basis, the direct hire labour and material costs also being on a similar basis. (Again the reason for this assumption is the fact that it results in the most general control system.) The costs of financing the individual contracts are included in the indirect portion of the costs and are the responsibility of the contractor, the general arrangement being that they are to be recovered through the monthly billing procedures as part of the indirect expenses.

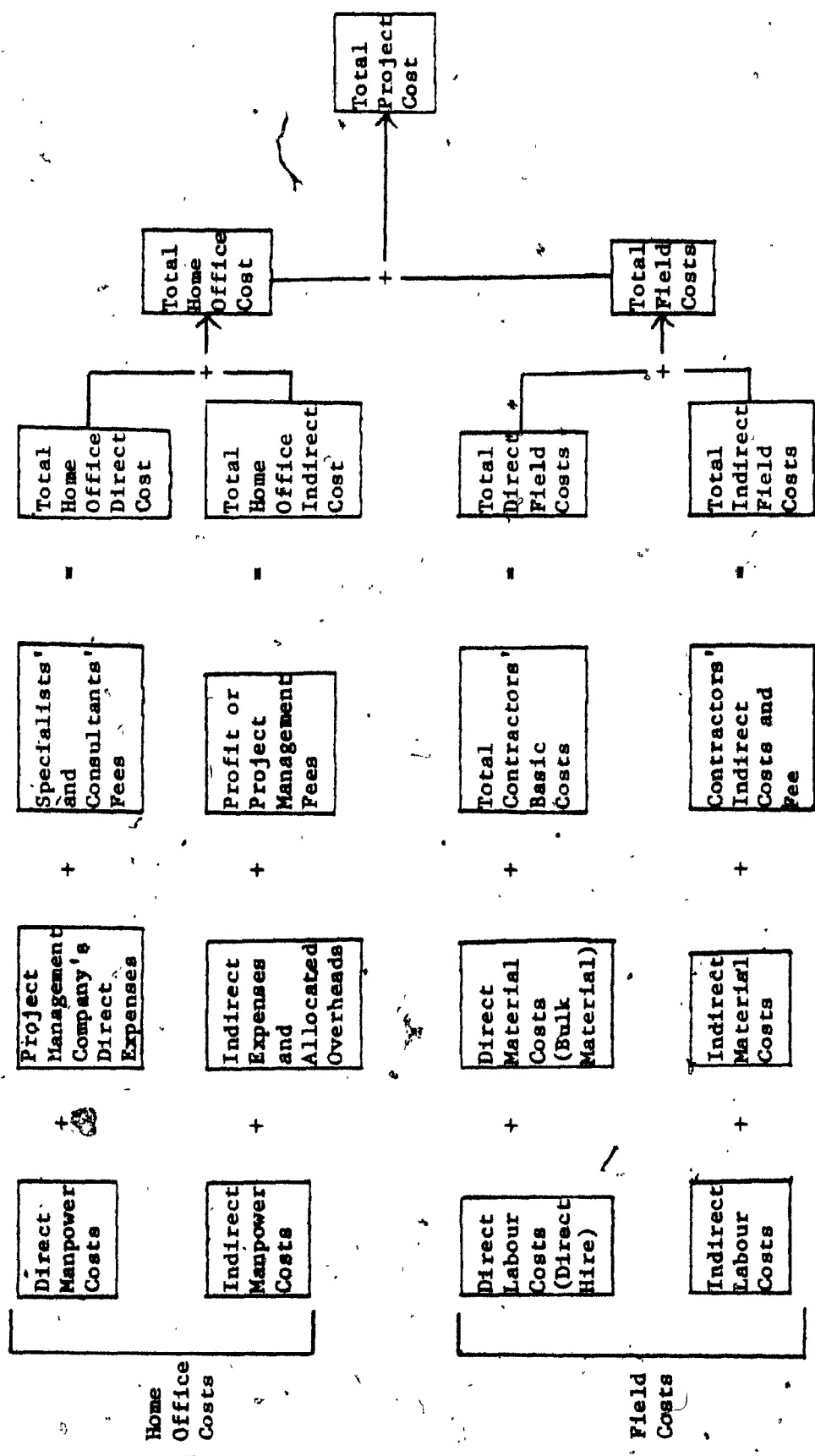
The exact role of the cost control department and the objectives of the cost control system can be defined by applying the MBO (Management by Objectives) approach shown in Figure 1.1.1, and by answering the questions asked therein an overall picture of the cost control operations can be developed. For the project category mentioned in the introduction to the report the answers can be as follows (from the project management standpoint):

- What must be done?

An effective cost control system must be developed, supported by functional organization, and it should be integrated with the other project control elements of planning, estimating and scheduling.

- Why must it be done?

Example: Cost Breakdown for Major Construction Projects: Project Management Viewpoint Figure 2.1.2



Note: The financing costs are included in the indirect costs, the fees/profit margin in each case being as stipulated by the respective contractual agreement

It must be done to establish project baseline control in support of the project management functions, which include internal control over the home office operations, and control over contracts, direct hire labour and bulk material in the field operations.

- When must the system be developed?

The cost control system must be developed as early in the project as possible to cover all the project developments right from the conceptual stage. The level of detail can then be expanded as required.

- Where must cost control be applied?

Cost control should be applied to all home office and field operations. The contractors will be responsible for their internal controls and periodic reporting to project management their progress being monitored periodically by project management to verify their claims.

- Who will do it?

The cost engineering/cost control department will develop the system (or modify the company's standard system if any) to suit the specific project needs, and be responsible for the cost control operations.

- How will cost control be exercised?

The cost control strategy will be similar to overall project management and control strategy (shown in Figure 1.1.2 in Chapter 1) as follows:

- Establish a control budget, based on a realistic (definitive) project estimate, and update it periodically or as required



to incorporate the impact of scope changes thus arriving at the revised or current control budget;

- Collect all cost related data in an organized fashion, process it and summarize it for review and analysis;
  - Analyze the cost performance and report it;
  - Forecast future cost performance, including the estimate to complete and the projected final cost at completion, taking into consideration the performance to date and any other criteria affecting the forecast;
  - Compare the projected final cost with the current control budget, detect budget variances and report them;
  - Initiate corrective action if predetermined tolerance limits are violated or if it is otherwise necessary.
- How much time will cost control require and what will be the frequency of control application?
- Cost control will be a continuous operation beginning at the conceptual stage. The normal control period will be monthly except in case of scope changes or when an early warning may be needed due to an adverse trend which may lead to a major cost overrun.
- What should the cost control operation cost?

For a major construction project of the type being examined, sophisticated data processing facilities (including a computer) are normally necessary, their cost being justified by the immense volume of cost related data to be processed and by their speed of operation. The only other major cost

item is the salaries and benefits paid to the cost control personnel. The exact magnitude of these costs will depend upon the level of control detail required and the access to data processing facilities.

## 2.2 The cost control methodology:

Before discussing in detail the various elements of the project cost control system, it is important to outline the system as a whole in order to show how the different elements and subsystems fit together. This section, therefore, deals with the integration of the system, the sequence of operations and the data flow for cost control. It is also important to note that cost planning has to be integrated with cost control to control the costs as planned.

The planning process begins with the assignment of key personnel for planning the project, and its costs. The organizational structure (dealt with in Chapter 3), should be able to facilitate the functions carried out by the project personnel through organizational integration of the project management and control services. The next major step is to define the scope of the project to a level of detail where it is possible to develop a definitive estimate which will form the basis for the cost budget. This is achieved by a systematic breakdown of the project into elements which can be estimated, budgeted for and controlled. This breakdown is known as the 'Work Breakdown Structure' or 'WBS' (dealt with in Section 4.1) which forms the central framework for the project. It is also necessary to have a medium for assigning cost budgets to these elements and to collect the actual costs on the same basis. This medium is found in the 'Project Cost Code' (dealt with in Section 4.2) which is normally developed from a 'Standard Cost Code' for consistency. The project cost code facilitates the distribution of the budget among the project elements as defined by the Work Breakdown Structure, thus

developing a cost model of the project plan. Cost budgets are assigned to the individual cost accounts (representing the 'WBS' elements) and the actual costs applicable are accumulated against the budgets using the same accounts, thus facilitating a comparison. A cost trending subsystem (dealt with in Section 4.6) is used for accumulating, and keeping a record of any trends or deviations from the planned performance which may result in a cost and/or a schedule impact. The changes of scope are handled through a formalized change order subsystem (covered in Section 4.7) so that the cost budget can be adjusted to accommodate these changes.

The actual cost data is collected through an integrated performance control and data collection system composed of three main subsystems, namely:

- Design/Engineering performance control and data collection (see Section 5.2);
- Procurement performance control and data collection, including material and equipment control (discussed in Sections 5.3 and 5.4);
- Construction performance control and data collection, including physical progress, manpower and contract control (dealt with in Sections 5.5, 5.6, 5.7 and 5.8).

These subsystems are used to control the physical performance by measurement and transmit the cost related data to the cost control department, along with physical forecasts of the work to go. By assigning the proper cost codes to the various data elements thus obtained, and by applying the applicable costs or unit rates where

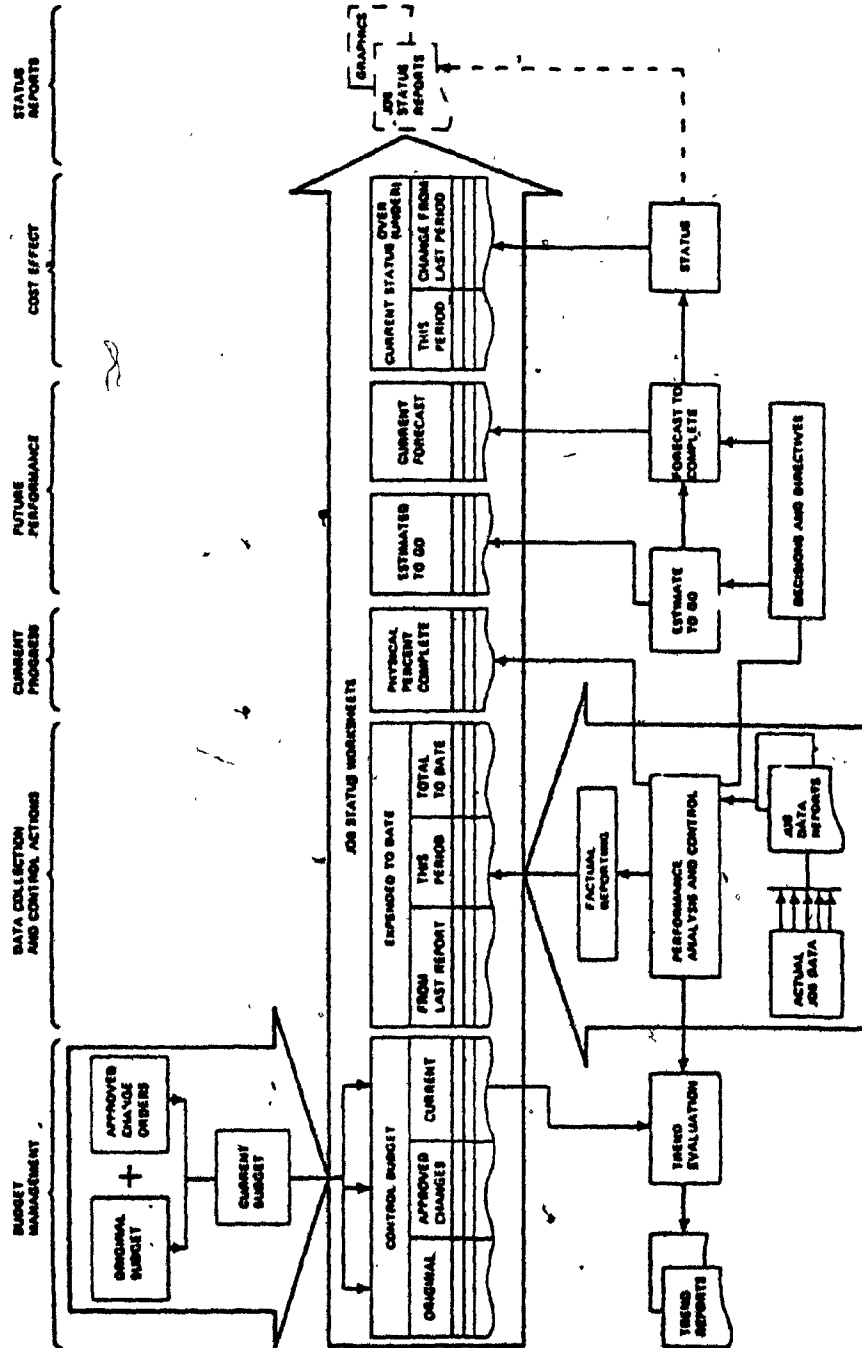
necessary, it is possible to accumulate the actual costs and commitments to date for each cost account. Similarly the physical forecasts of work to go are converted into the estimated cost to go by using the cost forecasting subsystem (covered in Section 5.9). The actual cost to date is added to the estimated cost to go in order to get the current cost forecast (the projected final cost) which is then compared with the updated budget at the cost account level. If the cost variance from the budget lies beyond the preset tolerance limits for variances, corrective action may have to be initiated. The comparison between the budget and the forecast is done on a monthly basis, and monthly cost reports, summarizing the cost performance by cost account or at successively higher levels, produced for management review (dealt with in Section 5.9).

In summary, the four primary functions to be performed to achieve effective control over project costs, are (8):

- Budget management;
- Analysis of actual performance and evaluation of the current status;
- Forecasting the cost of remaining work and the final cost;
- Cost reporting and initiation of corrective action if necessary.

Figure 2.2.1 summarizes the primary functions in sequential order.

A cost control program for a major construction project can, therefore, be defined as a program which establishes and operates the systems and subsystems required for performing the primary functions and



Analysis and Control

Figure 2.2.1 Project Cost Control: Sequence of the Primary Functions

Source: "Managing Capital Expenditures for Construction Projects", by Guthrie, p. 120.

the support functions as required. Figure 2.2.2 summarizes the basic cost control system showing system integration and the functional data flow. The primary responsibility for establishing and maintaining the cost control program lies with the cost engineering and control department.

The planning background, the sequence of operations and the use of the various elements in the cost control system, are further elaborated in the case study (Chapter 6).

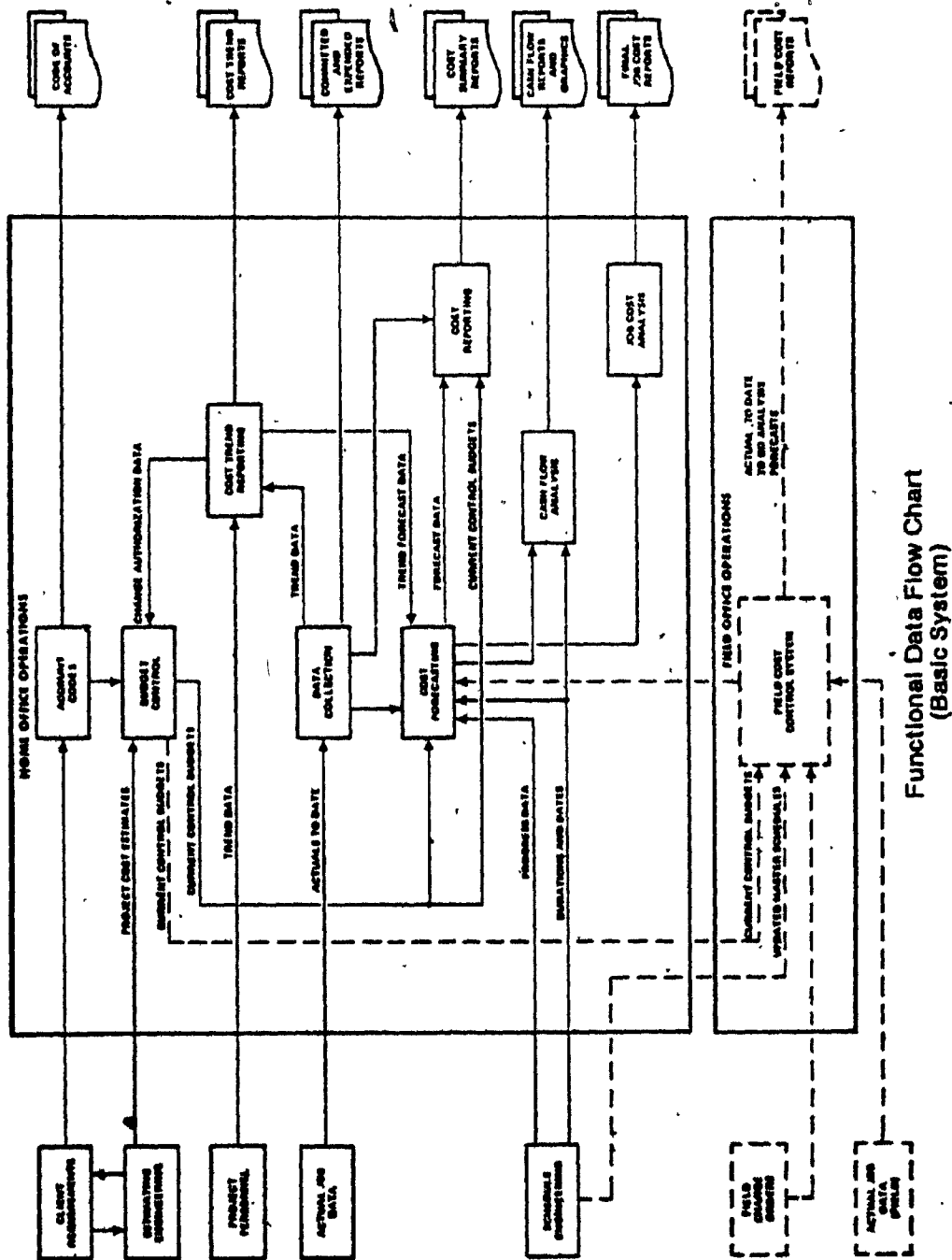


Figure 2.2.2 Functional Data Flow Chart (Basic System)  
 Source: "Managing Capital Expenditures for Construction Projects", by Guthrie, p. 144.



2.3 Problems related to project cost control and the methodology for handling them:

Before developing the details of the cost control system, it is necessary to examine some of the key problems which can lead to cost overruns directly or indirectly. As resource expenditures generate most of the project costs, a majority of the cost related problems also originate from the resources and the related criteria shown in Table

2.3.1

Resources Criteria	Manpower	Materials	Machines Equipment	Money	Methods and Systems
Adequacy	X	X	X	X	X
Quality		X	X		X
Timing	X	X	X	X	X
Productivity	X		X		
Unit or Bulk Prices	X	X	X	X	X

Table 2.3.1 Resources and criteria affecting cost performance.

The cost of the same resource, even if it is locally available, can differ from region to region depending upon the criticality of the related criteria shown in Table 2.3.1. The resources can be affected by influences which may or may not be under the jurisdiction of the project team, and if these influences disturb any of the criteria shown in Table 2.3.1, a cost overrun may be experienced immediately or at a later date.

From the project management point of view the problem causing influences can be divided into two major categories namely 'internal'

and 'external'. In general, the internal influences can be considered as those which lie under the jurisdiction of the parties within the project organization. These influences can normally be traced, and theoretically many can be controlled to some degree, although subjective issues (such as the morale of the personnel) can, in practice, be very difficult to control. Some examples of internal problems are:

- Unsuitable system design or inadequate controls and control standards;
- Below par technical performance due to low morale and productivity, personality conflicts, etc.;
- Internal cash flow problems due to red tape, payment delays, etc.

Although such problems are a result of internal causes, such as lack of training/experience, attitudes of personnel, red tape, etc., on which enough data is normally available, some of them are still difficult to control.

The external problems result from causes outside the jurisdiction of the project management team, and their impact on the project is normally unavoidable. The only approach, which can be adopted under such circumstances, is to monitor the impact of such influences on the individual resource costs, and the overall project budget and schedule, in order to keep track of why the money or time consumption took place, and where it went, for future references. There are no complete remedies to such problems, but the impact of some of them (e.g. unfavourable weather) may be reduced to some extent through rescheduling, overtime, etc. Some examples of external problems are:

- Wage and cost escalation;
- Weather delays;
- Procurement delays.

Although these problems can be traced back to causes such as inflation, bad weather, strikes, etc., they are uncontrollable in most cases, although some of them (such as strikes on the project) may be avoidable through prior agreements and efficient planning.

Section 2.4 deals with problems related to systems in some detail, the problems related to the resources being discussed later in Chapter 5.

The cost control system is instrumental in detecting problems requiring immediate attention, in measuring their impact on the project in terms of budget dollars, and providing most of the necessary back-up cost data required for analysis of problem areas. The impact of the problems can result in one or more of the following:

- Loss of quality;
- Slow work progress (against the schedule) resulting in delays;
- A cost overrun (against the current control budget).

All three effects mentioned above can be expressed in terms of cost by assigning dollar values, but it is not always practical to do so as the results achieved may not be worth the extra effort, time and cost involved. This applies mainly to the quality aspect which is best dealt with through quality control. However as the cost budget is distributed over the project schedule based on the dollar requirements for each individual control period, it is important to relate the actual costs

incurred to the progress achieved, and the cost control system should be able to measure the impact of slow progress and delays on the project cost. Tables 2.3.2, 2.3.3 and 2.3.4 summarize some of the important delay factors in the construction industry and how contractors, architects and engineers rank them. These tables, by no means include all the delay causing factors related to construction, but they serve to give the reader some idea as to how important these factors are, and how severe their impact on the project can be, based on the opinions of project related personnel.

The cost control system measures the cost impact of the delays resulting from problems related to these factors and others. This impact appears as a cost variance in the periodic cost summaries and it can be traced back to the problem area by conducting a cost analysis of the problem area. The integrated performance control and data collection subsystem, with a built in 'Earned Value' concept, is the key feature of the cost control system for measuring the cost impact of delays. A detailed discussion about the 'Earned Value' concept follows in Chapter 4 under performance measurement, analysis and control.

Cost overruns (excluding the indirect cost impact of delays) can result from a number of causes such as estimating errors, scope changes, insufficient allowance for cost escalation and contingency, etc. Some of the problems resulting in cost overruns are discussed later in Chapter 4 as they relate to the resources of manpower, materials, equipment and money.

The cost control system measures the cost overrun and identifies it with the problem area. The cause of the variance can then be traced

November, 1971

TABLE: 2.3.2

-CONTRACTOR RESPONSES TO QUESTIONNAIRE ON BASIS OF PERCENTAGE OF REPLIES RECEIVED

Delay factors (1)	Very important (2)	Important (3)	Minor importance (4)	No significance (5)	Severity index (6)
Weather	59	31	9	3	90
Labor Supply	26	32	18	5	80
Subcontractors	46	21	15	8	77
Design changes	24	34	24	6	70
Shop drawings	23	36	20	20	59
Foundation conditions	27	30	28	15	57
Material shortages	23	31	32	14	54
Manufactured items	19	32	31	18	51
Sample approvals	17	29	33	21	46
Jurisdictional disputes	17	27	27	29	44
Equipment failure	13	19	43	25	32
Contracts	13	18	36	35	31
Construction mistakes	10	17	39	33	27
Inspections	6	17	48	31	23
Permits	8	12	26	54	20
Building codes	10	9	28	52	19
	2	8	27	63	10

-ARCHITECT RESPONSES TO QUESTIONNAIRE ON BASIS OF PERCENTAGE OF REPLIES RECEIVED

Delay factors (1)	Very important (2)	Important (3)	Minor importance (4)	No significance (5)	Severity index (6)
Subcontractors	36	36	22	4	74
Labor	33	27	26	13	66
Weather	29	29	38	7	53
Manufactured items	26	33	33	13	53
Finances	28	20	26	35	48
Material shortages	15	22	44	29	37
Shop drawings	14	21	40	24	35
Permits	19	13	30	38	32
Foundation conditions	10	19	42	29	29
Design changes	4	17	38	34	26
Construction mistakes	4	16	41	37	22
Jurisdictional disputes	11	18	40	38	21
Sample approvals	4	15	37	43	19
Building codes	8	10	24	57	18
Contracts	7	9	32	51	16
Equipment failure	4	8	31	56	13
Inspection	2	4	31	63	6

Source: Journal of the Construction Division, Proceedings of the American Society of Civil Engineers, Nov. 1971. Causes of delay in the construction industry by John R. Baldwin.

CONSTRUCTION INDUSTRY DELAYS

Item Ranking by Group A Ranking by Group B Absolute difference in Rank

1	1	1	0
2	2	4	2
3	3	2	1
4	4	3	1
5	5	5	0

Total = 4

Rank Agreement Factor = 4/5 = 0.80

Note that for the 17 items on the questionnaire, for perfect agreement between two groups, this factor would be zero. If the two groups were in complete

-ENGINEER RESPONSES TO QUESTIONNAIRE ON BASIS OF PERCENTAGE OF REPLIES RECEIVED TABLE: 2.3.4

Delay factor (1)	Very important (2)	Important (3)	Minor importance (4)	No significance (5)	Severity index (6)
Weather	26	31	30	3	64
Subcontractors	22	32	34	3	54
Labor	18	29	32	22	45
Manufactured items	20	21	40	18	41
Finances	22	12	14	51	34
Foundation conditions	12	22	39	27	34
Permits	14	18	22	46	32
Material shortages	11	19	48	22	30
Design changes	9	19	36	33	28
Shop drawings	7	19	37	36	28
Jurisdictional disputes	11	15	28	45	26
Equipment failure	5	14	45	36	19
Construction mistakes	3	16	43	36	19
Inspection	3	15	32	47	18
Contracts	9	7	33	54	16
Sample approvals	3	8	34	54	11
Building codes	4	3	24	68	7

disagreement, that is if they ranked the items in opposite orders, the factor would be 16.

From the replies to the questionnaires, the agreement factors were:

Groups	Rank agreement factor
Contractors and Architects	3.53
Contractors and Engineers	2.82
Architects and Engineers	1.82

These figures suggest that there is good agreement among the three groups.

back to the problem as stated earlier in the case of delays. The resource control features in the performance control and data collection subsystems are the main detecting devices for cost escalation, the cost trending subsystem being the detector for estimating errors, scope changes and \*insufficient contingency allowance, etc.

For major construction projects a common cause of serious cost overruns is poor cash flow management resulting in substantial cost increases due to higher interest on project finances, excess funds to make time cost trade-offs in order to avoid delays in the critical activities, carrying charges on commodity purchases on credit, etc. This problem can be avoided only by sound cash flow planning and management. In summary, the cash flow schedule is derived by converting the schedule of commitments and expenditures from its accrual basis to a cash basis showing the expected cash flows. After this the project financing requirements are planned and monitored on this basis.

2.4 Internal management and control problems related to systems and the methodology for avoiding/solving them:

The success of a project control system depends on correct system development, as well as the efficiency of the personnel using it. Most of the system problems are related to the suitability of the system to the organization and its projects, as well as the attitude of personnel toward the system. Some of the common problems encountered are as follows:

- Many systems require excessive 'care and data feeding' relative to benefits obtained, thus making the system expensive to run. This problem can be avoided by developing a standard system which is flexible enough to be applied to the projects normally undertaken. The two main areas within the system which can be made flexible (without disturbing the overall system) are:
  - The level of detail required for control;
  - The control procedures, including reporting frequency, approvals, etc.

This flexibility may be achieved by making the system as general as practicable (without losing efficiency) and modifying it to some extent to suit the requirements of each individual project by deleting the features not needed or by adding extra features if necessary.

- In many cases sophisticated analytical models and management information systems designed by technical people are not

geared to the temperament of the managers, (9). Thus a system may be effective and useful, but due to its innovative concepts a conservative management may be reluctant to accept it readily based on its merits (as against its apparent drawbacks). Therefore it is important to have a management development program in order to expose the management to new concepts, systems and technology. In house systems analysts may be employed by companies able to justify their salaries due to a continuous volume of construction involving major projects;

- Many systems point out problems after the fact, or just make linear projections of trends, which may be misleading and meaningless for forecasting the outcome of major construction projects involving complex functional interrelationships between personnel, disciplines and data generated at various project levels and locations. Similarly, as a project is bound by a cost and a time constraint, neither retrospective cost control nor forecasting should be used on its own. In order to achieve 'realistic' and 'forward looking' control the forecasts should be based on a retrospective analysis of the performance to date and any other factors which may affect the projected performance. A definitive forecasting technique based on data generated during performance control, and other supplementary data, will normally result in a reasonably accurate forecast;



- Overlapping of systems can result in duplication of data entry and confusion. This problem can be solved through correct system design, correct definition of tasks and responsibilities and a centralized project database containing all the project data. This database can be updated based on the input provided by the disciplines concerned and data retrieval for periodic cost reporting should be done from this single source of information. Where the overlaps in systems cannot be avoided, the interfaces should be dealt with properly and all the personnel affected by the overlaps should be informed about the exact procedures to be followed for dealing with the overlaps;
- Systems requiring the design/engineering, procurement or construction personnel to carry out cost-coding and calculations may produce unsatisfactory results (due to incorrect coding, calculations, etc.) as the technical personnel may not be keen on carrying out the data collection functions for cost control. Their main interest, and concern, will be the technical aspects of the project. As such, the performance reports/documents from the field should be designed to transmit cost related data and not cost calculations. The cost coding functions should be carried out by the assigned cost engineers to avoid coding errors and ambiguities;
- The frequency of reporting is important for timely detection of problems and initiation of corrective action. The

frequency of performance reporting should be based on the elements to be controlled and how critical they are for the success of the overall project. Cost reporting at the project level can be monthly (or as required), with an early warning if a major change/overrun is to be expected. From this point of view good communication, between the field staff and the planning and controls department, is also important;

- Failure to detect the original sources of costs and cost overruns can result in control problems. It is important to identify the direct and indirect costs with the activities where they belong, and hence it is important to segregate the costs where they are first incurred. For example, material damage or loss during transportation and storage, and the resulting costs, should not be allowed to filter through to the work item where the materials are eventually used. These costs should be segregated as soon as they are detected and should be coded as indirect material costs due to damage or losses by using the appropriate prime, subprime and detail codes in the project cost code.
- The problem of using only the ordinary accounting system mainly concerns the long time lag in the reporting function, and the difficulties in tying planning to monitoring<sup>(10)</sup>. It is not uncommon that companies with a computerized accounting system suffer disadvantages such as long time

delays between the arrival of an invoice, and the time when the payment for the same invoice is shown in the data output. The delays occur mainly due to the key-punching and checking functions which take time. If this problem is to be overcome, an integrated 'project-specific' accounting system is needed instead of the ordinary (standard) accounting system. The main principle is that as soon as a commitment is made or an invoice received, it is first fed into the system and recorded under the right work/package and account code. Then the invoice circulates for attestation, administrative approval, accounting and payment according to normal routines. The invoices should be approved by the field office for technical performance before they are submitted to the accounting office thus reducing discrepancies between resource budgets and claims. The cost engineer normally checks the unit costs used, and the total cost to date based on the progress approved by the field office. Any changes made when the payment actually takes place have to be fed into the system also, to update the commitment and expenditure register.

It is important to remember these issues while developing a cost control system for a specific project (or modifying a standardized system to suit a specific project), and to take steps to eliminate such problems. Problems related to the use of the system can be remedied only by proper training.

The cost control system described in this report is based on the use of a Work Breakdown Structure the level of detail being determined by

the work plan, and the criticality of the work elements to be controlled, thus avoiding the problem of excessive data requirements for cost control. The project cost code, derived from a standard code, is integrated with the Work Breakdown Structure. The level of detail in the project cost code is kept compatible with the Work Breakdown, thus making the project cost code a cost model of the Work Breakdown Structure. Budgets can, therefore, be assigned to each element to be controlled, and the actual costs collected on the same basis to facilitate a comparison. The integrated performance control and data collection subsystem is used for controlling the actual performance and the resource expenditures for the same work elements in the Work Breakdown Structure, as well as for collecting and transmitting the cost related data for cost control. The trending subsystem is used for detecting any changes (trends) in the physical project environment, and the physical trend is translated into a cost and/or time trend which may be a potential deviation from the budget and/or schedule. The trends are evaluated and analyzed to determine whether they constitute a change of scope, a budget transfer, a schedule change/adjustment, or a cost and/or time overrun, thus establishing the basis for an early warning. This reduces the danger of after the fact reporting when it may be too late, or too expensive, to take corrective action. It also improves the accuracy of the cost forecast by keeping the database up to date. The cost forecast is a combination of actual costs to date, the outstanding commitments and other related data from cost trending and other subsystems. The reporting function covers performance reports for data transmission during performance control, and the periodic project level reports including the cost summaries and forecasts.

Although the accounting system is not described in this report, it is assumed that it is integrated with cost control in order to ensure accurate feedback on the actual paid costs. It is also assumed that the cost control system is backed up by sophisticated data processing equipment such as a computer and an efficient communication system compatible with the requirements of the project under way. In order to bring out the best in the managers, the system should have the following features:

- The output from the cost control system should be summarized showing the actual cost performance against the budget (variances) to facilitate management by exception based on predetermined tolerance levels for variances;
- All the back up cost data must be available in an organized form to trace the causes of the cost variances by conducting a cost analysis;
- The cost summaries should be in commonly accepted formats and as straightforward as possible to avoid ambiguities, queries and misinterpretation by the outside authorities related to the project.

In summary, the system should provide the management with a cost baseline for control while maintaining traceability of data up to the detail level used in the project code of accounts at least.

It is beyond the scope of this report to examine the various reporting formats in detail, except for those included in the case study. However, the type of information to be reported and the reporting frequency are discussed under performance analysis and control.

Traceability of data is maintained through the hierarchical account

coding system which collects the cost data from the detail level, consolidates it through the sub-prime and prime accounts, and assigns it to the construction area and facility concerned. The distribution code is used for summarizing the resource costs for each area facility and the total project. The indirect costs for each area facility can be accumulated at the prime/sub-prime level, the distribution code being used for identifying the resource/contract to which the indirect costs are to be assigned. The indirect costs can include financing costs, escalation, taxes, overheads, etc.

CHAPTER THREE

ORGANIZATION AND RESPONSIBILITIES RELATED TO COST CONTROL

### Chapter 3

#### 3.1 Organization for project and cost control:

The purpose of this chapter is to examine the organizational aspects and the functional responsibilities related to cost control. The organizational structure can differ from company to company (and sometimes from project to project managed by the same company), but the organizational concepts can be similar. The concept of a 'Project Task Force' may be found useful for control of major projects justifying the time and the cost of maintaining the task force. The following discussion attempts to clarify the concept.

##### What is a task force?

A task force is simply a team of professionals and administrative support personnel assigned to a project, on a full time or a part time basis, although the size of the task force can fluctuate from project to project, or even during the planning and implementation of the same project. The disciplines grouped under the title of a task force normally depend on the role of the project management company and the type of project to which the task force is assigned.

##### How does a task force operate?

A task force normally operates under the leadership of a project manager who has the ultimate responsibility for performance on the project. The project management support personnel are normally grouped together in order to integrate the planning, scheduling, estimating and cost control functions. It is important to have good interaction among



these disciplines for good project control, as they are interdependent to a large degree. For example, a cost overrun can be a function of a delay or a schedule slippage and trade-offs may be needed at times to meet either the time or the cost constraint. Similarly, changes of scope have to be estimated as they relate to the total project cost and/or schedule, especially if they affect any critical activities. These functions can be carried out efficiently when the concerned disciplines have easy access to all the related data originating from other disciplines. A task force can normally solve this problem to some degree through functional interaction due to physical proximity.

3.2 Location of personnel for project planning and control, including cost control:

Firms with a continuous annual volume of new construction prefer to centralize planning/engineering, scheduling, estimating, cost-control, procurement, administrative and financial control in one or more central offices located in the urban areas, for the inherent advantages offered by such locations, including:

- Easy access to data banks;
- New technology for data processing;
- Close contact with contractors and vendors;
- Communications facilities for data transmission;
- Economy of operations due to volume processing;
- Better interaction between the disciplines;
- Face to face analysis of problems resulting in joint determination of solutions;
- Better home office support; etc.

Most of the strategic planning and engineering decisions are made in the central office based on the planning data collected by the key members of the task force assigned to the project, who visit the site first during the conceptual phase and are later located at the 'Task Force' headquarters at or close to the site. It is logical to locate the Task Force somewhere in an urban area near the site wherever possible, as most of the tactical planning and field-engineering data, as well as the performance data during the implementation stage, comes from the site. The Task Force headquarters may be viewed as a satellite of the home or

central office, where most of the project control personnel are located, and it has its own satellite in the form of a site or field office which is responsible for field performance control, and for provision of control data to the control office. The procurement head-office is located at the Task Force headquarters; although most of the bulk buying may be done by the procurement department of the home-office depending on the circumstances.

The sizes of the departments and the offices will depend on the size of the project and the personnel requirements for the immediate tasks on hand. A smaller company, with a one time only job, may prefer to locate all the key departments at or near the job-site to avoid unjustified communication costs, and to facilitate on the spot decisions.

### 3.3 The cost engineering and control department:

The cost engineering department provides the analytical methods and procedures for monitoring, analyzing, forecasting and controlling the costs of a project. It has, at times, to deal with and interpret some of the most tenuous information regarding the project (including rumours and third party knowledge about potential problems) in order to carry out the functions mentioned above efficiently. It should not be confused with the cost accounting department which performs the administrative functions such as making out invoices, paying out bills and progress payments, computing the payroll, preparing tax summaries and returns, etc. Here the standards (or documents) for comparison are a result of the formal data collection and reporting systems, and contain the exact dollar amounts for comparison.

It is advantageous to integrate the accounting department functionally with the cost engineering/control department in order to ensure a feedback of the actual paid costs for analysis and forecasting. The cost engineering/control department can be a part of the planning and control division along with planning/scheduling and estimating. An example of the overall organization and functional integration of the planning and controls department is shown in Figure 3.3.1.

In summary, the broad functions related to cost engineering and control are (11):

- Participate in the development of the project implementation plan;
- Establish standard and project account codes;

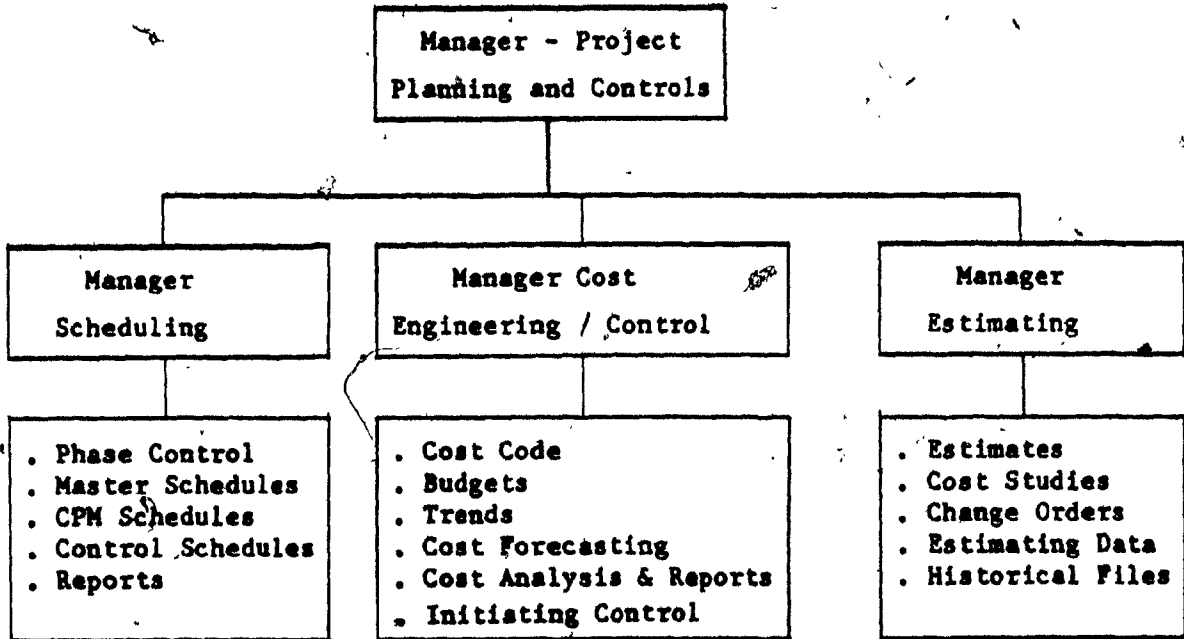


Figure: 3.3.1 Organization of The Planning and Controls Division

(Based on Figure 5-22 from "Managing of Capital Expenditures for Construction Projects". by Guthrie, p. 98

- Establish a cost budget for the execution of all the phases of a project, within the planning, contractual and resource constraints, and update it;
- Establish and maintain a monitoring, reporting and forecasting system which will clearly define the status of the project in relation to the budget;
- Establish and maintain an early warning system capable of detecting deviations from the plan;
- Establish and maintain a central control group through which all the cost information can be co-ordinated;
- Establish and maintain historic data files for future use.

The four major functional categories required to achieve the above objectives are:

- Account codes;
- Trend analysis;
- Budget control;
- Forecasting and reporting.

The organization and functions of the cost engineering department can be as shown in Figure 3.3.2.

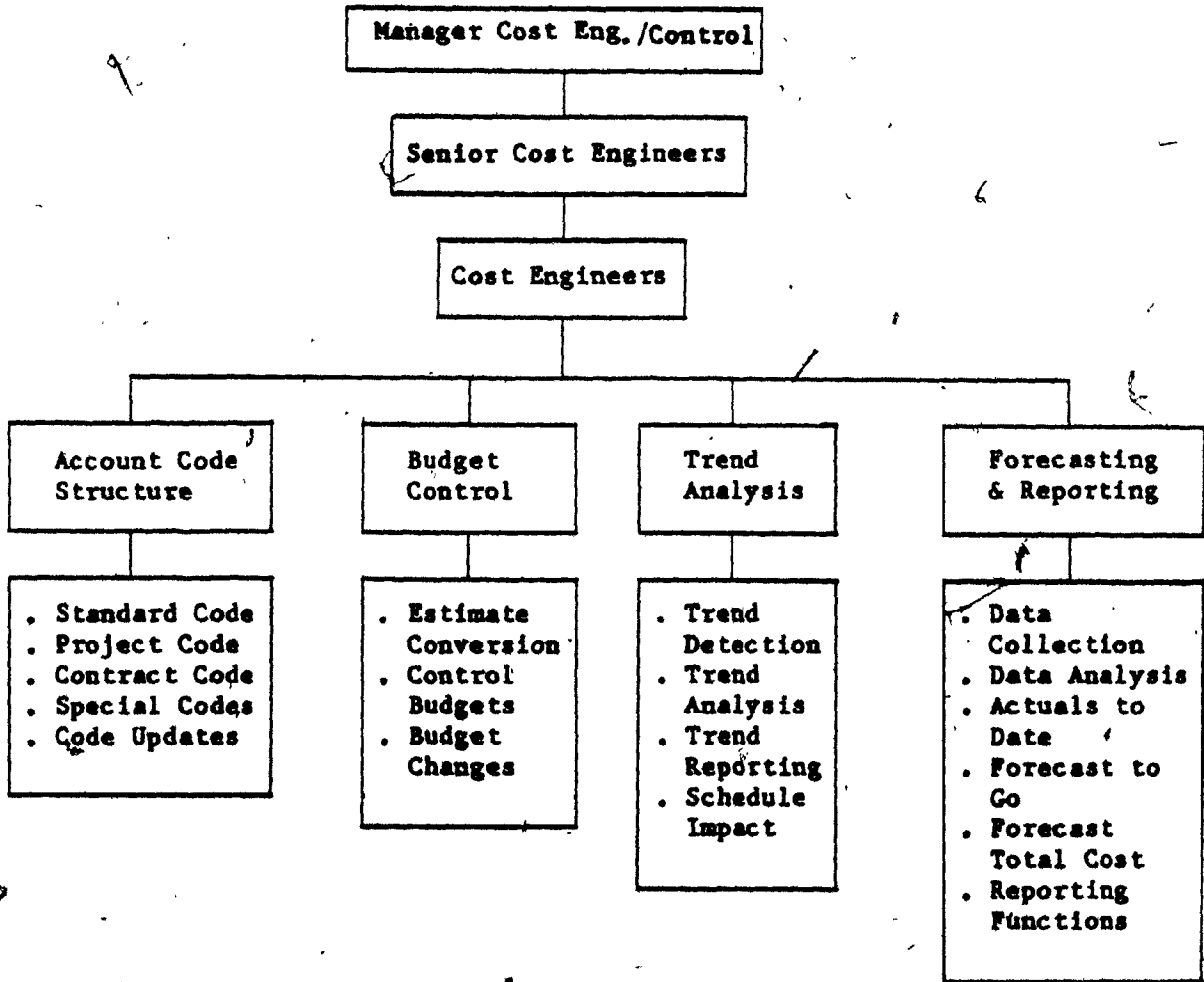


Figure: 3.3.2 Organization of The Cost Engineering / Control Department  
Source: "Managing Capital Expenditures for Construction Projects"  
by Guthrie, p. 100.

### 3.4 Functional responsibilities related to cost control:

The cost controller or the cost engineering manager can be functionally responsible to the project manager either directly or through the planning and controls manager depending on the company's organization. He is directly responsible for supervising the preparation of the project cost documents. The responsibility includes monitoring, analyzing and reporting budgets, cash flows, forecasts and the status to the project manager and other relevant project related authorities.

His functions include the following <sup>(12)</sup>:

- Prepare the cost engineering and control procedures for individual projects;
- Prepare the cost code of accounts for all proposals and projects;
- Supervise the work of cost engineering personnel, including on the job training;
- Monitor, analyze and report the cost status to the project manager and other relevant authorities;
- Provide cost engineering input for project control and co-ordinate with planning, scheduling, estimating and other disciplines for integration;
- Develop and implement improved techniques for planning and control to maintain the competitiveness of the company's services.

The cost engineer is functionally responsible to the project manager through the manager of cost engineering. He is directly responsible



for assisting the cost-engineering manager in his functions and perform all the supplementary cost related functions depending on the organization. His functions include (13):

- Assist the manager of cost engineering for cost control;
- Prepare the control budget, package budgets for work packages and distribute the budgets into the required cost elements using the project account code;
- Review and update the account code to keep it compatible with the Work Breakdown Structure, the control budget, cost accounting and reporting;
- Prepare and issue trend reports including analysis and evaluation;
- Prepare change order budgets, based on the change order estimates prepared by estimating for authorized changes, and update the control budget as well as the package budgets affected;
- Prepare and issue cash flow schedules;
- Assemble the actual costs and commitments to date;
- Prepare a cost forecast for the work to be done and a projection of the cost at completion;
- Prepare a monthly cost report, summarizing the cost performances and status, for management review;
- Maintain and operate an early warning reporting system.

His supplementary functions may include:

- Quotation evaluations as related to equipment cost versus installation cost;

- Economic evaluations as related to process optimization;
- Assistance to scheduling by providing the manhour input for activities;
- Assistance and home office support to the field cost engineer depending on the organization.

Additional duties may be assigned to the cost engineers depending on the requirements of the individual projects. However, it is important to remember that the cost engineering department cannot run a successful cost control operation without active co-operation and input from the other project related disciplines. As such, it is necessary to describe briefly the cost related functions of other project related disciplines also. The estimating functions can be summarized as follows (14):

- Prepare the cost estimates for the proposal and verify that all known costs are included and are correct, including application of cost adjustment factors, overheads, burdens, etc.;
- Prepare a summary of the contingency allowances as applicable;
- Prepare a summary of the probable cost escalation for application to the estimates and comparison with the actual escalation;
- Prepare a summary of the financing costs, the cost of taxes, etc. as they relate to the project and the estimate. In the proposal stage these taxes are added to the estimate and during the execution stage the actual costs of taxes incurred are distributed periodically;

- Prepare a summary of the freight, transportation costs and other overheads related to procurement of materials and equipment;
- Prepare a summary of miscellaneous overheads and expenses;
- Prepare cost estimates, as required by each functional group, during the execution stage, including estimates of changes and job forecasts as they relate to the scope schedule and budget;
- Assist the purchasing department in verifying the cost of each item by analyzing the purchase orders to ensure that all the commitments are known and documented.

The cost related functions of the design/engineering manager include:

- Prepare and report activity status (including design, studies, etc.) using progress percentages, graphs and other reporting formats as needed;
- Report the time and rates charged by design/engineering personnel via time sheets;
- Manhours expended by activity;
- Trends and scope changes, etc.

The cost related functions of the procurement department include:

- Tracking and reporting all commitments and expenditures on each purchase order;
- Issuance of vendor advices initiating changes to issued purchase orders;
- Issuance of contractor advices initiating changes to established contracts;

- Issuance of bid analysis documents to the project manager summarizing the cost and commercial aspects of enquiries;
- Maintenance of a purchase order log and records of all transactions;
- Damage and loss claims, collection and reporting;
- Expediting of orders, and tracking, logging delivery status including reporting;
- Processing of invoices related to procurement, verification and approval for payment;
- Preparation of purchase order summary report, which is a summary of all costs related to procurement including firm commitments, open commitments, expenditures, escalation, freight, handling, taxes, etc.

The cost related functions related to construction (on site) can include:

- Reporting of actual manhours (labour) and rates via timesheets;
- Progress and quantity reporting showing current status and forecast;
- Actual cost data and forecast including overheads and expenses;
- Reporting trends and changes originating from the site;
- Reporting labour distribution and performance data (including productivity data);
- Monitoring progress of contracted work to determine compliance with contract terms in the areas of budgets, schedules, sponsor approvals, invoicing, etc.;

- Review and verify contracts progress reports against the actual measured progress just prior to the cut-off date for control;
- Review, verify and approve requests and invoices for progress payments;
- Review all change order requests to determine compatibility with the contract terms, justification and approval.

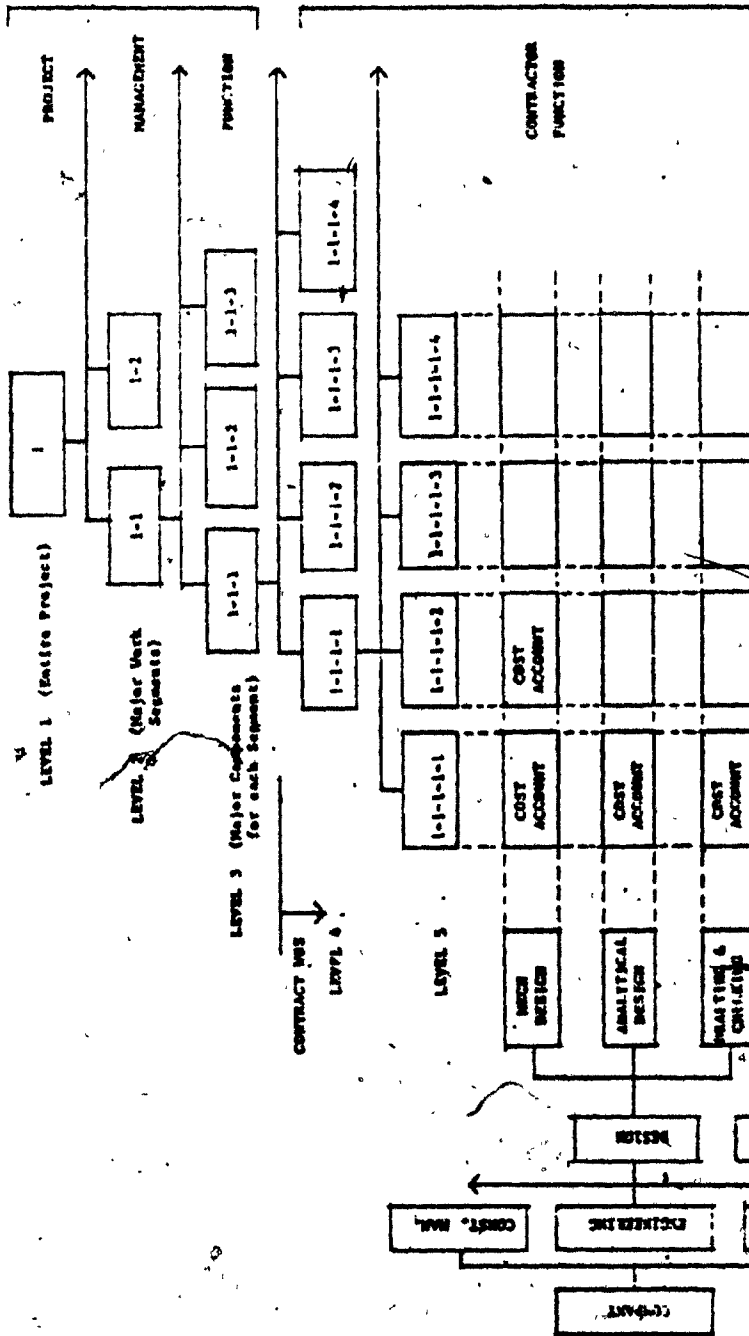
CHAPTER FOUR

PROJECT COST CONTROL SYSTEM: THE MAIN ELEMENTS

## Chapter 4

### 4.1 The cost control technique - The Work Breakdown Structure:

Several different techniques are used in project cost control depending on the nature and the size of the project. Some of them are integrated with network planning. Tying costs to activities may be valuable in order to make early estimates, but it may not be enough for cost control, especially of major construction projects involving multiple disciplines and lengthy schedules. The main reason for this is that the detail level may not be enough for such complex projects. Probably the most frequently used method for cost control of such projects is the 'WBS' or the 'Work Breakdown Structure' in which the project is systematically broken down into a number of work packages, sub-packages and finally into its elements thus resulting in a very detailed analysis for resources generation and control. Completeness of information is an automatic result of a good 'WBS', and the more levels it contains the more reliable the information will be for progress and cost control. From the project management viewpoint, it is important to develop the WBS to the contract level at least, further subdivision being made with the help of the contractors/suppliers (15). For example, the highest level of the WBS is the entire project, the second level being composed of major work segments, the third level being composed of the major components of the work segments, followed by further breakdown. Figure 4.1.1 shows an example of a WBS where the fourth level is the contract level, the subdivision beyond that level being made by the



Cost Accounts at Level 5 as indicated by the Contractor (and approved by the Project Management Team) for control.

FIGURE 4.1.1. Work Breakdown Structure (and WBS Integration with the organizational structure.)  
 A System for measuring Cost and Schedule performance,  
 by Richard H. Campbell, AMCS Transactions, 1978.

SOURCE:

FUNCTIONAL ORGANIZATION OF THE PROJECT

MAN. TEAM FOR CONTRACT



contractor. The contractor, in effect, develops a WBS for his contract, by dividing the major components in the third level of the project WBS into manageable pieces of effort for which internal responsibilities can be assigned. During proposal activities, the contractor may propose alternatives to some selected elements of the WBS in order to enhance the effectiveness of the contract WBS in achieving the project objectives. The changes proposed by the contractors are reviewed by the project management team, and after negotiations and approvals these selected elements become the basis for further evolutionary extension by the contractor during the contracted effort. The contractor indicates the levels of his contract WBS at which cost and associated data reporting is made to project management. Traceability of data is required to this control level indicated by the contractor, and approved by project management, which is, in fact, the cost account level. It is important to integrate the project management organization functionally with the contractor developed portion of the WBS. The functional integration should include the related disciplines including engineering, planning, scheduling, cost control, construction management, etc., for assignment of responsibility (for identified work tasks) and to facilitate performance measurement and control through organized data accumulation. The WBS is structured in accordance with the way the work will be performed and reflects the way in which project costs and data will be summarized for control. The preparation of the WBS should also consider other areas which require structured data, such as scheduling, contract funding, technical performance parameters, etc.

As the WBS forms the central framework for the project from which all required scope data is derived, its development should be carefully structured with inputs from all key personnel involved. The WBS should define the elements and type of work, exact quantification, the degree of detail and the brand name where necessary. The responsible department or discipline engineer should assist in establishing the cost calculations for each package. He can discuss modifications to the account codes with the cost engineer in order to accommodate the items left out to this stage, and can assist the estimating engineer in updating the estimate by providing any specific data required. All the estimates are based on the scope definition available at the time of estimation and all the project scope data is derived from the updated WBS at all stages. The direct and indirect costs for each package are estimated separately and distributed in the account code structure while establishing the control budget. The actual costs are accumulated on the same basis using the same account code, the WBS elements representing the cost accounts being controlled for progress and quality simultaneously. Thus progress, cost and quality control is exercised over the project on the basis of the same elements.

The WBS can be entered into a network showing milestones if required for network control. In a computerized project control system the 'WBS' will form the master scope file from which all the project scope data can be retrieved as required.

Changes to the project scope (and hence the WBS) as well as the account code structure, are inevitable as the project develops. However, it is important to note that if the scope is allowed to change

freely without justification, it will render all previous plans void making it difficult to achieve the desired performance, whether the WBS approach is used or not.

4.2 Account code structures:

Account code structures are required to identify project elements in order to assign budgets and collect costs on the same basis to facilitate a comparative analysis. Account codes should be cost oriented and should closely follow the work plan reflecting the financial and contractual obligations of the project and the breakdown as required (16). The two types of cost codes commonly used for the account code structures are: (a) the standard cost code and (b) the project cost code. They are also used to interface with the numbering of drawings, specifications, material procurement documents, activity labels on schedules, quality assurance reports, etc. and thus form the focal point of the project control system.

(a) The standard cost code -

The standard cost code provides for uniformity, transfer and comparison of information among projects, which is invaluable for estimating and forecasting purposes. In some sectors of construction, there are more or less widely accepted industry standard cost codes. The Uniform Construction Index, developed as a joint effort of eight industry and professional associations, is a standard cost code designed primarily for building construction. Some examples of the standard cost code 'UCI' are as follows (17):

0	0
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 → Conditions of contract

00000 - 00099 → Unassigned

0 1 → General requirements

.01020 → Allowances

01021 - 01099 → Unassigned

.01100 → Alternatives

01101 - 01199 → Unassigned

.01200 → Project meeting

.01201 - 01299 → Unassigned

0 3 → Concrete

etc.

0 2 → Site work

.02000 → Alternatives

02001 - 02009 → Unassigned

.02010 → Subsurface exploration

.02011 → Boring

.02012 → Core drilling

.02013 → Standard penetration tests

.02014 → Seismic exploration

02015 - 02099 → Unassigned

The standard code is developed very carefully, based on the individual company requirements and past experiences, as it forms the basis for the project cost codes and is the main tool for creating a data bank for estimating and forecasting.

(b) The project cost code:

The project cost code is project oriented although it is normally based on the standard cost code. It is a systematic categorization of all the work or cost items related to a specific project. There is normally a different project cost code for each project, but as they are derived from the standard cost code, cost data from different projects can be compared and used for estimating purposes.

The project code should be prepared as early as possible after the project is authorized so that costs can be distributed accurately from the very beginning. As the project code is adapted to incorporate the peculiar aspects and characteristics of the specific project, it contains some components not found in the standard code and it deletes anything not required for the job at hand. It is important to keep the project code as concise and simple as possible, in keeping with the objectives of planning, documentation and control, because it serves as an interface among all the administrative and supervisory personnel. Apart from the standard cost code being used by the builder organization, it may be necessary to co-ordinate the project code with the sponsor's cost structure.

The project code is generally composed of the following elements: (Figure 4.2.1)

- A project number;
- An area-facility code;
- A work type code derived from the standard code;
- A distribution code.

Developing the project code from a standard code:

The project number (18):

The project number should be chosen to identify the project for which the costs are being accumulated and should show things such as the type of project, the type of contract, the year it was started, its sequence with other projects started that year and possibly its location.

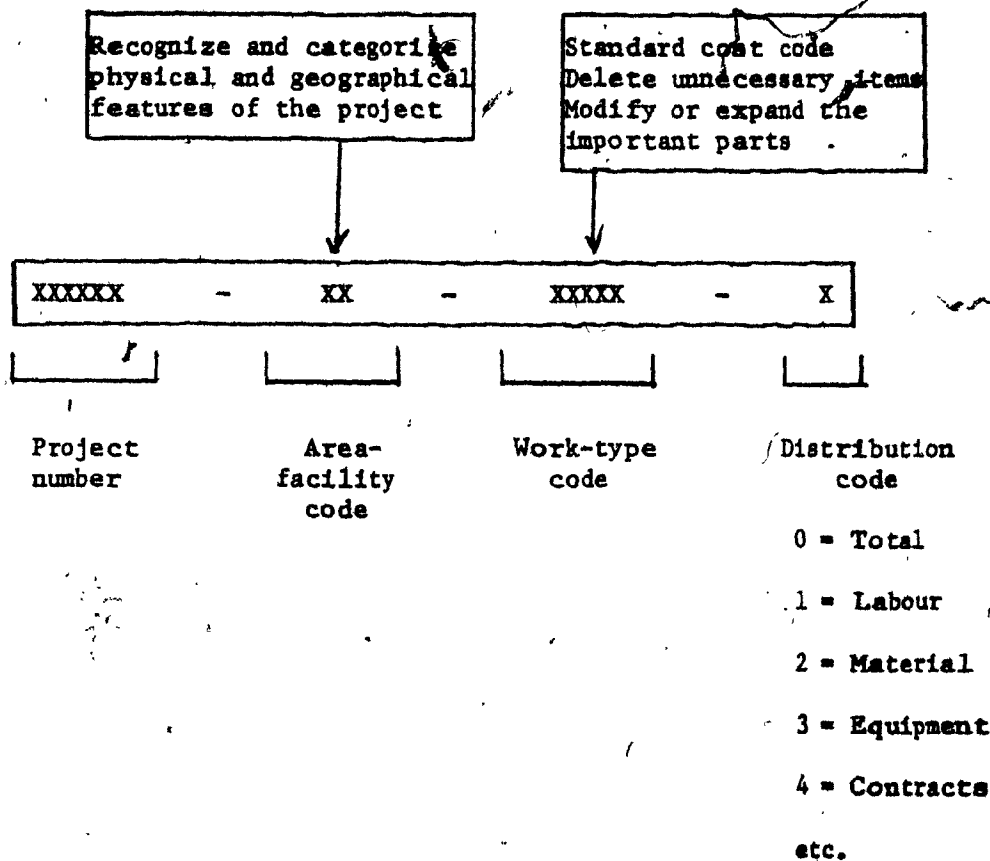


Figure 4.2.1 The Project Cost Code

Source: "Professional Construction Management", by Barrie and Paulson, p. 253.

It is normally found practical to print the project number only in the report heading rather than use the extra digits and spaces for each line item reported. Similarly in computer files using magnetic media, the project number will normally appear only at the beginning of the file, and not in each cost record.

The area-facility code (19):

The area-facility code is based on distinct geographical and physical features that logically distinguish one part of the project

from another, which often forms the basis for structuring the construction management operations. These major divisions of a project can be termed as 'areas'.

e.g. A hydroelectric project would have the following areas and more

- 1) dam
- 2) tunnel
- 3) shaft
- 4) penstock
- 5) powerhouse
- 6) transmission lines
- 7) support facilities, etc.

Within each area there can be further subdivisions which can be referred to as 'facilities'

e.g. Under area 5) the powerhouse there might be a number of generator units, each of which can be considered a facility.

The area-facility code helps to keep track of the costs by different areas and to isolate the costs attributable to the different area managers or supervisors. It is important not to confuse the area facility code with the work-type code.

The work type code (20):

The work type code is basically the responsibility code portion of the project cost code. It is based on the standard cost code and is categorized along recognized trade and subcontractor specialities which helps in tracking costs to the respective trade and the parties responsible for them. This code is derived from the standard cost code by first deleting the items that have no relationship to the project and then making additions to suit the level of detail required by the project at hand. In some categories it may be sufficient to collect the costs at the level of the major breakdown. On the other hand, the standard cost code may not have enough detail for some other categories making it necessary to subdivide the codes further into more components.



The distribution code (21);

The distribution code is required to break the details further down into resource elements such as labour, materials, equipment and subcontract costs, for resource management. By using the distribution code the costs associated with labour can interface with the payroll system, the material costs can tie into the procurement schedule and accounts payable, the subcontract costs can go into accounts payable, the equipment costs can be either internally accounted or paid to rental agencies, and all the components aid the development of accurate cash flow forecasts and estimates. Company standards are normally used for the code numbers to be used for the distribution code.

An example of a typical project cost code is shown in Figure 4.2.2.

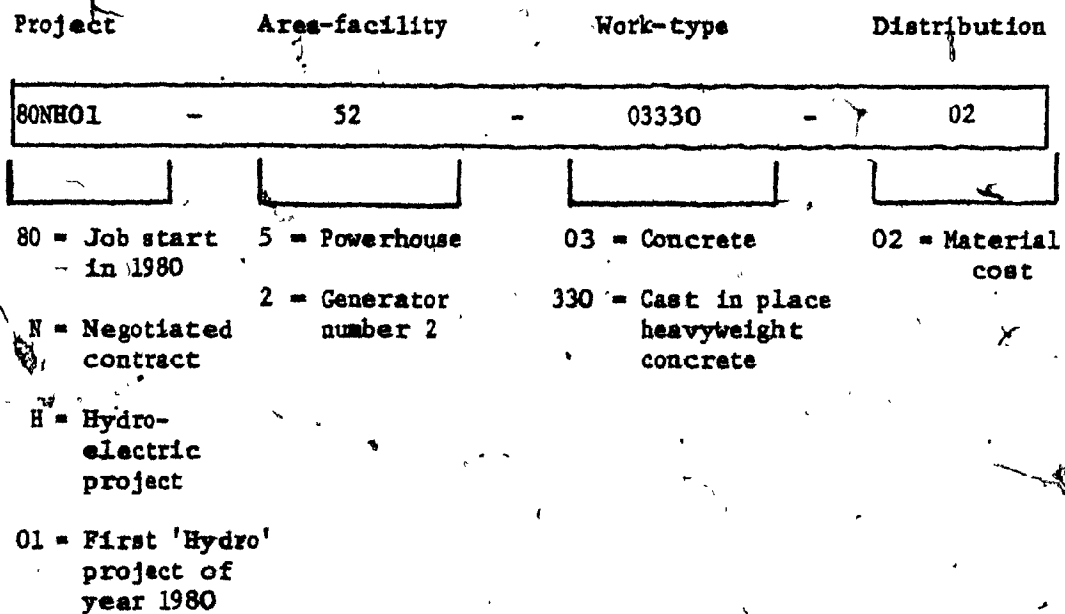
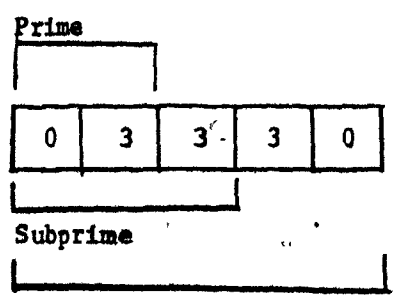


Figure 4.2.2 Example Project Code

Source: "Professional Construction Management", by Barrie and Paulson,  
p. 255.

The desired level of detail in a cost code is normally reflected in the account hierarchy which can apply in the standard cost code as well as the four elements of the project cost code (22). The highest level of enumeration in a cost code is normally known as the prime account, the next level of detail or subdivisions being referred to as the sub-primes with further levels of detail being added as required.

For example the 'work type' or 'construction' code item '03330' shown above can be broken down as shown below:



Detail Level

where

- 03 = concrete (prime account)
- 033 = cast in place concrete (subprime account)
- 03330 = cast in place heavyweight concrete (detail level)

#### 4.3 The project cost estimate:

As the project cost estimate is the basis for preparing the control budget for the project, it is necessary to discuss briefly the different types of estimates and how they are prepared.

An estimate is, in fact, a cost forecast representing the anticipated final cost of the project for a predefined scope and time frame. The choice of the estimating technique depends on the purpose of the estimate, the expected accuracy, the scope definition, the time and the funding available for the development and presentation of the estimate. In general, the more detailed the scope definition, the better the estimating accuracy (possible). The terminology commonly encountered in describing the types of estimates is as follows:

- Order of magnitude estimate;
- Conceptual or preliminary estimate;
- Definitive estimate;
- Tender check estimate, etc.

These estimate types are discussed, along with their uses, under the case study in Chapter 6. Figure 4.3.1 summarizes the estimating methodology graphically for the first three estimate types mentioned above, the definitive estimate being used as the basis for preparing the control budget. The tender check estimate is obtained by further detailing (and rearranging in parts if necessary) the definitive estimate, and as the name suggests it is used for evaluating contractors' bids. Figure 4.3.2 shows an example of a data sheet showing the basic data requirements and the expected accuracy parameters for the four estimate types. Although these illustrations are not meant to be regarded as the

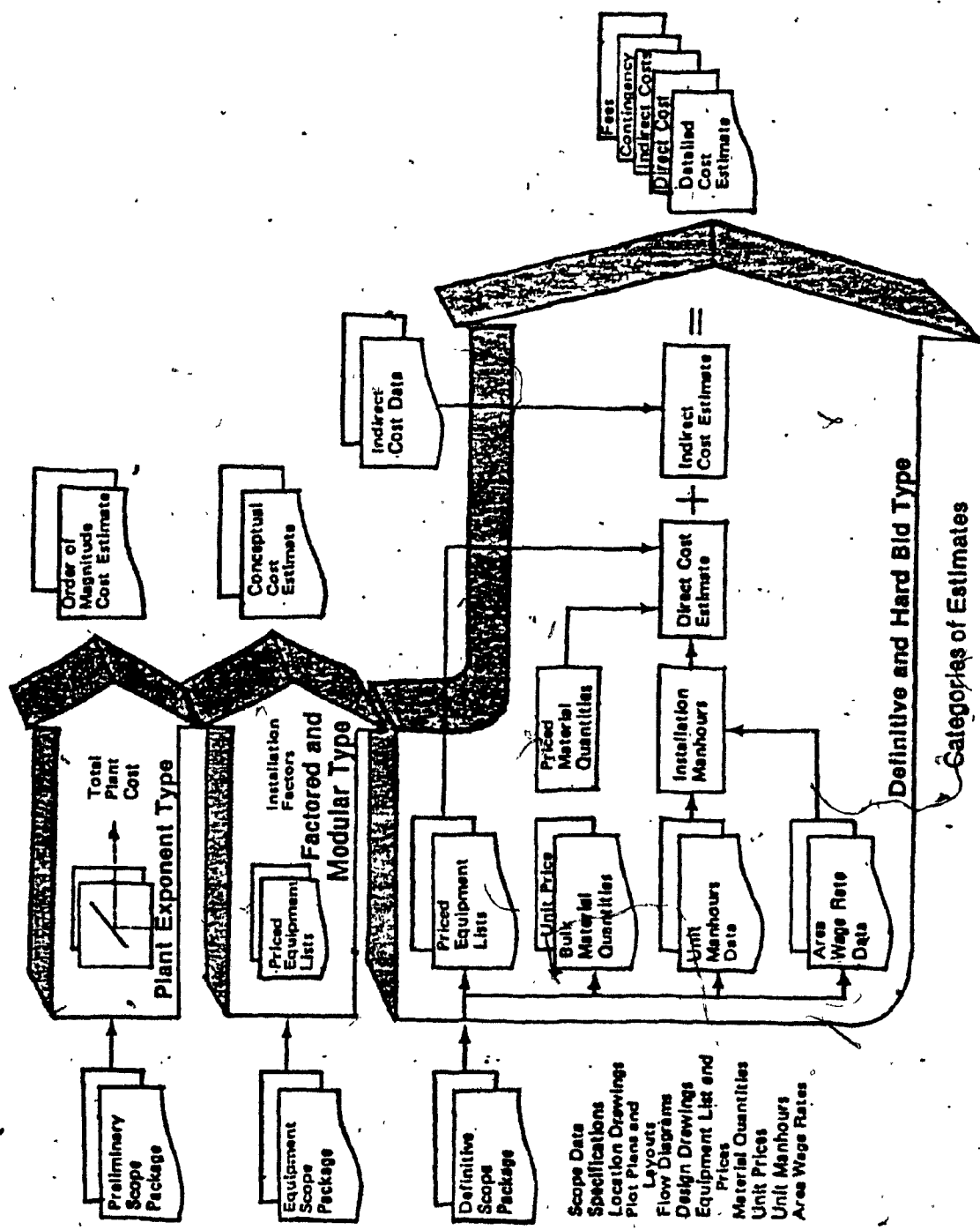


Figure 4.3.1 The Estimating Methodology

Source: "Managing Capital Expenditures for Construction Projects", by Guthrie, p. 36.

Estimating Categories		
Order of magnitude	Complexity	Order of magnitude

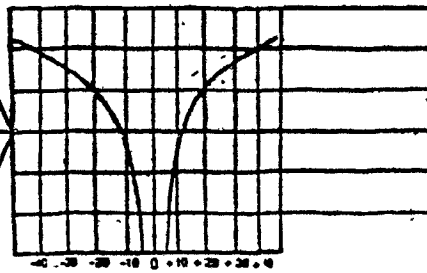
### ESTIMATING DATA SHEET

Use this data as a general reference to the minimum information required for five classified types of estimates and the accuracy parameters expected from each under normal conditions.

#### Basic Scope Data

Order of magnitude	Complexity	Order of magnitude	Location, site requirements Plant type and capacity Siting and structure requirements Storage requirements Utility plant requirements Auxiliary facilities and effluent piping	Project Scope
			Location General description Soil bearing data Site plan and data maps Road and rail accessibility	Site Data
			Rough sketches Preliminary flowcharts Engineered flowcharts	Process Description
			Preliminary lists and specifications Engineered equipment list and specifications Preliminary arrangement drawings Engineered arrangement drawings	Equipment Parameters
			Preliminary flowcharts and specifications Engineered flowcharts and specifications Preliminary piping layouts and vessel sketches	Piping
			Rough sketches Engineered foundations Engineered structures Detail drawings	Concrete
			Rough sketches Engineered structures Detail drawings	Structural Steel
			Preliminary instrument list Engineered list and flow diagrams Detailed drawings	Instrumentation
			Preliminary motor list and sizes Preliminary single line diagrams Substation lists and specifications Sumner's diagrams and specifications Engineered motor list and sizes Engineered single line diagrams Detailed drawings	Electrical
			Insulation specifications Preliminary list of insulated items Plant list and detail drawings	Insulation
			Paint specifications Preliminary list of painted items Plant list of painted items	Paint
			Preliminary building size and type Preliminary structures, size and weight Building plans and elevations Structural plans and elevations Cost building drawings Detail structural drawings	Buildings and Structures
			Preliminary utility systems Preliminary storage systems Preliminary effluent piping systems Plant utility systems Plant storage systems Plant effluent piping systems	Offsite Facilities
			Engineering and drafting Plant layout drawings Revisions	Manhours

#### Accuracy Parameters



Plant equipment type  
Factored type  
Modular type  
Definitive type  
Hard bid type

Estimating Data Sheet  
Figure 4.3.2

Source: "Managing Capital Expenditures for Construction Projects",

by Guthrie, p. 38.

standards for estimating every type of construction project, they are representative of the type of data needed for estimating and the methodology. The definitive estimate is based on, and structured along the same lines as the work breakdown structure in order to facilitate budget preparation and distribution.

The two important factors, apart from scope changes, which must be taken into consideration while preparing an estimate, are cost escalation and contingency. A detailed discussion, on how these two factors are dealt with, follows.

4.4 Cost escalation and how its impact is monitored:

Cost escalation, as it relates to a project, is a result of increases in the manpower wages/fringe benefits, the material/equipment costs, financing charges, other indirect costs, overheads, etc., due to factors such as inflation, an increase in the cost of living, fluctuations in the prime lending and foreign exchange rates. As it is difficult to predict the exact magnitude of escalation costs beforehand, the methodology for dealing with them can be as follows:

- An allowance is made in the definitive estimate for cost escalation, based on various forecasts by private and public bodies. If the escalation indices in the project region vary significantly for each resource, individual resource related indices should be applied to the resource costs to arrive at the estimate. A composite index can be used only in cases where the escalation in individual resource costs is more or less equal. The allowance for each cost account (or a larger WBS element as required) is added on to the basic estimate for the element/operation. The total cost estimate thus obtained becomes the basis for the control budget of the WBS element in question (after adding any estimated contingency costs);
- The actual escalation costs are monitored to detect any variances from the allowances made; and to determine which resources/operations have cost more/less than anticipated, why they cost more/less, and whether the escalation allowance for the remaining work needs to be updated;

The escalation allowance is updated periodically or as required if it is found that the previous allowance is insufficient due to the costs being consistently higher than anticipated. The update frequency for escalation does not have to be the same as the control period (monthly).

For cost plus contracts (which is assumed to be the case in this report) all the reimbursable costs (as per the agreement), including the related escalation costs, are normally billable to the client. In such cases, the project management team is responsible for ensuring that the contractors' claims are justified, and that there is no overclaiming, by examining if necessary the claim back-up data (for example, subcontractors' and raw material suppliers' invoices, etc.). For lump sum or unit price contracts it is the responsibility of the suppliers/contractors to include the escalation allowance in their bids. The project management team provides the escalation allowance for its own services and for direct hire work (subject to approval by the sponsor).

During the control phase the escalation costs are segregated by using the distribution code (or as per the coding procedure for escalation) wherever they can be identified. Some of the major sources of information for identifying escalation costs are payroll reports, purchase orders/contracts (commitment breakdown), accounts payable reports, payment listings, payment and holdback status reports, etc., as applicable. Where such information is not readily identifiable, the related project personnel should be consulted immediately upon detection of a cost overrun at the cost account level during the standard verification and approval procedures for payments. The escalation costs collected



through the distribution code can be summarized at the prime/subprime level in the account code if required (in regions where the escalation rates are very high) to show the escalation costs in the monthly cost reports. Regardless of the type of the contract it is important to include escalation clauses in the agreement such as (23):

- A description of the specific cost elements, contributing to the budget, which are subject to cost escalation, and those which are not;
- The indices and methods to be used for calculating escalation and/or their source;
- An indication of the frequency at which the basic contract budget will be adjusted (based on the update period for escalation rates);
- Who is to absorb the additional costs until formal billing;
- The method of calculating the effect of local inflation for contracts involving foreign currencies (international projects).

#### 4.5 Contingency management:

In general, contingency for construction projects implies the cost arising from factors, and incidents, difficult to predict during the estimating stage. The exact definition of contingency, and what it includes, may differ from company to company depending on the operating methods. For example, some companies may treat estimating errors and omissions as contingency, whereas some others may treat them as cost overruns (as will be seen in the case study, Chapter 6). In general, it is practical to treat the costs resulting from major unanticipated problems (such as labour strikes/walkouts, delays due to continuous bad weather, etc.) as cost overruns due to unforeseen circumstances, and the contingency allowance should neither be made nor used up to cover them. The main possibility of controversy here is in deciding if the cost overrun experienced (or expected) is a result of an error on the part of the project management company or the contractors/suppliers (such as estimating errors or omissions of major items). In such cases it is normally mutually beneficial for the sponsor, and the other party concerned, to avoid disputes over who is to absorb the costs. This, perhaps, justifies the need of cost plus contracts, stipulating the methodology to be followed under such circumstances. The related contract clauses can include the financial liabilities of the parties, the nature of problems (resulting in cost overruns) which may be considered for additional funding, the data requirements for justifying the additional funds, assessment and approval procedures, etc. Even with these arrangements the problem of controversy may still exist,

as it involves people and their attitudes/viewpoints which may differ considerably from one another.

This leaves the sources of contingency costs resulting from the uncertainty and shortcomings in the scope definition, unanticipated site conditions requiring minor changes to the work plan, etc. A reasonable allowance can be made for such costs based on past experience, statistics, judgment and a risk analysis if necessary. This allowance should be made in consultation with the contractors concerned for the cost plus contract budgets. The contingency allowance for direct hire work and the professional services will be provided directly by the project management company, the allowances for lump sum contracts being made by the contractors concerned in their bids. If there is a long time lapse between the preparation of the definitive estimate and the contract awards or purchase order issuances, the contingency allowance for the contract/purchase order in question must be adjusted if necessary to reflect any new information or further detailing of the scope definition. In general, the more detailed and accurate the scope definition, the less the contingency allowance required. Thus the contingency allowance in the 'order of magnitude' estimate is normally the highest (for the project) and is then reduced successively through the conceptual and definitive estimating stages as required to its minimum when the commitment is confirmed by signing an agreement.

The estimated contingency spread for the project can be plotted on a graph based on the schedule of activities which are likely to require contingency funds as per the estimate (Figure 4.5.1). The actual contingency costs can be plotted similarly (on the same graph if needed)

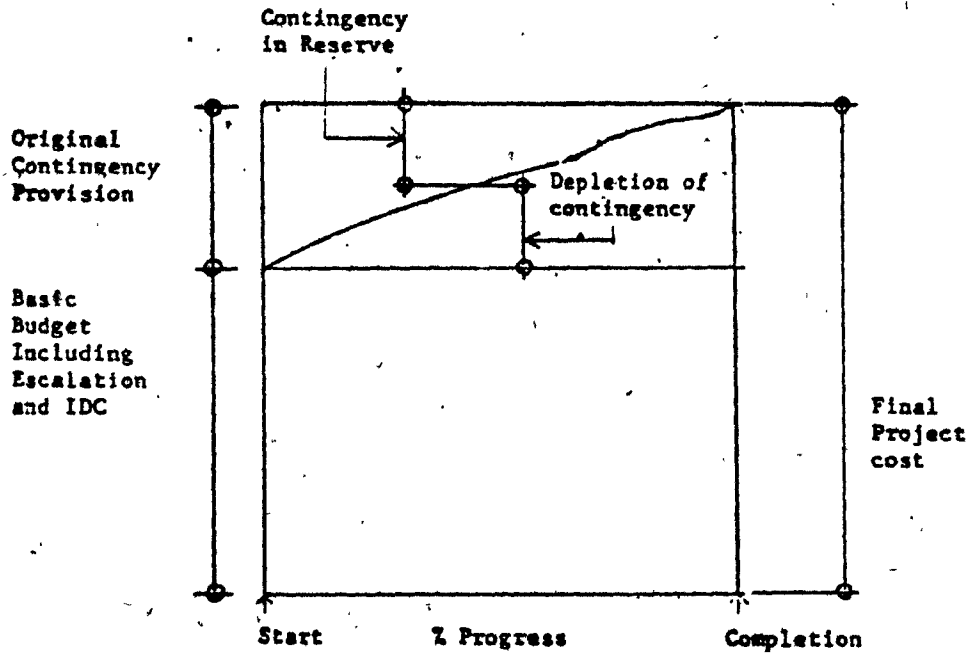


Figure 4.5.1  
Depletion of Contingency

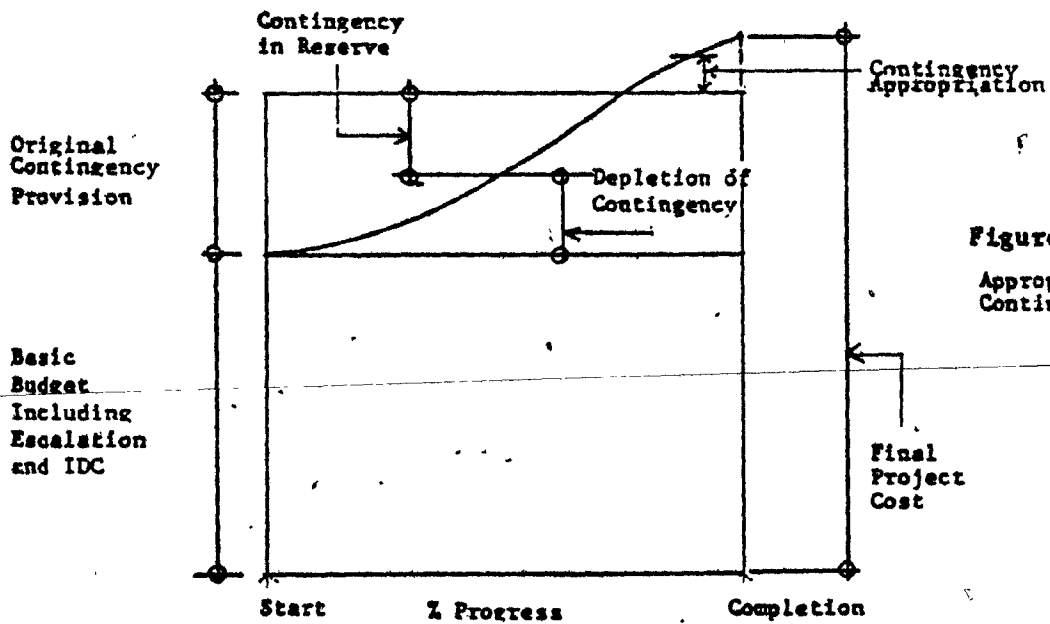


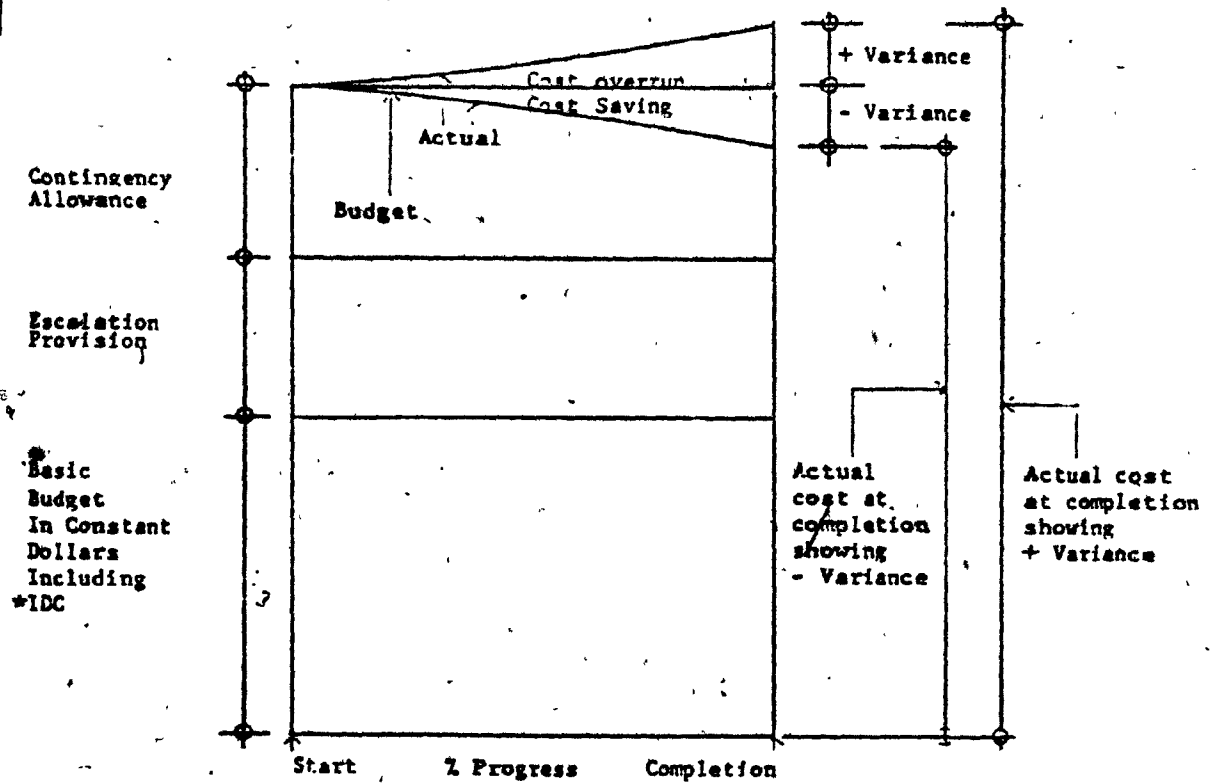
Figure 4.5.2  
Appropriation of Contingency

Source: A major technical report, "The Management of Contingency and Escalation in Construction", by W.E. Taylor, 1979, p. 31.

to show the actual rate of contingency depletion (as shown in Figure 4.5.2). If the depletion rate is consistently higher than the allowance (on the basis of the actual contingency cost to date and the forecast contingency cost at completion), additional funds will have to be negotiated for, depending on the contract agreement. On the other hand, if there is some contingency allowance left over (on the same basis as stated earlier), it will constitute cost savings (as shown in Figure 4.5.3). In case of a cost plus contract the over/underrun will normally be passed on to the sponsor (assuming no controversies or problems arise), whereas in case of a lump sum contract the contractor will bear the impact on his budget. This is easier said than done, especially in case of a cost overrun, as no party will be ready and willing to bear the additional costs if they can help it. The only way this problem can be partially solved is by making the contract clauses (covering contingency costs) as clear as possible, and by working in close co-operation to reach a solution (which, again, is a people problem).

The contingency management methodology can be summarized as follows:

- The estimated contingency allowances for the individual control elements will be held in reserve as a lump sum total for the project;
- This total allowance can be spread over the project schedule based on the estimated spread of the contingency costs as they relate to the operations which are likely to generate them. (This spread can be represented by a graph as shown in Figure 4.5.1);



\*IDC - Interest/Financing Cost During Construction

FIGURE: 4.5.3 Components of Total Project Cost

SOURCE: A major technical report, "The Management of Contingency and Escalation in Construction", by W.E. Taylor, 1979, p. 6.

- The cost variances from the budgets assigned to the control elements (excluding the contingency allowance which is now part of the lump sum figure) will be analysed periodically to determine the causes contributing to the overrun. The contingency costs to date will be the difference between the total actual costs to date minus the sum of the budgeted cost of work done (including the escalation) and the cost of scope changes or any cost addition (to that particular cost element) due to a budget transfer;
- The actual contingency costs thus obtained will be plotted and monitored against the expected contingency costs. If the two amounts/graphs match reasonably well (the difference being within the tolerances established), contingency funds can be allocated to the cost elements needing them, the lump sum allowance being depleted by the allocated amount (total). Whether the allocations will be based on the budgeted spread or the actual spread will depend on the terms of the contracts involved. If the agreement says that any costs resulting from estimating errors (including contingency allowance) are the responsibility of the estimator/bidder (after signing the contract), the budgeted spread will have to be used for allocation except in unusual circumstances. But for a cost-plus contract, within the tolerance limits, the actual costs may be used;
- If the two graphs (and the expected and actual contingency costs) differ by a wide range (i.e., a margin larger than the

tolerance ) a thorough analysis may be necessary to determine  
the problem causes and take corrective action.



#### 4.6 Trending and cost trends:

A 'trend', in project management, implies any deviation from the project plan (or the planned performance), which can affect the outcome of a project (24). Trending, therefore, is an early warning system designed to detect and report any deviations from the plan as well as their potential impact. It facilitates the decision making process for corrective action by providing the management with timely information regarding the potential time and/or cost impact of any changes/deviations ahead of time. Trending is important in the preconstruction stages also, especially for projects involving multiple disciplines where it is necessary to keep track of the deviations (and their impact) originating from each discipline. Any trend, which is expected to result in a cost impact directly or indirectly, can be termed as a cost-trend. Cost trend types include (25):

- Scope trends, which are deviations from the plan resulting in a change of scope. They can include design changes made for better technical performance (of the facility after completion), essential changes to the construction plan, etc. These are sponsor authorized changes affecting the control budget directly;
- Forecast trends, where the actual cost is affected due to a cost variance between the actual commitment/cost and the budget, or due to an unauthorized deviation from the plan and/or scope resulting in a cost overrun. Forecast trends do not change the control budget under normal circumstances;

- Budget transfer trends, which are transfers of individual cost items within the control budget, such as changing from labour and material to subcontract. In such a case the control budget remains unchanged but the changes in individual control elements are reflected in the revised budget.

Trending is initiated at the start of design and maintained through the construction phase (26). During the construction phase trending becomes a part of performance control and data collection. Trending is a continuous process and is, in effect, a system for maintaining a comprehensive diary of the project. Trend control formats can include cost trend reports (Figure 4.6.1), a cost trend register, a trend forecast control log and a project control chart for trend status. The major areas to look for cost trends include (27):

- Design and/or specification changes;
- Material quantity and/or price changes;
- Manhours and/or wage rate changes;
- Unit rate changes for contracts/purchase orders;
- Changes in indirect/overhead costs;
- Changes in contracts;
- Schedule changes;
- Revised escalation or foreign exchange rates, etc.

Although the cost engineering department is responsible for initiating and maintaining the trending system, the success of the trending system depends on active participation by all key personnel on the project in relaying trend data to the cost engineering department. Trend reporting should be frequent, simplified and comprehensive.

HOLMES & NARVER, INC.

COST TREND REPORT

CLIENT \_\_\_\_\_ CONTRACT \_\_\_\_\_  
 LOCATION \_\_\_\_\_ DATE \_\_\_\_\_  
 PROJECT \_\_\_\_\_ REVISION \_\_\_\_\_

TREND NO. 11 TREND TYPE FORECAST

DESCRIPTION OF TREND

ADD TO THE SUBCONTRACT FOR EARTHWORK & SITE PREPARATION  
 (S/C 3029-5-46 NX)

1. RENOVAL OF FILL MAT'L	\$1,600
2. INSTALL WATER LINE	3,100
3. ADDED DRAIN LINE	<u>2,600</u>
TOTAL	\$7,300

SOURCE OF TREND

ESTIMATE VERSUS PURCHASE ORDER

COST IMPACT

DIRECT FIELD SUBCONTRACT \$7,300

Type of Estimate Factored  Semi-definitive  Definitive

SCHEDULE IMPACT

NONE

INITIATED BY C. WELLS DATE 7/1/75

APPROVED BY TCH DATE 7/27/75

FIGURE: 4.6.1

Cost Trend Report

SOURCE: "Managing Capital Expenditures for Construction Project"  
 By Guthrie, P. 184

The functions related to trending can be as follows:

- Review project data from the various disciplines and areas;
- Detect and analyse deviations from the planned performance;
- Initiate or update trend and cost trend register;
- Prepare trend report and discuss with project manager (or his authorized representative) for preliminary approval;
- Analyse trend reports, determine cost trend type and the impact on the schedule by calling trend meetings periodically or as needed;
- Issue cost trend reports, update cost trend register, and file cost trend data, after approval by the project manager and the sponsor when necessary;
- \* Cumulate trend reports to assemble periodic summaries of trends for discussion in the trend meetings;
- Make any modifications necessary and prepare the cost trend input to the monthly cost report.

In order to carry out cost trending effectively the assigned cost engineer should maintain a personal contact with the key personnel on the project almost on a daily basis. A daily review of the project correspondence file can also reveal significant cost related data. Impact costs (for the project as a whole) resulting from the trends can be reviewed during the trend meetings before issuing cost trend reports.

#### 4.7 Scope development and changes:

It is very difficult, if not impossible, to define the exact scope of a major construction project in the early stages. As the project develops, changes to the original scope are inevitable due to modifications to the overall project plan including design improvements, additional facilities, etc. Changes of scope normally originate from the sponsor himself or from the design/engineering disciplines. The only other possibilities are 'Acts of God' such as unexpected site conditions or changes in the project environment resulting from influences beyond control of the project management team. While developing a change of scope, it is important to take into consideration its impact on the overall project plan (especially the critical activities affected), and hence the impact on the project schedule and/or budget. The scope change data flow can be as follows (28):

- The original inputs come from scope trends and direct requests from the client through the project manager. These changes are reviewed for their cost and schedule impact on the project and a formalized change request is filled out for each change;
- The request is duly recorded in the scope change request register by the assigned cost engineer, and submitted to the project manager for his and the sponsor's approval;
- After the primary approvals are obtained, the contract change authorization (change order) package is prepared as described below:
  - The engineering disciplines develop the scope of the approved change in detail and prepare the necessary drawings,

specifications, equipment lists and all the other documentation needed to modify the schedule, and estimate the cost impact on the project;

- Based on this information, the materials department develops definitive material quantities and forwards them to the estimating department;
- The procurement department obtains quotations, pricing data, delivery dates, etc. and forwards them to estimating and scheduling;
- The scheduling department makes the necessary modifications to the schedule and forwards the information to estimating highlighting the major schedule changes (critical areas) likely to affect the cost of the project as a whole;
- The estimating department then prepares a definitive cost estimate of the scope change, showing any impact costs on the remaining project separately;
- The assigned cost engineer then assembles a change order package including the cost estimate for the scope change, the updated schedule, a contract change authorization and the back up data as required including the impact costs;
- This package is submitted to the project manager and the sponsor for review and their formal approval. Modifications are made if necessary and the package is issued for implementation after approval;
- The cost engineer then updates the control budget to incorporate the scope changes and any other impact costs in their respective accounts.

The assigned cost engineer maintains an up to date record of all scope change requests, scope changes, the related cost data and the contract change authorizations issued.

#### 4.8 Budget management and control:

The budget management and control system is used for maintaining an up to date control budget for comparison against the actual costs, and for preventing any unauthorized scope changes (through budget control). The budget control system operates under three distinct phases for each element (in the WBS with an account), being controlled. These phases are (29):

- The initial control budget;
- Authorized changes to the initial control budget;
- The current (revised) control budget.

The initial control budget (30):

The initial control budget is based on the definitive estimate and can be defined as a distribution of the definitive estimate within the project code of accounts according to the work plan and control strategy. This permits accumulation of budgeted costs and actual costs for the control elements on the same basis, thus facilitating a comparative analysis. The assigned cost engineer is responsible for preparing the control budget, and if at that stage the estimate is not compatible with the level of detail required for the project cost code, the cost engineer should develop it using 'suspense' accounts (to be detailed later) to match the scope development, and by updating the code of accounts. The sources of information can be summarized as follows:

- Estimates from estimating personnel;
- Quotations from procurement personnel and subcontractors;



- Current catalog prices;
- Historical cost data;
- Prorating using historical data or prior estimates;
- Discussions with the discipline personnel;
- Other outside sources such as official publications and statistics.

The initial control budget should be detailed by cost codes in the following categories:

- Direct materials;
- Indirect materials;
- Direct labour;
- Indirect labour;
- Direct contract
- Indirect contract;
- Home office manpower (including engineering, procurement and construction management personnel);
- Home office expenses and overheads;
- Field expenses and other overheads.

Additional categories, such as foreign exchange, escalation, etc., may be included depending on the individual project requirements. The structure of the costs of professional services and fees is also a determining factor. The control budget is normally itemized on a budget worksheet and then the key figures are transferred to the cost summary worksheet after the distribution is approved by the manager of cost engineering and the project manager.

As the project develops, modifications to the control budget normally become necessary due to various reasons such as design/engineering changes for better performance, changes to the work plan, external problems affecting the project, etc. These changes to the control

budget can be divided into two categories namely <sup>(31)</sup>:

- Changes to the budget resulting from scope changes (after client's approval and authorization). The inputs in this case come from the formal authorized change order subsystem described earlier in Section 4.7;
- Budget transfers, which are transfers between individual control elements with the budget, the inputs coming from the cost trends as described under trending (Section 4.6).

In theory at least, the budget is not supposed to be revised to correct estimating errors by the designers/contractors or to pay for unauthorized scope changes. This can result in a cost overrun, but it may be mutually beneficial for the sponsor and the contractors to negotiate a financial solution based on the cost-plus arrangements, if additional funding is needed and justified, in order to avoid major delays and cost overruns (as stated earlier under contingency).

The 'current' or 'revised' control budget <sup>(32)</sup>:

The current control budget, at any given time represents the initial control budget plus the value of all approved contract changes, and hence budget changes, issued to date. The monthly cost report can include the approved control budget at the start of the period or the initial control budget, the approved changes to the budget during the control period and the revised or current control budget.

The current control budget represents the standard for comparison for the actual cost performance on the project, the budget revisions taking place on a periodic basis, or as required, to adjust the budget for authorized scope changes.

The control budget is normally divided up into smaller control budgets for individual control packages or disciplines depending on the control strategy. In some cases, it may be found practical to control by resource budgets rather than the costs. A good example is a manhour budget. As labour wages, fringe benefits and insurance rates are subject to revision depending on union agreements, etc., it may be more practical to control by manhours rather than by costs. Alternatively, the unit labour costs and the budgets will have to be updated constantly.

CHAPTER FIVE  
PERFORMANCE CONTROL AND DATA COLLECTION

## Chapter 5

### 5.1 General on performance control:

Once the scope of the project, the project schedule and the control budget are approved, they become the standards against which the actual performance is monitored. For the project type being examined here the performance control functions apply both to the project management team's performance and the field performance. The control hierarchy is shown in Figure 5.1.1.

The performance of the project management team itself is measured against the company standards including internal budgets, schedules and quality control standards. The engineering, procurement and construction management personnel, in turn, control the physical performance in the field. The actual physical performance data, collected by the field personnel, are converted to cost data by the cost control personnel with assistance from estimating, scheduling, accounting and procurement when necessary. The performance data for the activities of the project management team, are transmitted to cost control, by the supervisory personnel from the respective departments, through performance related documents and reports which normally have standard predesigned formats depending upon the level of detail and other project requirements.

This results in an integrated performance control and data collection system, which is essential for monitoring the actual physical performance, and for collecting the performance data in an organized fashion for input to the budget control system.

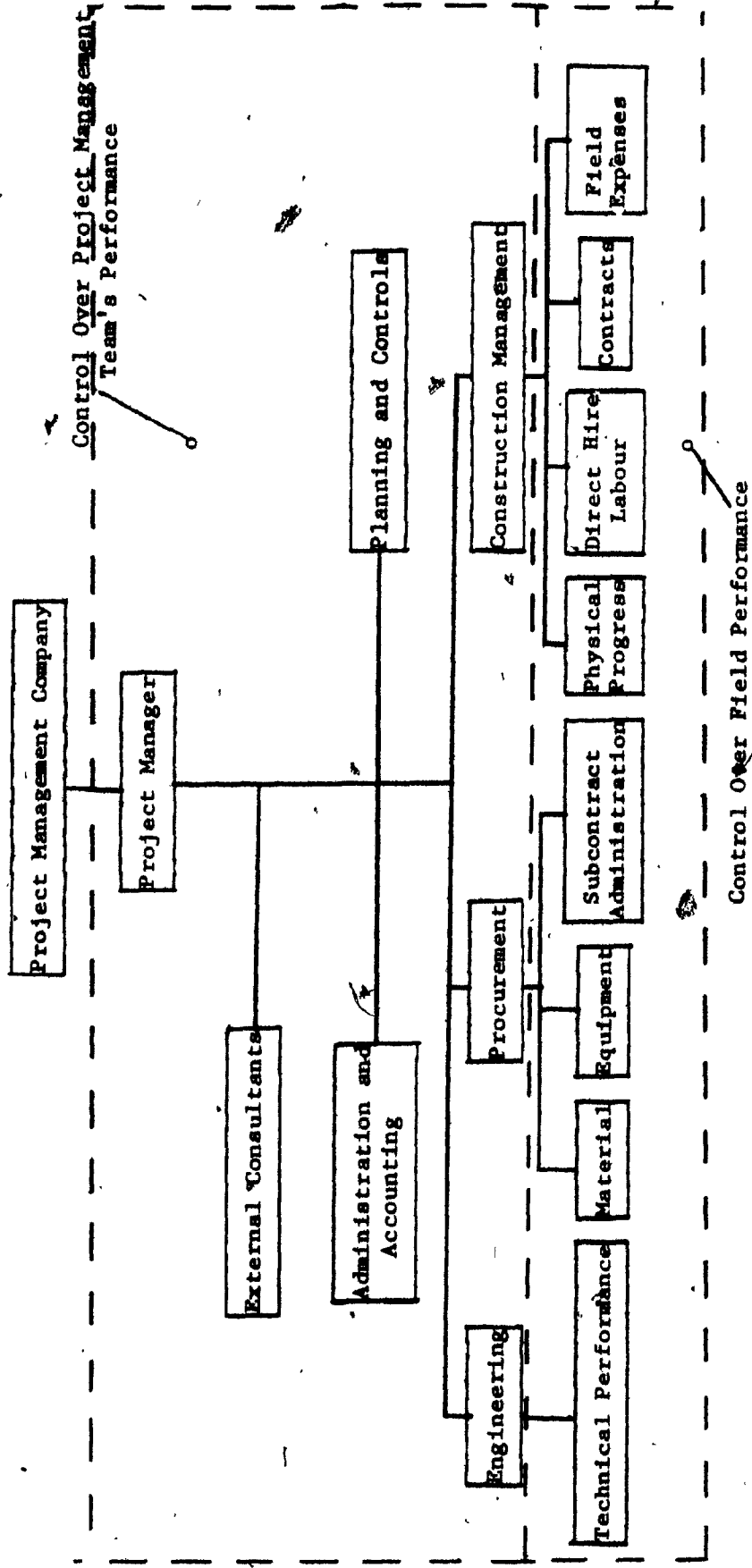


Figure 5.1.1 Hierarchy of Control over Actual Performance

In summary, the analysis and control functions are carried out as follows:

The supervisory personnel use checklists, the measurement and testing facilities, their experience and familiarity with the project, the project documents, etc., to detect deviations from the planned performance. The data sheets and performance reports generated during the physical control process become the basic sensors for budget control by reflecting job status and progress as well as the resource consumption. Therefore, timeliness, completeness and accuracy of performance reporting is of vital importance for effective cost control. Formal performance reporting, supplemented by personal contact and word of mouth, will ensure timeliness of performance reporting. In most cases completeness and consistency can be achieved by using preprinted checklists and reporting formats. Accuracy can be achieved only through experience and training, supplemented by a good system.

Once the data is collected it is analysed manually or using a computer, compared against the budgets and control initiated. Upper and lower tolerance levels for deviations are normally established based on past experience, the type and size of the project, the discipline in question and the risk involved, to serve as alarm systems for initiation of corrective action. Each significant deviation is analysed to determine its cause and origin, the output data being used for forecasting, control and corrective action as needed.

Analysis for determination of the problem causes (33);

After a potential overrun or a deviation is detected, it is necessary to isolate and analyse the areas of concern before the nature and type of corrective action can be decided upon. For example, if material costs have been consistently higher than anticipated, the priority should be assigned to studying the material acquisition procedure including vendor selection, transportation, handling, storage, etc. If the costs have been segregated properly, it will not be difficult to pinpoint the problem source. A detailed study of the sub-account will then reveal significant information about the causes of the problem. The analyst or the cost engineer should maintain good relations with all the key personnel connected with the project, as they can provide or withhold vital information regarding their operations. Most people do not like to be questioned about the shortcomings of their performances, and there is a tendency to find excuses to 'shift the blame' or 'pass the buck' to someone else. This problem may or may not be overcome by assurances from the management that the study is being conducted in an impersonal manner without the intention of victimizing anyone in particular, and by making the related personnel aware of the importance of the information they provide. But, in general, personnel problems are the most difficult to solve.

While analyzing the deviation, the quantifiable factors are isolated first, the related data being found through the data collection system via the performance documents supplemented by relevant data from outside sources. After this, selected few, statistically significant



factors are tested by sensitivity analysis or otherwise to determine the most significant factors, a detailed analysis being made of those factors found to be vital. From this analysis conclusions can be drawn and recommendations made for the type, range and the feasibility of the corrective action to be taken. The baseline for realistic comparison is normally available in the control estimate or contract terms.

Sensitivity analysis isolates variables that are most critical to the optimum performance of a project, and the values of such variables that vary most critically from the performance baseline.

There are a number of causes that can lead to slippages requiring different types of corrective action. It is normally practical to develop a checklist of these causes and update it from time to time so that no time is lost to search for causes when the problem arises.

Sections 5.2 through 5.8 discuss the various subsystems used for performance control and data collection. The functions and responsibilities related to performance control may differ from company to company depending on the organizational structure.

## 5.2 Design and engineering performance control and data collection:

Design and engineering performance is one of the most important criteria for the success of the project, as decisions taken during this stage will have a major impact on the final project cost. As control influence is optimum during this stage, it is important to solve most of the technical, installation and co-ordination problems at this stage in order to reduce field engineering efforts during construction/installation. Control standards are therefore imposed on design, drawings, specifications and requisitions including quality, completeness, deadlines and accessibility.

The reporting requirements can be summarized as follows:

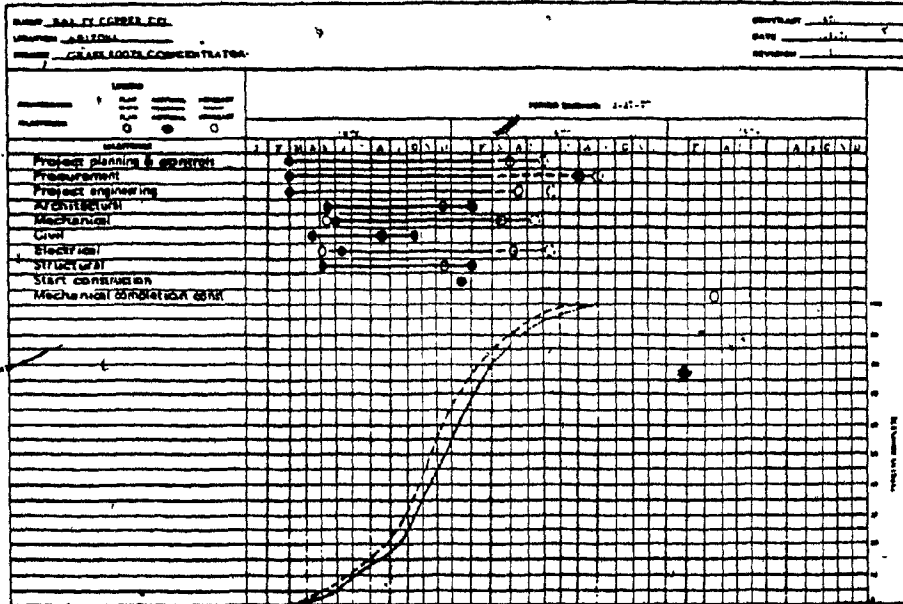
- Activity status and forecast including design, studies, etc.;
- Time and rates charges by engineering personnel via time sheets;
- Manhours expended by activity;
- Progress percentages and reports (Figures 5.2.1 and 5.2.2);
- Technical performance including departures from standards and exception reports;
- Cost trends and scope development.

The recommended standards for control are:

- Manhours per drawing or specification as budgeted;
- Design and engineering schedule;
- Performance and progress curves;
- Cost budget for the design/engineering activities.

The reporting formats can be as required (predefined) for the project. Reviews should be carried out as often as required and should include

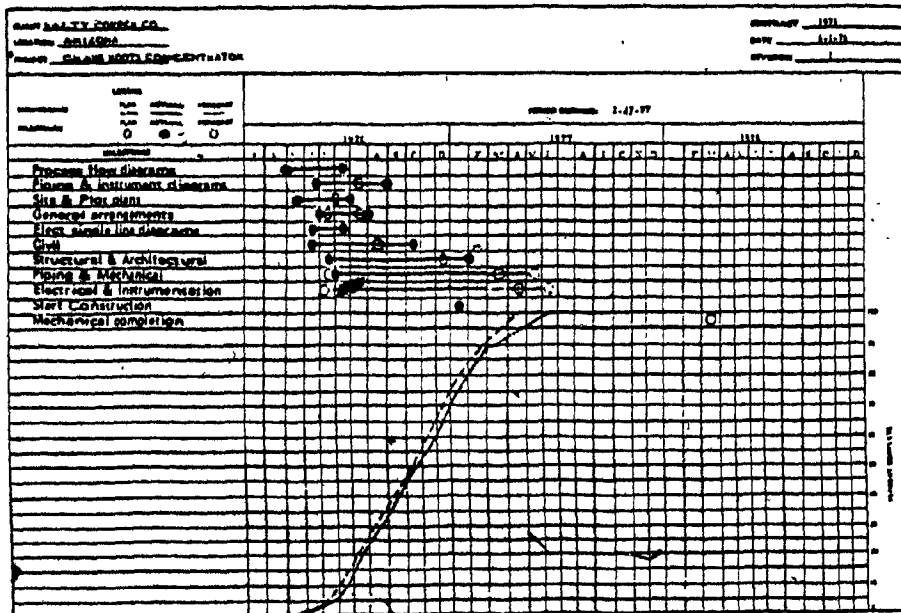
HOME OFFICE PROGRESS SUMMARY



Home Office Progress Summary

Figure 5.2.1

ENGINEERING PROGRESS SUMMARY



Engineering Progress Summary

Figure 5.2.2

Source (5.2.1 and 5.2.2): "Managing Capital Expenditures for Construction Projects", by Guthrie, p. 269.

design, engineering, specifications, design transmittals, approvals, etc. Engineering performance can be affected during the construction stage by factors such as design improvements or changes, regulatory agencies, rework problems, specification changes, drawing changes, physical progress, manpower performance, the quality of materials and equipment available, etc.

Design costs are continuously monitored through design/engineering status reports which highlight authorized budgets, current cost forecasts and percentages of design/engineering work completed. Costs to date are compiled from the time sheets handed in periodically by the supervisors, showing regular time and overtime charged by the engineering personnel, and the expenses and overheads taken from expense and payment vouchers/reports. The forecasts are based on manhour forecasts which in turn may be based on the current scope.

### 5.3 Procurement performance control - General:

For the project organization described in Chapter 1 (Figure 1.1.1) the main functions of the procurement department will be related to bulk material or major equipment purchasing, expediting to ensure progress and timely completion, logistics, inspection/testing, issuing materials/equipment to contractors for construction/installation, and the cost related functions described in Chapter 3. Performance control is needed in two areas, namely:

- Performance control of the procurement department (project management team);
- Performance control of the procurement activities (field operations).

Control over the home office operations is similar to design/engineering performance control, the reporting requirements being:

- Activity status and forecast for procurement activities (departmental);
- Time and rates charged by procurement personnel;
- Manhours expended by activity;
- Progress percentages and reports regarding procurement activities.

The recommended standards for internal control are:

- Manhours per activity (procurement personnel);
- Procurement activities' manhour budget (departmental);
- Procurement department schedule for internal control;
- Cost budget (departmental) for the procurement activities.

Control over the field operations is exercised by the procurement personnel primarily through imposition of time constraints and need dates in the field, expediting, quality inspection, logistical planning and budget control. The reporting parameters include:

- Activity status and forecast of suppliers' activities including progress percentages and curves (Figure 5.3:1);
- Status of purchased equipment and material;
- Status of quantities;
- Status of costs and commitments;
- Trends and their cost impact, including logistical and other problems;
- Reports on material/equipment issued to contractors on the field;
- Inventory reports and reports on damages/losses.

The recommended standards for control are:

- Procurement schedule, including need dates in the field and milestones;
- Project technical and administrative standards including lead times, performance curves, quality control guidelines, etc.;
- Logistical plans including transportation, handling and storage standards;
- Drawings, specifications and quantities;
- Contract/purchase order budgets and cash flow schedules.

If any deviation (or potential deviation) is detected during the expediting procedures, its impact on the schedule and the budget is analysed, and corrective action is initiated whenever necessary.

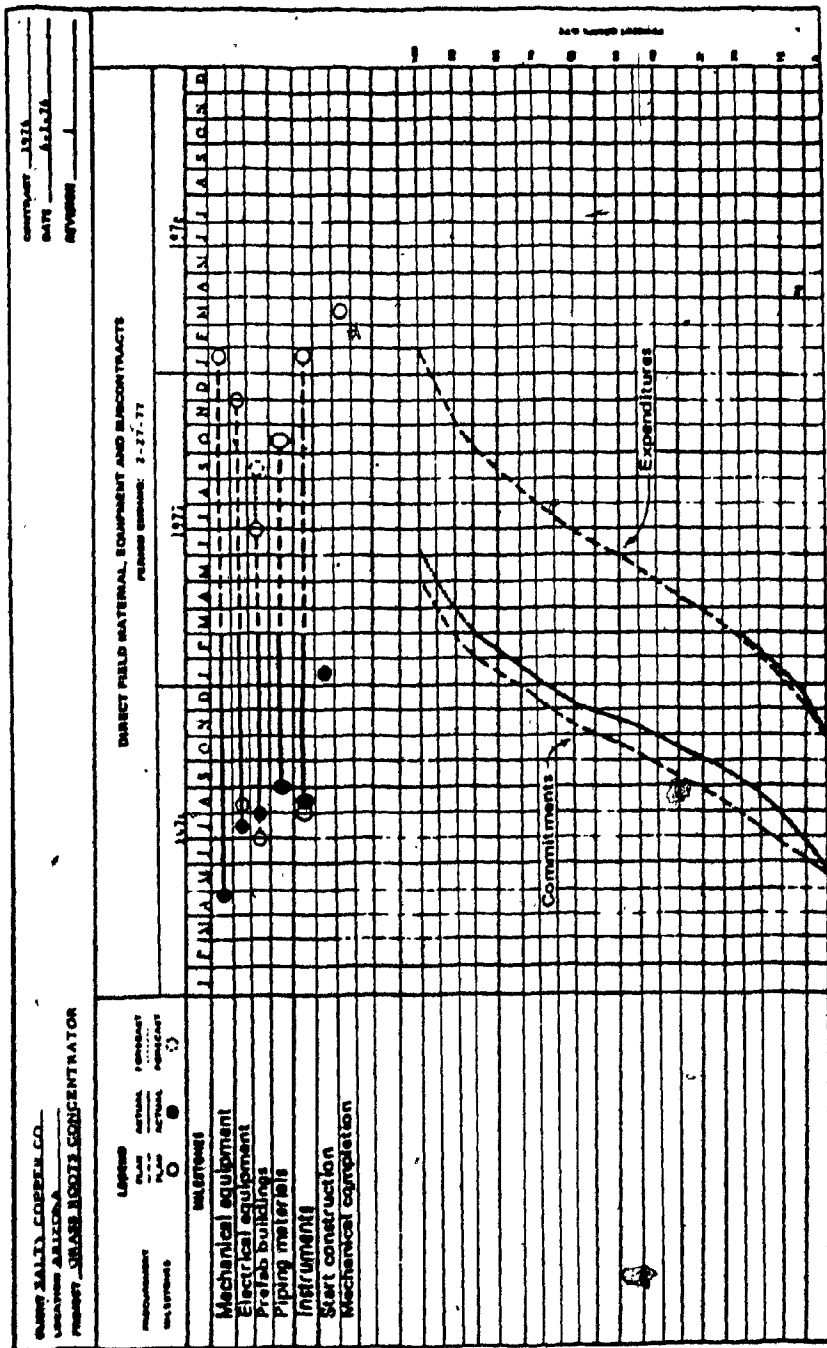


Figure 5.3.1.

Source: "Managing Capital Expenditure for Construction Projects", by Guthrie, p. 270.

Procurement performance can be affected by problems such as:

- Delays due to lack of progress in the supplier's plant as a result of his internal problems, transportation delays, etc.;
- Loss of quality during manufacture, transportation or storage;
- Changes in unit or lump sum prices due to more escalation than allowed for, or other causes.

The two main subsystems which constitute field procurement control are 'material control' and 'equipment control'. The commodities acquired will either be used for 'direct hire work' or 'acquired on behalf of contractor for economy of volume purchases/rentals'. In cases where the acquisition is for direct hire work, the commodities are tracked through purchase ordering, expediting, transportation, storage and issuance for construction/installation, to their final place in the designated work item. When the acquisition is done on behalf of the contractors, the respective contractors have the responsibility for control during usage, once the commodities are handed over to them. Control is exercised by detecting quantity and cost variances, which can be traced back to problems related to the acquisition of materials or equipment, by conducting a cost analysis. Corrective action can then be initiated if necessary.

Some problems related to commodity acquisition and control are listed here, along with the methodology for solving them (where possible) (34):



- Errors in material take-off may arise due to carelessness, inexperience, correct calculations based on incorrect data, incorrect calculations based on correct data, or errors in both the data input and the calculations. The only way this problem can be avoided is by being very careful during the early stages and through adequate review and checking procedures;
- Wastage, pilferage or inaccurate measurements of delivered quantities resulting from carelessness and measurement errors in most cases. This problem is encountered in the handling, storage and usage of bulk materials very frequently, and it can be partially solved by providing adequate handling and storage facilities, the measurement errors being avoided (to some degree) through efficient material control (including the efficiency of both the system and personnel). The quantities delivered minus the rejected quantities should normally equal the quantities used plus the quantities left over plus the scrap. If these figures do not match, the records of the bulk material tracking procedure and/or usage records are checked in order to find out what happened to the material unaccounted for;
- Uneconomical lot sizes, poor timing, etc., may result in higher prices or loss of the advantage gained by bulk ordering. By analysing the order dates and quantities it can be determined whether the orders can be combined to obtain lower costs;

- Excessive transportation, handling and storage costs can be avoided through good logistical planning and control. It is important to segregate these costs as soon as they are incurred for analysis and control purposes;
- Poor judgment and lack of timely purchasing can result only from inexperience and improper procedures. This can be avoided through proper supervision by experienced personnel and by assigning priorities to the important purchases;
- Inadequate expediting can result in delays or loss of quality due to lack of progress and performance control, and therefore efficient expediting procedures are needed;
- Late payments for delivered materials and the resulting penalties or carrying charges can be avoided by good cash flow planning, and accounting procedures integrated with cost control in order to ensure data feedback on actual cash flows;
- More cost escalation than allowed for may result in a cost overrun, though it may be nobody's fault on the project team. More funds will, nevertheless, be needed to compensate for an overrun resulting from unpredicted escalation.

5.4 Material and equipment control and data collection:

The purpose of material control is to provide visibility over the status of all equipment and material items from the receipt of a requisition to delivery at the job-site. This includes control over all documentation such as specifications, drawings, vendor data and field material handling. It also provides take off facilities for requisitioning and commodity purchase. Commodity tracking is also an important function of material control. Commodity tag numbers are assigned to all equipment items and material components, and they form the basis of the tracking system. The material control department is normally a part of the procurement department and is responsible for:

- Specification control;
- Drawing control;
- Quantity control, including records and status reports;
- Requisitions for equipment and commodities including subcontracts;
- Vendor print control including co-ordination and procedures;
- Bills of material;
- Field material control including receiving reports, warehousing, inventory control, issue materials, field expediting, field requisitioning, field reporting.

The data collection and control activities can be summarized as follows:

- The cost engineer receives a copy of the purchase order from the purchasing department, checks the account codes and transfers the information to the commitment and expenditure

register including account number, description, vendor's name, purchase order number, unit price, quantity or number ordered, basic price, freight, total price and other pertinent information. At the end of the month the individual material accounts can be added and the total material commitment to date recorded by the proper account code in the 'committed to date column' on the cost summary work sheet;

- The expediting personnel follow the progress of the commodities (including manufacturing process) and track them until they arrive at the job-site;
- The receiving personnel accept the delivery and acknowledge receipt after checking for damaged materials and quantities, and initiate the material testing procedures. The field engineer or other designated discipline engineers test the materials for quality and specifications, and certify them. Figure 5.4.1 shows the spectrum of material measurement;
- The vendor submits the approved invoice to the accounting office for payment;
- A listing of the invoice payments is sent to the cost engineer by the accounting department and this information can be recorded in the commitment and expenditure register. The invoice amounts are spread to the cost accounts for the work items concerned and added to any existing amount in the 'invoice to date' column. At the end of the month the log is summarized by material account code and the total

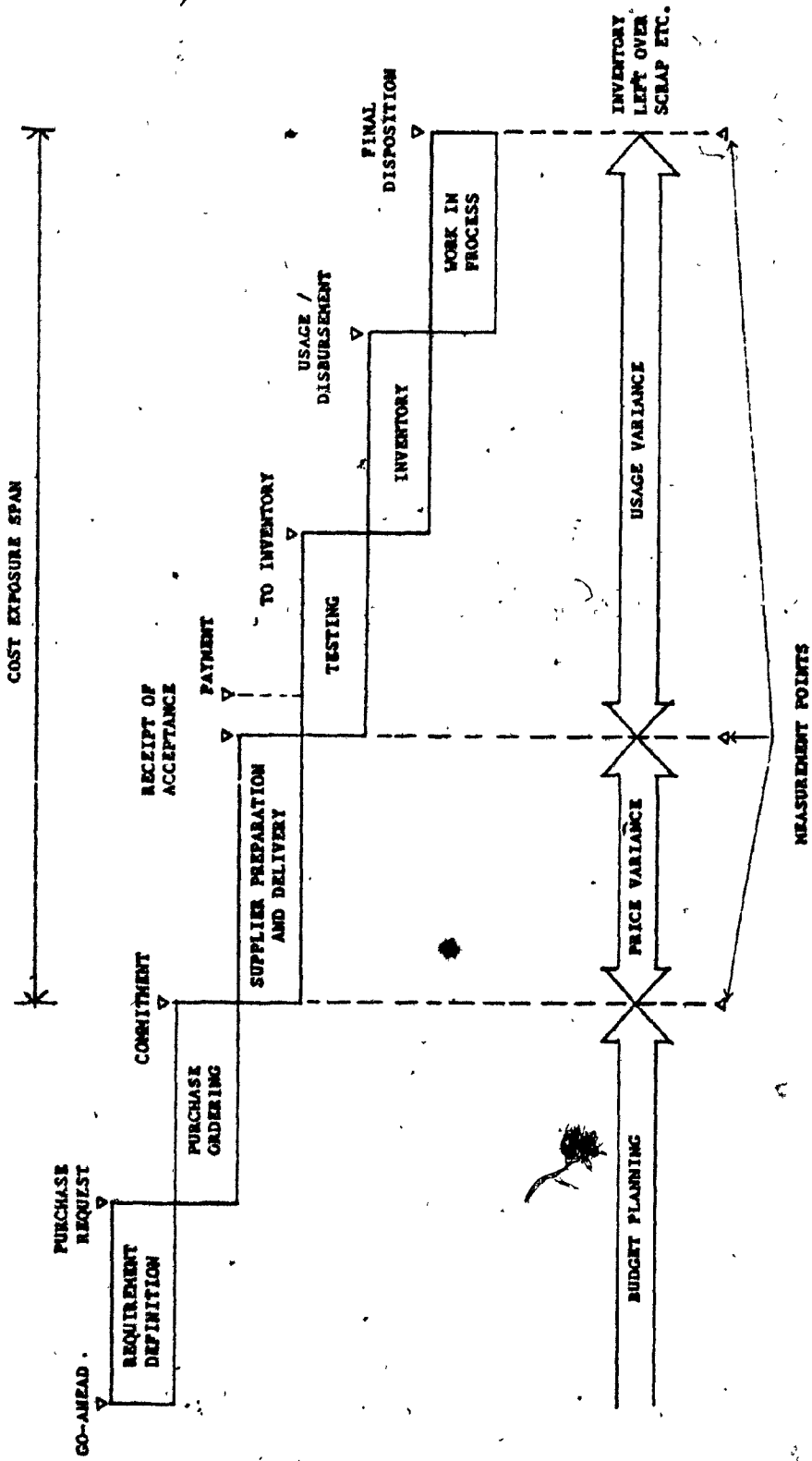


FIGURE: 5.4.1 MATERIAL MEASUREMENT SPECTRUM (Current Requirement)

SOURCE: A System for measuring Cost and Schedule Performance by, Richard N. Campbell, A.A.C.E. Transactions 1978.

material expenditure to date is transferred to the 'expended to date' column on the cost summary work sheet;

Bulk material tracking can be handled by creating a separate account from which costs can be transferred to other accounts to keep track of the costs associated with the materials up to the point where they are issued for use on the job-site.

All costs incurred to this point are accumulated at this level, and when the material is actually drawn for installation in a particular area, the detail account for that work area and work type is charged for the amount, the suspense account being reduced by the same amount. Thus the suspense account will be reduced to zero when all the material in the suspense account has been used up. It is necessary to keep track of the quantities issued and left over (inventory control) in order to account for the losses (if any) during handling and storage.

The cost control system will detect the price variance (if any) when the materials and the suppliers' invoices are received. A comparison of the total cost of material received with the estimated cost of the same material will show the percentage increase, which should not exceed the escalation allowance for materials, if the purchase orders have an escalation clause. If the actual increase is more than the allowance, a cost analysis will determine whether the increase is due to insufficient escalation allowance, due to excessive indirect and overhead costs including freight, handling, losses during transportation/storage, due to an uneconomical lot size, change in quality due to non-availability,

etc. Once the materials are paid for, the actual costs are assigned to the respective bulk material accounts, and then transferred to the appropriate work items, as the materials are issued for work, by using the project cost code. When the materials are issued to contractors it will be their responsibility to control the usage within their respective work areas. The total quantities issued for work should normally match the actual measured quantities during the periodic progress measurements, which, in turn, should match the quantity estimates (as per the updated drawings). A variance during usage is the result of extra material needs, and hence increased costs, due to waste, pilferage, inaccurate measurements, errors in quantity take-off or physical progress measurement, etc., and a cost analysis can reveal the problem causes.

Equipment control, for the purpose of this report, implies the acquisition of major equipment and delivery to the contractor for usage. The respective contractors will then be responsible for control of the equipment during usage, equipment time allocation to operations and for the internal accounting related to rent allocations. The project team and/or the contractor will determine which equipment is needed based on the individual project requirements. The construction contractors will be responsible for acquiring/possessing the equipment required for their contract, unless otherwise specified by (or negotiated with) the project management team. For direct hire work the project management team will determine which equipment to acquire based on needs, availability, etc., and make an economic analysis of rental versus purchase for the equipment/machinery to be acquired. The functions related to equipment/machinery control will be similar to those required for material control described earlier. For heavy machinery acquired for the project as a whole, the acquisition costs, or rentals, as the case may be, can be accumulated in a separate account. Time allocations can be made to individual work items based on the usage time for that work item. The costs of machinery usage, as they relate to work items, can be calculated by applying a standard hourly charge rate (if accurate and practical) reflecting the acquisition cost or rental, operating costs, depreciation (for purchased machinery), maintenance, repairs, etc. The cost of idle time related to rented machinery will be allocated to the work items, where the machinery is used, as indirect costs related to machinery, the time allocation being made in the same proportion as the actual usage hours per work item. The reporting requirements for machinery on site are:



- Machinery/equipment usage data through time sheets, showing equipment description, number, dates and hours worked, type of work done, classification by cost code, hourly rates, total hours and dollars by day and by code, special remarks including breakdowns, etc.

The control standards can include a schedule and a cost budget for the acquisition and usage of the machinery. Problems related to machinery and equipment can include (35):

- Unsuitable equipment for the organization and/or obsolescence;
- Uneconomical mode of acquiring or replacing equipment;
- High operating/maintenance costs and/or low productivity;
- High percentage of equipment down time or idle time;
- Unanticipated working conditions at the work site.

The problems can be traced by analyzing the reported equipment costs.

### 5.5 Construction performance control - General:

Analysis and control functions, for the construction operations on site, are carried out by the construction management department. Like procurement, performance control and data collection will be needed in two areas, namely:

- Costs related to construction management activities (project team);
- Costs related to actual construction/installation.

\* Performance control of the construction management activities is similar to design/engineering or procurement (home office personnel) control, the reporting parameters being:

- Activity status and forecast for construction management activities;
- Time and rates charged by construction management personnel;
- Manhours (construction management only) spent, by activity;
- Progress percentages and reporting regarding construction management activities.

The recommended standards for internal control are:

- Manhours by activity (construction management personnel);
- Construction management manhour budget;
- Construction management schedule;
- Cost budget (departmental) for construction management activities.

Performance control of the actual construction/installation activities includes:

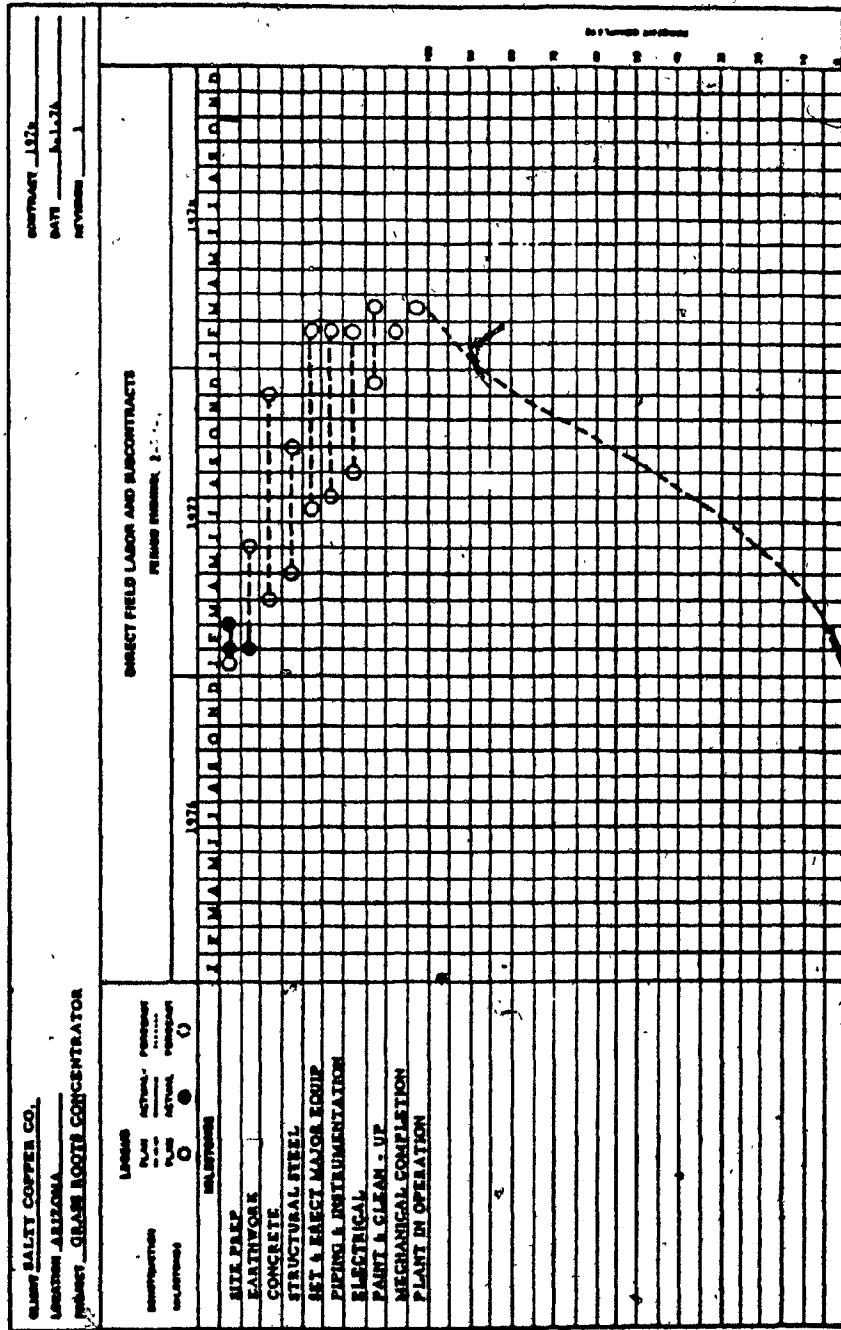
- Physical progress control against the schedule (percentages and milestones);
- Control of installed quantities by measurement, and by comparison against the planned quantities, as well as quantity control;
- Control of manhour expenditures by comparing actual manhours spent against the manhour budgets;
- Control of field expenses.

The reporting requirements for construction control are:

- Activity status and forecast via checklists, showing physical progress percentages, completed activities/milestones, graphs (Figure 5.5.1) and trends;
- Quantity reports showing status and forecast;
- Actual manhours expended and productivity;
- Actual cost and forecast data for field expenses and overheads.

The standards for control can include:

- Schedules (for control packages and total project);
- Plans, specifications and working/shop drawings;
- Manhour and cost budgets (by control packages and total project);
- Control budget for field expenses;
- Standards and guidelines such as performance curves, manhours per activity, schedule and production curves, productivity trends, etc.



Construction Progress Summary  
 Figure 5.5.1 Construction Progress Summary  
 Source: "Managing Capital Expenditure for Construction Projects", by Guthrie, p. 271.

The assigned construction management personnel carry out the control and data collection functions; the cost related data being forwarded to the site cost engineer through periodic reports in predetermined reporting formats. The construct/supply-install contracts are controlled internally by the respective contractors. The contractors will be responsible for handing in monthly contract reports related to cost and schedule performance related to the contract scope. Control of construct/supply-install contracts is discussed later in this chapter.

For the project category examined in this report, the sub-contract functions of the project management team will include expediting of the critical subcontracts only, to ensure schedule compliance and quality within the assigned subcontract budget. It will also be the responsibility of project management to ensure that the main contractor's internal planning does not affect these subcontracts adversely.

It is beyond the scope of this report to discuss the construction performance control techniques and procedures in detail. The issues treated under performance control, therefore, cover mainly the sources of cost related data, the methodology of data collection, the standards for control, uses of the collected data, the problems related to the resources and how the cost control system detects them.

The two major subsystems for controlling the construction cost (apart from material control on site) are 'physical progress measurement' and 'manpower control'.

#### 5.6 Physical progress measurement and control:

The physical progress on site is the result of expended resources including materials, manhours, equipment usage hours, contract costs and overheads/expenses. The measurement of physical progress is necessary to ensure that the project is on schedule and within budget. Control is exercised by monitoring the usage of the resources for the construction activities.

Physical progress on site is measured through completed activities, milestone achievements, completed contracts, etc., and verified by actual measurements on a periodic basis (normally monthly to co-ordinate with the other project control disciplines) and by comparison against the plans, drawings, specifications, etc. Schedule control is maintained by monitoring the progress achieved against the construction schedule. Theoretically, if the project is on schedule, the physical achievement being as planned (with no unauthorized work being carried out), it is possible to make a direct comparison of the planned costs with the actual paid costs at any given cut-off date. But in practice such a situation seldom exists, as for a major construction project the construction activities (as measured) will seldom be exactly on schedule. Some contracts or activities may be ahead of schedule while some others may be behind. In such cases it is important to measure the impact of the schedule variance (if any) on the project cost, and it may not be sufficient to make a direct comparison of the planned cost with the actual cost. Thus it is necessary to compare the budgeted cost of the work done (actual

progress) with the budgeted cost of work scheduled (planned progress) as well as with the actual (accrued) cost to date in order to measure the cost variance and the schedule variance. This progress measurement concept is shown graphically in Figure 5.6.1.

The actual (accrued) cost is obtained from the reports on actual resource expenditures (excluding the resources not yet installed), the budgeted cost of work performed being the budgeted cost of physically measured progress. The budgeted cost of work schedule is already known. This results in a physical progress and time related cost analysis, rather than a cost analysis related to calendar time only, as in the case of a comparison between planned costs and paid costs at a given time <sup>(36)</sup>. This concept is known as the 'Earned Value' concept, and it can be applied to all project related operations which have schedules and control budgets assigned to them.

The earned value concept can be used internally for management and externally for performance reporting, the data elements being as shown in Illustration 5.6.2.

Illustration 5.6.2

Element	Explanation	Acronym
Work planned	Budgeted cost for work scheduled	BCWS
Work accomplished/ Earned value	Budgeted cost of work performed	BCWP
Cost of work accomplished	Actual cost of work performed	ACWP
Work authorized	Budgeted cost at completion	BAC

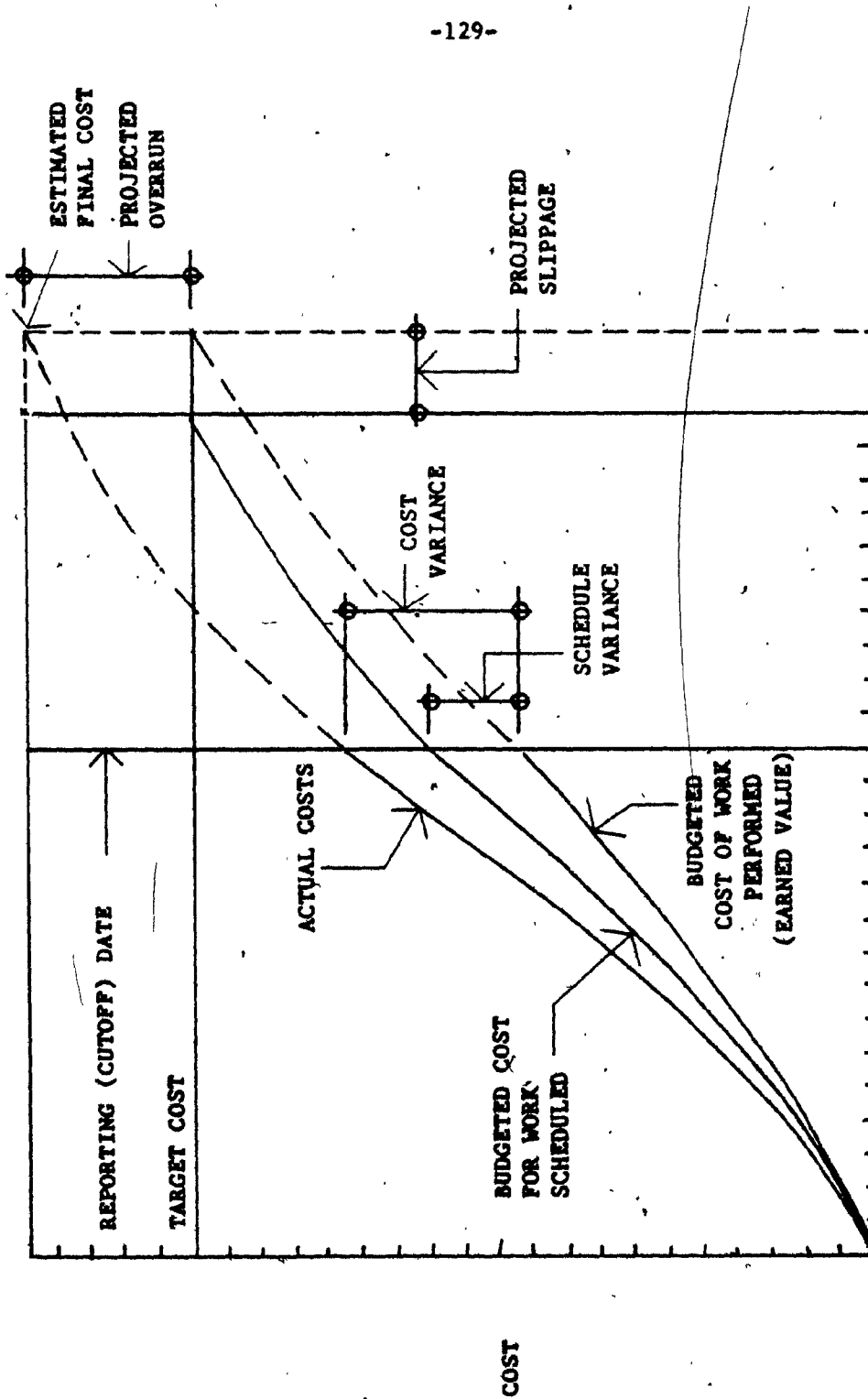


FIGURE: 5.6.1 The Concept of Earned Value.  
SOURCE: "A System for measuring Cost and Schedule Performance"  
By, R. Campbell, A.A.C.E. Transactions, 1978.



Element	Explanation	Acronym
Estimate of final cost	Estimated cost at completion	EAC
Cost Variance	Cost variance (BCWP minus ACWP)	CV
Schedule Variance	Schedule variance (BCWP minus BCWS)	SV
At completion Variance	Variance at completion (BAC minus EAC)	ACV

The actual cost of work performed (ACWP) consists of direct and applicable indirect costs. The budgeted cost for work scheduled (BCWS) is the time phased budget plan (baseline) which represents the work plan. The budgeted cost for work performed (BCWP), the 'earned value' or the 'planned value of work accomplished', represents the value of completed work.

Interpretation of BCWS/BCWP/ACWP Relationships

Schedule Variance	Cost Variance		Description
	BCWS	BCWP ACWP	
\$ 1	\$ 1	\$ 1	On schedule On cost
\$ 2	\$ 2	\$ 1	On schedule Under cost
\$ 1	\$ 1	\$ 2	On schedule Over cost
\$ 1	\$ 2	\$ 2	Ahead of schedule On cost
\$ 1	\$ 2	\$ 3	Ahead of schedule Over cost
\$ 1	\$ 2	\$ 1	Ahead of schedule Under cost
\$ 3	\$ 2	\$ 1	Behind schedule Under Cost
\$ 2	\$ 1	\$ 3	Behind schedule Over Cost
\$ 2	\$ 1	\$ 1	Behind schedule On cost

Schedule Variance = BCWP - BCWS

Cost Variance = BCWP - ACWP

Interpretation of BAC/EAC Relationships

At completion variance

BAC	EAC	Description
\$ 1	\$ 1	Forecast on budget
\$ 2	\$ 1	Forecast underrun
\$ 1	\$ 2	Forecast overrun

At completion variance = BAC - EAC

Source: "A system for measuring cost and schedule performance",

by Richard H. Campbell, A.A.C.E. Transactions, 1978.

In simple terms, the Budgeted Cost of Work Performed (BCWP) is the budgeted cost of the progress to date and hence the value earned by the contractor as per the budget. The total cost variance is obtained by comparing this value (BCWP) with the Actual Cost of Work Performed (ACWP), which is what the progress to date has actually cost. A part of this total cost variance may be the dollar cost of a delay and this schedule variance can be isolated by comparing BCWP with the Budgeted Cost of Work Scheduled (BCWS) which is the budgeted cost of the schedule progress to date as of the cut-off date for control. An analysis of the schedule variance can then identify the problem areas. The remaining variance (after deducting the schedule variance from the total cost variance) will be a result of problems such as more resource expenditures than planned, estimating errors, etc.

Table 5.6.3 (Recommended) Cost Performance Report For Contracts (Format Incorporating Earned Value)

Administrative Details .....										
Contract Details .....										
Item	Cumulative Cost To Date			Forecast Cost To Go			Cost At Completion		Remarks	
	Budgeted Cost	Act. Cost Work Perf.	Variance	Budgeted Cost	Act. Cost Work Perf.	Variance	Budget	Forecast At Compl.		Cost Variance At Compl.
Work Breakdown Structure Control Elements										
General & Administrat. Undistributed Budget										
Sub-Total										
Management Reserve										
Total										
Reconciliation To Contract Budget Baseline										
Variance Adjustment										
Total Contract Varian.										

Source: Based on "A System For Measuring Cost & Schedule Performance" by R.H.Campbell, A.A.C.E. Transactions, 1978

### 5.7 Labour/Manpower control and data collection:

The manpower control and data collection system is used to keep track of the actual hours worked by employee and activity, for labour assigned to different work areas as required. The basic manhour data comes from the time cards or the daily time check records showing each man's timetable against the work items and the activities. These records are normally kept by a timekeeper or the foreman, who assembles the daily time sheets showing the date worked, the trade type, type of work, employee name and number, hours worked (regular and overtime) by worker, total hours worked that day by employee and activity, and total hours worked that day. The time sheets are checked by the site cost engineer, for account codes and wage rates, with the help of the payroll personnel, before the data is fed into the budget control and payroll system. The time sheets are preprinted for consistency and completeness. They are also partially self-checking through cross balancing (adding both vertically by columns and horizontally by rows), and can include remarks about weather conditions, accidents and delays due to other causes. Depending upon company policy the coding can be done by the site cost engineer to avoid coding errors by foremen who may not be used to coding. The manhour and cost data thus collected is sorted and consolidated on a weekly basis in the form of weekly summaries (37):

- The manhours by account codes are consolidated in a weekly labour report, summarized each month, and verified with the field office accounting ledger (Table 5.7.1);
- Weekly 'labour distribution' by accounts to provide the 'labour cost distribution' to the cost ledger (Table 5.7.2);



Table 5.7.2 Labor Distribution Summary

**LABOR DISTRIBUTION SUMMARY**

CLIENT SALTY CORP. - ARIZONA CONTRACT 1976  
 LOCATION ARIZONA DATE 10/1/75  
 PROJECT JA-EV PLANT PERIOD ENDING 9/30/75

AC	DESCRIPTION	ASBESTOS WORKER	BOILERMAKER	CARPENTER	CEMENT MASON	ELECTRICIAN	INSULATION	IRON WORKER (HEAVY)	IRON WORKER (STRUCTURAL)	LABORER	MILLWRIGHT	OPERATING ENGINEER	PAINTER	PIPEFITTER	WELDER	SHEETMETAL WORKER	TEAMSTER	TOTAL
030	Reinforce Steel			1100				850	240	5124		112	20		20	200	2413	5659
031	Formwork							1010		709								8012
054	Reinforce Steel									378								1719
055	Concrete				850													2238
110	Rough Carpentry																	-0-
160	Misc Metal Work								5									5
270	Fire Protect System					8												8
290	Profab Bldg									42						10		52
300	Electrical					56												56
400	Water Utilities									40				11				51
470	Sewerage Utilities									398								398
500	Process Equipment					121			240	385	84			40	61			311
600	Piping									126				252	130			1102
700	Instrumentation																	-0-
	TOTALS			1100	860	185		1860	485	1084	2084	112	20	303	281	210	2413	20,231

Source: "Managing Capital Expenditure for Construction Projects", by Guthrie, p. 199.

- A weekly labour summary by account and area to consolidate the manhour and cost data for each week showing the account code, description of work, manhours by area and activity, the total manhours per activity and the total manhours per area (Table 5.7.3);
- A weekly labour summary by contractor to consolidate the manpower data for each contract package including the number of men working and manhours spent each week, the format being similar to the area-manhour summary;
- Weekly physical progress record for productivity measurement and schedule control.

The manhour and cost data, contained in the weekly labour summaries, is further consolidated on a monthly basis in the form of a 'Field Labour Summary'. The field labour summary becomes a comprehensive labour report showing the physical progress achieved, budgeted manhours, the actual manhours to date, forecast manhours to complete, forecast total manhours, manhours over/under budget, productivity trends, the average budgeted and actual wage rate, the forecast average wage rate, dollars to date, dollars forecast, dollars budgeted, dollars over/under budget and remarks.

The labour summaries are used for manpower and cost control as follows:

The labour distribution summary establishes the total manhours per activity and trade, to give the composite manhour requirements per activity and account. This data can be of use for detecting estimating problems (such as insufficient manhour estimates), for forecasting the

### AREA MANHOURLY DISTRIBUTION

CLIENT \_\_\_\_\_ CONTRACT \_\_\_\_\_  
 LOCATION \_\_\_\_\_ DATE \_\_\_\_\_  
 PROJECT \_\_\_\_\_ PERIOD ENDING \_\_\_\_\_

IAC	DESCRIPTION	AREA DESIGNATION				TOTAL
		ABQALQ	CHAHRAM	TOZAYNAH	SHEDGIM	
030	EARTHWORK	400	900	530	460	2290
051	FORMWORK	392	648	512	417	1969
054	REINFORCING STEEL	155	368	274	196	993
065	CONCRETE	364	597	487	386	1834
160	MISC METALS	22	274	240	51	587
170	SHEET METAL WORK	204	315	200	195	914
270	FIRE PROTECTION SYSTEM	80	120	85	85	370
290	BLDG. PREPARK	674	1290	840	730	3524
300	ELECTRICAL WORK	110	304	126	115	655
360	ROAD WORK	410	1100	570	570	2650
370	FRAMING	610	1900	260	260	2930
400	WATER UTILITIES	340	810	450	400	2000
420	SEWER UTILITIES	170	405	230	197	1002
440	FUEL UTILITIES	120	210	140	140	610
600	PIPING	155	180	155	155	645
800	INSULATION	190	87	40	40	357

TOTALS **4396** **9403** **5139** **4387** **29525**

Table 5.7.3 Area Manhour Distribution  
 Source: "Managing Capital Expenditure for Construction Projects",  
 by Guthrie, p. 200.



manhour requirements for future use and for estimating the manhour requirements for future projects. The labour summaries by account and area/contractor show the labour distribution for individual work areas or contracts by activity and account, the data being used for manpower planning, co-ordination and for monitoring the contractors' claims for labour costs. Weekly cost distribution by accounts provides the actual labour cost input to the budget control system for detecting cost variances which may be a result of manhour variances or changes in wage rates, fringe benefits, etc. The weekly progress and productivity report measures the labour productivity, as it relates to physical progress on site, on a cumulative basis. Productivity problems, its measurement and the uses of productivity data are discussed later.

The field labour summary can be regarded as the key document (related to the manpower performance on site) for management review, along with the monthly cost summaries. It summarizes the manhour and dollar expenditures, forecasts and budget variances to highlight the problem areas, the back-up data being provided by the weekly summaries, for identifying the problem causes and taking corrective action.

The Field Labour Summary can include the following data and more:

- Account code and description;
- Physical percent complete;
- Standard (planned) manhours to date;
- Actual manhours to date;
- Projected to go manhours (forecast);
- Total projected manhours at completion;

- Total budgeted manhours;
- Manhours over/under budget;
- Standard (planned) productivity to date;
- Actual (measured) productivity to date;
- Projected (actual) productivity at completion;
- Projected to go productivity (forecast);
- Average wage rate budgeted;
- Average wage rate to go;
- Dollar cost to date;
- Dollar cost to go (forecast);
- Total projected dollar cost at completion;
- Total dollar budget;
- Total dollars over/under budget;
- Remarks.

The field labour summary, therefore, summarizes the labour manhour and cost input to the budget control system. The manhour variances are the main sensors for cost overruns related to productivity. The direct overruns in manpower costs result from problems related to cost escalation due to wage escalation, opportunity costs, etc. The periodic cost analysis determines the exact causes of these problems, to direct the management efforts for corrective action. The weekly summaries and the time sheets provide the back-up data for the analysis functions. The contractors' claims for labour cost reimbursement are also backed up by manhour data in similar formats to facilitate verification and traceability of data.

The labour related data can also be presented graphically in terms of percentages (as shown in Figure 5.7.4) every month.

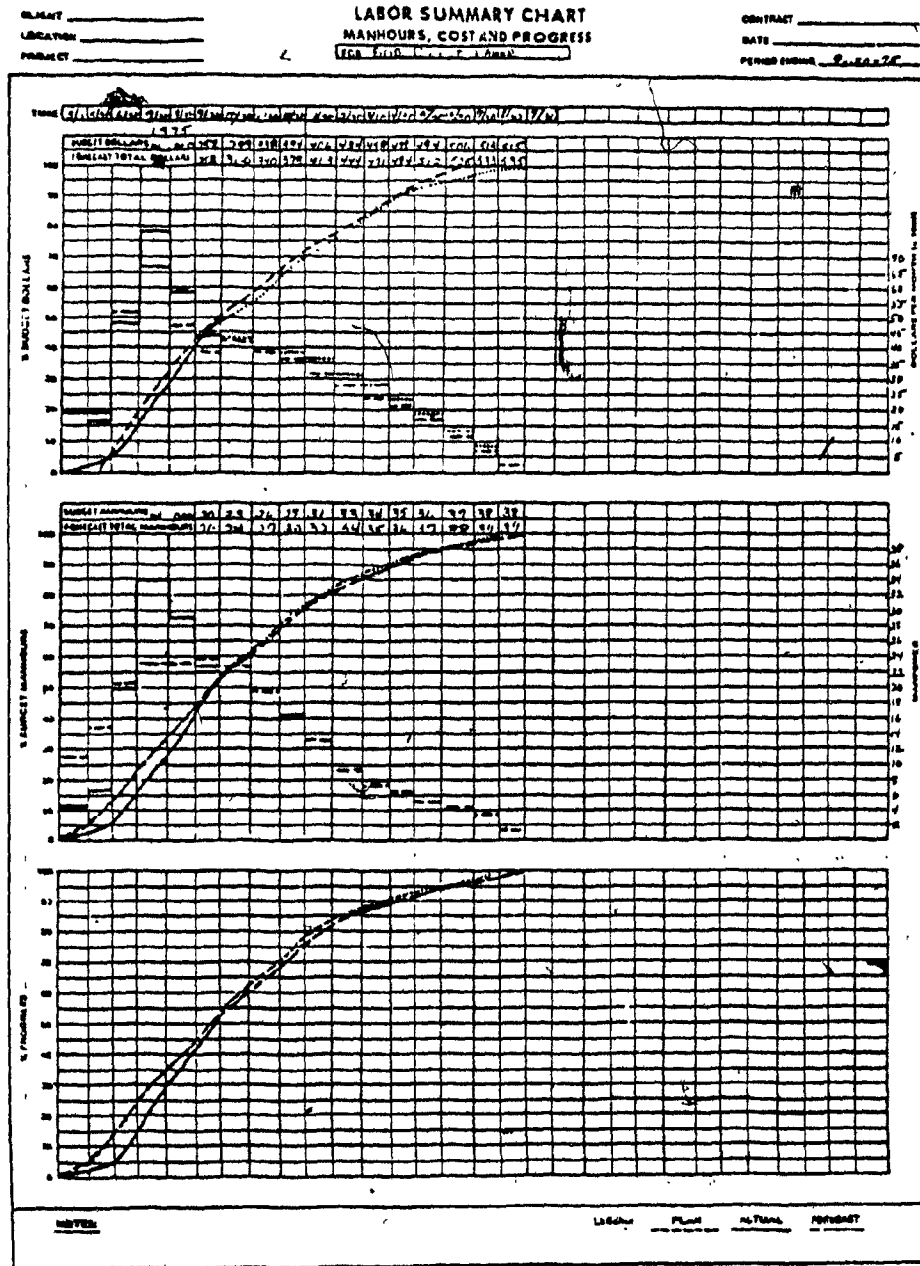
Problems related to manpower and their impact on the project:

As far as a construction project is concerned, the impact of manpower problems can result in one or more of the following three effects:

- Loss of quality (workmanship);
- Cost overruns (dollars);
- Delays due to productivity problems (manhour overruns).

Loss of quality can occur due to lack of skills, training, experience, etc., as well as the number of working hours per day/week. This aspect of manpower problems has to be handled by way of quality control as the cost control system cannot measure the impact of bad workmanship unless there is a rework problem resulting in additional costs. Cost overruns can be a result of a number of problems such as manhour overruns, estimating errors, more escalation of wages/benefits than allowed for, unexpected indirect costs related to manpower such as lost work-days through bad weather or strikes/walkouts (for which the labour may still have to be paid as per union agreement), accidents, etc. It is almost impossible to predict the exact increases in the labour wages, fringe benefits, compensation, insurance, etc., for the entire duration of a long term project, as these are subject to adjustments based on the union agreements. Most of these payroll details are beyond control of the supervisors and they have nothing to do with the supervisors' efficiency. This problem can be avoided by budgeting and

Figure 5.7.4 Labor Summary Chart



Source: "Managing Capital Expenditure for Construction Projects",  
by Guthrie, p. 218.

monitoring in terms of manhours, instead of labour dollars, for control purposes, the escalation costs being dealt with as described under cost escalation (Chapter 4, Section 4.6). The cost overruns resulting from strikes, vandalism, lost work-days through bad weather and other similar problems can be handled as discussed under contingency management (Chapter 4, Section 4.7). Estimating errors can occur from incorrect data, incorrect calculations or both, and they can be avoided only through efficient estimating methods and the competence of estimating personnel.

Perhaps the most significant problem related to manpower is the productivity on the job which can be affected by various factors such as workers' morale, working hours and environment, local practices, etc., which are largely subjective issues and are difficult to handle. While productivity control is primarily a construction management function, from the cost control point of view, it is important to measure the productivity on the job in order to forecast the manhour requirements for comparison with the manhour budget. The method of measuring productivity used here follows the objective of productivity based manhour forecasting, although other methods are possible.

**Manpower productivity measurement:**

The manpower productivity for a project is difficult to predict beforehand as it varies from region to region, contractor to contractor, and trade to trade. But official publications by various private and public bodies (such as journals, handbooks, etc.) can furnish enough productivity related data which can be used by updating it. The following factors can be considered as the

minimum to be applied while estimating the likely productivity, and the manhour requirements, for the project:

- Geographic location and local practices;
- Local employment conditions;
- The climate and weather conditions;
- Site conditions;
- Supervision;
- Scheduling;
- Project size and type.

Similarly, a mathematical relationship must be developed as a means for measuring productivity. Assuming that progress control is maintained over the construction operations, for a given progress percentage, productivity can be defined as follows (38):

$$\text{Productivity} = \frac{\text{Standard Manhours/Operation}}{\text{Actual Manhours/Operation}}$$

The following discussion and calculations demonstrate how the productivity profiles can be used for developing projections of manhours for forecasting and control. The productivity based forecast can be used for assessing the validity of a definitive forecast. This method uses the average cumulative productivity profiles for forecasting the total manhour requirements at project completion, the method of productivity forecasting being as follows (39):

- A standard average (cumulative) productivity profile (curve  $P_s$ ) is generated by updating the historical productivity data available to suit the current project environment and conditions. This profile is plotted as

a graph to be used as the productivity measurement standard to start with (Figure 5.7.5);

- The actual average (cumulative) productivity on the job ( $P_{ax}$ ) is calculated periodically by applying the formula

$$P_{ax} = \frac{M_{sx}}{M_{ax}}$$

where  $x$  = the actual (measured) progress (percent) to date;

$M_{sx}$  = the standard (budgeted) manhours for  $x\%$  progress;

$M_{ax}$  = the actual (reported) manhours for  $x\%$  progress;

The values of  $P_{ax}$  thus obtained periodically are plotted on the same chart (as the curve  $P_s$ ) to generate the actual productivity profile  $P_a$ , as shown in Figure 5.7.5;

- Based on these profiles, and the standard cumulative average productivity at completion ( $P_{sc}$ ), the projected (forecast) average cumulative productivity at completion ( $P_{ac}$ ) is computed (as shown in Illustration 5.7.6) periodically;
- If  $P_{ac}$  is consistently (say for two consecutive forecasts) less than  $P_{sc}$  to a significant degree and it ( $P_{ac}$ ) does not show an improvement (i.e.  $P_{ac}$  does not approach  $P_{sc}$ ), corrective action may be needed to improve productivity. On the other hand, the  $P_{ac}$  being aimed at may be too optimistic thus signifying an error in the manhour estimate (and budget). If, however,  $P_{ac}$  is tending to  $P_{sc}$  with the curve  $P_a$  showing a significantly different profile as compared to  $P_s$ , the historical productivity indices used (for generation of the

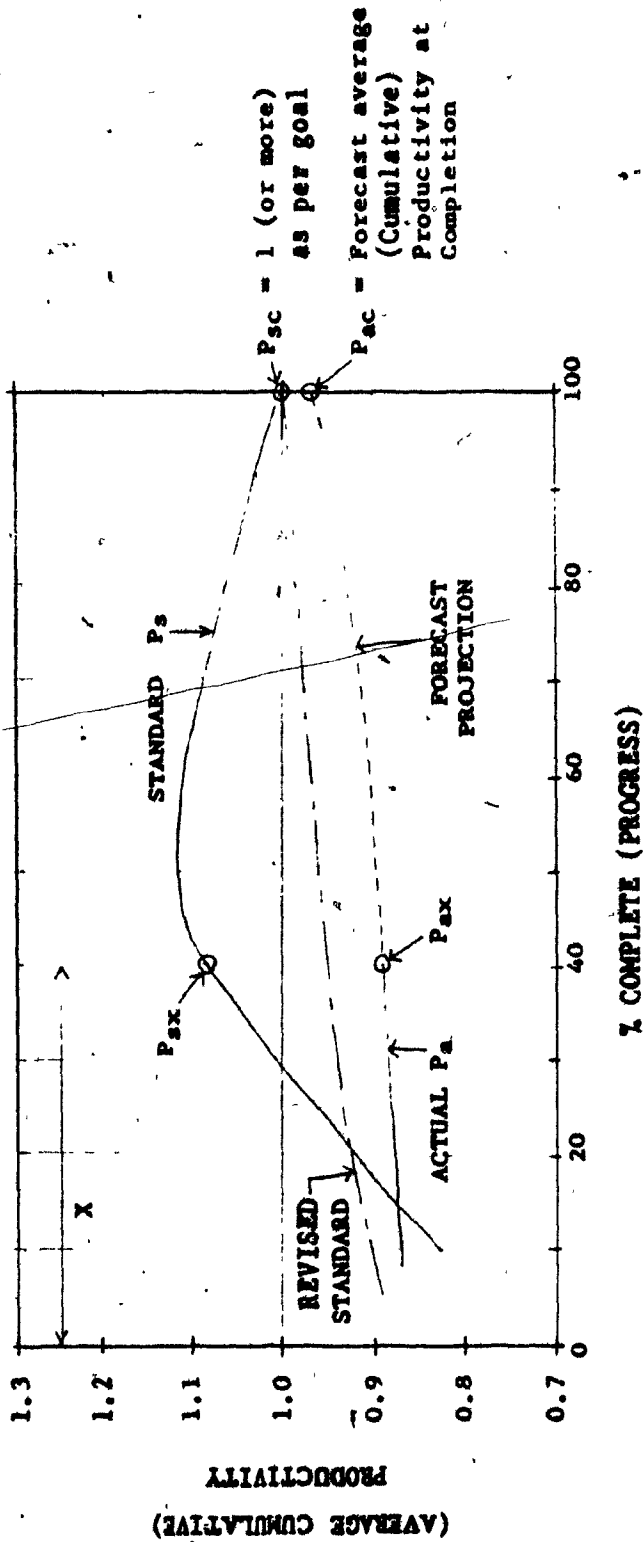


FIGURE: 5.7.5. Productivity Measurement & Forecast  
SOURCE: Based on "Productivity Analysis - A Case Study," by Charles J. Peles, A.A.C.E. Transaction, 1977



standard profile  $P_s$ ) may be outdated. In such a case, the standard profile ( $P_s$ ) should be reassessed and revised without changing the value of  $P_{sc}$  (as shown in Figure 5.7.5);

The main advantage of this method is the fact that it permits a more realistic productivity evaluation and manhour forecast. Example: Based on historical data the productivity may be low (below 1) as assumed in Figure 5.7.5 (shown by the curve  $P_s$ ). So there is no reason for alarm as long as the actual productivity (even though low) does not vary significantly from the standard productivity for the same progress percentage. If there is a variation, the methodology discussed in the previous paragraph can be applied for analysis.

- Based on the periodic projection of the expected productivity at completion, and other data, realistic manhour forecasts can be generated as shown in Illustration 5.7.6.

#### Illustration 5.7.6

Projection of manhours through use of the productivity profile based on manhours:

The variables are as follows:

Physical percent complete	-	x
Standard (planned) productivity at x% completion	-	$P_{sx}$
Actual (measured) productivity at x% completion	-	$P_{ax}$
Standard (planned) productivity at 100% completion	-	$P_{sc}$
Projected (actual) productivity at 100% completion	-	$P_{ac}$

Total standard (planned) manhours at 100% completion =  $M_{sc}$   
Total projected (actual) manhours at 100% completion =  $M_{ac}$   
Total projected manhour over (under) run at 100% completion =  $M_{oc}$

Projected productivity at completion ' $P_{ac}$ '  
=  $\frac{\text{(Standard productivity at completion)} \times \text{(Actual productivity at } x\% \text{)}}{\text{(Standard productivity at } x\%)}$

$$= \frac{P_{sc} \times P_{ax}}{P_{ax}}$$

Projected actual manhours at completion ' $M_{ac}$ '  
=  $\frac{\text{Total standard manhours at completion}}{\text{Projected productivity at completion}}$

$$= \frac{M_{sc}}{P_{ac}}$$

Projected manhour over (under) run at completion ' $M_{oc}$ '

= Projected actual manhours at completion - Total standard manhours

$$= M_{ac} - M_{sc}$$

A positive value for  $M_{oc}$  constitutes an overrun, a negative value indicating an underrun.

On the job performance of labour can be affected by the following factors and more, which can result in a manhour over/underrun (40);

- Acquisition rate of direct labour;
- Attrition rate of direct labour;
- Average month's service of direct labour;
- Average month's service of supervisors and supervisory ratio;
- Dissatisfaction with manpower scheduling;
- Lack of steady flow of work;
- Time interval between similar jobs;
- Out of sequence work;
- Density of workers in the work area;
- Changes or problems with related trades or subcontracts;
- Elapsed schedule time;
- Overtime;
- Engineering changes;
- Equipment changes;
- Material and equipment availability and deliveries;
- Machine control percentage;
- Visible backlog;
- Lot size for prefabricated items;
- Cumulative units produced;
- Accident rate and safety measures;
- Percentage of bad weather;
- Contractual or jurisdictional disputes.

The above checklist is by no means complete and other related causes should be taken into account depending upon the project under

way. For international projects, or projects in a little known environment, factors such as local languages, practices and customs should be taken into consideration. Availability and morale of skilled labour in the project area is another important factor.

5.8 Performance control of construct/supply-install contracts,  
and data collection (assuming cost plus contractual arrangements):

Depending upon the contractual terms, a construction or supply-install contract may be regarded as a project in itself with one main additional constraint, which is its relationship with the project as a whole. Therefore the functions related to performance control of contractual work cover the two main areas of:

- Internal control, by the contractor, over progress, quality and the contract budget;
- Analysis of the impact of individual contract performance, based on the data provided by the respective contractors, on the project schedule, budget and overall quality.

Although the control functions are similar to those required for project control, the main problems encountered here can result from the fact that the project management team and the contractors may not be using the same database or similar control techniques. As such, it is not always sufficient to have a contract just as a part, or a phase, of the project. It is important to integrate it with the project right from its conception, and to ensure that the contractor understands, and correctly interprets, the relationship of his portion of work with the project as a whole, so that his internal scope development, schedule and budget control program, etc., are compatible with the project. For the project category examined in this report, the contracts are assumed to be co-ordinated and managed by the construction management department, only the critical subcontracts/

purchase orders being monitored by the procurement department through expediting procedures. The major concern of the project management team, therefore, is to ensure that the contractors' internal performance measurement and control systems are sound and compatible with project control as a whole. This is achieved by examining and evaluating the contractors' control systems and techniques, some indispensable criteria being incorporated in the contractual agreement to prevent future problems.

The basic principles of contract management are (41):

- Contract work must be properly defined and organized;
- The contractor's internal management systems must be sound;
- The contract baseline for performance measurement must be established and controlled;
- An accurate basis for cost/schedule performance measurement must be employed (e.g. earned value);
- Contract status and trend data must be valid and traceable, at least to the account level;
- Effective management review and decisions must be facilitated through organized reporting.

The main features a system must have for effective contract management are (42):

- Use of work breakdown, with an active input from the contractor at the contractual level;
- A set of criteria, which can serve as standards for measurement of the adequacy of the contractors' management systems including organization, planning, budgeting, accounting, analysis, revisions and access to data;

- Use of the earned value concept for cost/schedule performance of individual contracts;
- Solicitation and contract provisions for the essential control features;
- A validation process including an implementation visit, readiness assessment, demonstration review and acceptance;
- A set of standard contractors' reports;
- Monitoring of the contractors' systems after acceptance.

The contractual agreement requires the contractor to perform certain functions such as planning, scheduling, budgeting, etc., and sets forth the characteristics and capabilities (work assignments, cost control, etc.) normally inherent in a contractor's management system. This approach ensures integration with project control while allowing the contractor some flexibility of internal operations. The standard reports to be filled out by contractors should follow the standard formats used for project control so that the reporting formats remain consistent.

The contractual control procedures can be as follows:

- The contractually stipulated periodic status reports (including the cost performance report shown in Figure 5.6.3 earlier) should be checked and approved by the assigned site engineer for physical progress;
- The site cost engineer should check the claims by comparing them against the contract budget breakdown after assigning the proper project cost codes to the work items, before

incorporating them in the cost summary worksheet. Cost variances (beyond the tolerance limits) for the contract budgets should be analyzed (by requesting additional cost data from the contractor if necessary), and queries raised if necessary, at this stage;

- The contractor can then submit his progress payment claim, backed up by the approved cost performance report and other related documents, to the accounting office for payment;
- Payment can be released after deducting the holdback stipulated by the contract, and a listing of the progress payments sent to the cost control department along with the holdbacks deducted for input to the monthly cost summaries and reports.

Besides the inherent advantages of the earned value concept for cost analysis, the main advantage of this contract management system is the fact that, as a result of the contractor system review, project management gets a good working knowledge of the contractors' operations, procedures and terminology, leading to better communications with the contractor and greater confidence in contractor generated performance data. The main disadvantage can be the fact that within the cost variance tolerance limits the contractor can claim very high indirect and overhead costs thus leading to high overall project overheads.

The field expenses and overheads are usually unavoidable and they include cost items such as job organization, signs, barricades, winter protection, clean-up operations, security and so on. These costs can be collected directly as they are incurred and entered in the field cost ledger from where they can be transferred to the project cost and commitment ledger as project overheads.



### 5.9 Cost forecasting and reporting:

The cost forecasting system is one of the most important management tools for forward looking control, its objective being to generate a realistic forecast of the cost of work yet to be done, and hence the projected final cost at completion. It can be defined as a periodic evaluation of the project in terms of the projected final cost at completion, which is compared against the current control budget. This comparison is normally done as shown below:

Initial control budget + Authorized budget changes to date

- Current cost budget

Actuals to date + Predicted to go = Current cost forecast

The control budget, budget changes and the collection of actual cost data have been discussed already. But the term 'predicted to go' denotes the key figure for a realistic cost forecast by far, and it is derived by using the data inputs from the performance and trend reports generated by the performance control and cost trending systems. The activity and resource forecasts are based on the actual performance to date (and in the near-past), engineering and schedule revisions, changes to the construction plan, etc., and they are converted to cost forecasts by applying the latest estimating and cost data. As the project develops, the estimates turn into commitments and these figures are updated for each progressive forecast. Depending upon the changes and trends, forecasting for individual packages should be compatible with the level of detail required for control, based on the agreements between parties and other criteria. Figure 5.9.1 shows the main elements of the cost forecasts system.

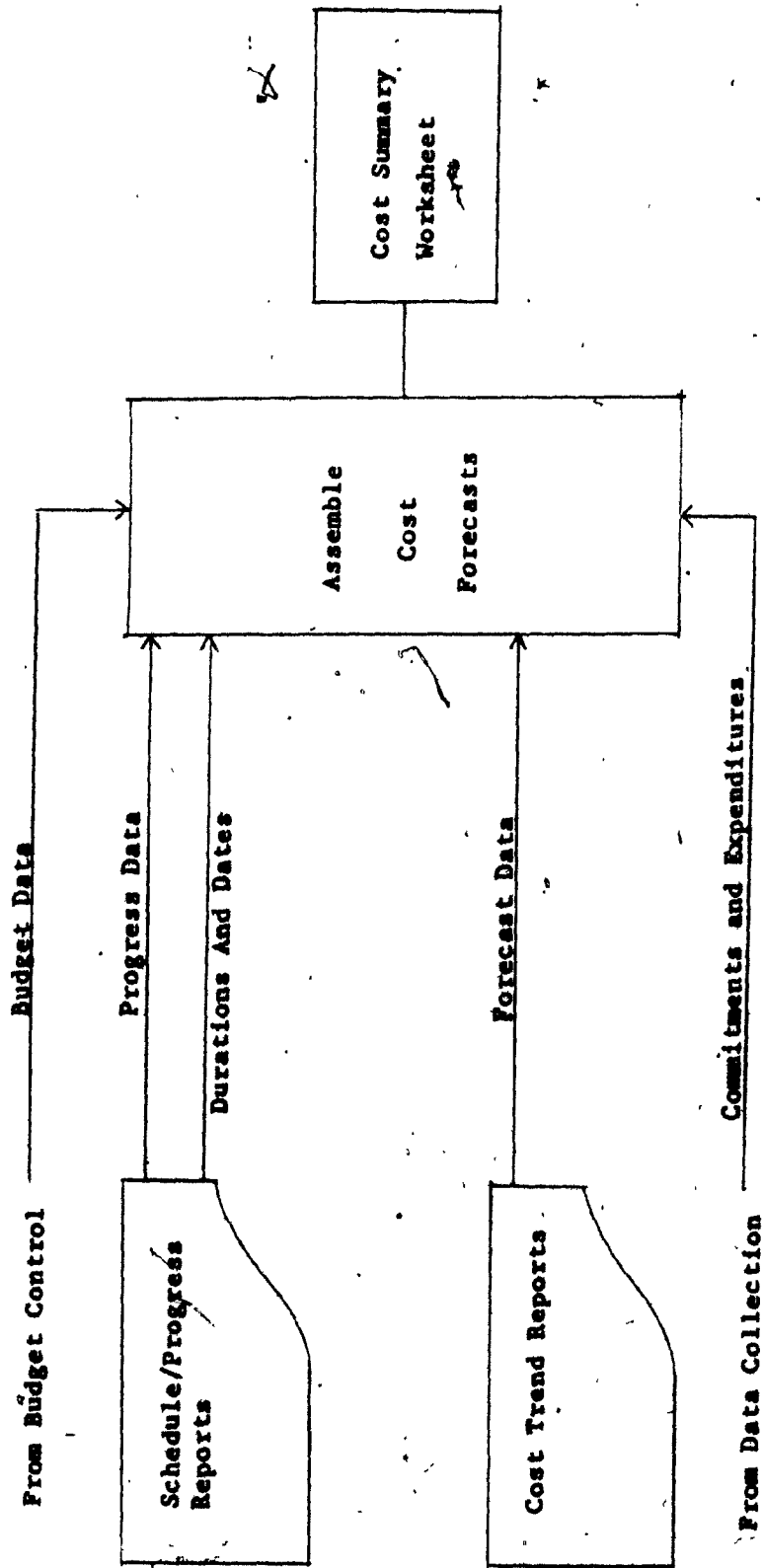


Figure 5.9.1 Cost Forecasting System  
Source: "Managing Capital Expenditures For Construction Projects" By K.M.Guthrie, p. 202

The methodology for cost forecasting is as follows:

- Cost forecasts for design/engineering, procurement, construction management, project management, and other professional services are based on activity status, the manhour requirements for the remaining work, and the projected home and field office expenses for professional services; the main data input coming from the design/engineering performance control and data collection (including cost trending) subsystem;
- Forecasting of costs related to field activities can be as follows:
  - Field labour and manpower cost forecasts are based on the activity manhour estimates and the total manhour forecast, productivity trends on the job, wage escalation, overtime wage requirements and other similar factors. The data input comes from the labour control system in the form of the field labour summary, other weekly labour summaries (such as labour distribution area manhour, etc.); payroll reports, etc. Table 5.9.2 shows an example of a manhour and cost forecast worksheet for field labour. Illustration 5.9.3 explains how some of the numbers in the manhour and cost forecast are derived, the other items described being readily available;
  - The material cost forecasts are based on the most up to date quantity take offs, actual physical measurements, the material status data and other related trend data. The main data input comes from the material control and

Table 5.9.2 Manhours and Cost Forecast

MANHOURS AND COST FORECAST

NO	DESCRIPTION	EXPENSE										FORECAST									
		DATE		PERIOD		PERCENT		DOLLARS		PERCENT		DOLLARS		PERCENT		DOLLARS					
		START	END	START	END	START	END	START	END	START	END	START	END	START	END	START	END				
0200	SALES	4,280	11/25	15,600	12/17	7,800	1/12	11,250	1/19	6,237	3/2	1,335	5/14	102	1/11	1,170	2/10	101	7/00		
0201	PROPERTY	9,010	12/20	110,500	1/15	20,100	2/1	14,300	2/15	109,876	2/1	3,500	11/21	122	1/12	39,900	2/20	135	10/50		
0202	MANAGEMENT	1,500	1/20	5,000	1/1	1,700	2/1	1,100	2/1	2,100	1/2	800	2/17	136	6/1	1,170	3/10	141	14/00		
0203	CONTRACT	6,000	1/1	19,000	2/12	4,100	1/1	11,200	1/1	15,500	1/1	2,500	1/1	3,200	1/1	3,600	1/1	4,500	1/1		
100	GENERAL CONTRACT	300	1/1	1,000	1/1	300	1/1	1,000	1/1	300	1/1	1,000	1/1	300	1/1	1,000	1/1	300	1/1		
110	MECHANICAL	1,200	1/1	4,000	1/1	1,200	1/1	4,000	1/1	1,200	1/1	4,000	1/1	1,200	1/1	4,000	1/1	1,200	1/1		
120	ELECTRICAL	3,000	1/1	10,000	1/1	3,000	1/1	10,000	1/1	3,000	1/1	10,000	1/1	3,000	1/1	10,000	1/1	3,000	1/1		
130	PLUMBING	1,500	1/1	5,000	1/1	1,500	1/1	5,000	1/1	1,500	1/1	5,000	1/1	1,500	1/1	5,000	1/1	1,500	1/1		
140	PAINTING	500	1/1	1,500	1/1	500	1/1	1,500	1/1	500	1/1	1,500	1/1	500	1/1	1,500	1/1	500	1/1		
150	OTHER	1,000	1/1	3,000	1/1	1,000	1/1	3,000	1/1	1,000	1/1	3,000	1/1	1,000	1/1	3,000	1/1	1,000	1/1		
TOTAL		17,500	1/1	65,000	1/1	17,500	1/1	65,000	1/1	17,500	1/1	65,000	1/1	17,500	1/1	65,000	1/1	17,500	1/1		

Manhours and Cost Forecast

Source: "Managing Capital Expenditure for Construction Projects", by Guthrie, p. 195.

Illustration 5.9.3

The manhours and cost forecast can include the following:

- Account code and description of the activity/discipline;
- Budgeted manhours, wage rate and dollars;
- Expended manhours, wage rate and dollars both for the current period and to date, the effective wage rate being

$$\frac{\text{Labour dollars}}{\text{Labour Hours}}$$

- Forecast of manhours, wage rate and dollars

Manhour forecast:

- Manhours required to complete;
- Forecast total manhours = Expended manhours + forecast manhours to complete;
- Percent budget manhours =  $\frac{\text{Forecast total manhours}}{\text{Budgeted total manhours}} \times 100$ ;
- Over/under status = Forecast total manhours - Budget total manhours;
- Percent expended =  $\frac{\text{Manhours to date}}{\text{Forecast total manhours}} \times 100$ ;
- Wage rate to complete: It is the average rate by cost code item for work to be done. It can be based on the effective wage rate of work done and the estimated average wage rate for future work based on the current progress and schedule status;
- Dollar cost to complete and total cost forecast:
  - Dollars to complete = Forecast manhours to complete x Wage rate to complete;
  - Forecast total cost = Expended dollars + dollars to complete;
  - Percent budget dollars =  $\frac{\text{Forecasted total cost}}{\text{Budgeted cost}} \times 100$ ;
  - Over/under budget = Forecast total cost - Budgeted cost.

trending subsystems. The cost forecast is derived by applying the current prices plus the applicable escalation factors depending on the terms of the contract and the delivery schedule. Table 5.9.4 shows an example of a material forecast worksheet and Illustration 5.9.5 shows how the forecast figures are derived;

- The equipment cost forecasts are based on the projected equipment usage, the current rental costs of rented equipment and on updated unit costs for the equipment;
- The construction overhead cost forecasts are normally based on the actual overheads updated by applying the relevant escalation factors. Their allocation to operations may be different from the previous periods;
- The contract cost forecasting methodology depends on the type of contract <sup>(43)</sup>. The fixed price or lump sum contracts are forecast like purchase orders and reviewed with the contract administrator. In the case of unit price contracts, the primary forecast may be the labour hours, material quantity or work units depending on the contract, and it is then converted into a cost forecast by reviewing the actual progress with subcontract administration.

The 'cost plus' contracts are the most difficult to forecast if the contractor's information systems are inefficient or incompatible with the project control systems as a whole, as most of the cost data comes from the contractor's formal progress and performance reports. This data can be checked against costs derived from actual measurement

Figure 5.9.4. Material Forecast Worksheet

CONTRACT 1976 CLIENT SALTY COPPER COMPANY  
 DATE 9/30/75 LOCATION ARIZONA  
 REVISION 2 PROJECT 57-EV PLM/H

**MATERIAL FORECAST WORKSHEET**

FOR: DIRECT FIELD MATERIALS

ACCT. NUMBER	DESCRIPTION	MATERIAL BUDGET	MATERIAL COMMITTED TO DATE	MATERIAL REMAINING	TRENDS	TOTAL MATERIAL TO COMMIT	TOTALS MATERIAL COST	OVER (UNDER) BUDGET	REMARKS
010	SITE PREP	-0-	-0-	-0-					
020	DEMOLITION	-0-	-0-	-0-					
030	EARTHWORK	-0-	-0-	-0-					
051	FORMWORK	20,360	25,127				25,127	5,367	
054	REINFORCE. STL.	41,750	23,550	850		850	24,400	(17,350)	COMBINED BUY
055	CONCRETE	59,165	51,864	1,896		1,896	59,165	-0-	
110	ROUGH CARPENTRY	6,228	5,470	1,058		1,058	6,528	-0-	
160	MISC METAL WORK	66,320	32,566	33,924		33,924	66,320	-0-	
170	SMT METAL WORK		-0-	-0-		-0-	-0-	(10,287)	C.O. #4
270	FIRE PROTECT SYS	10,287	-0-	-0-		-0-	-0-		
280	AIR COND/H & V		-0-	-0-		-0-	-0-		
290	BLDGS PREFAB		-0-	-0-		-0-	-0-		
300	ELECT INTERIOR	38,500	23,939	6,161		6,161	30,100	(8,400)	
320	PAINTING		-0-	-0-		-0-	-0-		
360	RD WK & SURFACE		-0-	-0-		-0-	-0-		
370	FENCING		-0-	-0-		-0-	-0-		
390	ELECT UTILITIES	90,200	-0-	64,070		64,070	64,070	(26,130)	C.O. #7
400	WATER UTILITIES	-0-	337	-0-	1,000	1,000	1,337	1,337	TREND FIN
420	SEWERAGE & DRAIN	4,450	16,273	-0-		-0-	16,273	11,823	
440	FUEL SYS		-0-	-0-		-0-	-0-		
500	PROCESS EQUIPMENT	916,150	851,036	49,700	10,012	59,712	910,750	(8,000)	C.O. #7
600	PIPING	205,544	245,237	5,000		5,000	250,237	44,993	QTY. INCREASE
700	INSTRUMENTATION	37,140	36,821	219		219	37,140		
800	INSULATION	-0-	-0-	-0-		-0-	-0-		
		1,499,194	1,313,227	168,908	11,012	179,920	1,493,147	(6,647)	

Material Forecast Worksheet

Source: "Managing Capital Expenditure for Construction Projects", by Guthrie, p. 204.

Illustration 5.9.5

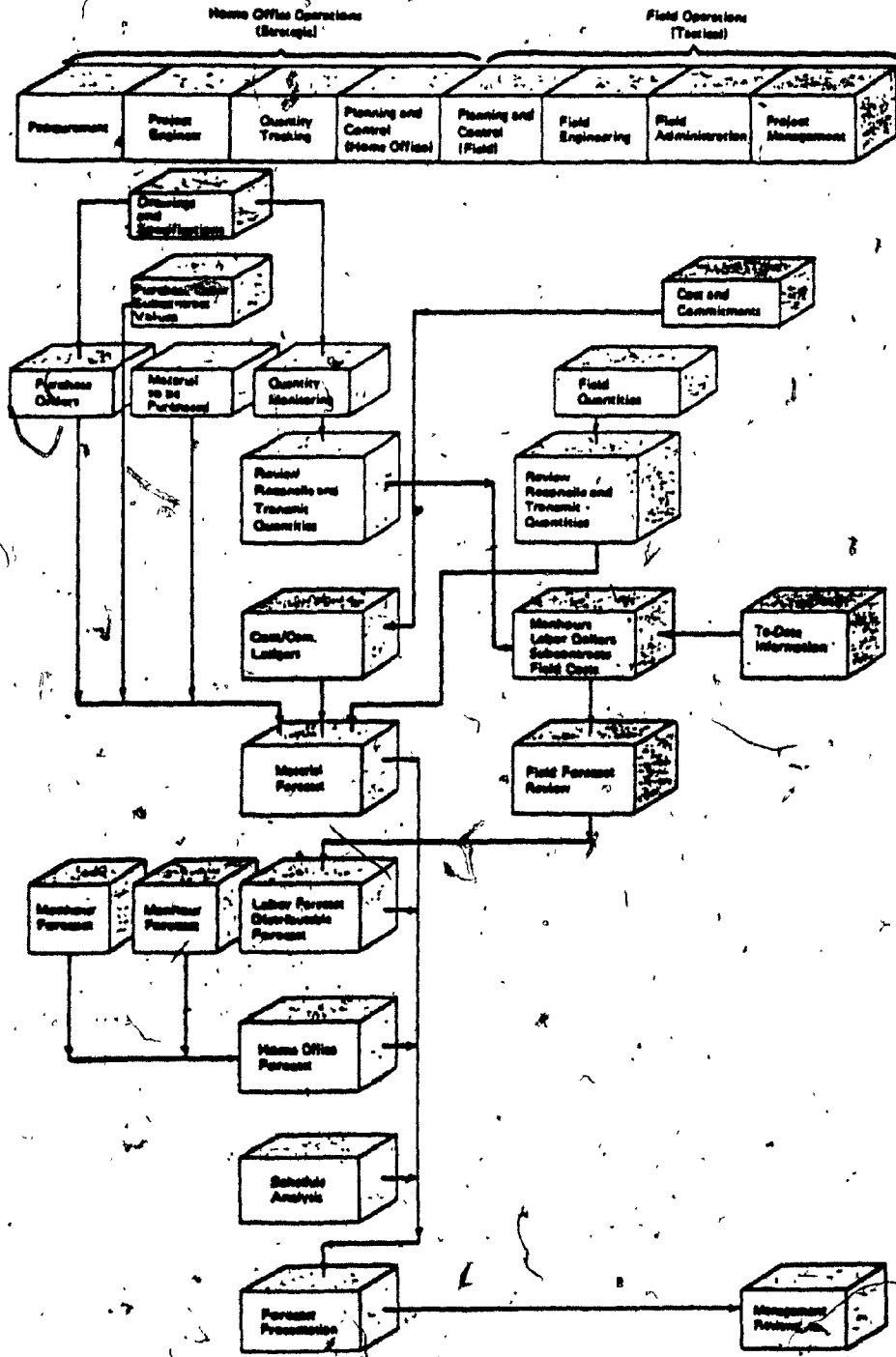
Material cost and forecast can include the following :

- Account code number and description of the material/work item;
- Material budget;
- Material commitments to date;
- Material remaining (quantities on site);
- Trends from the trend reports;
- Total material to commit = Remaining material + Trends in process + purchase order adjustments + other adjustments, by account code;
- Total material forecast = Material commitments to date + material to commit by account code;
- Over/under budget = Total material forecast - material budget;
- Remarks, explanations and discussion.



of work performed to detect and analyse deviations. Any ambiguities can then be resolved by reviewing the data with the contractors and a cost forecast can then be developed. Combination contracts are monitored and forecast by the fixed, unit price and cost-plus elements and then combined for a composite forecast. The data input for contract cost forecast comes from the contract control system. Figure 5.9.6 summarizes the elements of definitive forecasting.

Figure 5.9.6 The Elements of Definitive Forecasting



Source: "Managing Capital Expenditure for Construction Projects",  
by Guthrie, p. 127.

Periodic cost reports and summaries:

The objectives of periodic cost reporting is to provide management with a monetary synopsis of the project in terms of progress, commitments and expenditures to date, the forecast cost of work to be done, the total projected cost at completion, the control budget and the projected cost variance from the budget at completion. The monthly cost report is a project oriented package designed for the monthly review by management and the sponsor. The project manager normally has the option to select the exhibits to be included, depending on the sponsor's requirements and project needs.

The monthly cost report should normally have three basic elements as follows:

- A narrative section, including milestones such as completion of contracts, discussion and reasons for deviations from the budgets, discussion about trends highlighting decisions regarding changes of scope or modifications to the plan which result in a cost impact, discussion about problems requiring attention to avoid delays and/or cost overruns, corrective action planned/taken, etc.;
- The project cost summary, which is essentially a tabulation of the control elements defined in the WBS, along with their

cost codes and the related cost data. Regardless of the summary type, the elements of reporting criteria should include the required, or all, of the following <sup>(44)</sup>:

	Reporting criteria
Budget (What is allocated)	Current scope Current quantities Current manhours Current dollars
To date (What has been done)	Progress to date Elapsed time Commitments to date Expenditures to date
To go (What is left to be done)	Remaining scope Estimated quantities Estimated manhours Cost of work yet to be done
Forecast (What is the final forecast)	Time of completion or schedule impact Cost at completion (to date + to go)
Status (Compare actuals with budget/schedule)	Budget and/or schedule variance Reasons and/or remarks

The cost summary can have an extended format to show the performance during the current control period, and the cost impact of the schedule variance detected through the earned value feature, for greater detail of review information. But the sponsor, the corporate management of the

project management company and other authorities may require a summary format showing the total cost variance only. In such cases the full impact of the earned value can be shown only in the contract performance reports (used for contract control), the cost summary showing only the basic cost elements and the total cost variance (if any) for each account. Presentation of the performance during the current period separately is also a matter of necessity and control requirements, depending on the project type, the contractual arrangements and the control philosophy.

- The back-up summaries/reports can include a commitment report, a payment and holdback status report, a cash flow report, an exception report, summaries by project areas/facilities/disciplines, summary charts/graphs for progress and/or costs, etc.

The case study (Chapter 6) illustrates a 'cost report and forecast' package (with the exception of the narrative part). The monthly cost report can be accompanied by a monthly status report which summarizes the cost and schedule performance for 'one-page' presentation (Table 5.9.7).

The cost report helps the management by isolating the problem areas through cost variances, so that their efforts can be concentrated on those areas. The sources of the cost variance can then be traced back from the project area/facility to the construction/installation operation and further down to the resource by using the area-facility, work type and distribution portion of the account code. A thorough scrutiny of the costs related to that resource by the assigned cost analyst/engineer will normally reveal the exact causes of the problems. The cost accounting

Figure 5.9.7 Monthly Status Report

**REPORT OF THE VERIFICATION OF THE MONTHLY STATUS REPORT**

**1. PROJECT DESCRIPTION**  
 (City) Bally Copper Company  
 (Company) Walters & Harvey, Inc.  
 (Address) 1000 N. 10th  
 (City) Butte, Montana  
 (State) Montana  
 (Zip) 59703  
 (Date) October 1, 1974 to July 1, 1975  
 (Project Name) Installation of Spray Dryer Machine Number Three and Associated Facilities

**2. PROJECT SCHEDULE**  
 (Start Date) May 16, 1972  
 (End Date) May 23, 1975  
 (Actual Completion Date) May 16, 1975

**3. PROJECT PERFORMANCE (Thousands of Dollars)**

DISCUSSION	MONTH		PROJECT VALUE	ACTUAL COST	PERCENTAGE OF ACTUAL COST TO PROJECT VALUE	TOTAL PROJECT VALUE	TOTAL ACTUAL COST	PERCENTAGE OF TOTAL ACTUAL COST TO TOTAL PROJECT VALUE
	1974	1975						
1. CONTRACT VALUE	700	652	1352	48	3.6%	37000	1352	3.7%
2. CONTRACT VALUE	80	841	921	24	2.6%	37000	921	2.5%
3. CONTRACT VALUE	851	908	1759	72	4.1%	37000	1759	4.8%
4. CONTRACT VALUE	351	203	554	84	15.0%	37000	554	1.5%
5. CONTRACT VALUE	396	332	728	53	7.3%	37000	728	2.0%
6. CONTRACT VALUE	93	95	188	17	9.0%	37000	188	0.5%
7. CONTRACT VALUE	3272	2485	5757	228	4.0%	37000	5757	15.6%
8. CONTRACT VALUE	2485	2485	4970	174	3.5%	37000	4970	13.4%
9. CONTRACT VALUE	2485	2485	4970	174	3.5%	37000	4970	13.4%
10. CONTRACT VALUE	2485	2485	4970	174	3.5%	37000	4970	13.4%

**4. PROJECT SCHEDULE**

**5. PROJECT PERFORMANCE**

**6. PROJECT SCHEDULE**

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**125. PROJECT PERFORMANCE**

**126. PROJECT SCHEDULE**

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**200. PROJECT SCHEDULE**

Source: "Managing Capital Expenditure for Construction Projects", by Guthrie, p. 208.

personnel can provide copies of the primary sources of cost data such as invoices, time sheets, payment vouchers, payroll reports, etc. For contracts the problem can be traced to the account level in the WBS, further data being demanded from the contractor if needed.

The periodic cost reports and summaries are, thus, the end result of all the primary functions described under cost control overview in Chapter 2.

CHAPTER SIX

PROJECT COST CONTROL SYSTEM: A CASE STUDY



Chapter 6

PROJECT COST CONTROL SYSTEM: A CASE STUDY

6.1 General About the Company and the Case Study

The cost control system examined under this case study is the system currently used by the SNC Group, Montreal, the information content being derived from interviews with SNC executives and from SNC project management literature. In order to understand the full implications of the cost control system it is necessary to outline briefly the structure of the company, the company policies and objectives, the types and sizes of the projects undertaken and the role of SNC in handling these projects.

The SNC Group is one of the largest and most flexible organizations in Canada providing project management, engineering, procurement and construction services on the national and international markets. Some of the companies that make up the SNC Group are specialists in particular technologies, others are indigenous to the regions where they operate; still others are consortia or joint ventures formed with manufacturing or other engineering firms to serve specific markets. All exercise a high degree of autonomy, yet any member of the group can draw on the resources of any other when needed. Thus on every assignment SNC works through a multidisciplinary team with varied in-house expertise as needed. Ongoing research related to different project areas such as the social and economic impact of projects, market conditions, supply and demand of project resources, etc. ensures completeness of planning data. All the control systems and procedures are integrated, thus adding up to an integrated package of technical and management skills, backed up by up-to-date information, technology and systems, to plan and execute a very wide variety of projects such as:

- power generation, transmission and distribution;
- mining, mineral processing and metallurgy;
- transport: airports, harbours, roads and bridges;
- chemicals, petroleum and petrochemicals;
- institutional, commercial and residential buildings;
- environmental control;
- forest products, pulp and paper;
- telecommunications;
- light and heavy manufacturing;
- agro-industry, etc.

Some of the major SNC projects completed or under way are listed below along with the capital costs incurred or estimated:

<u>Projects completed or under way:</u>	<u>Total cost incurred or estimated:</u>
- El Qaseem electrification program, Saudi Arabia	\$900 million
- A pulp and paper mill at Puerto Piray, Argentina	\$500 million
- Mechanical and electrical design for the LG3 site at James Bay, Quebec etc.	\$ 1 billion (total LG3)
- Port of Warri, Nigeria (completed 1979)	\$170 million

The role and functions of the SNC Group can include project management, engineering, procurement, construction, commissioning or any

combination of functions related to these main functions. This case study does not cover the commissioning phase, although the cost control system application to commissioning is similar to the other project phases. For the purpose of this report the functions are assumed to be project management, engineering, procurement and construction management (co-ordination), actual construction work being contracted out. This study is system oriented and does not examine one specific project. The same applies to the documents illustrated in the case study, with the exception of the monthly cost report package (for Project No. 6057) which represents the cost performance of one project at a cutoff date.

In summary, the case study examines the integrated planning and control background and the cost control system used by SNC.

The terminology and abbreviations used by SNC:

EPCC = Engineer-Procure-Construct-Commission

PMS = Project Management Services

Professional services = Services provided by SNC and subconsultants

Commercial services = Contracts, purchase orders issued

The Master Network = Milestone schedule

Project Work Breakdown = Work Breakdown Structure (WBS)

Package breakdown = Work package development

ICS = Integrated Coding System

Subdivision code = Area facility code

Discipline code = Work type code

SMILE = Supply-Install/Material/Installation/Labour/Equipment

PRRS = Project Record Retrieval System

Preliminary Budget Estimate = Conceptual estimate (prepared by a  
refinement of the Order of Magnitude  
Estimate)

Target Cost Estimate = Definitive estimate

Control Estimates = Estimates prepared at appropriate intervals  
during design to keep the design compatible  
with the Target Cost

Cost and O/S Commitments to Date = Actual cost and outstanding  
commitments to date

Estimate to Complete = Forecast cost of work to go

Total Forecast = Cost and O/S commitments to date + Estimate to complete

Revised Target = Current control budget

Variance Amount = Total forecast - Revised target

Target Cost = Initial control budget

TSRC = Time Sheet Record by Contract

Services Cost Report = A summary of manpower costs related to professional services

Expense Cost Report = A summary of expenses related to professional services

Cost Report and Forecast = Monthly cost summary

Cost Item Report and Forecast = A cost summary for control of packages

Commitment Report = A summary of commitments

Holdback and Payment Status = A summary showing payment and holdback status

Cashbook = Cash flow summary

The SNC project management approach can be summarized as follows:

- The phase approach to projects (Figure 6.1.1)
- The task force organization concept whenever justified (Figure 6.1.2)
- Plan for the future
  - We cannot control what we did not plan
  - We cannot plan and control everything
  - We have to plan what we have to control
  - We have to be flexible, the detail of planning and control depending on the project needs and phase
  - We have to code what we have to control using the Integrated Coding System
- Seek assistance from the chiefs of disciplines for quality assurance of all services provided by SNC (Figure 6.1.3)
- Use the established SNC methods as they are largely integrated, flexible and can be easily audited
- Use the planning and control task overview (Figure 6.1.4) as a two-dimensional checklist

The planning and control requirements are twofold including

- Planning and control of the professional services provided by SNC
- Management and control of commercial services including contracts and purchase orders

During the conceptual, feasibility, preplanning and (part of) planning phases most of the control effort applies to the internal performance

# PROJECT PHASES

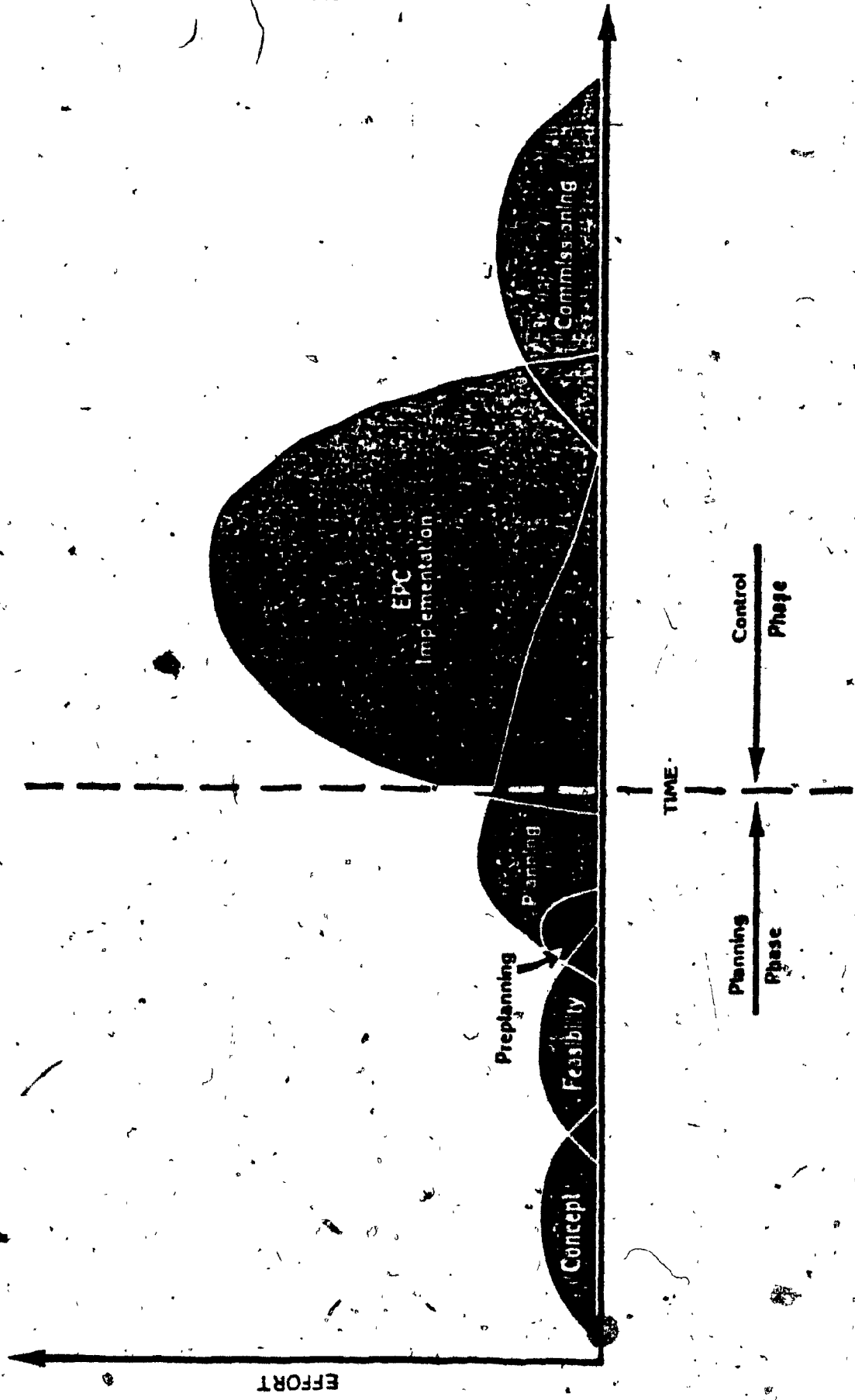


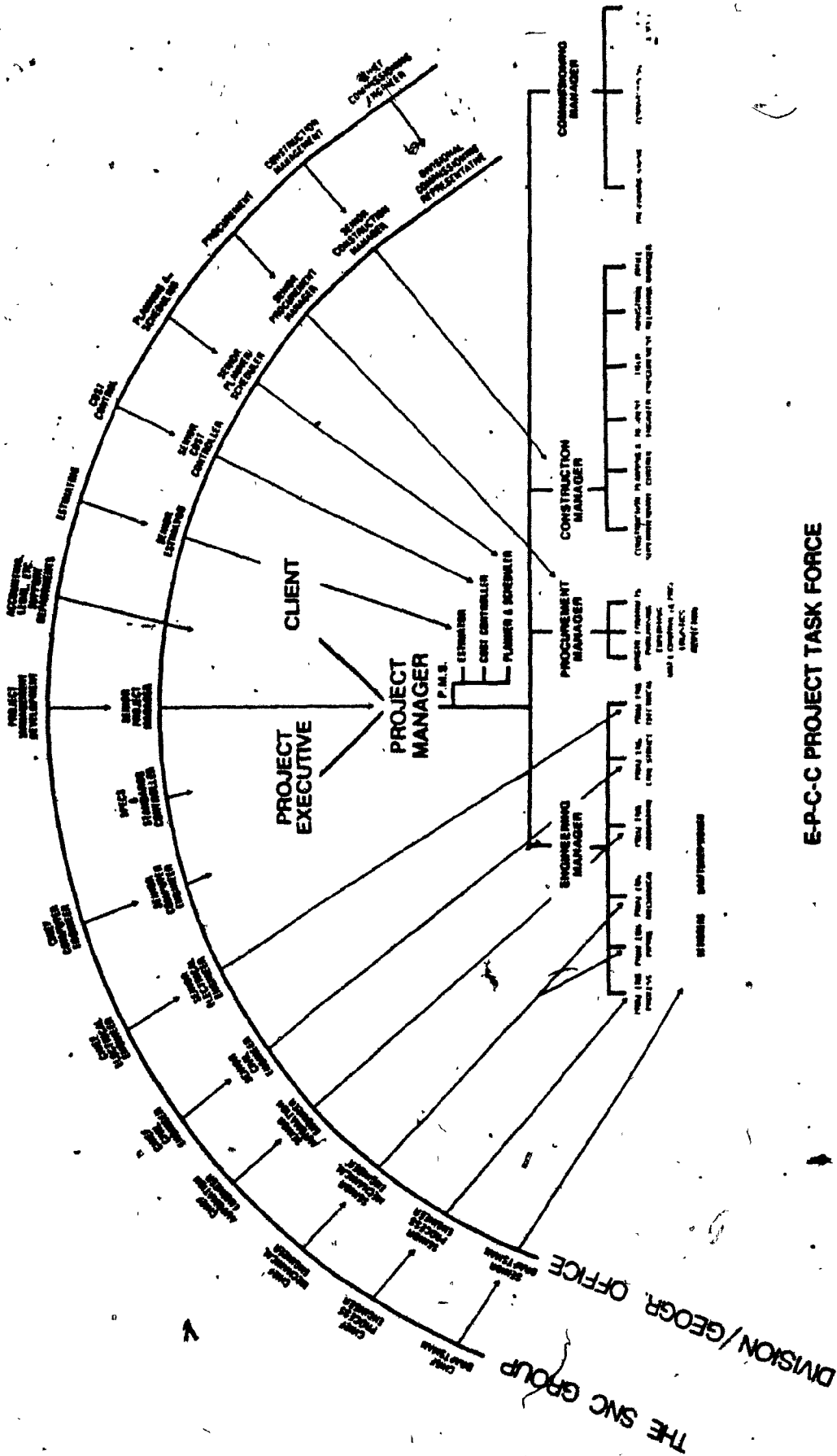
Figure 6.1.1.1





Figure 6.1.1.3

SNC PROJECT ORGANIZATION CHART  
& MANAGEMENT SUPPORT



E-P-C-C PROJECT TASK FORCE

FIGURE 6.1.4

PLANNING & CONTROL TASKS FOR E·P·C·C PROJECTS													
Functions of Mgt. P = Plan = Plan, Organize, Staff, Direct C = Control = Execute, Coordinate, Control, Measure and Appraise.													
Areas of Management Concern (Objectives & Resources)	MAJOR SERVICES												
	PROFESSIONAL							COMMERCIAL					
	SNC							External	SUPPLIER	CONTRACTOR	SNC - LABOR	MATERIAL	
	PROJECT TEAM							Auch. Utilic.	S	C	L	M	
	Client Mgt	PM P&C	E	P <sub>T</sub>	CM	CO	1						2
SCOPE	P	PLANT SCOPE, SCOPE OF SERVICES, WORK BREAKDOWN											
	C	CHANGE CONTROL											
QUALITY	P	SNC SYSTEMS & PROCES'S								DWS/SPECS			
	C	CQA QUALITY ASSURANCE								INSPECTION			
COST	P	C.C. EST	SERVICES BUDGET							CAPITAL COST ESTIMATE			
	C	C.C. CONTR	SERVICES COST REPORT							CAPITAL COST CONTROL			
TIME	P	PLANNING & SCHEDULING - C.P.M.											
	C	C.P.M.	UPDATES - FORECASTS - REPORTS										
RESOURCES	P	MANPOWER PLANNING								MANPOWER PLANNING			
	C	MANPOWER CONTROL								MANPOWER CONTROL			

SNC WORK & MANPOWER CONTROL

We cannot control what we did not plan.  
We cannot plan and control everything.  
We have to plan what we have to control.

LEGEND FOR MAJOR SERVICES:

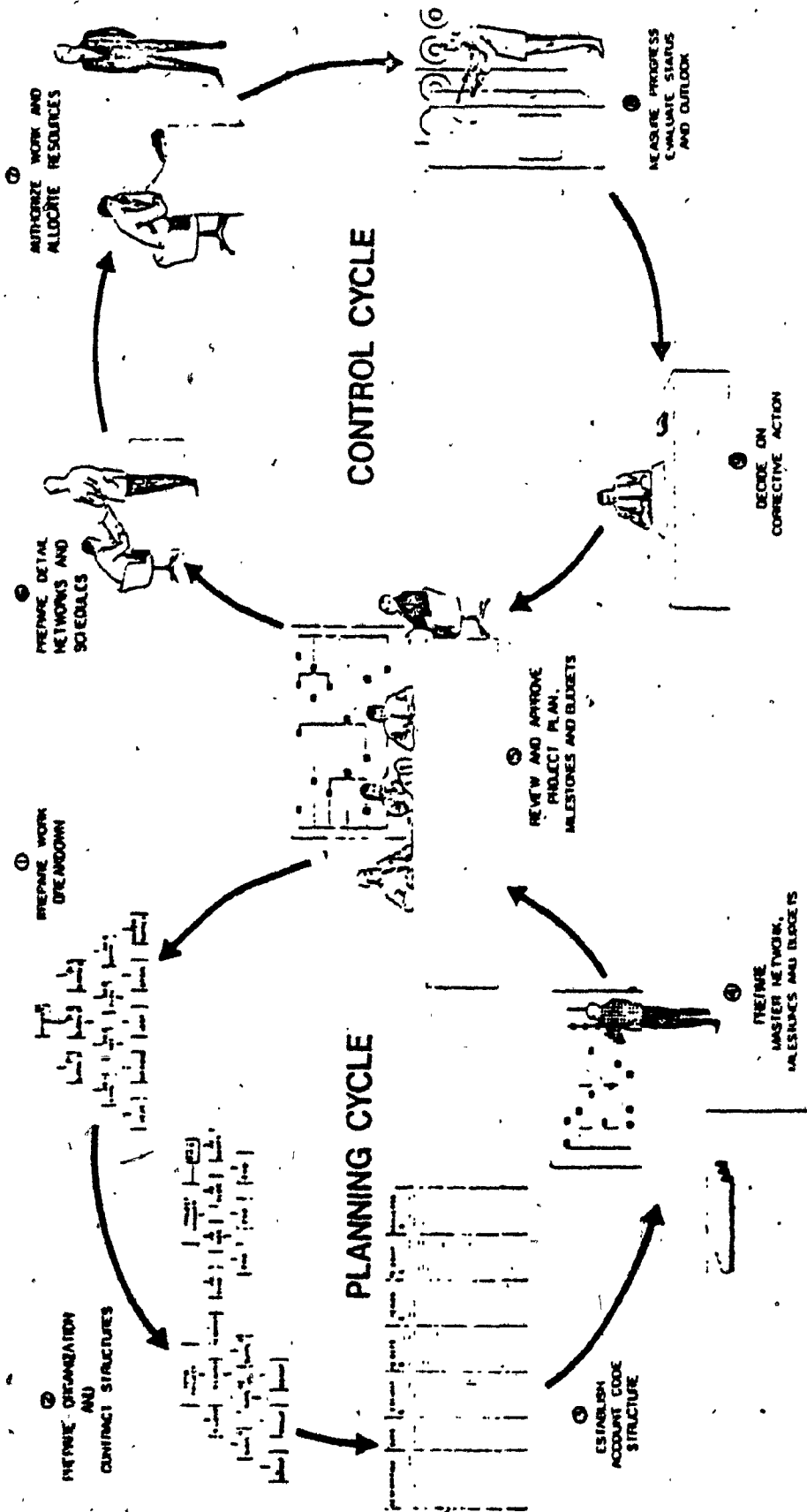
- |                            |                              |
|----------------------------|------------------------------|
| PM = Proj. Mgt.            | P <sub>T</sub> = Procurement |
| P&C = Planning and Control | CM = Construction Mgt.       |
| E = Engineering            | Co = Commissioning           |

of the SNC project team. During the EPC implementation phase (Control Phase in Figure 6.1.1) control effort applies to both professional and commercial services. The functional responsibilities and the planning background is discussed in sections 6.2 and 6.3 respectively.

In summary, planning and control are applied to all the operations related to engineering, procurement and construction, the planning-control effort itself being planned in advance during the preplanning phase, thus resulting in an integrated total control system. Figure 6.1.5 shows the management cycle for planning and control (progress), the level of detail becoming progressively deeper as more information becomes available. This forms the background for cost control.

Figure 6.1.5

# MANAGEMENT CYCLE FOR PLANNING AND CONTROL



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6.2 Typical task force and support organization used by SNC and the functions of the various disciplines and parties involved:

The basic pattern of the typical task force and support organization (shown in Figure 6.1.3) remains the same for every project, although there may be some modifications needed to adapt the organizational structure to the individual project needs and circumstances. The size of the task force can vary depending on the project size and workload. Similarly the location of project personnel may be dictated by the circumstances, e.g. some of the procurement department personnel, from the El Qaseem Project (Saudi Arabia) Task Force, are based in Montreal mainly for communication reasons (as Saudi Arabia does not yet have a telecommunication system network comparable to the one in North America, and most of the major suppliers, contractors, etc. are based outside Saudi Arabia). This creates the added complication of overseas communications between task force personnel, which is solved by establishing a dispatch service to and from site on a regular basis, the available telex and telephones being mainly for local use and for communicating important priority information to/from the site. All the major decisions are made by the project manager, and he can overrule any planning or control decisions made at the home office. The chiefs of disciplines and the senior engineers act as in-house consultants for the engineering disciplines both during the planning and EPC phases as required. The home office estimating, planning-scheduling and cost control departments also act in a similar role, although they have a more active role during the control phase also, e.g. for the El Qaseem Project, the monthly forecasting is done (and cost reports are produced in Montreal based on the project

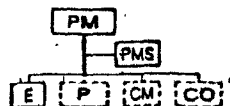
data provided by the Project Management Services wing of the Task Force in Saudi Arabia, using the dispatch system. This is done in order to establish and update one central project database, and retrieve information from the same database for project reporting, using the centralized computer installation in Montreal. The computer software is, however, flexible enough to be used on most recently developed computers if they are locally available for use and if the database is established near the site.

A summary of project services and phases is shown in tables 6.2.1 and 6.2.2, including all major functional responsibilities related to the project.

## 2. SUMMARY OF PROJECT SERVICES & PHASES

CODE	NAME	SUB PHASE	PHASE	CONCEPT	FEASIBILITY	PLANNING
				PHASE 1	PHASE 2	PHASE 3
						Plan the planning
10	CLIENT			Concept policies	Meetings/Reviews, Decisions/Approvals, Environm, Certification	Meetings/Reviews, Monitoring/Financing, Approvals.
20	SNC-MGT & CORPORATE SERVICES			Concept reviews, decisions, policies.	Meetings/Reviews, Approval.	Legal, Personnel, Accounting, Insurance, Financing, Panel Reviews, Public Relations.
30	PROJECT MGT.			Manage concept, Development, Order of magnitude Estimate.	Scope, Planning, Schedule, Cost, Economic Studies, Organization, Delivery System, Assemble Report	Master Schedule, Definitive Estimate, Project Coding, Risk Analysis, Alternates, External Approvals, Planning, Organization, Proj. Instructions.
40	ENGINEERING			Basic Data, Conceptual Process & layouts.	Scope, Planning, Process, Prelim-Engineering, Technical Studies	Design Scope, Criteria, P & I/D'S, Single Lines, Soil Invest., Major Specs, Bid Packages, Prel. Eng'g., Approx 20% of detail eng'g., Value Eng'g.
50	PROCUREMENT			Prel. Plan & Review, Check Market, Logistics.	Major Equipment Inquiries.	Logistics Master Schedule, Conditions, Equipment List, Bid Packages, Contracts, Overseas Strategy, Sources.
60	CONSTRUCTION MANAGEMENT			Orientation.	Site-Study, Constructibility, Identify, Major Difficulties.	Planning, Strategy, Conditions Packages, Temporary Facilities, Key Staff, Manpower Needs, Labour Relations, Constr. Procedures, Major Eq't, Early Work Schedule, Constructability, Quality Contractors.
70	COMMISSIONING MANAGEMENT			Preliminary Scope, Order of Magnitude Estimate.	Commissioning Estimate, Prel. Plan, Scope, Assess Facility Operator's Capability, Manpower Schedules.	Reviews/Meeting Monitoring, Key People, final Manpower Plan, Definitive budget, and Cost Estimate for Commissioning.
80	OUTSIDE: AUTHORITIES, REGULATORY BODIES, & OTHERS.				Preliminary Approvals, Agreements	Consult, Advise, Approve, Agree.
S	SUPPLIERS, VENDORS					- Technical Information - Budget Price Quotations
C	CONTRACTORS					- Technical Information - Budget Price Quotations

D TYPICAL PROJECT ORGANIZATION CHART



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PLANNING

PHASE 3

Reliability Project  
Planning Plan

Monitoring/Finan-  
cing, Approvals.

Accounting, In-  
g, Panel Reviews,

Definitive Estimate,  
Risk Analysis, Alter-  
Approvals, Planning,  
OJ. Instructions.

Criteria, P & I-D'S,  
Invest., Major  
Costs, Prel. Eng'g.,  
Final eng'g., Value

Schedule, Condi-  
List, Bid Packages,  
Cost Strategy, Sources.

Quality, Conditions Pack-  
Facilities, Key Staff,  
Labour Relations,  
Costs, Major Eq't, Early  
Constructability,  
Reports.

Monitoring, Key  
Power Plan,  
Cost, and Cost Es-  
timation.

Approve, Agree.

Information  
Quotations

Information  
Quotations

ENGINEER - PROCURE - CONSTRUCT

PHASE 4

Engineering, Procurement, Construction

Organize operations & maintenance, recruitment, training,  
facilities monitoring, inspection, approvals.

Reviews, monitoring, support (Finance, Legal, Public  
Relations), site visit, approvals.  
Panel Reviews, Financial & Contract Services.

Detail Networks, Worksheets, Bid and Construction  
Packages, Control, Scope, Quality, Cost, Time,  
Resources.

Detail Engineering for Packages, Final specs, Design (all  
disciplines), Models, Requisitions for Bidding, Bid Ana-  
lyses, P.O. Requests Manuals, Vendor Print, Approvals,  
Document Control.

Construction Contracts, Bid Evaluations, Material Procu-  
rement, Expediting (Mat., Eq't., V.P.'S) Logistics,  
Material/Quality Control, Inspection.

Constructability, Site Visits, Tender Reviews, Construc-  
tion Equipment, Temp. Facilities, Reports, Productivity,  
Receive, Warehouse, Resident Eng'g., Labor Relations,  
Mech. Completion.

Panel/Design Reviews, Operability/Maintainability Reviews,  
Safety Audits, Recruitment/Training Supervision, Client's  
Start-up and other Personnel.

Underwriters' Tests, Inspections, Dept. of Labour In-  
spection, Power & Utility Tests, Environmental Tests.

Bid, Vendor Data, Manufacture, Pack, Ship, Deliver,  
Install.

Site visit, Bid, Mobilize, Shop drawings, Order materials,  
Construct.

COMMISSIONING & START-UP

PHASE 5

Hands-on training, Plant  
Services, Procurement Ins-  
pection, Approvals.

Quality checks, Panel Reviews,

Final Project Report, Commis-  
sioning Field Mgt, Historical  
Data Gathering.

Field Assistance, Design Cor-  
rections.

Commissioning Materials, Field  
Procurement Services, Close out  
Report.

Follow-up, Support Commissioning,  
Hold-back Release, Close-out  
Report.

Field Management, Administrative  
Services, Personnel/Union Af-  
fairs, Monitor Commissioning,  
Laboratory, Services, Etc.

Final Field Certification &  
Approvals to Operate.

Technical Supervision Assistance.

FACILITY OPERATION

PHASE 6

Operate & Maintain,  
Performance Tests, Acceptance

Final Review with client.

Cost Close-out.  
Final client's operations  
Acceptance.

Final Follow-up, Design  
Updates.

Turnover Documents.

Turnover to Client, Final  
Report.

Safety & Hazard Audits.

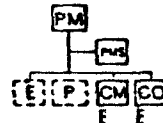
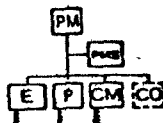


TABLE: 6.2.1

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### 3. PROJECT MANAGEMENT SERVICES & PHASES

CODE	SERVICES NAME	CONCEPT PHASE 1	FEASIBILITY		PLANNING PHASE 3		
			PHASE 2				
32	PLANNING & SCHEDULING	Preliminary Schedule	Plan this Phase Milestone Schedule for Planning and E-P-C Phase	Plan the planning	Prelim Planning	Project Plan	Larger De sheets, C Updates.
33	ESTIMATING	Order of Magnitude Estimate	Prel./Definitive Estimate, Return on Investment, Risk Analysis, Contingency, Evaluation Study, Prel. Cash Flow.	Plan the Planning, Scope, Coding, Bid Packages, Definitive Estimate (Target), Cash Flow, Value Engineering (Assist), Change Control.			Value Eng Check Est Forecasts
34	COST CONTROL, ACCOUNTING	Preliminary Financial Planning		Plan the Planning, Scope, Coding, Finance Planning			Cost Contr plete, Ca
31A	PROJECT SERVICES CONTROLS		Delivery System & Preliminary, Project Instructions for Planning and E-P-C-Phase	Project Controls, Project Services Cost,			Work and P

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ENGINEER - PROCURE - CONSTRUCT

PHASE 4

COMMISSIONING & START-UP

PHASE 5

FACILITY OPERATION

PHASE 6

Project Plan

ie, Master  
downs, Bid  
ark Schedule

Larger Detail Networks, Bar Charts, Construction Work-  
sheets, Commissioning Worksheets, Monitor Progress  
Updates, Alternates, Progress Reporting.

ie, Coding,  
re Estimate  
ive Engineering  
l).

Value Engineering (Assist), Control Estimates, Tender  
Check Estimates, Claims & Change Order Estimates,  
Forecasts to complete, Project Historical Data.

ie, Coding;

Cost Control, Accounting & Reports, Forecasts to Com-  
plete, Cash Flow, Change Control, Plant Ledger.

ct Services Cost.

Work and Manpower Control, Meeting Control, Project Progress Reporting.

TABLE: 6.2.2.

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### 6.3 The planning background for control:

Project planning takes place in three stages as follows:

- Plan the planning;
- Preliminary project planning;
- Project planning.

In general, the degree of detail required depends on the size of the project, the importance of portion under consideration, the depth of information available, and most important, the degree of control required. Example: During planning work and manpower planning is done from the "second level" on upwards. The "first level" details, like listing each drawing or each specification can be done to a large degree just before the actual design and drafting activities start. Some of the important cost related functions during the planning phase are reviewed below:

#### Plan the planning: (Figure 6.3.1)

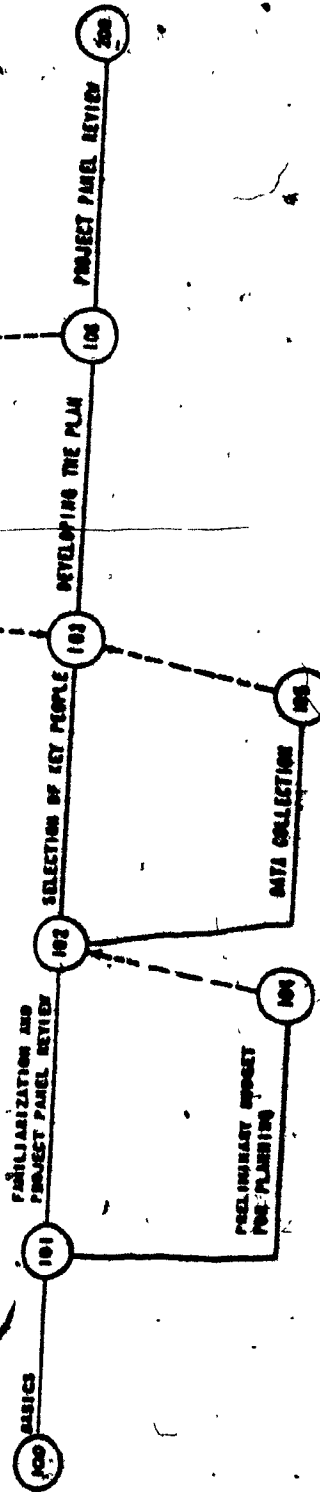
- The basics include establishing parameters for scope, quality, time and resources through objectives (and relative importance), policies, strategies-restraints-alternates, depth of planning and control (including need for risk analysis), and for special items such as foreign assignment, client relations, criteria for decision making, financing, etc.

- Assignment of the preliminary budget for planning phases to cover services' costs (salaries and expenses) including:

- Executives, Chiefs of Disciplines;
- Project Management;
- Planning and Scheduling;

Figure 6.3.1.

.1 Plan the Planning



- Estimating and Cost Control;
- Secretarial, Clerical;
- Engineering;
- Procurement;
- Construction Management;
- Commissioning.

(Note: Chiefs of disciplines are budgeted for in their respective disciplines.)

- Data collection and preparation for the planning meeting.

including:

- Assigning responsibility and estimate duration for each of the planning activities;
- Developing a milestone planning schedule;
- Preparing a breakdown of the scope of SNC services (as known) into general packages for the purpose of deciding which may have to be delegated to other divisions, subsidiaries or subconsultants;
- Drafting up a preliminary organization chart to reflect the above decisions;
- Developing an overall schedule for services broken down by responsibility centres;
- Reviewing the project contract and getting legal help to clarify if necessary;
- Listing all major problems then known including task force recruitment, office space, special technical aspects, construction methods, long deliveries, overseas implications,

start-up personnel training, logistics, financing, insurance for SNC, guarantees, etc.;

- Documentation of the plan for planning after review, including:

- Network and durations;
- Bar chart schedule (Figure 6.3.2);
- Budget;
- Establish manpower and other resources.

Preliminary project planning: (Figure 6.3.3)

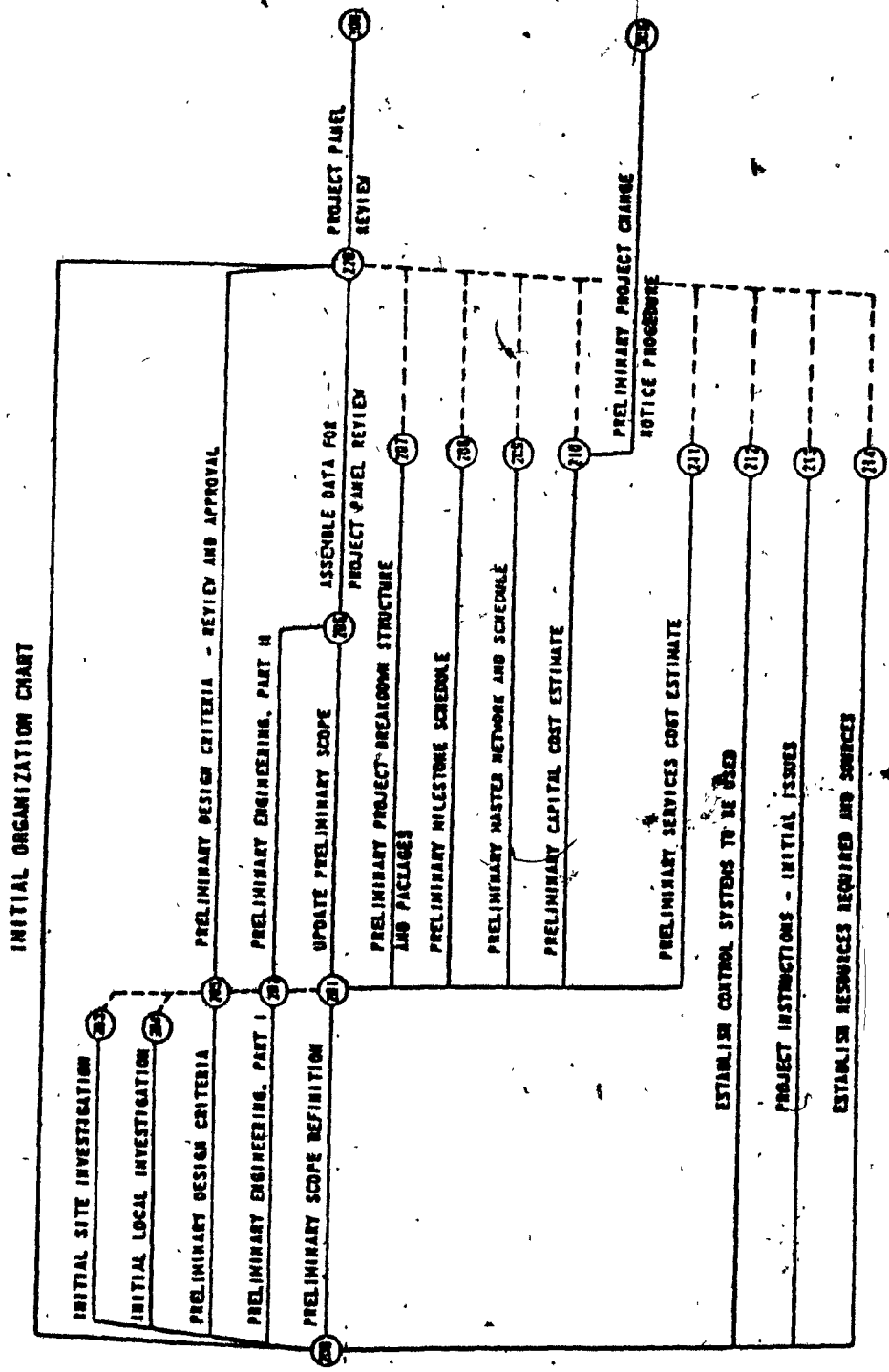
The preliminary project planning stage includes the activities to roughly define the scope, quality, cost, time, resources and to complete preliminary engineering. Some of the important functions from the cost point of view (apart from correct engineering solutions) are:

- Initial site investigations covering
  - Local regulatory authorities;
  - Local labour availability (skilled-unskilled) and productivity;
  - Local material resources;
  - Local engineering consultants, suppliers, fabricators, contractors, etc.;
  - Local housing and other facilities;
  - Transportation/customs;
  - Telecommunications;
  - Local codes, standards and regulations;
  - Special requirements for foreign work, etc.
- Planning and establishing controls (systems, methods, procedures) including



Figure 6.3.3 (Continuation of the flow chart in Figure 6.3.1)

.2 Preliminary Project Planning





- Monthly project progress report;
- SNC Integrated Coding System (ICS);
- Project filing and retrieval system;
- Document control and distribution system;
- Types of reports, meetings and frequency;
- Types of control charts, frequency of update and distribution;
- Project change control;
- Work and manpower control;
- Procurement data control;
- Vendor data control;
- CPM monitoring, updating and reports;
- Services cost reports;
- Capital cost reports;
- Commissioning cost reports;
- Construction worksheets;
- Labour productivity control;
- Cash flow/funding/financing control;
- Project administration.

Other criteria established are risk, quality assurance plan, safety plan, standards and inspection plan.

- Issue of project instructions to acquaint all the parties concerned with the scope, the people involved and where they can be reached, to establish the procedures to be followed and to outline the control methods to be used.

- Ensuring that all organizational aspects are taken care of including task force assembly. The typical organization has to be

modified to fit the project phases and circumstances, but the basic pattern remains the same.

- Updating and defining the preliminary project scope including the scope of the work (i.e. the plant or facility to be constructed) to be used for the preliminary work breakdown; the scope of services provided by SNC, its subconsultants and/or joint venture partners, using detailed checklists for 'scope of services' in each discipline. The professional services code of the ICS is normally used as a start, the established scope being double checked with the contract.

- Preliminary project work breakdown structure and packages (discussed later under work breakdown).

- Preliminary master schedule network (Figure 6.3.4) developed from a logical minimum of project milestones (project events selected as reference points in the accomplishment of the project). On an average about one milestone per month of project schedule (including start and/or completion of phases), spaced at about one to two month intervals, are considered useful. The milestones serve as the basis for reporting<sup>n</sup> progress (on milestones) in the monthly Project Progress Reports. Bar chart milestone reports can be produced, using the computer program for CPM, showing schedule, forecast and actual progress.

Milestone Sample:

	<u>Scheduled</u>
Planning organized	1 October 1977
Complete process flow sheets	1 November 1977
Preliminary project planning complete	1 January 1978

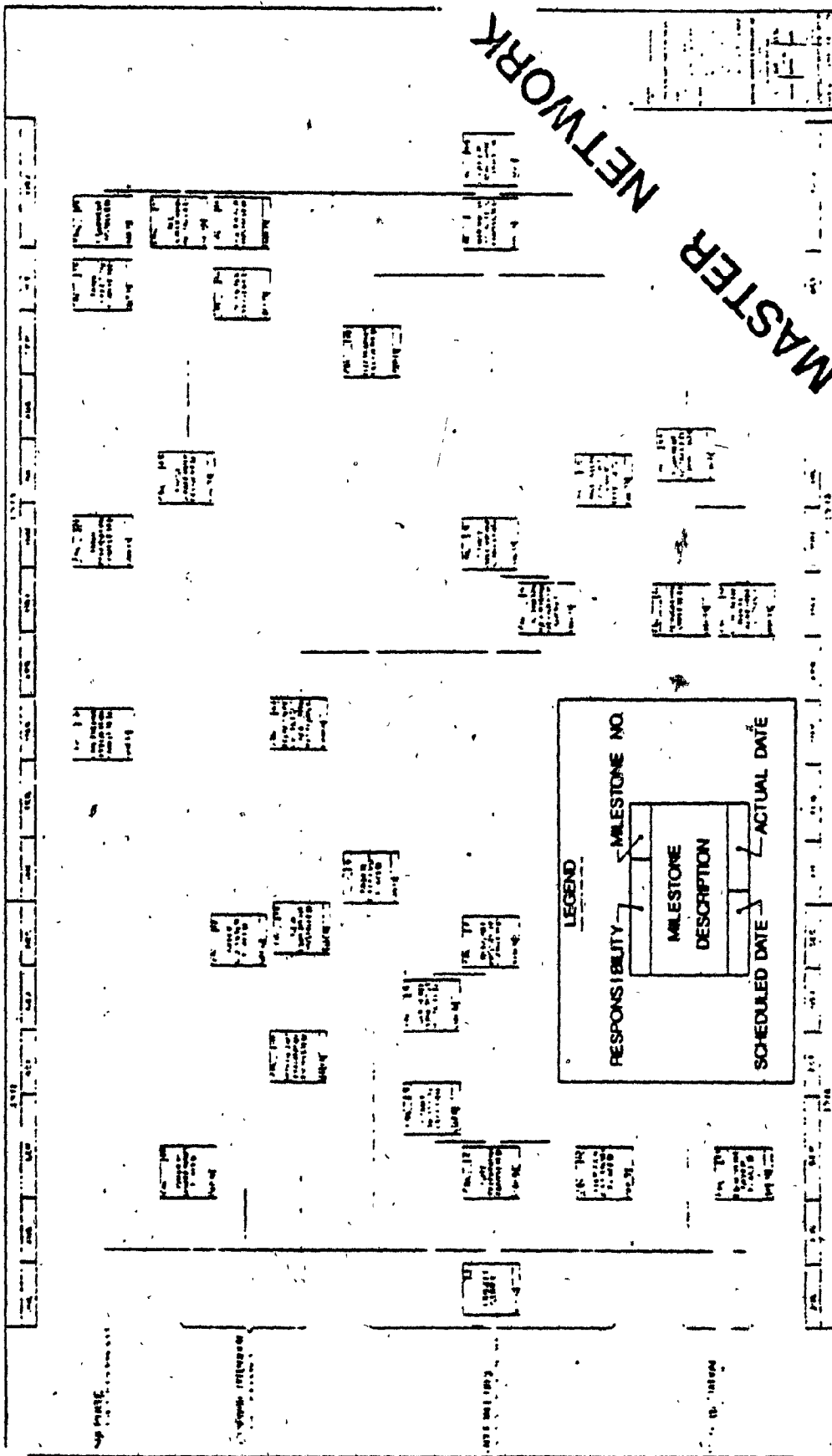


Figure 6.3.4

Complete utility flowsheets	15 January 1978
Plot plan finalized	15 February 1978
Definitive estimate prepared	31 March 1978
Project planning complete	31 March 1978 etc.

When the network diagram is completed, the milestones and all relationships shown, activity durations are entered and the preliminary schedule established. The preliminary network is developed keeping the 'major packages' in mind; or with details to the third or fourth level of the project breakdown (systems or sub-systems), as well as the project phases.

Two different types of summary barchart schedules are developed from the network:

- Schedule by 'Major Subdivision';
- Schedule by 'Major Subdivision' and 'Major Packages'.

Each has a breakdown into the main activities like:

E	Engineering
P	Procurement
F	Fabrication
C <sub>m</sub>	Construction and Installation etc.

Each main group of activities has the estimated (scheduled) duration shown.

- Preliminary 'Capital Cost' and 'Services Cost' estimates to develop the 'Preliminary Budget' estimate (discussed under cost estimating and types of estimates).

Project Planning: (Figure 6.3.5)

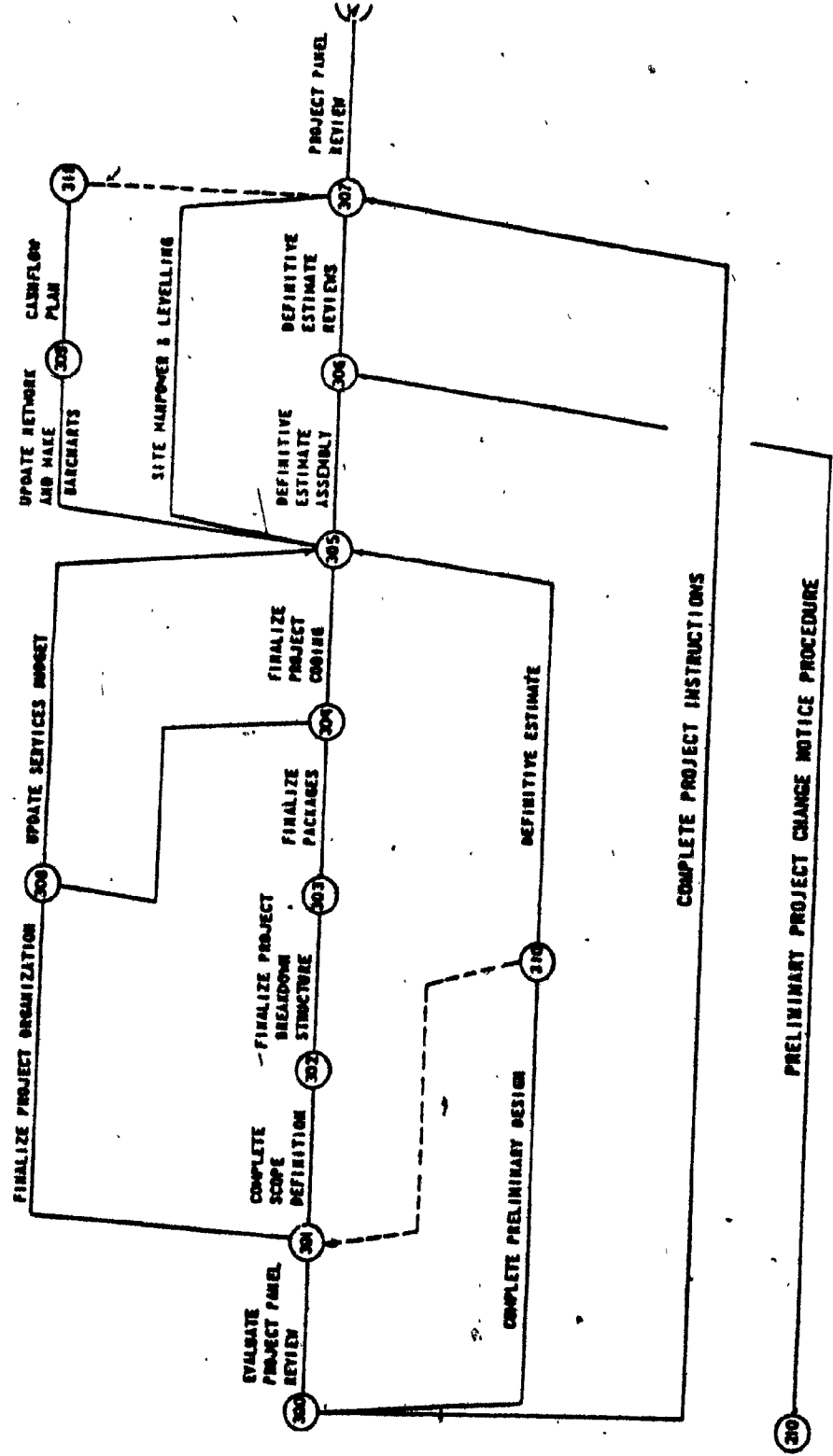
The project planning stage includes all the activities to establish in detail, the EPC objectives and basis for control (including scope, quality, cost and time, as well as the resources), the level of detail being as required for control.

The important functions include:

- Complete scope definition of
  - The plant or facility, structured by subdivision;
  - The services, based on the updated plant/facility scope and other updated project information, by checking against the discipline checklists and preparing a listing of EPC functions;
  - SNC's role (to confirm whether SNC is acting in the role of the construction contractor, the agent, the manager/consultant or the engineer). For the purpose of this report the role is assumed to be that of the project manager/consultant, engineer and procurement agent.
- Complete preliminary design and part of detailed engineering to such a degree as to allow the finalization of the project work breakdown structure and the preparation of the definitive estimate. Usually about 20% of detailed engineering is completed at this stage.
- Complete/update project instructions in the predetermined format.
- Finalize project organization by making any modifications necessary and set up a project staffing file for manpower

Figure 6.3.5 (continuation of the flow chart shown in Figure 6.3.3)

.3 Project Planning



requirements in conjunction with SNC's work and manpower control after review with Personnel Division for specification of requirements.

- Finalize project work breakdown based on the updated scope definition and work plan and document it for visual presentation. The completed WBS forms the basis for coding and control during the EPC effort and is updated as required to accommodate scope development, changes, etc.
- Finalize packaging by updating the preliminary packages based on the updated WBS, the content of each package being defined in detail in "Work Statements". A visual breakdown is prepared for each type of package and a serial number is assigned to each package for identification.
- Finalize project coding to identify primarily
  1. All parts of the facility
  2. Services to be provided by the project team
    - by the suppliers
    - and by the contractors.

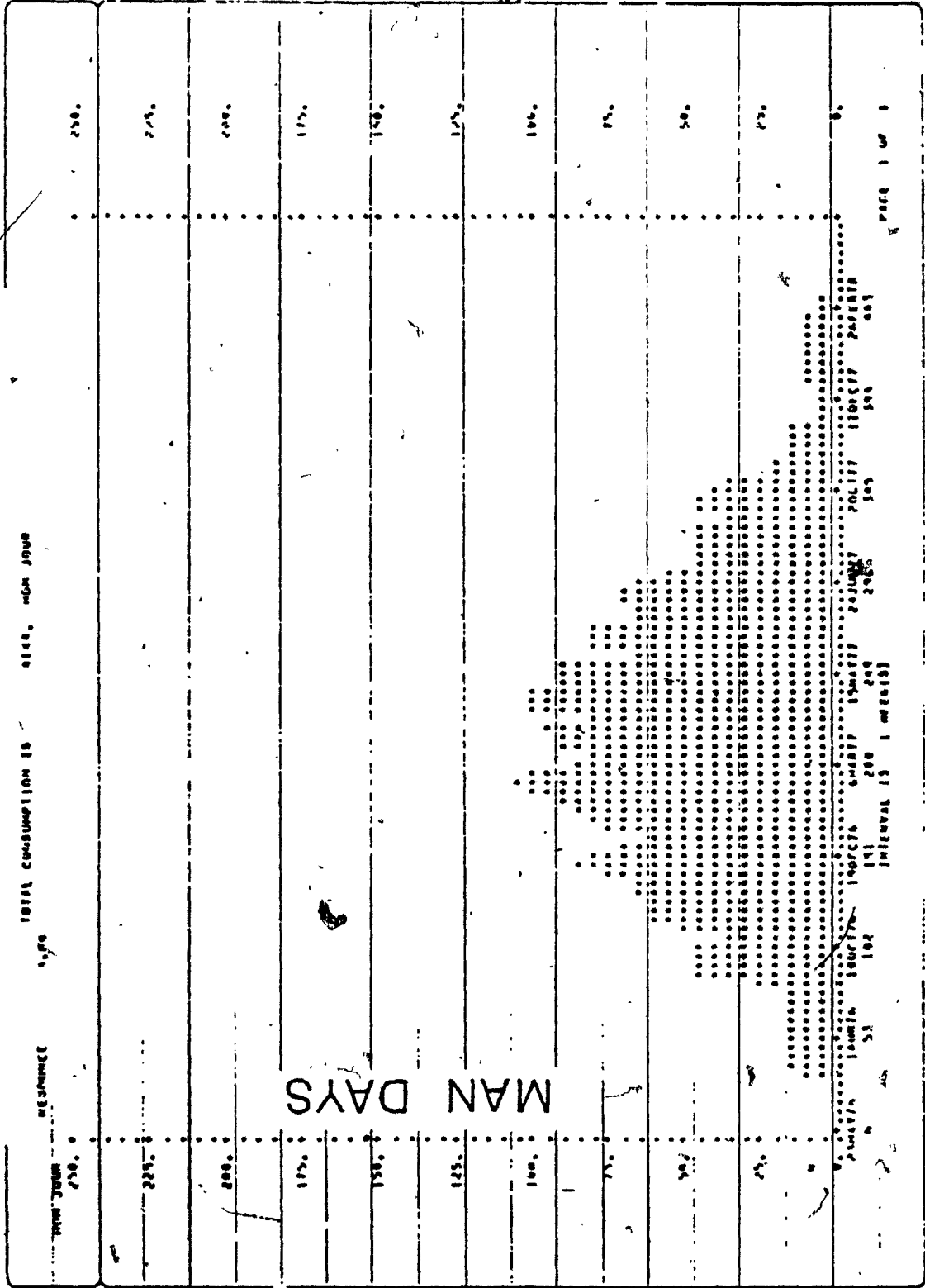
The coding is used to identify elements of scope (facility and services) established, quality, cost, time, resources, documents and responsibilities. The structuring of the project code is such that it allows the use of the 'UNIT PRESIDENT CONCEPT' throughout the project team, meaning thereby that control information can be summarized for sections of the facility and for units within the project team.

The final project coding becomes part of the project instructions or appendix thereto.

- Update work and manpower control based on the latest information in preparation of the services budget.
- Definitive estimate assembly (discussed under estimating) in accordance with the project work breakdown. The definitive estimate is summarized to show the various levels in the subdivision part of the project code, the typical capital work elements (trades) or packages, as required. This allows an easier review on the same basis as the WBS.
- Site manpower planning and levelling based on the detailed project data (Figure 6.3.6). Peak manhours and durations are established for each trade using CPM.
- Update network plan and prepare barcharts by comparing the material and labour requirements with the resource availability and updating the durations on the network plan to establish realistic starting and finish times.
- Review (and update if necessary) the definitive estimate to make any time/quality-cost tradeoffs and to validate input, assumptions, methods and the final definitive estimate. The review involves all the key project personnel who are responsible for input to the estimate.
- Project panel review of the project plan for confirmation or to decide on modifications (a similar review taking place with other project authorities).
- Update services budget based on the latest services' scope definition and enter it on company forms for evaluation, review, approvals (by the chiefs of disciplines) and computer input.



# CONSTRUCTION MANPOWER



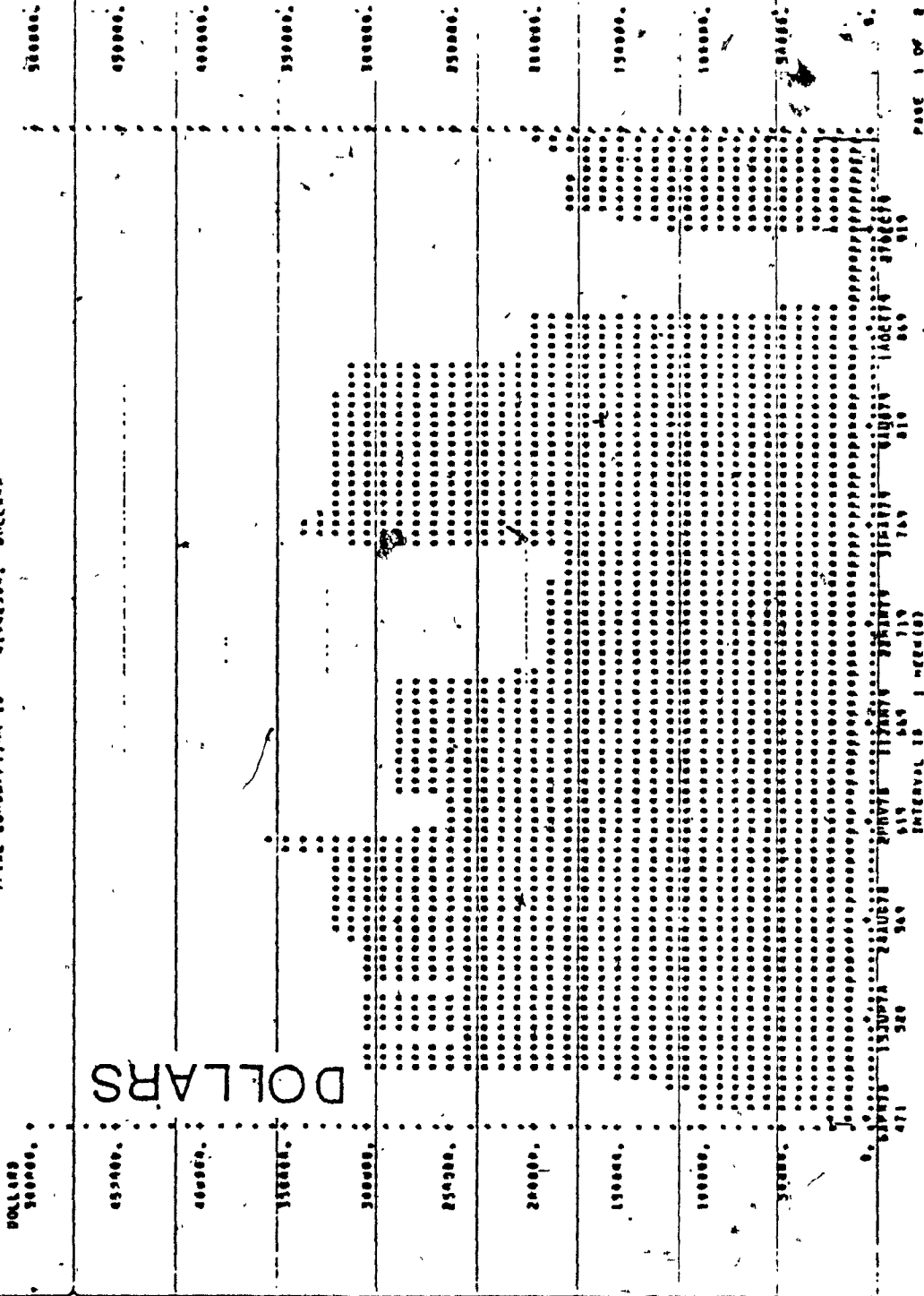
TIME (WEEKS)

Figure 6.3.6

- Prepare the cash flow plan/schedule based on the cash requirements for the execution of the project plan. Figures 6.3.7 and 6.3.8 show computer generated cash flow profiles based on the definitive estimate and the schedule. Similar profiles are generated during the control phase for the actual and forecast cash flows to compare them with the planned profiles.

# CASH FLOW

TOTAL CONSUMPTION IS 41042300. DOLLARS

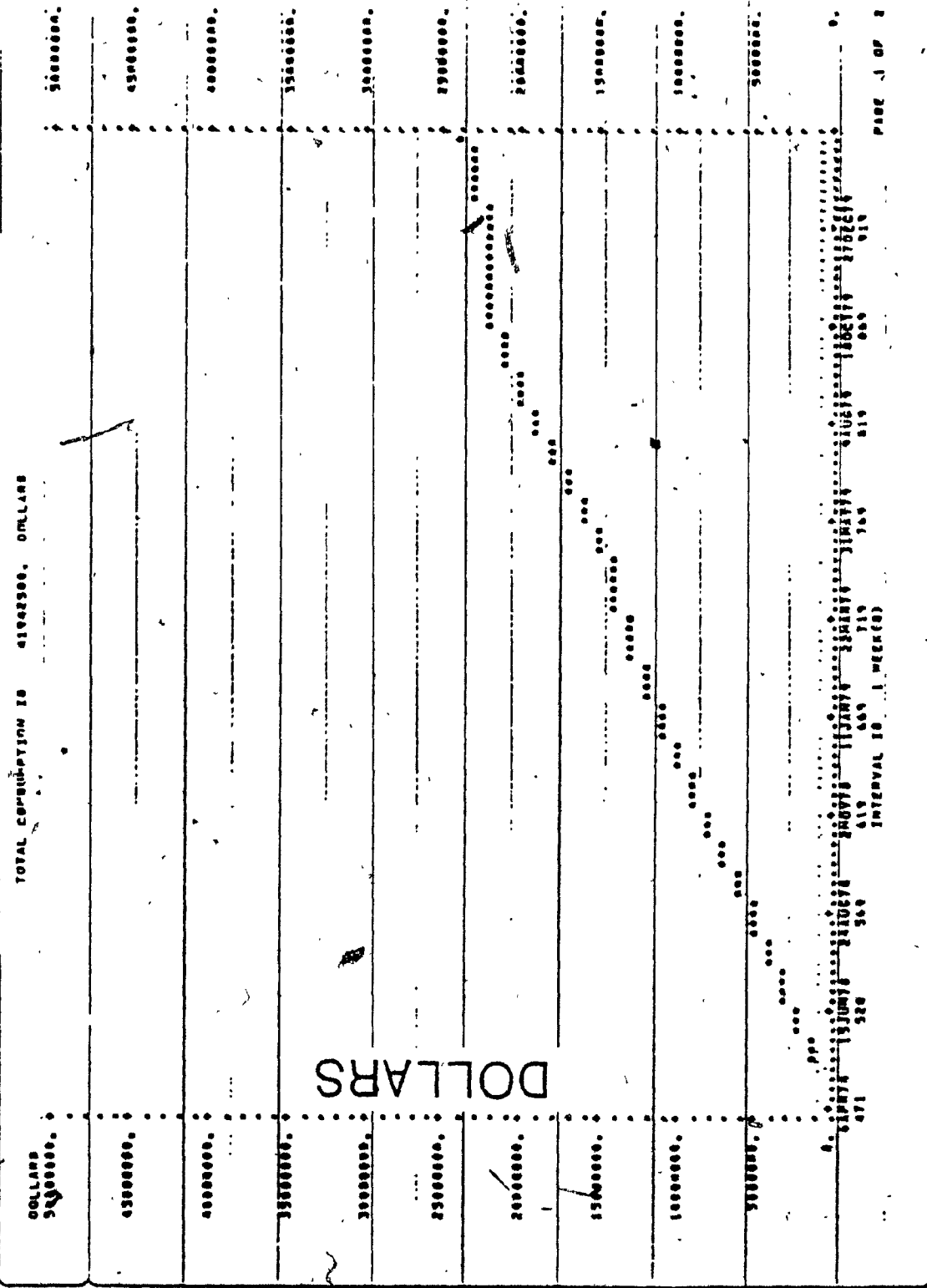


TIME (WEEKS)

Figure 6.3.7

# CUMULATIVE CASH FLOW

TOTAL COMPUTATION IS \$1942500. DOLLARS



TIME (WEEKS)

Figure 6.3.8

#### 6.4 Project Work Breakdown Structure (WBS), packages and coding:

The project work breakdown is a visual representation of the current scope of the project and it establishes a system for coding and reporting. It forms the basis for selecting project milestones, packages and assigning responsibilities. It helps to clarify the work organization, thus reducing the chances of omissions. It is the basis for the project subdivision coding and method of summarization of cost elements in subdivision. Figure 6.4.1 shows the method of work breakdown and Figure 6.4.2 shows the visual representation. The work breakdown is normally done in two stages as follows:

- The preliminary WBS is developed during preliminary project planning. At this stage it is usually sufficient to have the project breakdown detailed to the equivalent of four digits in the subdivision.

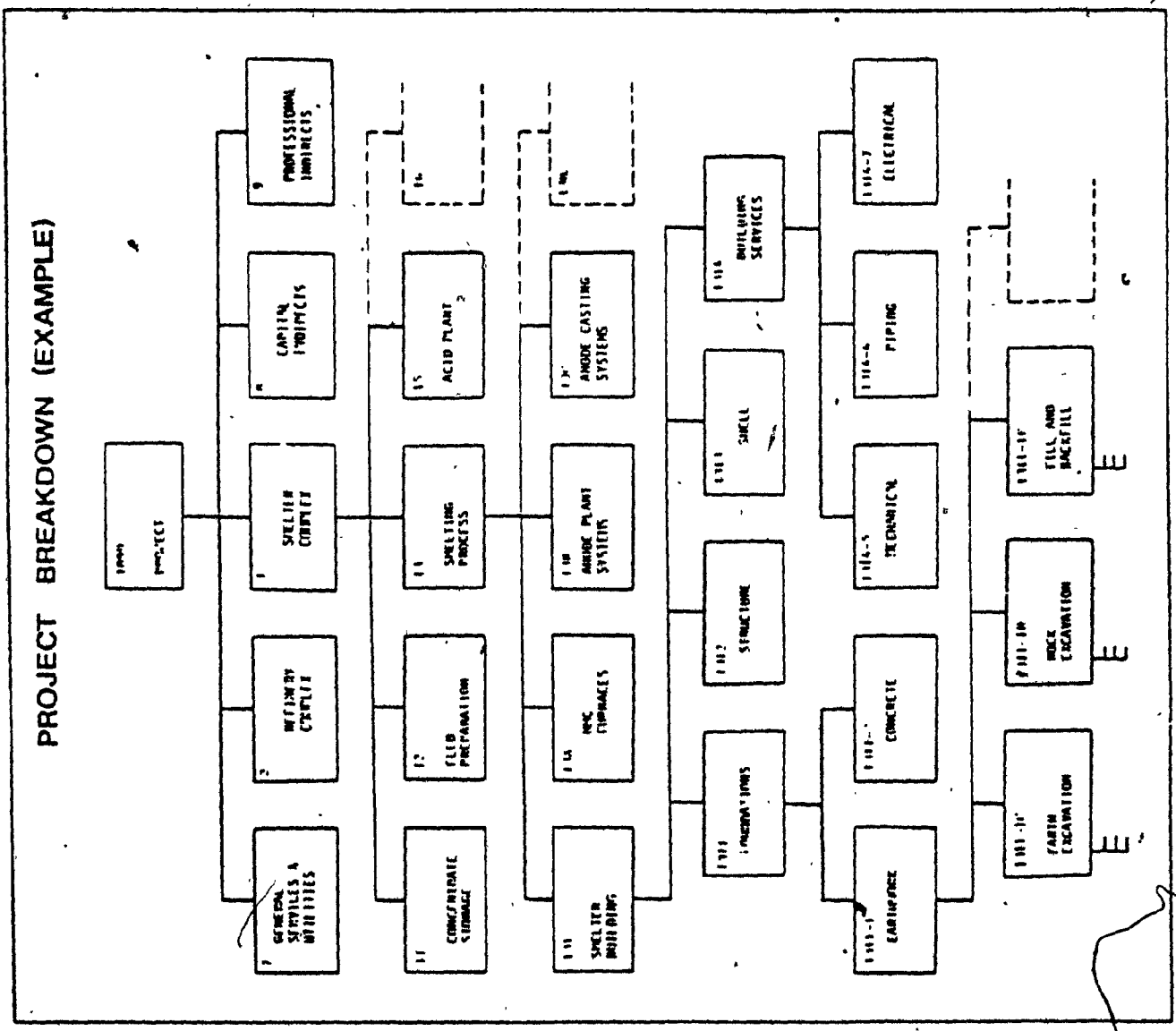
\*e.g. 2 = Service building (Major subdivision)  
24 = Steam generation (Subdivision)  
240 = Steam boiler (System level)  
240-1 = Demolition and Earthwork (Discipline)

\*See Cost Report and Forecast for Project No. 6057 (Section 8.9).

This provides sufficient basis for package development also.

- The WBS is finalized during the planning phase after sufficient data becomes available during scope development and detailed planning. The completed WBS forms the basis for finalizing the packages established during the earlier stage. The WBS begins with the total facility, being subdivided into successive smaller subdivisions (systems) and finally into capital elements which are referenced by the project code.

Figure 6.4.1



CONTRACT NUMBER

SUBMISSION CODE

END ITEM

PROJECT WORK BREAKDOWN

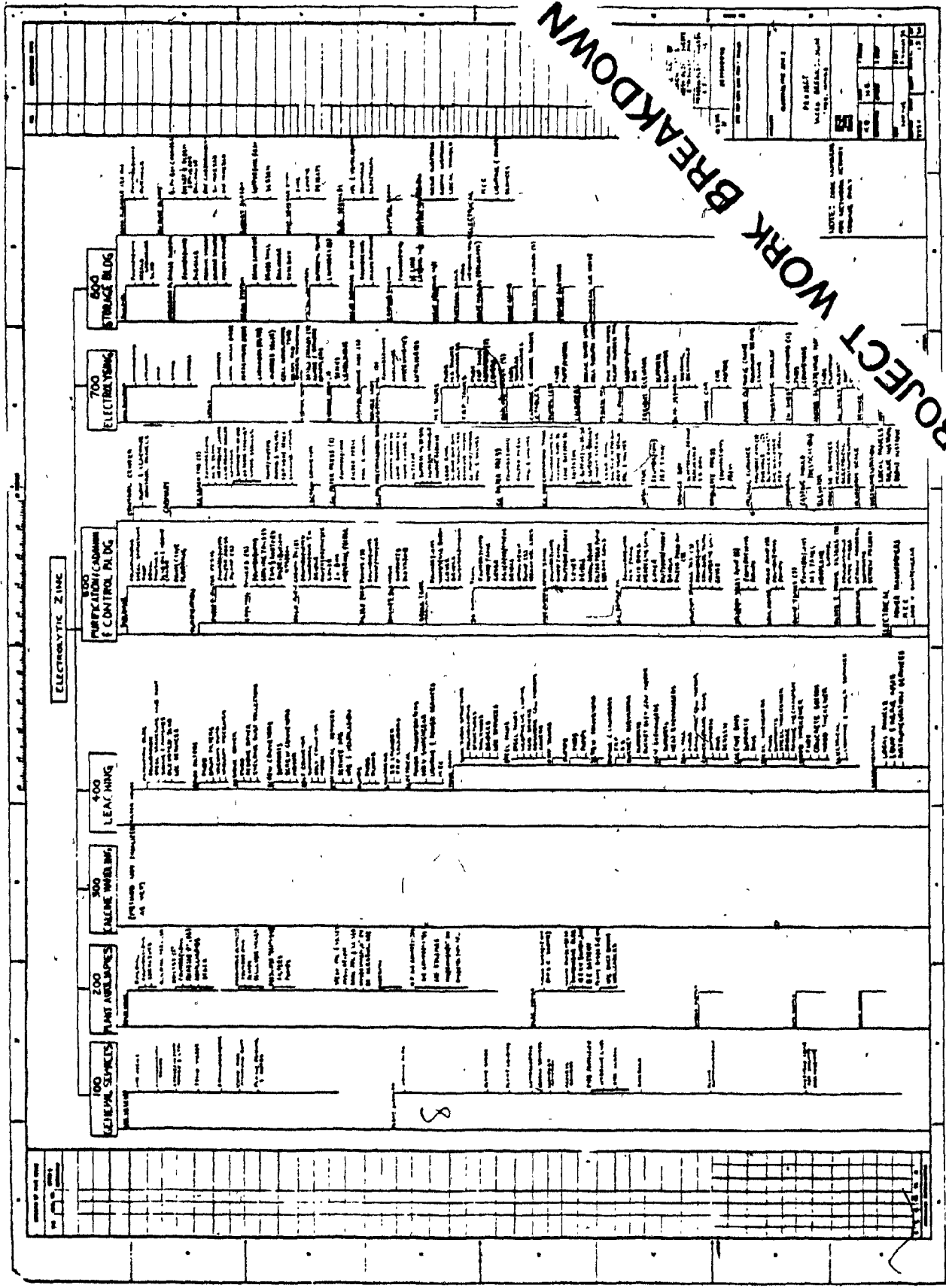


FIGURE: 6.4.2

Parts of the WBS are grouped or rearranged into a number of 'packages' for economy of operations and procurement, to facilitate contracting and control activities, etc. They can include construction contract packages, procurement packages, design-procure-construct (or fabricate and deliver) packages, etc. Correct package development facilitates schedule and cost control as control baselines can be based on packages rather than trying to control each individual element. The packaging is updated as new information is obtained and the WBS updated. A visual breakdown is prepared for each package (Figure 6.4.3) and each package is assigned a serial number for identification. The procurement department drafts and obtains approval of the General Conditions for Purchasing and for Construction Contracts. The quality control program is also initiated at this stage. In summary, packages are "all those technical and commercial documents which end up in one or more purchase orders, or in one or more construction contracts". In case of SNC direct Hire projects individual 'material' and 'labour' packages are also developed. The purpose of the packages is to achieve functional planning and control for engineering, procurement, construction, management commissioning and construction activities in "logical, economical and manageable packages", thus reducing the number of items to be controlled by the project manager himself.

The items or work elements are referenced to their respective package by using the project code, and specifications, as well as statements of work, describing the package items are included in the detailed scope of each package.





Changes of scope and change orders:

Changes of scope are the necessary changes to the original scope of work originating from the design team (for better design), from the client (for additional facilities or better quality than agreed upon), from the construction management discipline (due to essential changes in the construction plans) or from other unforeseen causes such as an Act of God. A formal approval by the client is essential before any scope change is authorized. After authorization the work breakdown structure and the target cost are revised.

The change order data flow is as follows:

- From origin to estimating/cost control;
- Estimating to project manager/cost control/concerned disciplines;
- Project manager to client;
- Client to project manager;
- Project manager to cost control/concerned disciplines.

Registering and invoicing:

- Cost control at the origin of the change;
- Cost control after client's approval (adjustments);
- Invoicing depending on the type of contract.

All scope changes are covered by change orders and recorded in a log.

The project cost code:

The project cost code is developed as early as possible after the project is awarded (normally initiated when the feasibility study is under way) so that project development can be structured on a basis which can be used for control later. The project cost code is based on the SNC

Integrated Coding System (Tables 6.4.4, 6.4.5 and 6.4.6), and is designed to cover the scope of work to the fullest extent practicable, the level of detail being as required. As the project advances the code is updated to incorporate new items and changes of scope as they arise, and as more data becomes available.

The project cost code is a multipurpose instrument used as a common reference for estimating, cost-control, drawing numbering, procurement, scheduling and equipment numbering. All contracts are referenced to and broken down using the code. The 'SMILE' concept used for contract breakdown is clarified below.

S = Supply and install contracts

M = Materials

I = Installation contracts

L = Labour (direct)

E = Equipment

This list can be extended to include items such as ESC (Escalation), T (Tax), etc. Every budget related to the project is broken down into the applicable categories (shown above) and control exercised on the same basis by accumulating the actuals against these categories within each account. This breakdown appears on the monthly cost report and forecast, for each account, with the applicable letter (S, M, I, L, E, etc.) in front of the cost figure (see Cost Report and Forecast for Project No. 6057).

A hierarchical (decimal) coding system is used, with grouping and subtotalling at present levels (subdivision level or otherwise). The coding system is designed to facilitate information retrieval by trade, discipline, system, geographic area, etc. as required.

Figure 6-4.4  
INTEGRATED CODING SYSTEM

Code de composant/ Code component	Application	Compagnie/Company	Division	Département/Department	Projet/Project	Subdivision	Élément capital/Capital element	Élém. serv. prof./ Prof. serv. elem.	Élém. serv. comm./ Comm. serv. elem.	No. de série/Serial No.	No. de composant ou de révision/ Component or revision No.	Type de coût, catégorie fiscale et devises/ Cost type, plant ledger category and currency type	No. d'employé/Employee No.	Groupe professionnel Professional group	Description professionnelle Manpower description	No. de groupement/Package No.
	Charges de temps (prof.) Time charges (prof.)															
	Code des dépenses Expense coding															
	Code des documents Document coding															
	Numérotation des dossiers File numbering															
	Code de réseau CFM Network coding															
	Code de coût en capitaux Capital cost coding															
	Numérotation d'équipement Equipment tag numbering															
	Costs des ressources humaines Manpower planning & control															
	Charges de temps (chantier) Time charges (site labour)															

PURPOSE

The ICS is intended to provide a standardized coding system to be used for the integrated planning, execution and control of SNC Group projects and corporate affairs.

AREAS OF APPLICATION

General

The areas of application of the ICS can best be summarized diagrammatically as shown below:

Legend: S - SNC (for definition, see section 1.2.2 below)  
P - Project Standard (for definition, see section 1.2.3 below) blank entry means that this code component is not used for this application.

Figure 6.4.5

<b>SNC</b>		INTEGRATED COILING SYSTEM		DATE	REV.	PAGE	TITRE / TITLE
		1.8.77		1	3.2/8	CAPITAL ELEMENT	
SPECIMEN DE CARTONS DE COUVRAGE / SIMPLE BOARD GLOSS		MATERIALS USED: 1.8.77					
DATE: 1.8.77		REV: 1		PAGE: 3.2/8			
MATERIALS USED: 1.8.77		MATERIALS USED: 1.8.77		MATERIALS USED: 1.8.77			
MATERIALS USED: 1.8.77		MATERIALS USED: 1.8.77		MATERIALS USED: 1.8.77			
MATERIALS USED: 1.8.77		MATERIALS USED: 1.8.77		MATERIALS USED: 1.8.77			
MATERIALS USED: 1.8.77		MATERIALS USED: 1.8.77		MATERIALS USED: 1.8.77			
MATERIALS USED: 1.8.77		MATERIALS USED: 1.8.77		MATERIALS USED: 1.8.77			
MATERIALS USED: 1.8.77		MATERIALS USED: 1.8.77		MATERIALS USED: 1.8.77			
MATERIALS USED: 1.8.77		MATERIALS USED: 1.8.77		MATERIALS USED: 1.8.77			

3.2.3 Capital Element List

CODE

<p>FONDATION</p> <p>COFFRAGE</p> <p>FER D'ARMATURE</p> <p>BÉTON</p> <p>DÉCOFFRAGE/NETTOYAGE</p> <p>FINITION</p> <p>ISOLATION/IMPERMÉABLE</p> <p>PIÈCE ENCASTRÉE</p> <p>BAYLON D'ANCRAGE</p> <p>COLMATAGE</p> <p>PRECONTRAINTE</p> <p>PRÉFABRIQUÉ</p> <p>DALLE SUR SOL</p> <p>CADRE RIGIDE</p> <p>DALLE SURÉLEVÉE</p> <p>MUR</p> <p>VOILE</p> <p>RÉSERVOIR/BASSIN</p> <p>FOSSÉ D'ÉVACUATION/TRANCHÉE</p> <p>ESCALIER</p> <p>VOILE</p> <p>COLONNE DE BÉTON</p> <p>FOUTRE DE BÉTON</p> <p>CHAPEAU DE PILIER BÉTON</p>	<p>2CA</p> <p>2CA-0A</p> <p>2CA-0B</p> <p>2CA-0C</p> <p>2CA-0D</p> <p>2CA-0E</p> <p>2CA-0F</p> <p>2CA-0H</p> <p>2CA-0K</p> <p>2CA-0L</p> <p>2CA-0H</p> <p>2CA-0P</p> <p>2CB</p> <p>2CC</p> <p>2CD</p> <p>2CE</p> <p>2CF</p> <p>2CH</p> <p>2CJ</p> <p>2CK</p> <p>2CL</p> <p>2CM</p> <p>2CN</p> <p>2CP</p>	<p>FOUNDATION</p> <p>FORMWORK</p> <p>REINFORCING STEEL</p> <p>CONCRETE</p> <p>STRIP AND CLEAN FORM</p> <p>FINISHING</p> <p>INSULATION/WATERPROOF</p> <p>EMBEDDED PART</p> <p>ANCHOR BOLT</p> <p>GROUTING</p> <p>PRESTRESSED</p> <p>PRE-CAST</p> <p>SLAB ON GRADE</p> <p>FRAME</p> <p>SUSPENDED SLAB</p> <p>WALL</p> <p>ENVELOPE</p> <p>POOL &amp; BASIN</p> <p>SUMP PIT / TRENCH</p> <p>STAIRS</p> <p>DIAPHRAGM</p> <p>CONCRETE COLUMN</p> <p>CONCRETE BEAM</p> <p>CONCRETE PILE CAP</p>
--	--	--

Figure 6.4.6

<b>SNC</b>		DATE		REV. PAGE		TITRE / TITLE	
INTEGRATED COOKING SYSTEM		1.8.77		1 3.2/13		CAPITAL ELEMENT	
DESCRIPTION DE S'ARTOURNE DE S'ARTOURNE / S'ARTOURNE S'ARTOURNE		S'ARTOURNE S'ARTOURNE S'ARTOURNE S'ARTOURNE S'ARTOURNE S'ARTOURNE S'ARTOURNE S'ARTOURNE		S'ARTOURNE S'ARTOURNE S'ARTOURNE S'ARTOURNE S'ARTOURNE S'ARTOURNE S'ARTOURNE S'ARTOURNE		S'ARTOURNE S'ARTOURNE S'ARTOURNE S'ARTOURNE S'ARTOURNE S'ARTOURNE S'ARTOURNE S'ARTOURNE	

3.2.3 Capital Element List

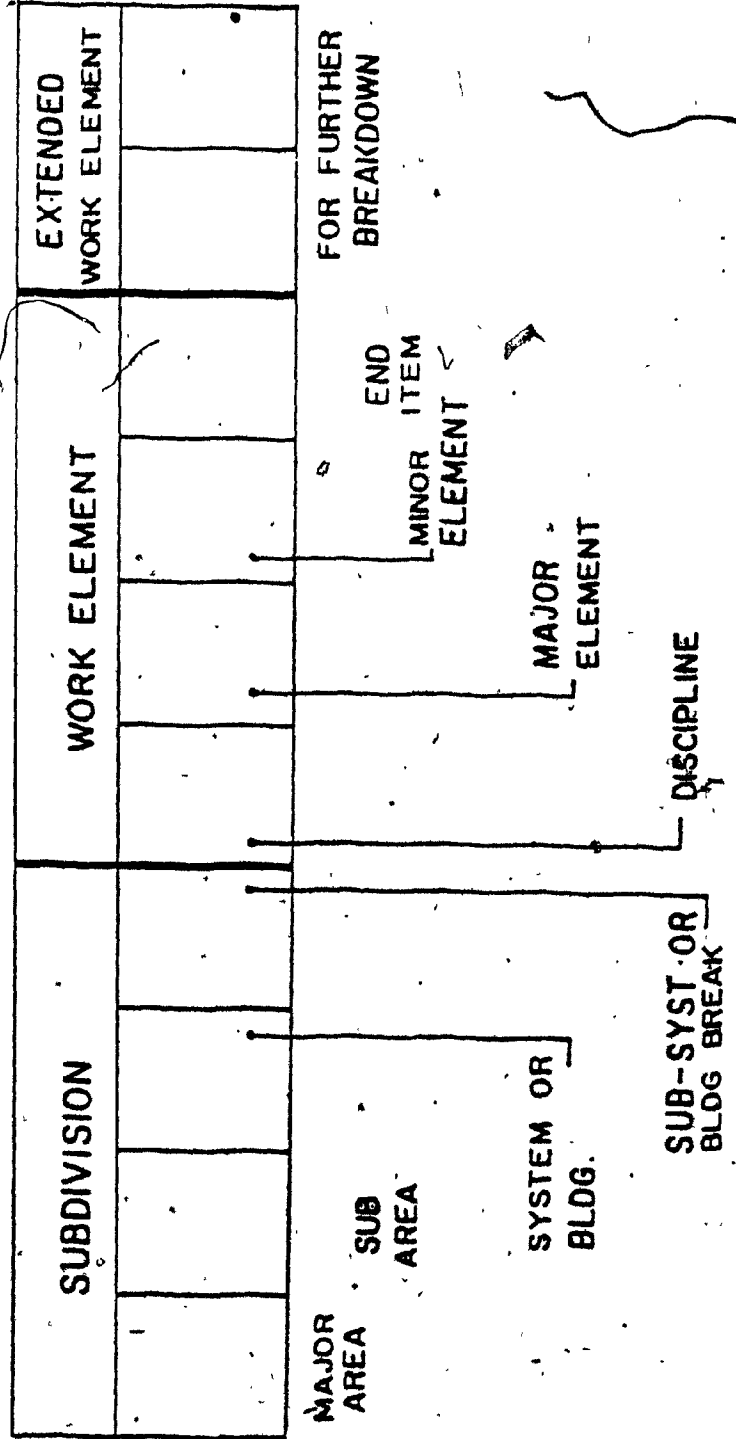
Liste des éléments physiques

CODE

EQUIPEMENT	CODE	EQUIPEMENT
ABSORPTION/ADSORPTION	5A	ABSORPTION/ADSORPTION
COLONNE D'ABSORPTION	5AA	ABSORPTION TOWER
COLONNE CARRÉE D'ABSORPTION	5AB	ABSORP TOWER PACK COL
COLONNE À PLATEAU D'ABSORPTION	5AC	ABSORP TOWER-TRAY COL
COLONNE DE DESORPTION	5AD	DESORPTION TOWERS
COLONNE À PLATEAU DE DESORPTION	5AE	DESORP TOWER TRAY COL
COLONNE CARRÉE DE DESORPTION	5AF	DESORP TOWER PACK COL
MATÉRIEL D'ABSORPTION - PHASE CAZEUSE	5AC	GAS PHASE ADSORP EQUIPT
MATÉRIEL D'ÉCHANGE D'IONS	5AI	ION EXCHANGE EQUIPT
MATÉRIEL D'ABSORPTION - PHASE LIQUIDE	5AL	LIQ PHASE ADSORP EQPT
BROYAGE	5B	BREAK-UP
DÉFIBREUR	5BA	WURSTOME MILL
BROYEUR À BOULETS	5BB	BALL MILL
BROYEUR À CONE	5BC	CONE CRUSHER
BROYEUR À DISQUE	5BD	DISK ATTRITION MILL
BROYEUR COLLOÏDAL	5BE	DISPERS COLLOID MILL
BROYEUR À JET	5BF	FLUID ENERGY/JET MILL
BROYEUR CIRATOIRE	5BG	CRATATORY CRUSHER
BROYEUR À HARTEAU	5BH	HARPER MILL
BROYEUR À MACHOIRS	5BJ	JAW CRUSHER
PIERRE À MEULE	5BK	GRIND STONE

The project cost code forms the framework for distributing the budgets and collecting the actual costs for the elements to be controlled. A typical coding block is shown in Figure 6.4.7.

Figure 6.4.7  
INTEGRATED CODING SYSTEM  
CAPITAL COST CODING  
SAMPLE BLOCK CODING





6.5 Cost estimating methodology, types of estimates and their uses as they relate to cost control:

The cost estimating methodology used by SNC is as follows:

- Establish the purpose of the estimate;
- Investigate the information available;
- Define the scope of work to be covered by the estimate;
- Determine the time and resources available (for the preparation of the estimate) and the effort that can be provided;
- Based on the requirements of the project (phases) and on the above criteria, establish the type of estimate which can be produced;
- Establish the estimating procedures and the degree of accuracy which can be expected.

Briefly the types of estimates normally used by SNC are:

- An 'Order of Magnitude' estimate, giving a rough indication of the total cost, usually prepared during the conceptual or feasibility phases, or for an appropriation request. This is normally a factored estimate.
- A 'Preliminary Budget' estimate, which is a refinement of the 'Order of Magnitude' estimate incorporating additional information based on preliminary drawings, sketches, equipment lists, etc. prepared to define the client's required. This is normally a combination of factoring and preliminary quantities, and is prepared during the preliminary planning stage.

- A 'Definitive' or 'Target Cost' estimate, which forms the basis for the control budgets and hence cost control. It is prepared during the planning stage when the scope of the project is established, the preliminary design completed, and the final design is advanced to about 20%. The definitive estimate serves to define the scope of the project (included in WBS) in terms of dollars (Target Cost) and is revised each time a scope change is authorized thus becoming the 'Revised Target Cost' (Current Project Budget). The 'Definitive' estimate is summarized to show the various cost subtotals at the subdivision levels in the project cost code, at the capital element level or packages, as required. The definitive estimate is reviewed by all the key project personnel and is used during the remainder of engineering to ensure that the 'design is compatible with the cost of limitations'. The definitive estimate is summarized by subdivisions or as required (Tables 6.5.1 and 6.5.2).
- 'Control' estimates are prepared at appropriate intervals (50%, 75% design completion) to assist the designers in keeping the design compatible with the target cost estimate, and also for use in making monthly forecasts.
- Estimates and cost comparisons, to assist designers in value engineering are made throughout the design phase to ensure selection of the most economic alternatives.
- 'Tender Check' estimates for each 'package' are used to ensure that the design is compatible with the target cost, and for use as the basis for evaluating contractors' bids as well as for negotiating adjustments if required.

Table 6.5.1

COST ESTIMATE SUMMARY DIVISION	CLIENT PROJECT LOCATION	DESCRIPTION	PROJECT SUMMARY										SHEET OF			
			U	QTY	MANHRS TOTAL	LABOUR COST	MATERIAL COST	PERM. EQUIP COST	SUB CONTR COST	CONST EQUIP COST	TOTAL COST	U	TOTAL COST	CENTR.	SUMO	
																CURRENCY
100		SITE IMPROVEMENTS				67000	148200	26000				115500		356700		
200		ADM / SERVICE BLDGS				134000	216000	33500	272000			18000		673500		
300		PROCESS BUILDINGS				535800	1337900	77700	641600			52000		2645000		
400		MISC. STRUCTURES				15000	42200	6500	11100			3500		73300		
500		GENERAL SERVICES				245300	456100	72500				27500		802000		
600		PROCESS SYSTEMS				850000	7214300	60000	223500			93300		8441100		
900		FIELD EXPENSES				125900	263300	50300				31700		450300		
		SUB TOTAL				1972100	9678000	306500	1148200			341500		13446900		
		PROJECT MANAGEMENT												1250000		
		SUB TOTAL												14696900		
		ESCALATION												528000		
		CONTINGENCY												765000		
		TOTAL												16049900		

Table 6.5.2

PROJECT ESTIMATE

CLIENT NAME: 637251049 LOCATION: 11/08/77 PAGE: 0001

ACCOUNT	ITEM	QTY	UNIT	PRICE	TOTAL	CONTRACT	PERMANENT	CONSTRUCTION	TOTAL
1	SMALLER COMPLETE	48200		1792407	8627215	36650575	2349962	02679224	02679224
2	MATERIAL COMPLETE	50000		11002310	5501155	12072681	630327	40000050	40000050
3	LABOR	0		2500000	0	0	0	0	0
4	MANHOURS	0		0	0	0	0	0	0
5	PERMANENT EQUIPMENT	0		0	0	0	0	0	0
6	CONSTRUCTION EQUIPMENT	0		0	0	0	0	0	0
7	SUBCONTRACT	0		0	0	0	0	0	0
8	TOTAL								

PROJECT CODE  
 DESCRIPTION  
 MANHOURS  
 LABOR  
 MATERIAL  
 SUBCONTRACT  
 PERMANENT EQUIPMENT  
 CONSTRUCTION EQUIPMENT  
 TOTAL

- Estimates of Changes of Scope are prepared to revise and update the Target Cost, and to issue 'Change Orders' to contractors.

Figure 6.5.3 shows the data requirements, and the relationships between the various factors involved in estimating, graphically.

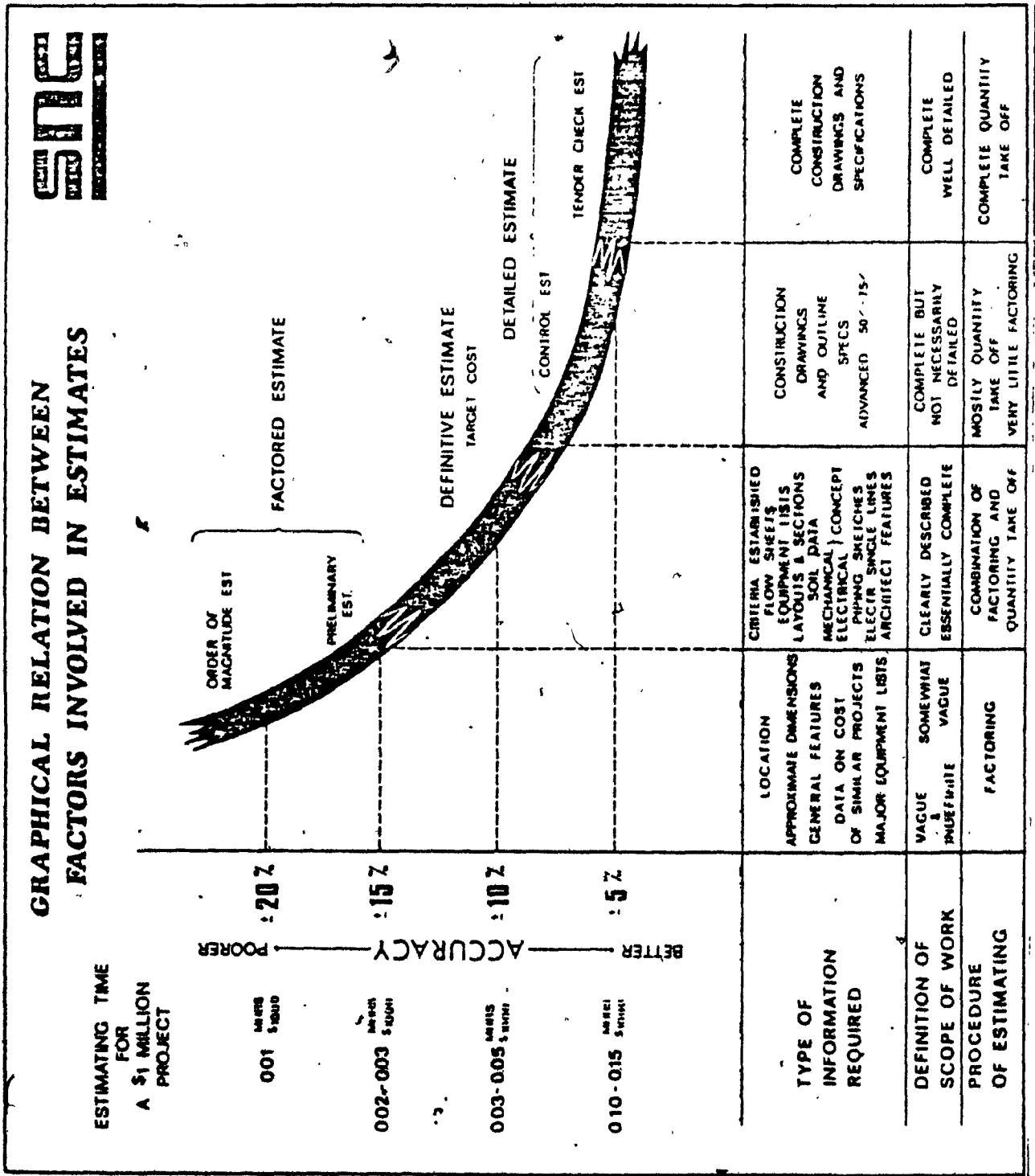
Contingency and escalation management and monitoring foreign exchange fluctuations:

Contingency is defined by SNC as "an allowance for unforeseeable elements of costs, or factors, which from the relationship of previous estimates and actual costs have been shown to be statistically 'Likely to Occur'. It is incorporated into the estimate as an integral part to cover design related factors, undefined items, refinement of defined items, during scope development, etc. It does not cover changes of scope, cost escalation, unidentified items or omissions, unforeseen circumstances (such as labour strikes, foreign exchange rate fluctuations, etc.), estimating inaccuracy. Appropriate contingency allowance is evaluated by reviewing each major element (subdivision or capital element as required) and establishing a degree of uncertainty in the form of a percentage. The two main criteria which affect contingency evaluation for any operation are:

- The depth of information available;
- Related risk.

The total cost of all contingencies estimated is kept as a line item in the monthly cost report. A part of this allowance is kept in reserve (depending on the project) till project completion and the remaining portion is written off at the rate of commitments and as per judgment

Table 6.5.3



thus offsetting the contingency allowances made for individual project elements as the uncertainty decreases. Changes for scope and cost escalation are treated separately, whereas unidentified items/omissions, unforeseen circumstances, estimating inaccuracy are considered direct overruns. Contingency depletion is elaborated in Section 6.9.

Cost escalation is defined by SNC as a reflection of the costs within the estimate, including contingency, when realigned from Estimate Date to the Center of Gravity (usually midpoint) of each activity period.

The methodology for handling escalation is as follows:

- Prepare a realistic estimate (definitive) based on present day costs;
- Determine comprehensive breakdown for different major components of work;
- Assign cost escalation per year to each component/resource by projecting past indices, or using current/forecast indices depending on the information available, and using judgment;
- Calculate escalation (using a computer subroutine) by multiplying cost of each component by the corresponding escalation rate per year, and by the duration from the Estimate Date to the Centre of Gravity of the activity period.
- Distribute the escalation into the base estimate for control, according to the schedule, any differences between the actual paid costs and the budget being considered an over/underrun.

For countries such as Chile or Argentina, where inflation is extremely difficult to predict, escalation costs are shown separately for each account using the distribution procedure, the ESG appearing as a breakdown item (such as Labour, Material, etc.) for each account.

As the project management company SNC does not speculate on foreign exchange fluctuations, but the effect of these fluctuations is monitored using one or more of the following approaches:

- A. One approach is to bring the paid cost back to the date of estimate and use a fixed exchange rate to calculate the equivalent paid cost as of the Estimate Date for comparison with the actual paid cost;
- B. Another is to convert the currency to a more stable currency such as U.S. dollars, Deutschmarks or Yen, so as to control against the budget established in the same currency;
- C. In the case of purchasing of foreign currency, the cost of purchase can be coded to a separate currency fluctuation account;
- D. 'Hedges' (insurances) can be purchased against currency fluctuations in order to take the gamble out of it.

In all cases it is important that the budget identifies the rate used for converting currencies and the date set for the comparison to determine exchange cost.

Historical data retrieval: SNC services

Historical data of actual cost performance of completed projects is a very valuable source of information for estimating new projects, or for assessing the accuracy of an estimate. The Project Record Retrieval System (PRRS) is a computerized record prepared for all completed major projects summarizing all pertinent project management performance data such as manhours, salaries, number of drawings per trade (discipline),



construction costs per trade, etc. Data retrieval is possible by project or by trade (Tables 6.5.4 and 6.5.5). This is achieved by using a computer program for sorting the project records in the databank and summarizing them by trade (discipline). The data retrieval system can be useful for forecasting also.

## PROJECT RECORD RETRIEVAL SYSTEM BY PROJECT

**SNC SERVICES RECORD**

CLIENT: INTERNATIONAL ZINC PROJECT: BEZP CONTRACT NO: 3354  
 TYPE OF CONTRACT: ENGINEERING: COST+X CONSTR MGMT: COST+X  
 TIME: JOB DURATIONS: START ENGR 3/74 START CONSTR 11/74 COMPL ENGR 1/76 COMPL CONSTR 7/76  
 ENGR: 25 MOS  
 CONSTR: 21 MOS

SNC SERVICES COST:	MANHRS	SALARIES	HOURS PER DMC	SALARY PER DMC	% OF COST
ENGINEERING:					
MANAGEMENT	2488	278025	28.	308.	0.92
CIVIL	1388	11645	173.	1456.	2.10
FOOTS & CONCRETE	16634	154588	181.	1688.	3.79
STEEL	12085	113775	141.	1323.	3.69
ARCHITECTURAL	3711	38346	79.	646.	2.25
MECHANICAL	58357	431464	182.	1563.	2.61
ELECTRICAL	26854	228282	127.	1082.	3.08
INSTRUMENTATION	16963	153233	104.	882.	13.83
SECRETARIAL	18844	54658	16.	61.	0.18
TOTAL ENGINEERING	169925	1456828	188.	1614.	8.88

CONSTRUCTION MANAGEMENT:	MANHRS	SALARIES	HOURS PER DMC	SALARY PER DMC	% OF COST
MANAGEMENT	12275	140016	14.	155.	0.47
PLANNING & SCHEDUL	7888	56420	9.	63.	0.19
ESTIMATING	11787	88987	13.	99.	0.30
COST CONTROL & ACC	8844	72826	10.	80.	0.24
PROCUREMENT & EXPE	34121	274225	38.	388.	8.91
SECRETARIAL	926	4143	1.	5.	0.01
SITE SUPERVISION	38127	401833	42.	445.	1.34
TOTAL CONSTR MGMT	113868	1037578	126.	1150.	3.45

PRE-AWARD STUDIES 0  
 EXPENSES (EXCL ITEMS BELOW) 836534  
 ARCHITECTURAL EXPENSES INCLUDED  
 SOIL INVESTIGATION 1

DRAWINGS	NUMBER OF DWGS	NUMBER OF REVS	CAPITAL COST	CAP COST PER DMC	DWGS PER \$100,000
CIVIL	8	28	549988	69459.	1.44
FOOTS & CONCRETE	92	238	4032888	44295.	2.26
STEEL	86	282	1978488	23246.	4.38
ARCHITECTURAL	47	79	1334788	28696.	3.48
MECHANICAL	278	688	16349988	59888.	1.67
ELECTRICAL	211	288	4446488	21294.	4.78
INSTRUMENTATION	182	139	1094888	6078.	16.45
INDIRECT COSTS	0	0	312500	0.	0.88
TOTAL	982	1646	38899488	33378.	3.88

NUMBER OF SUB-CONTRACTS: 239

CONSTRUCTION COST  
 ESTIMATED: 31674000  
 ACTUAL: 38899488  
 % VARIANCE: - 5.8

Table 6.5.4

Table 6.5.5

PROJECT RECORD RETRIEVAL SYSTEM BY TRADE

CLIENT	PROJECT	PROJECT NUMBER	MAN-HOURS	SALARIES/DWG	HOURS/DWG	% OF COST	NO. DWGS	NO. REVS	CAPITAL COST	COST PER DWG	DWGS/\$100K	REVISIONS/100K	REV DATES
CIMEX LAFARGE	CFMGT PL-500K 17Y 2503	11004	45500	103	930	2.0%	100	100	1927000	19270	14.500	7.10	12/60 9/60
B. W. JOHL INC.	METAL SUBMITTAL PI 2094	327	1765	90	200	0.5%	6	4	300000	50000	14.275	1.90	11/70 1/60
MARINE IND LTD	AGRAMUISHMENT PI 2113	1059	11433	177	762	3.9%	15	10	200747	13258	14.258	3.19	5/60 9/60
M.C.P.	MCH COMP CMH AMT 2154	626	8004	89	910	5.0%	7	22	150417	20502	14.500	4.47	9/60 7/60
MCH	COMPUTER CENTRE 2154	626	8004	89	910	5.0%	7	22	150417	20502	14.500	4.47	9/60 7/60
MELMORE	GIBILLET MULTIC 2169	3625	28076	10	280	0.1%	44	107	150016	2782	27.82	15.50	11/60 3/60
CHRISTIE HINCH-LTD	CRACKEN BARENT PI 2187	1115	7278	40	519	0.4%	14	29	160200	11118	14.258	4.29	6/60 2/60
HON-CHEM CAP LTD	PROCESS PLANT PI 2451	1218	7704	82	947	4.5%	14	45	170300	12167	14.258	4.29	5/60 9/60
NICHOLEN TIME	TIME MFG PLANT 2900	15504	95280	189	522	2.4%	143	400	2441000	28022	28.022	4.54	9/60 1/60
MARINE INDUSTRIES	ATFLER OF TIME 2902	917	6107	91	611	2.1%	16	45	270000	26500	26.500	3.13	5/60 1/60
AM CANADA	PM PL MAINT FACIL 3056	9178	26426	47	519	2.6%	51	150	491370	19658	19.658	3.00	3/60 9/60
DUPONT CANADA	VN HIGHWAY 3284	1412	18038	110	434	0.4%	12	40	177700	15271	15.271	2.55	12/60 9/60
MEL CANADA	MUG TELEVISION 3304	6	6	6	6	0.0%	1	1	1	1	1	5.75	5/75
CAN JAMES MARVILLE	MUSKAMP PI 3308	5356	23361	97	487	2.1%	30	50	1070000	31971	31.971	3.14	9/72 9/73
SHELL CANADA LTD.	C-B AFTER REACTION 3355	302	2064	121	680	0.8%	1	1	50000	10000	10.000	0.00	9/73 7/73
SHELL CANADA LTD.	2 PL EXHAUSTORS 3356	302	2064	121	680	0.8%	1	1	50000	10000	10.000	0.00	9/73 7/73
PLATE LABORATION	HUMERO CIV. CL. TIME 3402	6	6	6	6	0.0%	1	1	1	1	1	1.00	7/72
DEPT HEATH O.N.	HUMERO HOSPITAL 3769	6	6	6	6	0.0%	1	1	1	1	1	1.00	11/71 11/71
CLY LTD.	1975 EXHAUSTOR 3783	2050	10027	150	1821	10.2%	13	10	170500	13120	13.120	2.27	11/71 11/71
MICHLES CAL LTD.	HUTERNO, PLANT 3794	16224	13410	270	1022	5.0%	100	45	3000000	52721	52.721	3.27	9/74 9/74
BOMIER LTD.	CASE IMITATION 3822	230	1300	170	1700	2.0%	10	10	70000	7000	7.000	1.1	7/74 1/74
CANNING S.P. LTD.	CHOLET PL & REPAIR 3794	1000	1000	100	100	1.0%	10	10	10000	1000	1.000	1.0	7/74 7/74
SOME ALGENT	FERMO PL. M.F. 3808	1000	1000	100	100	1.0%	10	10	10000	1000	1.000	1.0	7/74 7/74
MALINGUE ZINC	MZP 3754	1000	1000	100	100	1.0%	10	10	10000	1000	1.000	1.0	7/74 7/74
UNITED BROS SING	ASBESTOS PLANT 3824	6767	6767	6767	6767	67.67%	6767	6767	6767000	6767000	6767000	6767	7/75 10/75
SKY	FERMO ALLOY PLANT 3726	10000	10000	10000	10000	100.00%	10000	10000	10000000	10000000	10000000	10000	7/75 10/75
SUN OIL	ANIMATEDS PLANT 3808	1000	1000	1000	1000	1.0%	10	10	10000	10000	10000	1.0	7/75 7/75

CLIENT → PROJECT NUMBER → PROJECT → WEIGHTED & ESCALATED TOTALS → ESCALATED TOTALS → MANNHOURS → SALARIES/DWG → SALARIES/DWG → HOURS/DWG → SALARIES/DWG → % OF COST → NO. DWGS → NO. REVS → CAPITAL COST → COST PER DWG → DWGS/\$100K → REFERENCE DATES →

6.6 Cost control during the control phase:

Definition of cost control as applied by SNC -

Cost control consists of evaluating progress and forecasting final costs against a predetermined budget. It is both an art and a science. It is a science because it includes the utilization of systematic techniques to control a project, and an art because it requires the control to evaluate present data and project it into the future.

Cost control application and operation -

Cost control applies to two major areas (for every project) as follows:

- 'Professional services' including planning, design/engineering, scheduling, estimating, cost control, procurement, project and construction management, SNC subconsultants, outside consultants, etc.;
- 'Commercial services' including purchases, contracts and some indirect items not necessarily covered by purchases or contracts.

It is a continuous operation, beginning with the conceptual estimate. The estimating (forecasting) and monitoring procedures are applied throughout the design phase, continuing through the tender call, contract award and construction stage, to the final actual paid cost. In the early stages most of the costs fall under the 'professional services' cost category. As the project progresses the cost structure

widens to incorporate procurement and construction costs. The project accounting function is fully integrated into the cost control discipline and is different from SNC's corporate accounting. Cost control follows the philosophy of 'planning for control and controlling as planned'. The main criteria established in the planning stage are as follows:

- The most important project element or elements which the project manager can act upon, so as to control the final cost;
- The level of detail required, based on criticality, size of the project or its portions, required accuracy, the services to be performed by SNC and others, and the strong and weak points of the project as assessed.
- To decide whether a manual or a computerized system is required in order to produce timely reports so that required action may be taken;
- Availability of human resources versus computer or mechanical equipment.

The project cost code, used for budget distribution and actual cost accumulation, is structured on the basis of these criteria.

The methodology for dealing with some of the key cost related terms and figures is described below:

**Commitments:**

- Define what constitutes a commitment for the project
- Define the type of commitment - Fixed e.g. a lump sum contract
  - variable e.g. payroll
  - final

- Obtain a breakdown of the total commitment from the suppliers or contractors for control and cash flow planning;
- Register the commitments daily and verify against the budget.

Cost to Date:

- Define the cost to date - invoiced
  - accrued
- Request the invoicing in line with the forecasting;
- Verify cost to date and code.

Estimate to Complete:

The estimate to complete is a cooperative effort by all the departments involved in the project, the estimating/forecasting procedures being applied through the various phases of a project. The actual paid costs override the estimates and previous forecasts as the work progresses, ensuring that no discrepancies are left between the theoretical and actual paid costs. The new, successive forecasts are based on the latest cost information thus obtained, after analysis. The personnel involved in the development of the estimate to complete during the various phases of the project:

- Engineering: - Discipline engineers
  - Chief designer
  - Project manager
  - Estimator and scheduler
  - Procurement personnel, etc.

(A monthly formal meeting is held to develop and discuss the estimate to complete prior to each cutoff date. Most of the cost data used at this stage is based on the definitive and tender check estimates.)

- Procurement: - Procurement personnel
  - Estimator and scheduler
  - Discipline engineers (as required), etc.
- Construction: - Trades superintendent
  - General superintendent
  - Construction manager
  - Project manager
  - Estimator and scheduler, etc.

(The drawings and documents are complete during this stage and only modifications to the field construction plan are required for co-ordination. The physical progress and cost data is collected by the site cost engineer who prepares the actual data input for the estimate to complete.)

**Accounting and banking activities:**

The project accounting is fully integrated with cost control in order to ensure feedback of actual paid cost data for input to the budget control system, and to integrate the project cost functions and reporting. The control criteria and functions include the following:

- Use methods which can be easily audited by the client;
- Group project documentation so that it is easily accessible, there being one common source of data for each project.

**The main functions include:**

- Verification of cost to date;
- Verification versus commitments for quantity and price;
- Verification of general conditions of the contract, especially the escalation and holdback clauses;

- Coding and budget verification;
- Negotiating and approving type of payment, issuing cheques, letters of credit, etc. and petty cash;
- Billing to client;
- Banking reconciliation;
- Financial statements showing expenditures and bank charges v.s. advances and interest.

The functions related to payments to suppliers and contractors:

- Verify material received or activities completed;
- Verify against commitments;
- Issue payment by cheque or letter of credit (after holdback);
- For final payment: Verify for possible liens;

Verify guarantee, or warranty;

Verify governmental regulations;

Verify for other reasons (e.g. other projects.

- Holdback to contractors: For final approval (after testing for malfunctioning, etc.);

For final completion;

Against guarantee.

In general, the accounting department is organized to perform all the backup functions for cost control and the monthly financial statement (incorporating a bank reconciliation) ties together and balances all the financial aspects of the project to ensure a complete and meaningful cost control.



6.7 Performance control and data collection for professional services:

The professional services include planning, design/engineering, scheduling, estimating, cost control, procurement, project and construction management, etc. Quality control over technical performance is maintained by the chiefs of disciplines, who may be regarded as in-house consultants. The senior professionals at the divisional headquarters also act in a similar capacity, although some of them may be assigned to a project task group at the home-office for the duration of the task concerned. The standard review and checking procedures apply to all project drawings and documentation. The 'master network', along with the planning, procurement and construction schedules and the CPM network, forms the basis for activity and time control throughout the project. The detailed schedules or subnetworks are used as the time constraints for the various project phases as applicable.

The costs of professional services include the salaries, premiums and other benefits paid to the professionals working on the project and the overhead costs, expenses, etc. The cost control methodology for the professional services can be summarized as follows:

- Salaries and Benefits: Budget by discipline (manhours and cost);  
Time sheet record by contract;  
Manpower planning and forecasting;  
Services cost report.
- Expenses: Budget by type of expenditure;  
Expense cost report;  
Forecast by department.

The manpower effort is expressed in terms of manhours, mandays, manweeks, manmonths or manyears, whichever is most suitable. Normally for cost data collection and reporting the 'manhour' is widely used. A larger unit such as the 'manmonth' can be used for manpower scheduling and other operations needing a large unit for measurement.

The manhours charged by the professionals working on a project are collected by the supervisory personnel and turned in twice a month in the form of timesheets (Table 6.7.1). The timesheets are coded to the project code or the corporate code depending upon the professionals involved and the role of the professionals concerned. Based on this input, the computer produces a Time Sheet Record By Contract (Table 6.7.2) in order to provide the actual time records to the project managers and other key personnel in the project team. Through the same computer program a 'Services Cost Report' (Table 6.7.3) is produced, showing the comparison of manhours and salaries with budgets, as well as the variances. The input to the 'Services Cost Report' comes from the timesheets, and the manpower planning and forecasting data which is a result of manpower planning for the various disciplines in the project task force.

The overheads and expenses are budgeted for by categories and types, based on past experience and individual project requirements. The actual overhead costs and expenses are collected through the integrated project accounting system and from the records of the department concerned. These expenses are summarized by the computer in the form of an 'Expense Cost Report' (Table 6.7.4), the system being similar to the manhour control system. The forecasts of overheads and expenses are provided by the individual departments based on their requirements. The overheads and expenses include costs of equipment and facilities required for people to perform their services efficiently. They can include items such as drawing



Table 6.7.2

TIME SHEET RECORD BY CONTRACT (TSRC)

ACCT.	MANAG. NY.	PRG.	18R40-30	COMPANY 01 SMC INC.	PERIOD ENDING 15 MAR. 1977	PAGE 11/	2	
EMPL. NAME OF EMPLOYEE	DP CL	COMT	SUBD	SUBJ	AC MT	HOURS	DATE	TYPE
0801 G. HELANGER	15 6E	4001	1100	40NU	20 10	52.5	15/03/77	10
SUM-TOTAL						15.0		
0644 R.W. LETHAM	15 6E	4001	1200	42ED	16 10	20.0	15/03/77	10
0366 L. HOURDOUGHKY	15 5C	4001	1200	43ND	16 10	17.5	15/03/77	10
1849 D.C. LUCKMAN	15 6L	4001	1200	45CD	16 10	40.0	15/03/77	10
0481 J. JULI	15 5C	4001	1200	46NU	16 10	26.0	15/03/77	10
0276 J. SIM	09 4C	4001	1200	46NU	2 10	22.5	15/03/77	10
0476 M. PU	15 6L	4001	1200	46NU		15.0	15/03/77	10
0785 C.M.H.	10 3A	4001	1200	46NU		22.5	15/03/77	10
SUM-TOTAL						60.0		
0276					1300 2A 10	15.0	15/03/77	10
0476					1300 J 28 10	15.0	15/03/77	10
0785					1300 MD 20 10	15.0	15/03/77	10
SUM-TOTAL						45.0		
G. RELAY					46ND 20 10			
J. MULVIN					500 48CU 16 10	11.0	15/03/77	10
1073 G. CARLE	15 5K	4001	1500	4860	16 10	5.5	15/03/77	10
1849 D.C. LUCKMAN	15 6L	4001	1600	45CU	16 10	12.0	15/03/77	10

EMPLOYEE NO. & NAME  
 DEPARTMENT CLASSIFICATION  
 PROJECT CODE  
 HOURS  
 DATE  
 TYPE

7



01 SNC INC.

EXPENSES COST REPORT

CT	SUBD	SUBJ	EXPENSES DESCRIPTION	PER MONTH	TO-DATE	FORECAST	IND. TOTAL	BUDGET	VARIATION
00	0800	2550	99 MISCELLANEOUS NR	1920	1920	1920	11500	951	
00	0800	2560	51 TRAVEL (AIRLINE) NR	4206	4286	4286	4050	-23	
00	0800	3011	03 COMMUNICATIONS	-12	-12	-12	2000	201	
00	0800	3011	53 COMMUNICATIONS NR	205	205	205	2000	179	
00	0800	3023	05 PRINTING & REPROD.	115	115	115	2000	180	
00	1000	2400	03 COMMUNICATIONS	25	25	25		-2	
00	4075	3023	05 PRINTING & REPROD.	7	7	7			
00	7000	3023	05 PRINTING & REPROD.						
TOTAL REIMBURSABLE				10902	661194	661194	692026	3083	
CURR YR REIMBURSABLE				10902					
TOTAL NR				2575	345569	345569	440750	9510	
CURR YR NR				2575					

facilities and equipment, reproduction facilities, task force space and furniture, computer services, utilities, testing laboratories and equipment, communications facilities such as telephone, telex, telecopier, etc. For international projects, the items mentioned earlier are also part of these expenditures.

The 'Services Cost Reports' and the 'Expense Cost Reports' form the professional services cost input to the project cost summaries and other project level reports including the monthly Cost Report and Forecast. They also form the basis for the reimbursable costs of professional services and non-reimbursable costs (which are included in the fees), as well as for billing the sponsor (assuming a cost plus project contract). The reimbursable and non-reimbursable costs can be an area of controversy with the sponsor/client as these cost classifications imply different allowances in different regions, depending on local practices and the sponsor's requirements. Some of these costs, normally incurred on international projects or projects located in remote areas, are listed in Table 6.7.5. The typical periodic 'work and manpower control summary' and 'progress report' formats are shown in Tables 6.7.6 and 6.7.7 respectively.

Table 6.7.5

Examples of indirect costs related to professional services:

- Agents' fees, normally under 5% of the engineering services contract value (or as applicable);
- Lawyers' fees (about 1% of contract guarantee per annum);
- Bank guarantees and bonds;
- Insurance (professional liability and others if needed);
- Taxes in the foreign country where the project is located (international);
- Communication costs including telephone, cable, telex, courier, etc.;
- Local site office overheads and expenses;
- Indirect costs related to personnel assigned overseas, such as:
  - Salary premium, hardship and living allowance;
  - Automobiles;
  - Relocation costs including lease termination, temporary accommodation, travel, excess baggage costs, shipment of personal and household effects for both mobilization and demobilization, storage of unshipped furniture in Montreal, etc.;
  - Passports, visas, work permits;
  - Medical and psychological testing;
  - Education for children;
  - Personal taxes and tax equalization;



- Additional leave benefits;
- Cost of recruiting or replacing personnel;
- Emergency evacuation, etc.

The project contract normally specifies the method of cost classification and the major non-reimbursable costs. All the non-reimbursable costs have to be recovered through the fees or the general negotiated overhead figure unless otherwise specified in the project contract, e.g. some of these allowances may be fixed figures in some contracts, while the same allowances may be the maximum allowable in some others, and they may be non-reimbursable items in yet others.



PROJECT NAME	CONTRACT NO.	PHASE	PLANNED			ACTUAL			REMARKS			
			START	FINISH	DURATION	START	FINISH	DURATION	1	2	3	
ENGINEERING	ELECTRIC STATIONS	DESIGN	1	150	150	1	160	160				
			2	160	160	1	170	170				
PROCUREMENT	EQUIPMENT	MATERIAL	1	160	160	1	170	170				
			2	170	170	1	180	180				
SHIPMENT	S.P. ORDER VALUE	% CUM.	1	160	160	1	170	170				
			2	170	170	1	180	180				
SITE DELIVERED	MATERIAL	% CUM.	1	160	160	1	170	170				
			2	170	170	1	180	180				
CONSTR'N & INST'N	MATERIAL	% CUM.	1	160	160	1	170	170				
			2	170	170	1	180	180				
COMMISSIONING	MATERIAL	% CUM.	1	160	160	1	170	170				
			2	170	170	1	180	180				
TOTAL PROGRESS	%	%	1	160	160	1	170	170				
			2	170	170	1	180	180				

(E-4E) Proc 28/12

TABLE 6.7.7.

#### 6.8 Performance control of commercial services:

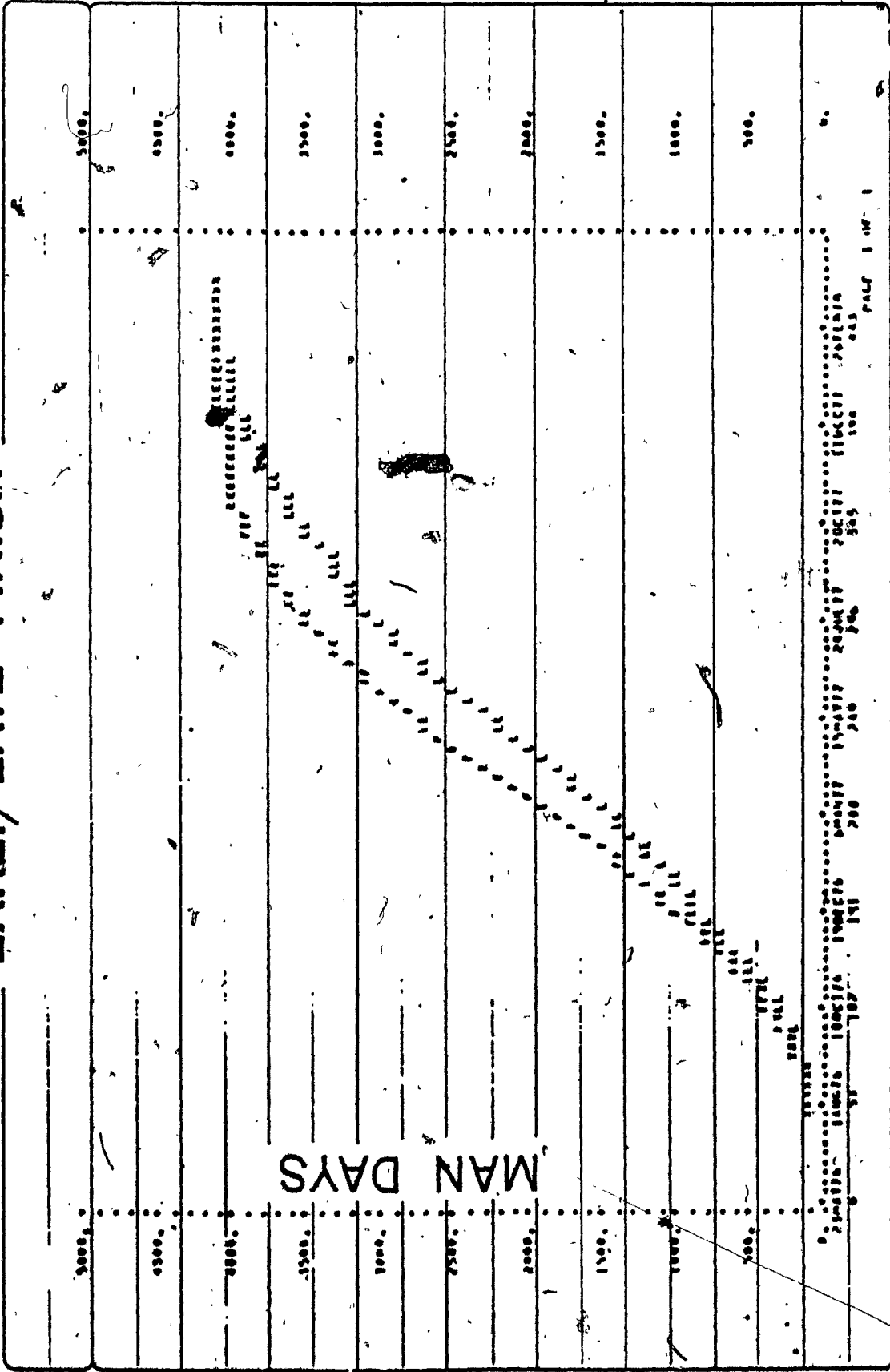
The commercial services include the services and goods provided by the suppliers/contractors, and the services provided by SNC for direct hire work (SNC acting in a contractor's role also). This case study focuses on control of commercial services provided by the suppliers/contractors as it has been assumed that SNC is not acting in a contractor's role. Under these circumstances, it is the responsibility of the suppliers/contractors to plan and control their own manpower and other resources. However, the procurement and construction management personnel have to satisfy themselves that the supplier/contractor's resources are sufficient for executing the job within the contract budget and schedule. For construction contracts, the contractor's construction plan is reviewed for compatibility with the overall project plan. An early/late finish graph (Figure 6.8.1) produced by using the computer provides an appreciation of the tightness of the schedule. The gap between the Early and Late Finish curves represents the amount of leeway available for scheduling or rescheduling to optimize manpower usage and crew assignments to the various site areas. The costs of commercial services are the costs of resources expended by the contractors/suppliers (including manpower, material and equipment costs) plus the fees/profit and negotiated general overheads if any.

The cost control methodology for commercial services, in summary, is as follows:

- Evaluation of contractor's claims for progress, extras and determination of final quantities for approval of payments on contracts, takes place in close co-operation with estimating.

Figure 6.2.1

# EARLY/LATE FINISH



# TIME (WEEKS)

The claims are verified and approved on site for quantity, quality, accuracy, conformity with contract terms, etc. and the validity of the estimates to complete is checked.

- All claims are checked at the head office by the cost control/ accounting team for indications of forecast variations, prior to recording and comparisons with the committed amounts from the commitment report (discussed under cost reporting and forecasts), in order to eliminate the possibility of over claiming on individual cost items, and highlight situations in which work is being carried out without due authorization.
- Payments are released after all the verifications are complete, all approvals obtained, and after they are recorded in the 'Cash Book' and the 'Holdback and Status File' (monthly statements produced by the computer summarizing the cash flows and the holdback and payment status by contractor). These summaries are used to plan and control payments and holdbacks against commitments as well as progress claims.

The procurement department is responsible for contract administration (among other functions). Figure 6.8.2 shows the typical organization of the procurement department and its functions. Figures 6.8.3, 6.8.4 and 6.8.5 show the procurement phases and the functional relationships between the various parties involved. The contractors concerned have to present their progress claims to the site office for progress payments. The progress (and payment) approval certificates are filled out by the site manager, attached to the invoices, and sent directly to the Project Cost Controller in the head office for payment. No conventional accounting

Figure 6.8.2.

SNC

PROCUREMENT

CONTRACT CONTRACT

- SOURCE & AVAILABILITY
- SELECTION IN BIDDERS
- PREPARATION OF CONTRACTUAL CONDITIONS AND DOCUMENTS
- TENDER CALLS
- TENDER OPENINGS
- COMMERCIAL EVALUATION AND RECOMMENDATION
- (PH - CONTRACT) NEGOTIATION
- METHODS OF PAYMENT
- INSURANCE
- BIDDING
- BIDDING IN CONTRACT

PURCHASING

- SOURCE AND AVAILABILITY
- SELECTION OF BIDDERS
- CONTRACTUAL CONDITIONS
- ENQUIRIES
- TENDER OPENINGS
- COMMERCIAL EVALUATION AND RECOMMENDATION
- NEGOTIATION WITH VENDORS
- WARRANTIES
- TERM OF PAYMENT
- BIDDING
- EXECUTION OF ORDER

EXPEDITING

- VENDOR DRAWINGS AND DATA
- MAINTAINING DELIVERY DATES
- FABRICATORS SCHEDULES
- PLANT VISITS
- SUB-VENDORS
- PROGRESS REPORTING
- INSPECTOR LIAISON

MAT'L CONTROL

- STATUS REPORTING
- RECEIVING AND REPORTING
- WAREHOUSING
- INVENTORY CONTROL
- ISSUING TO CONSTRUCTION

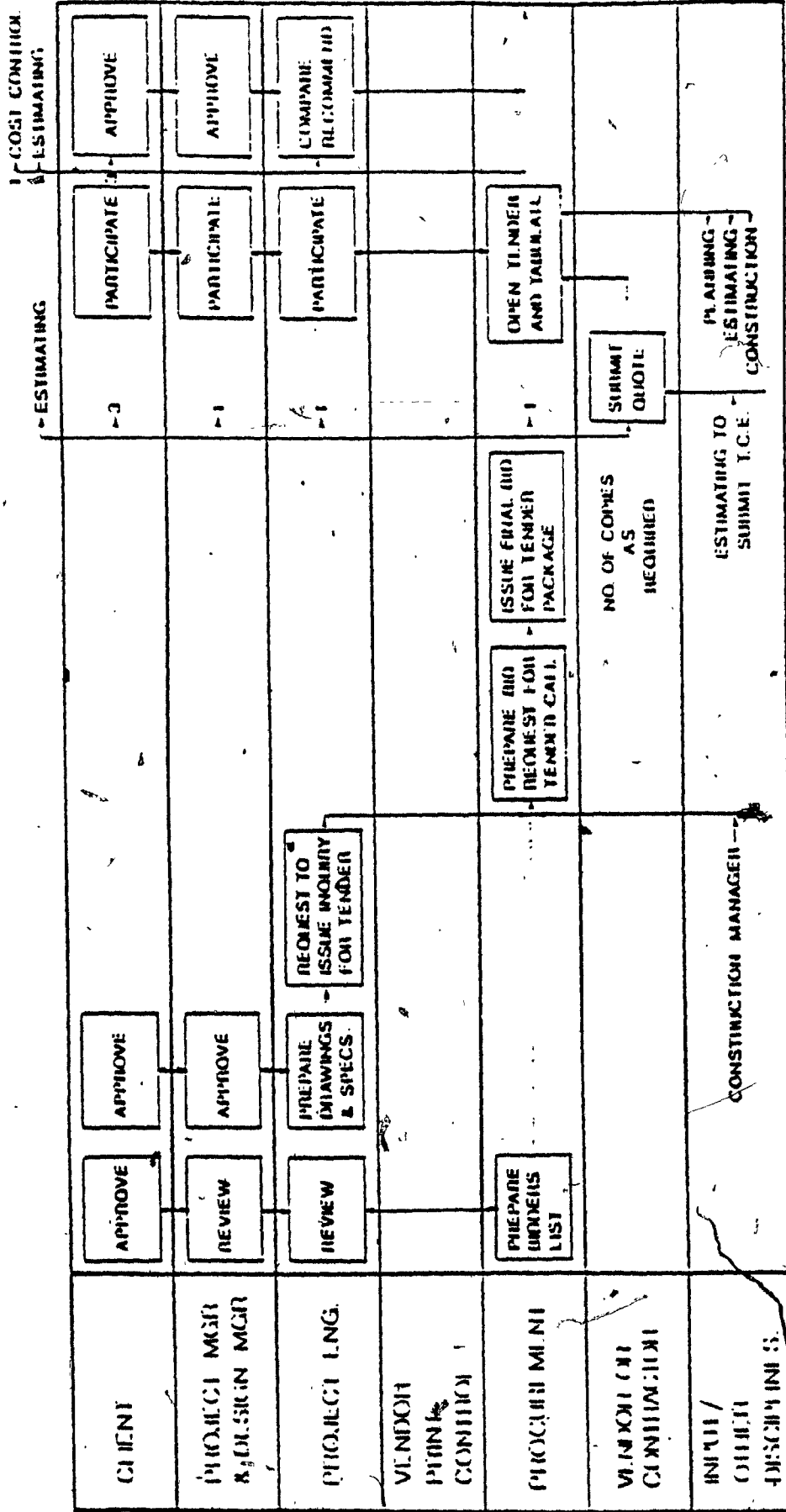
LOGISTICS

- TRAFFIC
- PACKAGING
- CUSTOMS
- CARRIER SELECTION
- FREIGHT MATL NEGOTIATION
- INTERNATIONAL FREIGHT
- MARINE INSURANCE

INSPECTION

- QUALITY ASSURANCE PROGRAMME
- DIMENSIONAL CHECKS
- TEST WITNESSING
- NDT
- MET CASE
- FIBRE INSPECTION

Figure 6.8.3



PROCUREMENT PHASE 1

SIC



Figure 6.8.4

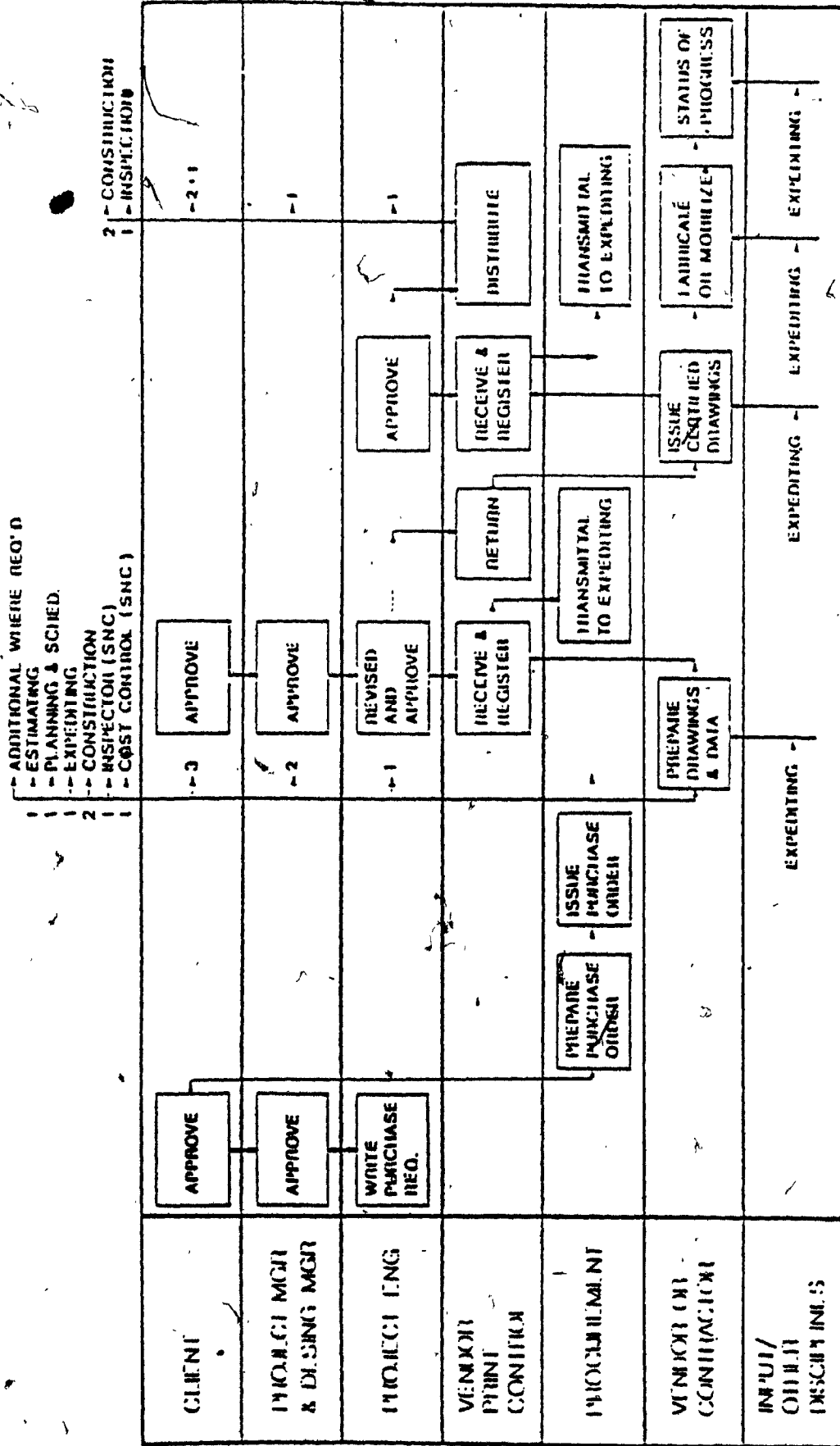
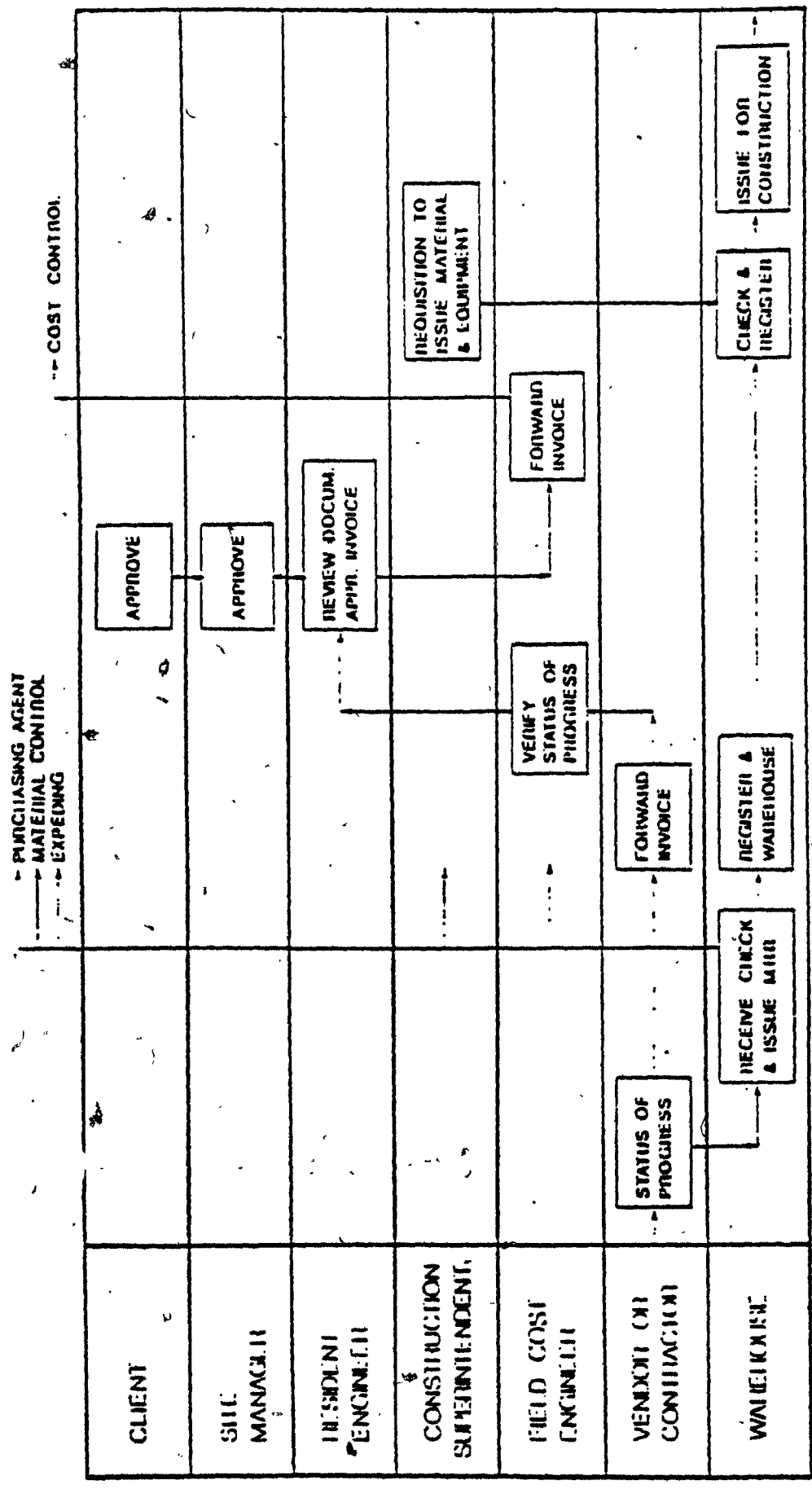


Figure 6.8.5



PROCUREMENT PHASE 3

SIC

records are maintained on site. The contractors have to use the standard progress and cost reporting formats provided by SNC unless otherwise specified. Appendix A illustrates the standard reporting formats for contractors along with the relevant instructions for their usage, the entire documentation therein being taken from the SNC capital cost control procedures, to demonstrate the control procedure for contracts. The standardized formats and pre-established frequency of reporting ensures consistency of progress reporting. The cost coding functions are carried out by the cost controller to eliminate coding errors.

#### 6.9 Cost reporting and forecasts:

A computerized cost reporting system is used to provide the project manager and his team with timely and thorough information on the cost being incurred during the progress of a project. It provides regular monitoring of variances in scope and cost for early decision making and effective cost control. This is an in-house program integrating cost control and project accounting, and can be fully audited. Reporting is on a monthly basis, with immediate "early warning" bulletins being issued at pre-determined variance levels. The Target Cost or the Control budget established in the definitive estimating stage, forms the yardstick for comparison, and it is revised to show changes of scope.

The total 'commitments' when added to the "estimate to complete" produce the best forecast of the total cost at the time of the report. Forecasts of all items included in the scope of the work as detailed in the Project Code are up-dated on a continuous basis, using all the latest information available including control estimates, tender check estimates, changes of scope, bid tabulations, contract awards, purchase orders, contractors' claims, cost trends, anticipated claims, quantity take-offs, field labour forecasts, etc. Recording and coding of commitments is carried out daily, with results being checked continuously against the planned commitments for value and timing.

The forecast is compared with the Revised Target to identify underruns or overruns for each coded item or component of the project. The Cost Report and Forecast is a working document, producing various levels of summaries for management information.

The upper and lower limits for deviations are established by the project manager, in consultation with the key personnel, for early warning purposes.

Frequency and utilization of reports:

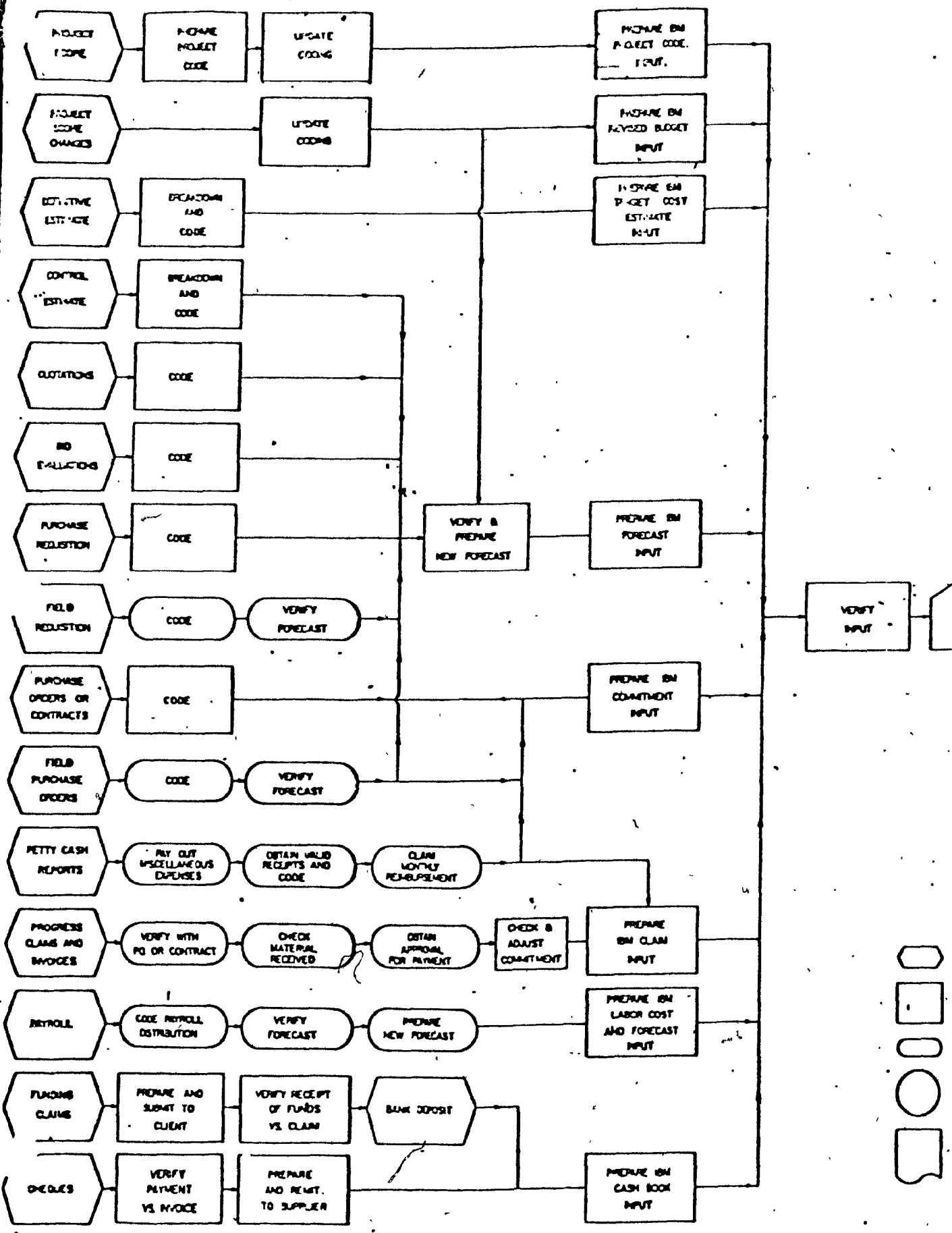
The project level reports are monthly with early warning at preset variance levels for exception reporting. The reports are  
\* utilized for the following purposes:

- Take action on design, engineering, procurement or construction;
- Verify the frequency of commitments and their sources;
- Status of payments and negotiating possibility;
- Verify cash flow;
- Verify advances against expenditures;
- Verify who is on the project and the time they charge;
- Verify the manpower requirements, in order to hire new people, or transfer people from one project to another depending on the tasks on hand;
- Know where the money has been spent and where it is going to be spent in future;
- Verify and control expenditures.

The capital cost control and accounting functions are summarized in Figure 6.9.1.

The project code permits generation of cost reports by subdivision or discipline (trade), as well as commitment reports, holdback and payment status, cash book, financial statements, etc. using the

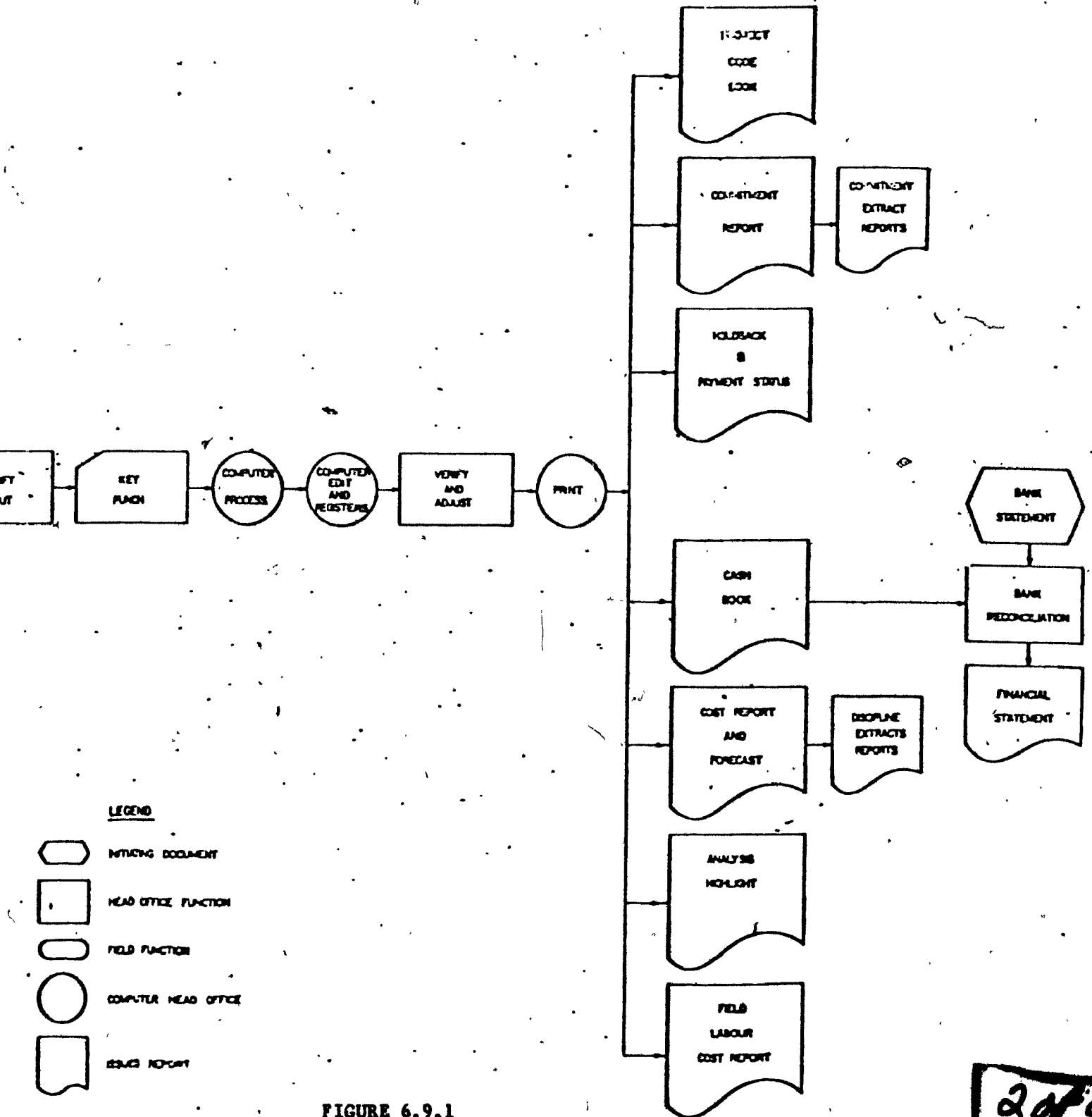
19



10/11/64 44-41



# CONTROL AND ACCOUNTING FUNCTIONS



**LEGEND**






-  INITIATING DOCUMENT
-  HEAD OFFICE FUNCTION
-  FIELD FUNCTION
-  COMPUTER HEAD OFFICE
-  SERVICE REPORT

FIGURE 6.9.1

2 of 2

computer for sorting and consolidating the cost data elements from the central project database. The cost report and summary specimens illustrated in this report (see Tables 6.9.3 to 6.9.9 Re. Project No. 6057) constitute the cost report package for a specific project at a control date. As such, the cost baseline (total) in these reports is balanced (with the exception of the 'cost item report and forecast by discipline' which is not for the above project, but has been included for illustrating the format), and the reports are co-ordinated showing the use of hierarchical coding. This will help the reader to understand clearly some aspects of the system discussed earlier in this case study. Some features of the reports and summaries to be noted are:

- All the 'cost report and forecast' specimens follow the same format (other summaries such as commitment report, holdback and payment status and cash book have different formats);
- The project code shows only the digits pertaining to the project level mentioned in the report title, e.g. in the 'cost report and forecast by major subdivision' the project code shows only the number '2' (major subdivision = service building) under 'project code'. While in the 'cost report and forecast by subdivision' the project code shows a cost breakdown at the third level in the hierarchy of the subdivision code (thus showing the number '240'). Further breakdown follows in the cost report and forecast. In the 'cost report and forecast by discipline' the single digit appearing under the project code is the 'discipline' (4th level in the project code) and is not to be confused with



the major subdivision. An example of the use of the code is shown below with reference to figure 6.9.6 and item 240-226-02.

Subdivision code	Capital (work) element and end item
(Major sub.) 2 = Service building	2 = Concrete
24 = Steam generation	22 = Building structure
240 = Steam boiler	226 = Slab on grade
	226-02 = Re. steel

240-226-02 = Re. steel for slab on grade in the service building structure for steam boiler installation.

- The contingencies are shown only in the cost report and summary by discipline as a line-item. Please note that there is no contingency amount shown under the cost and commitments column as the commitments (or costs incurred) are firm at this point. The contingency amount shown under 'Revised Target' is the total of all contingencies estimated for the current scope of the total project. As about 31% of the total forecast cost has been incurred at this point  $\left( \frac{\text{cost and O/S commitments}}{\text{Total forecast}} \times 100 \right)$ , 31% of the contingency allowance has been written off thus reducing the contingency estimate to complete and the contingency forecast at the same rate. As a result the variance column for contingencies shows a negative amount (which is in fact the amount written off) which offsets the cost overrun. As the project progresses and more costs incurred, this procedure continues. The cost overrun (prior to contingency application) changes depending on the costs incurred and estimated, and the contingency

variance also changes) as the contingency forecast changes. Theoretically, assuming that all costs estimated (including contingencies) are exactly correct, and no cost overrun results from any problems, both the cost variance (positive) and the contingency variance (negative) would match exactly thus cancelling each other. In such a case the actual project cost would be considered to be exactly on target. If there is a positive/negative variance after contingency application, it is considered as an over/underrun due to other causes such as more escalation than allowed for, missing items, an Act of God, etc. in the case assumed above.

- The variances appearing in the variance column are compared against the variance tolerances established in the planning stage, and if the tolerance limits are violated, early warnings are issued to trace the causes and take corrective action. Data traceability is maintained to the account level, each account being broken down using the 'SMILE' concept as required (e.g. The letters 'M' or 'L' appearing under the 'cost and O/S commitments' column denote 'Material' or 'Labour' respectively) thus showing the resource or factor with which the problem is associated.
- The target cost is 'revised' only for authorized scope changes, and is shown under Revised Target Cost for comparison against the forecast.

The monthly cost reports and summaries at the project level include:

Cost report and forecast (Summary by major subdivision): Table 6.9.2

This is a cost report summarized by groups of major systems (major project areas), thus advising area managers of forecasted cost variances within their area of responsibility.

Cost report and forecast (Summary by subdivision): Table 6.9.3

This report is a breakdown of the previous report and is meant for elaborating the systems (3rd level subdivisions), such as buildings or process systems.

Cost report and forecast: Table 6.9.4

This is a complete breakdown and tabulation of the project costs and commitments, the cost forecast and the project budget. The columns include the project code, description, cost and outstanding commitments, estimate to complete, the total forecast of cost (and quantities if needed), the revised target cost (and quantities if needed), the variance and the target cost (and quantities if needed).

The accounts are further broken down into Labour, Material, etc. using the 'SMILE' concept described earlier. This report gives a complete cost picture of the costs incurred to date and the forecast, as well as the cost-variance for establishing the current projected budget status.

Cost report and forecast (Summary by capital disciplines): Table 6.9.5

This is a summary of the project costs categorized by the discipline code, and is used by the engineers related to the respective disciplines for review of variances, and need for corrective action, if the actual costs of the design alternatives chosen exceed the planned costs.

Table 6.9.2

OCT 31, 1975

CLIENT'S NAME

PROJECT NO. 6057 14

PAGE 1

•• COST REPORT & FORECAST (MAJOR SUB-DIVISIONS) ••

PROJECT LINE	DESCRIPTION	COST & O/S COMMITMENTS	EST TO COMPLETE	TOTAL FORECAST	REVISED TARGET	VARIANCE AMOUNT	TARGET COST EST
2	SERVICE BUILDING	M 0 L 0	26.200 18.100	26.200 18.100	26.200 18.100	0 0	26.200 18.100
3	PROCESS & SERVICE BLDG	M 65,409 L 6,354	876,760 624,343	942,169 631,102	853,879 629,546	88,290 1,556	833,879 629,546
5	GENERAL SERVICES	M 397,117 L 0	44,519 71,280	441,530 71,280	441,530 71,280	0 0	441,530 71,280
6	PROCESS SYSTEMS	M 4,268,300 L 1,899	3,203,127 1,533,457	7,471,427 1,535,356	7,396,905 1,532,048	74,442 3,308	7,396,905 1,532,048
9	CONSTRUCTION IMPROVEMENTS	M 1,550,699 L 8,835	7,244,798 659,135	8,795,497 667,970	8,624,490 668,708	171,007 738	8,624,490 668,708
Total		M 6,281,518 L 17,493	11,399,306 2,906,315	17,676,823 2,923,808	17,343,884 2,919,682	332,939 4,126	17,343,884 2,919,682
TOTAL M & L		6,299,012	14,301,619	20,600,631	20,262,766	337,015	20,262,766

OCT 31, 1975

Table 6.9.3

CLIENTS NAME

PROJECT NO. 6057

14

PAGE

♦♦ COST REPORT & FORECAST (SUMMARY BY SUB-DIVISION) ♦♦

PROJECT CODE	DESCRIPTION	COST & C/S COMMITMENTS	EST TO COMPLETE	TOTAL FORECAST	REVISED TARGET	VARIANCE AMOUNT	TARGET CUST EST
2	SERVICE BUILDING						
24	STEAM GENERATION						
240	STEAM BOILER	M	26,200	26,200	26,200	0	26,200
		L	18,100	18,100	18,100	0	18,100
	TOTAL 240	M	44,300	44,300	44,300	0	44,300
		L	26,200	26,200	26,200	0	26,200
		M	18,100	18,100	18,100	0	18,100
		L	26,200	26,200	26,200	0	26,200
	TOTAL 2	M	44,300	44,300	44,300	0	44,300
		L	26,200	26,200	26,200	0	26,200
3	PROCESS & SERVICE BLDG						
31	WOOD PREPARATION						
312	CHIPPER BUILDING	M	108,744	108,744	108,744	0	108,744
		L	77,826	77,826	77,826	0	77,826
	TOTAL 312	M	186,570	186,570	186,570	0	186,570
		L	108,744	108,744	108,744	0	108,744
		M	77,826	77,826	77,826	0	77,826
		L	108,744	108,744	108,744	0	108,744
32	REFINER GROUNDWOOD BLDG						
322	REFINER GROUNDWOOD BLDG	M	629,816	691,225	602,935	88,290	602,935
		L	488,917	495,876	494,120	1,756	494,120
	TOTAL 322	M	1,118,733	1,186,901	1,097,055	89,846	1,097,055
		L	127,700	127,700	127,700	0	127,700
		M	37,600	37,600	37,600	0	37,600
		L	165,300	165,300	165,300	0	165,300
	TOTAL 326	M	733,516	818,925	730,635	88,290	730,635
		L	520,517	533,276	531,720	1,556	531,720
33	FINISHING						
331	ROLL HANDLING	M	14,500	14,500	14,500	0	14,500
		L	20,000	20,000	20,000	0	20,000
	TOTAL 331	M	34,500	34,500	34,500	0	34,500
		L	14,500	14,500	14,500	0	14,500
		M	20,000	20,000	20,000	0	20,000
		L	876,760	942,169	853,879	88,290	853,879
		M	624,343	631,102	629,546	1,556	629,546
		L	1,501,103	1,573,271	1,403,425	89,846	1,403,425
	TOTAL 3	M	1,501,103	1,573,271	1,403,425	89,846	1,403,425
		L	1,501,103	1,573,271	1,403,425	89,846	1,403,425

Table 6.9.3 (continued)

OCT 31, 1975

CUSTOMER NAME

PROJECT

NO. 6057

PAGE

CCST REPORT & FORECAST (SUMMARY BY SUB-DIVISION)

PROJECT CODE	DESCRIPTION	COST & C/S COMMITMENTS	FSI 10 COMPLETE	TOTAL FORECAST	REVISED TARGET	VARIANCE AMOUNT	TARGET COST EST
970	TOTAL 910	5,658	34,402	40,100	40,100	0	40,100
	UP-MINING-CONSTR.FACIL.	40,340	68,360	108,700	104,300	4,400	104,300
		46,053	364,274	410,372	413,869	3,497	413,869
		999	17,801	20,800	20,800	0	20,800
930	TOTAL 920	47,052	384,030	431,172	434,669	3,497	434,669
	CONSTRUCTION EQUIPMENT	50,176	168,739	218,935	218,935	0	218,935
		44	13,956	14,000	14,000	0	14,000
940	TOTAL 930	50,240	182,695	232,935	232,935	0	232,935
	ADMINISTRATION COSTS	564	1,792,877	1,793,441	1,793,296	145	1,793,296
		2,094	590,976	593,070	593,808	738	593,808
	TOTAL 940	2,658	2,383,853	2,386,511	2,387,104	593	2,387,104
951	SPARE PARTS	12,100	409,700	422,000	422,000	0	422,000
955	PROJECT MANAGEMENT	947,642	1,572,405	2,520,047	2,350,088	169,959	2,350,088
	9	1,550,699	7,244,798	8,795,497	8,624,490	171,007	8,624,490
		8,835	659,135	667,970	668,708	738	668,708
	TOTAL 9	1,559,534	7,903,933	9,463,467	9,293,198	170,269	9,293,198
	GRAND TOTAL	6,281,519	11,395,304	17,676,823	17,343,084	333,739	17,343,084
		17,492	2,906,315	2,923,808	2,919,682	4,126	2,919,682
	FINAL TOTAL	6,299,012	14,301,619	20,600,631	20,262,766	337,865	20,262,766

Table 6.9.4

OCT 31, 1979

PAGE 1

CLIENT'S NAME

PROJECT NO. 6037 14

\*\* COST REPORT & FORECAST \*\*

PROJECT CODE      DESCRIPTION      COST & DVS COMMITMENTS      EST TO COMPLETE      QTY UN      --TOTAL FORECAST--      --REVISED TARGET--      VARIANCE AMOUNT      --TARGET COST EST--      QTY UN      AMT

SERVICE BUILDING

STEAM GENERATION

STEAM BOILER

DENULITION & EARTHWORK

DENULITION

240-112-01 REMOVE FLOOR SLAB

240-112-02 REMOVE ROOF & ROOF STL

240-112-03 REMOVE ELEVATOR EG

240-112-04 REMOVE EQUIP. C PIPING

240-11

240-12 EARTHWORK

240-121 EXCAVATION

240-12

240-151 BACKFILL

240-1

240-2 CONCRETE

240-22 BLOC STRUCTURE

240-226 SLAB ON GRADE

240-226-02 RE-STEEL

240-226-03 CONCRETE

PROJECT CODE	DESCRIPTION	COST & DVS COMMITMENTS	EST TO COMPLETE	QTY UN	--TOTAL FORECAST--	--REVISED TARGET--	VARIANCE AMOUNT	--TARGET COST EST--	QTY UN	AMT
A 240-112-01	REMOVE FLOOR SLAB	M 0	911	17CY	911	911	0	17CY	17CY	911
A 240-112-02	REMOVE ROOF & ROOF STL	M 0	940	136MH 600SF 130MH	940	940	0	136MH 600SF 130MH	136MH 600SF 130MH	940
A 240-112-03	REMOVE ELEVATOR EG	M 0	584	80MH	584	584	0	80MH	80MH	584
A 240-112-04	REMOVE EQUIP. C PIPING	M 0	1,000	1,000	1,000	1,000	0	1,000	1,000	1,000
240-11		L 0	4,400	600MH	4,400	4,400	0	600MH	600MH	4,400
		M 0	1,000	1,000	1,000	1,000	0	1,000	1,000	1,000
		L 0	6,835	6,835	6,835	6,835	0	6,835	6,835	6,835
A 240-121	EXCAVATION	M 0	794	64CY 128MH	794	794	0	64CY 128MH	64CY 128MH	794
240-12		L 0	794	794	794	794	0	794	794	794
A 240-151	BACKFILL	M 0	120	JULY 90MH	120	120	0	JULY 90MH	JULY 90MH	120
240-1		L 0	558	558	558	558	0	558	558	558
		M 0	1,120	1,120	1,120	1,120	0	1,120	1,120	1,120
		L 0	8,187	8,187	8,187	8,187	0	8,187	8,187	8,187
A 240-226	SLAB ON GRADE	M 0	275	11M	275	275	0	11M	11M	275
240-226-02	RE-STEEL	M 0	107	16MH	107	107	0	16MH	16MH	107
240-226-03	CONCRETE	M 0	308	11CY	308	308	0	11CY	11CY	308
		M 0	211	33MH	211	211	0	33MH	33MH	211

Table 6.9.4 (continued)

PROJECT CITY	DESCRIPTION	COST COMMITMENTS	EST. TO COMPLETE	INITIAL FORECAST		REVISED TARGET		VARIANCE AMOUNT	CITY LP	CITY LP
				QTY UM	AMT	CITY UM	AMT			
	SPARE PARTS	14	409,700	422,000	422,000	422,000	0	0	42,000	42,000
	951	12,300	409,700	422,000	422,000	422,000	0	0	42,000	42,000
	PROJECT MANAGEMENT									
	SALARIES	M	761,604	1,117,643	1,944,292	1,779,331	165,959	0	1,779,331	1,779,331
	EXPENSES	M	69,033	189,722	248,755	250,755	0	0	250,755	250,755
	TOTAL	P	187,000	149,000	312,000	312,000	0	0	312,000	312,000
	952-0	M	947,647	1,772,409	2,320,047	2,350,084	164,959	0	2,350,084	2,350,084
	955	M	947,647	1,772,409	2,320,047	2,350,084	164,959	0	2,350,084	2,350,084
	TOTAL	L	1,550,659	7,244,724	6,723,447	6,624,190	171,007	0	6,624,190	6,624,190
	GRAND TOTAL	M	6,281,519	11,395,104	17,675,823	17,343,004	332,719	0	17,343,004	17,343,004
	FINAL TOTAL	L	17,643	2,306,315	2,923,008	2,919,642	4,126	0	2,919,642	2,919,642
			6,298,017	13,301,619	20,600,831	20,262,700	337,605	0	20,262,700	20,262,700

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Table 6.9.5

UCT 31.1.1975

CLIENT'S NAME

PROJECT NO. 6057 14

PAGE

COST REPORT & FORECAST (SUMMARY BY DISCIPLINE)

PROJECT CODE	DESCRIPTION	COST & GAS COMMITMENTS	EST TO COMPLETE	TOTAL FORECAST	REVISED TARGET	VARIANCE AMOUNT	TARGET COST EST
0	SUB-RUST SERVICES & FEE	947,642	1,572,405	2,520,047	2,350,000	169,959	2,350,000
1	EARTHWORK	M 19,851 L 4,650	19,877 214,845	39,728 219,295	17,728 218,295	22,000 1,000	11,770 218,279
2	CONCRETE	M 25,822 L 1,182	297,531 245,834	323,353 247,016	265,163 247,260	58,190 356	265,163 247,260
3	STRUCT. & MISC. STEEL	M 13,775 L 327	392,517 118,489	366,292 118,816	358,192 118,816	8,100 0	358,192 118,816
4	ARCHITECT. COMPONENTS	M 0 L 0	166,203 40,412	166,203 40,412	166,203 40,412	0 0	166,203 40,412
5	EQUIPMENT	M 4,542,808 L 184	5,460,955 711,840	10,003,763 712,024	9,978,771 710,038	25,912 1,986	9,978,771 710,038
6	PIPING	M 28,812 L 1,322	470,002 264,200	498,814 265,522	469,600 264,200	29,214 1,322	469,600 264,200
7	ELECTRICAL	M 540,442 L 393	256,957 418,060	797,399 418,453	777,143 418,453	20,256 0	777,143 418,453
8	INSTRUMENTATION	M 0 L 0	469,876 235,500	469,876 235,500	469,876 235,500	0 0	469,876 235,500
9	CONSTRUCTION INDIRECTS	M 162,367 L 8,835	2,324,981 659,135	2,491,348 667,970	2,490,300 668,708	1,048 738	2,490,300 668,708
TOTAL		M 6,281,919 L 17,493	11,395,304 2,906,315	17,676,823 2,923,808	17,343,084 2,919,682	333,739 4,126	17,343,084 2,919,682
TOTAL M C L		6,299,012	15,914,619	20,600,631	20,262,766	337,865	20,262,766
CONTINGENCIES			1,613,000	1,613,000	2,355,000	742,000	2,355,000
		6,299,012	15,914,619	22,213,631	22,617,766	404,135	22,617,766

Cost item report and forecast (in discipline order): Table 6.9.6

This is also a variation of the cost report sorted by items of similar nature. It helps procurement and construction management to assess the magnitude of the work package, to plan/replan the execution activities and to establish forecast trends.

Commitment report: Table 6.9.7

This is a ledger arranged in the sequence of project codes, of all items committed on a project by purchase orders or contracts. The report shows the total commitment per code item with the name of the supplier or the contractor and the claims submitted against the commitment, as well as the outstanding balance. The total commitment column is brought forward automatically to the cost and commitments column of the cost report and forecast.

Holdback and payment status: Table 6.9.8

This report sorts and regroups the information from the commitment report providing an alphabetical list of all contractors and suppliers of the project showing the description of the work to be performed, the total commitment for the contract or purchase order as issued, the gross claims, the holdback deducted (as per the respective agreement), the payment to date (as collected through the project accounting system) and the outstanding balance. The holdback and payment status report is structured by procurement package order, whereas the commitment report is structured by the project code. This report is used for monitoring the status of claims, holdbacks and payments for each contract/purchase order to ensure timely and correct payments.

JUN 30, 1976

EXHIBIT

MONTREAL QUEBEC

NO. 8884

PAGE 1

### COST ITEM REPORT & FORECAST (IN DISCIPLINE ORDER)

PROJECT CODE	DESCRIPTION	COST & D/S COMMITMENTS	EST TO COMPLETE	EST TO COMPLETE QTY/AM	--TOTAL FORECAST-- AMT	QTY/AM	--REVISED TARGET-- AMT	QTY/AM	VARIANCE AMOUNT	--TARGET COST EST-- QTY/AM	AMT
323-103	BOILS INVESTIGATION	M 23,870	1,870-	22,000	22,000		0		22,000		0
312-12	EXCAVATION & BACKFILL	M 0	0	0	0		0		0		0
3-121	CHIP EXCAVATION	M 1,500	1,500	243	1,500		0		0		0
240-151	BACKFILL	M 120	120	30CT	120		0		0		0
323-151	BACKFILL	M 1,550	1,550	100CT	1,550		0		0		0

NOTE: THIS SPECIMEN IS NOT PART OF THE REPORT PACKAGE FOR PROJECT NO. 6057 BUT HAS BEEN INCLUDED FOR THE FORMAT ONLY

PROJECT NO, 6057 14

COMMITMENT REPORT

PROJECT CODE	P.O. NO.	CO. NO.	SUPPLIER	DESCRIPTION	QTY	UNIT	COMMITMENT AMOUNT	GRUSS CLAIMS	BALANCE OUTSTANDING
32				PROCESS & SERVICE BLDG					
323				REFINER GROUNDWOOD BLDG					
323-1				REFINER GROUNDWOOD BLDG					
323-10				EARTHWORK & DEMOLITION					
323-103				SOILS TESTING					
				SOILS INVESTIGATION					
				SLB. SURFACE INVESTIGATION M			8,066.14	8,066.14	8,118.33
				SLB. SURFACE INVESTIGATION M			16,984.47	8,866.14	8,118.33
				TOTAL P.O.			16,984.47	8,866.14	8,118.33
				323-103					
				323-10					
323-11				DEMOLITION					
323-111				REFINER BUILDING					
323-111-12				RENOVC-BR-WALL-SW-GH-RM					
				RENTAL COMPRESSOR-OPER M			300.00	0.00	300.00
				323-111-12			300.00	0.00	300.00
				323-111			300.00	0.00	300.00
323-114				FIVE REFINER FOUNDATION					
323-114-01				REMOVE CONC.					
				RENTAL LOADER & TRANSP. M			35.00	0.00	35.00
				323-114-01			35.00	0.00	35.00
				323-114			35.00	0.00	35.00
323-115				SIXX CHEST FOUNDATIONS					
323-115-01				REMOVE CONC.					
				RENTAL COMPRESSOR-OPER M			1,700.00	416.00	1,284.00
				323-115-01			1,700.00	416.00	1,284.00
				323-115			1,700.00	416.00	1,284.00
323-118				ACCESS TO REFINER ROOM					
323-118-05				MECHANICAL-DEMOL/RELOC					
				RENTAL-600 CFM COMPRESS M			832.00	832.00	0.00
				323-118-05			832.00	832.00	0.00
				323-118			832.00	832.00	0.00
				323-11			2,867.00	1,240.00	1,627.00
				323-1			19,851.47	10,116.14	9,737.33
323-7				CONCRETE					
323-23				BUILDING FACILITIES					
323-232				REFINER FOUNDATIONS(S)					
323-232-09				PILING-14-H-73					
				68 00 PIPE C PILING SUP			23,055.00	0.00	23,055.00
				69 00 ASS.PILE & FITTIM			1,782.90	0.00	1,782.90
				69 00 ASS.PILE & FITTIM			45.00	0.00	45.00

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Table 6.9.7 (continued)

CLIENT'S NAME PROJECT NO. 6051 14

COMMITMENT REPORT

PROJECT CODE	P.O. NO.	CD. NO.	SUPPLIER	DESCRIPTION	QTY	UNIT	COMMITMENT AMOUNT	GROSS CLAIMS	BALANCE OUTSTANDING
955-030	706 00		SMC-RUST SERVICES	SMC-RUST-FIX FEE JUN.75 M			13,000.00		
	706 09		SMC-RUST SERVICES	SMC-RUST-FIX FEE JUL.75 M			13,000.00		
	706 10		SMC-RUST SERVICES	SMC-RUST-FIX FEE AUG.75 M			13,000.00		
	706 11		SMC-RUST SERVICES	SMC-RUST-FIX FEE SEP.75 M			13,000.00		
	706 12		SMC-RUST SERVICES	SMC-RUST-FIX FEE OCT.75 M			13,000.00		
				TOTAL P.O. 706			117,000.00	117,000.00	0.00
				955-030			117,000.00	117,000.00	0.00
				955-0			947,642.16	947,642.16	0.00
				955			947,642.16	947,642.16	0.00
							1,550,647.73	1,053,197.70	497,500.03
				** FINAL TOTAL			6,281,519.33	2,436,504.74	3,847,014.59

HOLDBACK & PAYMENT STATUS \*\*

P.O. NO.	SUPPLIER	DESCRIPTION	P.O. AMOUNT	GROSS CLAIMS	HOLDBACK DEDUCTED	PAYMENT TO DATE	UNPAID BALANCE
65	A. JOHNSON & CO.	CHIPPER CYCL. SURGE AIN	24,800.00	0.00	0.00	0.00	24,800.00
501	ACHE DECALCOMANIA	1000 MAL. DECALS	115.95	115.95	0.00	115.95	0.00
10	ALLEN BRADLEY	BLANKET CROER-DRIVES	0.00	0.00	0.00	0.00	0.00
37	ALLEN BRADLEY	MOTORS 25 HP.	36,162.00	0.00	0.00	0.00	36,162.00
505	ATHES BUISNESS	PAYROLL SUPPLIES	288.00	144.00	0.00	144.00	144.00
67	ASS-PILE & FITTIM	PRUYN POINTS	1,827.90	0.00	0.00	0.00	1,827.90
564	AU COIN DU TAPIS	SUP. & INSTAL. CONGLEUM	376.30	376.30	0.00	376.30	0.00
548	BARRIETTE & FILS	ELECTRICAL-TRAILER INST	1,206.96	1,206.96	0.00	1,206.96	0.00
501	BELL CANADA	REPAIR TELEPHONE INSTAL	98.93	0.00	0.00	0.00	98.93
6	BLUUIT SOREL	M.O.-VERT. SCREW PRESS	129,608.00	23,570.60	0.00	23,570.60	102,237.40
26	BLACK CLAMSON	EST. ESCAL. - POT CHIP SCK	36,900.00	5,475.00	0.00	5,475.00	31,425.00
41	BLACK CLAMSON	MISC. AGITATORS	32,121.19	0.00	0.00	0.00	32,121.19
703	BLAIRLOCK BRUS.	DUTY	518.17	432.75	0.00	432.75	85.42
563	BOILEY & CIE LTEE	FLANCES, BULTS, MUTS	46.16	46.16	0.00	46.16	0.00
514	BOILEY PROD. SANIT.	HOPS. PAILS, BAGS ETC	420.95	420.95	0.00	420.95	0.00
531	BOILEY PROD. SANIT.	WASTE PAPER BASKET ETC	35.35	35.35	0.00	35.35	0.00
558	BOILEY PROD. SANIT.	COCO MAT	8.95	8.95	0.00	8.95	0.00
563	BOILEY PROD. SANIT.	COCO MAT	8.95	8.95	0.00	8.95	0.00
504	BOULEVARD AUHID	1/2 TM FORD PICKUP	4,785.64	4,785.64	0.00	4,785.64	0.00
53	C.A.F. MACHINERY	METAL DETECTOR	3,645.00	0.00	0.00	0.00	3,645.00
39	CAN. GEN. ELECT	CONDUCTOR	32,544.20	1,978.00	0.00	1,978.00	30,566.20
50	CAN. GEN. ELECTRIC	MISC. MOTORS	4,168.38	0.00	0.00	0.00	4,168.38
5	CAN. GEN. ELECTRIC	700HP. 1200RPM MOTOR	28,159.75	0.00	0.00	0.00	28,159.75
11	CAN. GEN. ELECTRIC	METALCLAD SWITCHGEAR	29,290.00	0.00	0.00	0.00	29,290.00
13	CAN. GEN. ELECTRIC	BEARINGS, RECTIFIER ETC	271,604.00	103,481.60	0.00	103,481.60	168,122.40
15	CAN. GEN. ELECTRIC	BLANKET CADDERS-MOTORS	12,300.00	0.00	0.00	0.00	12,300.00
19	CAN. GEN. ELECTRIC	BLANKET UNDER-MOTORS	0.00	0.00	0.00	0.00	0.00
21	CAN. GEN. ELECTRIC	TERMINAL KITS	1,045.00	1,045.00	0.00	1,045.00	0.00
30	CAN. GEN. ELECTRIC	SAFETY SWITCH 600V	2,152.00	2,152.00	0.00	2,152.00	0.00
33	CAN. GEN. ELECTRIC	MOTORS	12,168.78	0.00	0.00	0.00	12,168.78
34	CAN. GEN. ELECTRIC	BUENDY LADDER, DANOS ETC	31,162.91	6,516.14	0.00	6,516.14	24,646.77
47	CAN. GEN. ELECTRIC	CABLE TRAYS, DEROS, LUGS	4,273.05	758.44	0.00	758.44	3,514.61
54	CAN. GEN. ELECTRIC	MISC. MOTORS	5,868.64	0.00	0.00	0.00	5,868.64
RA2208	CAN. GEN. ELECTRIC	MOTOR-1200 HP.	1,010,668.00	260,325.00	0.00	260,325.00	750,343.00
7	CAN. INGERSOLL RAND	PR WARY, SECOND. SCREENS	144,565.00	55,650.00	0.00	55,650.00	88,915.00
7	CAN. INGERSOLL RAND	GR. WO. FILTERS	501,195.00	93,897.00	0.00	93,897.00	407,298.00
42	CARTHAGE MACH.	48 IN. RECHIFFER	11,570.00	0.00	0.00	0.00	11,570.00
9	CARTHAGE MACHINE	104 - 15 KNIFE CHIPPER	85,817.00	12,916.90	0.00	12,916.90	72,900.10
64	CARTHAGE MACHINE	SLIDING MOTOR BASE	14,250.00	0.00	0.00	0.00	14,250.00
517	CITE D'ALMA	RENTAL-GRADER OPERAITU	56.00	56.00	0.00	56.00	0.00
705	CU EXPRESS	TRC LIGHT-PH-6057-4	117.60	117.60	0.00	117.60	0.00
527	CU-P AGRIGILE	GLASS FENCE WINE FIG	98.80	98.80	0.00	98.80	0.00
545	CONSTRUCT. ALMA	RUNTING OIL TRAILERS	405.60	405.60	0.00	405.60	0.00
56	CRANE SUPPLY	HYDRA OIL CLUBE OIL PIP	9,773.40	9,773.40	0.00	9,773.40	0.00
30	CRANE SUPPLY	HYDRA OIL CLUBE PIPE	2,405.62	2,405.62	0.00	2,405.62	0.00

Cash book: Table 6.9.9

When operating out of a trust fund on behalf of the client, or when a project bank account is opened, the monthly cash book shows every cheque issued including the date of issue, the recipient, the voucher on which the payment was approved, cheque number and the credited amount. Deposits from the client and the accrued interest are shown under the 'debit' column. The month and the balance is also shown. In short, the cash book summarizes all the cash flows during the month.

Financial statement:

The monthly financial statement shows the expenditures and the bank charges versus the advances and the interest earned. It includes a bank reconciliation, and ties together and balances all the financial aspects of the project.

Procurement source summary:

This summary is produced by a rearrangement of the commitment input by 'procurement source' or by currency use in the payment of the orders as required.

Table 6.9.9

OCT 31, 1975

CLIENT'S NAME

PAGE

PROJECT NO, COST 14

CASH BOOK

DATE	DESCRIPTION	VOUCH. NO.	CHEQUE NO.	DEBIT	CREDIT	BANK BALANCE
10/75	TIF ELECTRIC LTD	A000	0072		41.40	
10/75	DOLLY BRD. SANY	A072	0073		2.92	
10/75	KUNZO PRINTING INC	A070	0074		116.00	
10/75	DOLLY PRUD. SANY	A009	0075		0.93	
10/75	DE SNEULES COACHES	A006	0076		127.13	
10/75	DL SNEULES COACHES	A006	0076		1,227.00	
10/75	FERR. COLE BATHIN	A001	0077		735.03	
10/75	REXORDO CAM. LTD	A003	0078		673.40	
10/75	GOODALL RUBBER	A004	0079		801.37	
10/75	CAN GENERAL ELEC	A076	0080		4,516.14	
10/75	CAN GENERAL ELEC	A076	0080		1,979.00	
10/75	CAN GENERAL ELEC	A076	0080		758.44	
10/75	SNC RUST PAYROLL	A116	0081		2,474.04	
10/75	M S S INC.	A070	0082		30,094.69	
10/75	M.S.S. INC.	A002	0083		107.00	
10/75	M.S.S. INC.	A002	0082		5,614.90	
10/75	SNC RUST PAYROLL	A116	0084		7,157.77	
10/75	B OF M-MORNING.	A105	0101		6,523.40	
10/75	SNC-RUST SERVICES	A115	PRICE		270,781.63	
MONTHLY B/F						136,439.71
CREDIT ANALYSIS						
290,320.00						
211,399.17 X						
270,781.63 Y						
** FINAL BALANCE FORWARD						
2,140,200.13						
964,507.30 X						
1,181,700.77 Y						



CHAPTER SEVEN  
OBSERVATIONS AND CONCLUSION

## Chapter 7

### 7.1 Observations: An evaluation of the SNC system:

The case study, in general, demonstrates the practical applications of the cost control methodology discussed in Chapters 2 through 5. It is easy to see that the SNC philosophy places as much emphasis on planning as they do on control. Every aspect of the project, including the planning and control effort itself, is planned in as much detail as possible. The major single factor, which gives SNC a distinct advantage in its planning and control operations is the fact that it is a large, multidisciplinary company with a wide variety of in-house expertise, and largely integrated systems and procedures. Similarly the planning data readily available from its many subsidiaries and affiliates (from various industries and disciplines) makes it possible to achieve the required level of planning detail. The matrix organization of the home office ensures integration of the various professional services as regards to the effect of individual decisions (made by individual disciplines) on the project as a whole. The seemingly unimportant fact that all key personnel are located in the same building (at the home office), generates a better interaction among the project personnel. This also makes possible joint reviews of progress and decisions made, thus resulting in joint resolution of problems as required. Of equal importance is the fact that all the methods and procedures to be used, are well documented (as seen from Appendix A) the required documents forming part of the project instructions. A centralized computer installation allows the development

and updates of a centralized project database from which the latest project data can be readily retrieved. It also allows speedy data processing and generation of comprehensive cost summaries using the project cost code. The integration of the project accounting with cost control results in two advantages as follows:

- It takes the routine administrative and accounting functions away from the cost engineers thus giving them more time and incentive to perform their primary functions (including detection of problem areas, cost analysis and initiation of corrective action) effectively;
- It ensures feedback of the actual paid costs and the allocated expenses/overheads to the forecasting/budget control system.

The SNC philosophy of 'planning for control' and 'controlling as planned' implies the 'MBO' (Management by Objectives) approach discussed in Chapter 1. This is reflected in the planning and control methodology (discussed in Sections 6.3 through 6.9 of the case study).

The development of the work breakdown structure is similar to the one discussed earlier in Section 4.1. The contractors' participation in the development of the WBS depends on the individual project contracts and requirements. But regardless of whether the entire WBS is developed by SNC or not, its development reflects a contractor's point of view also as SNC can act (and has acted) in a contractor's capacity also.

The project cost code, based on the Integrated Coding System, resembles the cost code discussed in Section 4.2. The use of the SMILE concept for cost breakdown facilitates traceability of data to the

resource costs for each cost account representing the WBS element to be controlled.

The estimate types and their uses are similar to those discussed in Section 4.3. The methodology for handling cost escalation follows the philosophy that based on historical data and statistics cost escalation is bound to occur, and as such, the escalation costs should also be estimated and built into the definitive estimate like any other cost items. The contingency management methodology is also similar based on the fact that contingency costs are defined by SNC as costs which are known to exist (based on historical data and statistics), but cannot be defined or identified with the work items during the early stages (e.g. preparation of the definitive estimate). Thus both escalation and contingency become part of the definitive estimate, and hence the target cost against which the total cost forecast is compared. Any cost over/underrun at the cost account level, therefore, includes the net impact of the escalation costs also. An underrun signifies a cost saving. The same applies to the contingency costs except that the contingency budget (left after writing off depletion) is applied only at the project level to arrive at the total overrun/saving. Omissions and estimating errors are treated as cost overruns. This methodology reflects a belief that every known cost must be estimated, budgeted for and controlled. In case the actual cost escalation or contingency exceeds the allowances made, the party preparing the estimate will be responsible for the justification of the additional funding requirements for cost plus contracts. In case of lump sum contracts the contractor will be responsible for completing the project within the contract budget based on his bid.

Due to the integrated methods and procedures a cost trending system is not needed. Performance reporting, deviation detection and review of the impact on the project are part of the standard procedures. The scope change (change order) procedures are similar to those described in Section 4.7.

The budget management methodology is also similar to the methodology discussed in Section 4.8 except for the terminology. Control is forward looking, the cost forecast at completion being compared with the revised target cost.

The methodology for controlling the professional services is similar to the one described earlier in Sections 5.2 through 5.5. The contracts (commercial services) are controlled by obtaining a breakdown of the total commitment from the contractor and measuring his progress claims against his own commitment breakdown. The earned value concept is used in the sense that the actual costs incurred (claims) are compared against the budgeted cost of work done (as per commitment breakdown), the physical progress being checked on site before approving the claim. Thus the total cost variance obtained is based on earned value, but the portion of the cost overrun resulting from delays (schedule variance) is not shown separately.

The monthly cost reports summarize the actual costs, forecast costs, budgets and cost variances (if any) at the cost account or subdivision levels, as required, for control by areas/packages/contracts/disciplines, etc. This facilitates management by exception. The problem sources can then be traced by examining the breakdown of each account (the SMILE breakdown). Corrective action can then be initiated.

## 7.2 Conclusion:

The cost control implications (of major construction projects) discussed in this report demonstrate that cost control is not just an 'accounting' or a 'number crunching' operation. It involves in-depth planning as well as integration of disciplines, functions, systems and procedures. Similarly, problems related to cost control are much more complex than just the accounting problems. They can involve just about any project resource, element or operation and lead to a cost overrun directly or indirectly. While it is possible to solve some of them, some others cannot be solved. Some of the most difficult problems are those related to people, their attitudes and performance, along with those resulting from the so called Acts of God. The cost control system is instrumental in measuring the impact of these problems on the projected (final) cost which is sensitive to most of these problems. This sensitivity of the final cost to the problems is useful for management by exception, the problem source being traced by using the account code. Corrective action can then be taken for improving the performance. It is also important to note that a cost variance is a result of a deviation in the physical performance except in cases such as cost escalation, increased financing charges and other costs related to money itself. Thus the primary line of defense, against a major cost overrun, is the physical performance control and data collection system. If a major potential deviation is detected in the physical performance control procedures, it has to be reported immediately for analysing its potential impact on the project cost and to avoid a cost overrun by

trying to improve the physical performance. If, the physical progress is as scheduled, the 'management by exception' procedures can be applied.

In summary, the success of the cost control program for a major construction project depends as much on correct system development, methods and procedures, as it does on the efficiency and attitudes of the people using it. And even so, the cost overruns resulting from Acts of God may still occur, the main aim, in such cases, being to minimize them.

APPENDIX A

Monitoring and Processing Contractor's Progress Payment  
and Final Release of Holdback





PROCEDURE

CODE NUMBER  
3401

TITLE

CAPITAL COST CONTROL  
ACCOUNTS PAYABLE PROCEDURE

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PAGE  
CAPITAL COST CONTROL

1. POLICY

- .1 Suppliers and Sub-Contractors will be instructed to submit the original and two copies of all invoices and progress claims directly to the site for approval.
- .2 Payment Approval Slips will be raised on site, attached to invoices, and sent directly to the Project Cost Controller in Head Office.
- .3 All payments will be made from Head Office by the Project Cost Controller.
- .4 No conventional accounting records will be maintained on Site.

2. SITE PROCEDURES

.1 Approvals

- .1 Stamp date invoices received
- .2 Attach P.A.S. to invoice and enter it in Invoice Register showing:
  - a) P.A.S. Number
  - b) Supplier
  - c) Invoice Number or Reference
  - d) Amount
  - e) Name of Approver
  - f) Date sent to Montreal
- .3 Obtain warehouse approval for material received in good condition and according to purchase order.
- .4 Obtain Engineer's approval on equipment and instrument invoices that items are according to spec.
- .5 On Sub-Contractor's Claims, obtain Engineer's approval for quantities and/or percentages of completion, and Cost Engineer's approval on coding.
- .6 Obtain Site Manager's approval on all progress claims. In addition, Construction Manager will be signing invoices in excess of \$1,000.00



PROCEDURE

CODE NUMBER

3401

TITLE

CAPITAL COST CONTROL  
ACCOUNTS PAYABLE PROCEDURE

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FROM

CAPITAL COST CONTROL

2. SITE PROCEDURES (Cont'd)

.1 Approvals (Cont'd)

.7 Continuous check of Invoice Register for invoices not returned from approvals and expedite.

.8 Mail invoices approved to Head Office, Attention: Cost Controller.

Note: a) Invoices with cash discount must be expedited on a priority basis and mailed to Head Office within two days of receipt, marked with a red sticker.

b) Progress Claims must be sent to Head Office in time to reach the Project Cost Controller by the 5th of the month for inclusion in the Funding Claim.

3. HEAD OFFICE PROCEDURES

.1 Stamp date received on Payment Approval Slip.

.2 After invoices are received from the Site, properly approved as per Item 2.1 above, check prices and quantities against purchase order and approve.

.3 Perform mathematical check and approve.

.4 Enter invoices on Accounts Payable Voucher (a voucher is to be used to cover invoices against a single supplier but for more than one purchase order).

.5 Complete Cost Breakdown portion of voucher.

.6 Insert totals of invoices on the voucher in the space provided and balance "Gross Amount" total to total amount of Cost Breakdown where applicable.

.7 Investigate Change Order status in cases of overrun of commitments.

.8 Project Cost Controller signs approval for payments.



**PROCEDURE**

CODE NUMBER

TITLE

**CAPITAL COST CONTROL  
ACCOUNTS PAYABLE PROCEDURE**

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**CAPITAL COST CONTROL**

3. HEAD OFFICE PROCEDURES (Cont'd)

- .9 Send top copy of voucher to Computer Co-Ordinator together with tape of total value.
- .10 Check entries for correct field, legibility, etc.
- .11 Key punch.
- .12 Run proof-listing and print cheques.
- .13 Make adding machine tape on cheques to balance with original (3.8).
- .14 Match cheques to vouchers and return to Cost Controller.
- .15 Print cheque number on voucher.
- .16 Obtain cheque signatures.
- .17 Mail cheques to supplier with third (green) copy of voucher.
- .18 File one cheque copy with yellow copy of voucher.
- .19 File one cheque copy numerically.
- .20 File yellow copy of voucher with attached invoice and cheque copy alphabetically by Supplier's name and purchase order number.

**Note:** Accounts Payable Vouchers should be held for additional invoices only if more are definitely expected within two weeks.



PROCEDURE

CODE NUMBER 3401

MONITORING & PROCESSING OF CONTRACTOR'S PROGRESS PAYMENTS AND FINAL RELEASE OF HOLDBACK

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CAPITAL COST CONTROL

1.0 Objective:

- .1 Ensure that the interests of the Client are protected in the disbursement of funds during the progress of the contract.
- .2 Provide documentation to protect the interests of the Client following final payment and release of the Contractor.
- .3 Ensure that Change Orders (changes to the contract scope) which have been agreed upon are incorporated into the Progress Claim for payment.
- .4 Standardize and streamline billing procedures to ensure that the contractor received prompt and adequate payment for work completed during the progress of the contract.
- .5 Provide the Site Manager with a constantly updated record of the Contractor's progress payments and the amount remaining in the contract to complete the work.

2.0 Application to Contracts:

This procedure is written with the full complete responsibility services type contract in view. Depending on the type of contract:

- 1) Only part of the procedure may be applicable.



PROCEDURE

CODE NUMBER

3401

TITLE

MONITORING & PROCESSING OF CONTRACTOR'S  
PROGRESS PAYMENTS  
AND FINAL RELEASE OF HOLDBACK

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FROM

CAPITAL COST CONTROL

2.0 Application to Contracts: (Cont'd)

- 2) The Owner may prefer to use his own forms or the Contractor's forms instead of those supplied by S.N.C.
- 3) On small contracts, or where S.N.C. supplies field supervision services only, the individuals performing the duties outlined in the procedures may change. However, unless specifically arranged otherwise with the Owner, these procedures should be followed and these forms used in all contracts where S.N.C. approves the Contractor's Claims for Payment. In particular, Form 6100-06 Breakdown of Contractor's Lump Sum Price and Schedule should be completed by the Contractor, even when he is paid directly by the Owner.

3.0 Change Orders:

- .1 The preparation and processing of Change Orders are covered by Procedures No. 2225-3412, which should be applied in conjunction with these Procedures. Only those Change Orders which have been issued to the Contractor as per Procedures No. 2225-3412 will be incorporated into the Progress Claims for Payment by the Contractor.



PROCEDURE

CODE NUMBER 3401

TITLE MONITORING & PROCESSING OF CONTRACTOR'S PROGRESS PAYMENTS AND FINAL RELEASE OF HOLDBACK

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FROM CAPITAL COST CONTROL

3.0 Change Orders: (Cont'd)

.2 The Contractor will maintain an up-to-date record of all Change Orders on Form 6100-19. Refer to the specimen of form attached hereto for a description of how Change Orders will be incorporated into the progress billing.

4.0 Backcharges and/or Debit Memos:

Backcharges will not be included in the Contractor's Progress Billing, but will be settled directly by the Cost Controller, Montreal, with the Contractor.

5.0 Progress Payments:

The following is a brief description of the system used in processing of a Contractor's Progress Claim for Payment. S.N.C. forms to be completed by the Contractor will be furnished by S.N.C. Specimens are attached herewith (See Item 7.0).

.1 Before the First Progress Payment:

The Site Manager must have in his possession a copy of Form 6100-06 "Breakdown of Contractor's Lump Sum Price and Schedule" duly completed by the Contractor and agreed upon.



PROCEDURE

CODE NUMBER

3401

TITLE

MONITORING & PROCESSING OF CONTRACTOR'S  
PROGRESS PAYMENTS  
AND FINAL RELEASE OF HOLDBACK

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FROM

CAPITAL COST CONTROL

5.0 Progress Payments; (Cont'd)

.2 All Progress Claims up to 100% Completion:

For each Progress Claim, the following forms will be submitted by the Contractor to the Site Manager who will approve them then forward same to the Cost Controller for payment:

- .1 Form 6100-10 Progress Claim for Work Completed (Lump Sum Items) if applicable.
- .2 Form 6100-11 Progress Claim for Work Completed (Unit Price Items) if applicable.
- .3 Form 6100-15 Progress Claims for Work Completed (Cost Plus Items) if applicable.
- .4 Form 6100-19 Summary of Change Orders Issued To Date, if applicable.
- .5 Form 6100-12 Progress Claim for Materials on Site, if applicable.
- .6 Form 6100-13 Engineer's Progress Certificate, which summarizes all the above information.
- .7 SNC Form 6100-28 Statutory Declaration for Second and Subsequent Progress Claims.



PROCEDURE

CODE NUMBER 3401

TITLE MONITORING & PROCESSING OF CONTRACTOR'S PROGRESS PAYMENT AND FINAL RELEASE OF HOLDBACK

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FROM CAPITAL COST CONTROL

6.0 Final Claim for Payment & Release of Holdback:

.1 For Final Payment to Contractor and the Release of Holdback, the Contractor will submit the following:

- .1 SNC Form 6100-29 Statutory Declaration for Sub-Contractors
- .2 SNC Form 6100-30 Statutory Declaration for Prime Contractor.
- .3 Form 6100-16 Contractor's Final Claim for Payment and Release of Holdback.

.2 It is important to note the Form 6100-16 will not be signed by the Site Manager until he has carried out a final inspection, and the work has been accepted, as evidenced by the signature of the Site Manager and the Client's Representative on Form 6100-08 Final Handing Over & Acceptance.

.3 The Cost Accountant, upon receipt of all the above forms, will verify that all ~~back~~ charges against the Contractor have been billed.

7.0 Forms:

The following are attached herewith as specimens of the various forms used in these Procedures.





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CODE NUMBER

3401

**TITLE**  
**MONITORING & PROCESSING CONTRACTOR'S  
 PROGRESS PAYMENT AND  
 FINAL RELEASE OF HOLDBACK**

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**CAPITAL COST CONTROL**

7.0 Forms: (Cont'd)

- .1 Form 6100-06 Breakdown of Contractor's Lump Sum Price and Schedule.
- .2 Form 6100-10 Progress Claim for Work Completed (Lump Sum Items).
- .3 Form 6100-17 E/I Progress Claim for Work Completed (Preset Terms).
- .4 Form 6100-11 Progress Claim for Work Completed (Unit Price Items).
- .5 Form 6100-15 Progress Payment for Work Completed (Cost Plus Items).
- .6 Form 6100-12 Progress Claim for Materials on Site.
- .7 Form 6100-13 Engineer's Progress Certificate.
- .8 Form 6100-19 Summary of Change Orders Issued to Date.
- .9 SNC Form 6100-28 Statutory Declaration for Prime Contractor.
- .10 Form 6100-14 E/O Engineer's Progress Certificate for Partial Release of Holdback.
- .11 Form 6100-16 Contractor's Claim for Final Payment & Release of Holdback.
- .12 Form 6100-09 Engineer's Final Certificate and Recommendation for Release of Holdback.
- .13 Form 6100-08 Final Handing Over & Acceptance.
- .14 SNC Form 6100-30 Statutory Declaration for Prime Contractors (Final).
- .15 SNC Form 6100-29 Statutory Declaration for Sub-Contractor.

8.0 Responsibility for Procedure:

This procedure will be administered by the Construction Manager.



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CAPITAL COST CONTROL

FORM 6100-06

BREAKDOWN OF CONTRACTOR'S LUMP SUM PRICE

1. Purpose

To establish the value of each cost item in the contract for comparison with the estimated amount claimed for the same item on the progress payments.

2. Prepared by

Prepared by Cost Controller, and completed by the Contractor.

3. Instructions

As soon as a Lump Sum Contract is signed, the Cost Controller will fill out Form 6100-06 in accordance with the Project Cost Code, as follows:  
(refer to specimen)

- .1 All items marked with an asterisk (\*) in the title block.
- .2 Col. 1 (Item No.) in numerical sequence as required.
- .3 Col. 2 (Description or Class of Work) and Col. 3 (Cost Code) with the itemized descriptions and cost codes in accordance with the Project Cost Code.
- .4 Fill in the total Lump Sum Price for the contract at the bottom of Col. 4.

4. Procedure

After the Form 6100-06 has been completed as above by SNC personnel, it will be sent by the Cost Controller to the Contractor who in turn will fill in all the data on the sample form marked \* as follows:

- .1 Contractor's Reference.
- .2 Col. 4 Value for each item in the Breakdown. Note that the total of all these items must equal the Total Lump Sum Price at the bottom, which is the contract amount.

The Contractor will then sign the form as called for and return it to the Cost Controller. The Cost Controller (through the Project Estimator) will check the value breakdowns given by the Contractor and approve the completed form on behalf of SNC and distribute the copies as indicated in 5. below.

5. Distribution

Cost Controller	1
Site Manager	1
Contractor	1
	<hr/>
	3



PROCEDURE

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FROM CAPITAL COST CONTROL

8100-066/0



The SNC Group Complete Contracting Limited Canada HSB 102 (514) 282 9881

BREAKDOWN OF CONTRACTOR'S LUMP SUM PRICE

CONTRACT SUBDIV SUBJECT SERIAL DATE

\* OWNER NAME OF CONTRACTOR \* PROJECT CONTRACTOR'S REFERENCE \*\* ? \* LOCATION SNC INC. REF NO \* PAGE OF

Table with columns: ITEM NO., DESCRIPTION OR CLASS OF WORK, COST CODE, VALUE, SCHEDULE (START, COMPLETE). Includes a row for TOTAL LUMP SUM PRICE.

APPROVED BY \* SUBMITTED BY \*\* TITLE \* TITLE \*\* DATE \* DATE \*\* FOR \* SURVEYER HENNINGER & CHENEVERT INC. FOR CONTRACTOR \*\*

TABLE: A 1



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FORM  
**CAPITAL COST CONTROL**

FORM 6100-10

PROGRESS CLAIM FOR WORK COMPLETED (LUMP SUM ITEMS)

1. Purpose

To provide payment for portion of Lump Sum Work completed.

2. Prepared by

Contractor. In case of disagreement by the Site Manager, the form will be recalculated by the Contractor and resubmitted to the Site Manager.

3. Content

This form is to be used only in conjunction with and attached to SNC Form 6100-13. Items on this form will be entered using the breakdown as established on SNC Form 6100-06. The following information will be entered for making a progress payment:-

- Col. Cost Control Numbers as per Form 6100-06.
- Col. 1. Description of particular items as per Form 6100-06.
- Col. 2 Original Contract Value of the items as per Form 6100-06.
- Col. 3 Lump Sum Change Order number(s) issued to date against the relevant Cost Code Item. Enter individually each change order bearing a value against the particular cost code item.
- Col. 4 Value of Change Order(s) for the particular Cost Code & 5 Item.
- Col. 6 Net revised value item as a result of Change Order(s). Should there be no Change Order against this Cost Code Item, then the value remains the same as per Col. 2.
- Col. 7 Estimated percentage of work completed on that particular item. This is always the total percentage to date.
- Col. 8 Amount claimed by the Contractor against the item, which is obtained by multiplying Col. 6 by Col. 7.
- Col. 9 Amount claimed previously from preceding Progress Claim.
- Col. 10 Amount this Claim is the difference between Columns 8 & 9.

4. Instructions

Form 6100-10 is individually prepared for each Progress Claim. No Change Order will be entered or money claimed against it unless an official Change Order has been received by the Contractor from SNC. In cases where SNC provides supervision services only, official Change Orders may be issued directly to the Owner. It is the Site Manager's responsibility to ensure that amounts claimed are correct.

5. Distribution

Site Manager	1
Cost Controller	1
Owner	1
	3

30000-0001/1



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CAPITAL COST CONTROL

PROGRESS CLAIM FOR WORK COMPLETED  
(LUMP SUM ITEMS)

**SNC**  
The SNC Group  
1. Clingstone Drive  
Aurora, Ontario L1P 1K3  
(514) 282-2851

PERIOD COVERED BY THIS CLAIM

CONTRACTOR

OWNER

FROM TO  
CLAIM NO.

CONTRACTOR'S REFERENCE

PROJECT LOCATION

SHEET OF

THIS IS TO CERTIFY THAT THE ABOVE NAMED CONTRACTOR HAS COMPLETED WORK UNDER THIS CONTRACT, AS FOLLOWS

ITEM NO.	COST CODE	DESCRIPTION	CHGTR VALUE FROM 6100-646	CHGTR NO.	CHANGE ORDER INCREASE DECREASE	REVISED CONTR VALUE	COMPLETED	AMOUNT CLAIMED TO DATE BY CONTRACTOR	AMOUNT CLAIMED PREV	AMOUNT THIS CLAIM
117	101		121	021	141	141	171	181	191	191
TOTALS										

AMOUNT CERTIFIED AND CARRIED FORWARD TO FORM 6100 126 ITEM 1A

WE HEREBY REQUEST PAYMENT OF THE AMOUNT CLAIMED HEREIN PURSUANT TO THE CONTRACT.

I HEREBY CERTIFY THAT THE ABOVE WORK HAS BEEN PERFORMED, THE GOODS SUPPLIED OR THE SERVICES RENDERED AS THE CASE MAY BE, AND THAT THE PRICE CHARGED IS ACCORDING TO CONTRACT AND I RECOMMEND PAYMENT IN THE AMOUNT CLAIMED.

CONTRACTOR'S NAME  
DATE

SNC SNC RESIDENT ENG/SITE MANAGER

DATE



PROCEDURE

CODE NUMBER

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MONITORING & PROCESSING CONTRACTOR'S  
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FROM

CAPITAL COST CONTROL

FORM 6100-17

PROGRESS CLAIM FOR WORK COMPLETED  
PRESET TERMS

1. Purpose

To provide payment for portion of Lump Sum Work on preset dates or percentage and conditions.

2. Prepared by

Cost Controller with Contractor or Supplier.

3. Content

1. Original Contract Price plus additions and deletions from Change Orders issued with recalculated Revised Contract Value.
2. Preset terms and conditions of payments.
3. Amount according to each term or condition.
4. Total claimed at the issuance date.
5. Previous amount claimed (claimed to date on previous form).
6. Amount payable on completion of this current form.

4. Instructions

Form 6100-17 is individually prepared for each Progress Claim. No Change Order will be entered or money claimed against it unless an official Change Order has been received by the Contractor/Supplier from SNC. In cases where SNC provides supervisory services only, official Change Orders may be issued directly to the Owner. It is the Cost Controller's responsibility to ensure that amounts claimed are correct.

5. Distribution

Site Manager	1
Cost Controller	1
Owner	1 (where required)
	3



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MONITORING & PROCESSING CONTRACTOR'S  
PROGRESS PAYMENT AND  
FINAL RELEASE OF HOLDBACK

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FROM CAPITAL COST CONTROL

<p><b>6100 1 12 79</b></p> <p><b>The SNC Group</b> 1, Clarence Drive Aurora, Ontario T6B 1C8 (416) 292 8861</p>		<p><b>PROGRESS CLAIM FOR WORK COMPLETED</b> (Preset Terms)</p>		<p>CONTRACT SERIAL</p>
<p>Owner</p>	<p>Contractor</p>	<p>Contractor's Reference</p>	<p>Period Covered by this Claim</p>	<p>SUBDIV SUBJECT SERIAL</p>
<p>Project</p>	<p>SNC INC Reference</p>	<p>From</p>	<p>To</p>	<p>Date</p>
<p>Location</p>	<p>Contractor's Reference</p>	<p>Claim No</p>	<p>Sheet</p>	<p>of</p>

<p>ORIGINAL CONTRACT PRICE: \$</p>	<p>REVISED CONTRACT PRICE: \$</p>
<p>ADDITIONS &amp; DELETIONS INCLUDING</p>	<p>CLAIMED TO DATE</p>
<p>CHANGE ORDER NO</p>	<p>PREVIOUS CLAIM</p>
<p>TERMS OF PAYMENT:</p>	<p>AMOUNT</p>
<p>TOTAL REVISED CONTRACT PRICE \$</p>	<p>AMOUNT THIS CLAIM</p>

WE HEREBY REQUEST PAYMENT OF THE AMOUNT CLAIMED HEREIN PERMANENT TO THE CONTRACT.

CONTRACTOR PER DATE

I HEREBY CERTIFY THAT THE ABOVE WORK HAS BEEN PERFORMED, THE QUANTITIES SHOWN ON THE SERVICE RECORDS AS THE CASE MAY BE, AND THAT I HAVE CHARGED IN ACCORDANCE TO CONTRACT AND I RECOMMEND PAYMENT IN THE AMOUNT CLAIMED.

SNC INC Resident Eng./Site Manager Date

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PROGRESS PAYMENT AND  
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FROM CAPITAL COST CONTROL

FORM 6100-11

PROGRESS CLAIM FOR WORK COMPLETED  
(Unit Price Items)

1. Purpose

To provide payment for portion of unit price work completed.

2. Prepared by

Contractor. In case of disagreement by the Site Manager, the form will be recalculated by the Contractor and resubmitted to the Site Manager.

3. Content

- Col. 1 Pay items as designated in the tender form.
- Col. 2 Cost Code items furnished by Cost Controller.
- Col. 3 Description of unit price items as designated in the tender form.
- Col. 4 Unit of measurement.
- Col. 5 Unit price as designated in contract documents.
- Col. 6 Original contract value of item as per estimated quantities indicated in contract documents.
- Col. 7 Total amount claimed to date by the Contractor for each item listed.
- Col. 8 Claimed previously by Contractor as per preceding Progress Claim.
- Col. 9 This Claim is the difference between columns 7 & 8.
- Col. 10 Estimated quantity which will be required to complete this contract (to be established by the Contractor and Site Manager).

4. Instructions

- .1 In the case of a contract where only unit prices are involved, only this form will be used in conjunction with SNC Form 6100-13.
- .2 In the case of a lump sum or cost plus contract where some of the work to be performed is payable on a unit price basis, this form will be used for payment of the unit price items in conjunction with forms 6100-10 or 6100-15 and 6100-13.





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FORM

CAPITAL COST CONTROL

FORM 6100-11


PROGRESS CLAIM FOR WORK COMPLETED (Cont'd)  
(Unit Price Items)

4. Instructions (Cont'd)

- .3 All items of work in the contract must be listed on the form to show the total contract value whether or not a claim for payment is made for all items.
- .4 Change Orders will be entered individually for payment. For example of how to enter Change Orders see Specimen Form Pay Item 91 and 125 referring to Change Order F2 in Description Column.

5. Distribution

Cost Controller	1
Owner	1
Site Manager (?)	1
	<hr/>
	3

 <b>The SNC Group</b> 1, Campbell Drive Montreal, Canada H3B 1C8 (514) 261-5511		<b>PROCEDURE</b> MONITORING & PROCESSING CONTRACTOR'S PROGRESS PAYMENT AND FINAL RELEASE OF HOLDBACK	
CODE NUMBER 3401	RECEIVED BY DATE Nov. /78	CAPITAL COST CONTROL	

 <b>The SNC Group</b> 1, Campbell Drive Montreal, Canada H3B 1C8 (514) 261-5511		<b>PROGRESS CLAIM FOR WORK COMPLETED UNIT PRICE ITEMS</b>		CONTRACT SUBJECT SERIAL
---	--	---	--	-------------------------------

OWNER	PROJECT	LOCATION	CONTRACTOR	CONTRACTOR'S REFERENCE	SNC INC CONTRACT NO.	PERIOD COVERED BY THIS CLAIM		DATE
						FROM	TO	

PAY ITEM	COST CODE	DESCRIPTION	UNIT	ESTIMATED ORIGINAL CONTRACT VALUE	CLAIMED TO DATE BY CONTRACTOR		CLAIMED PREVIOUSLY BY CONTRACTOR		THIS CLAIM		ESTIMATED TO COMPLETE QUANTITY
					QUANTITY	AMOUNT	QUANTITY	AMOUNT	QUANTITY	AMOUNT	

THIS IS TO CERTIFY THAT THE ABOVE-NAMED CONTRACTOR HAS COMPLETED THE FOLLOWING WORK UNDER THIS CONTRACT.

WE HEREBY REQUEST PAYMENT OF THE AMOUNT CLAIMED HEREIN PURSUANT TO THE CONTRACT

AMOUNT CERTIFIED AND CARRIED FORWARD TO FORM 5100 13E ITEM 18

WE HEREBY CERTIFY THAT THE ABOVE WORK HAS BEEN PERFORMED AND THAT THE PRICES CHARGED ARE ACCORDING TO THE CONTRACT AND RECOMMEND PAYMENT IN THE AMOUNT CLAIMED

SNC INC REPRESENTING SIGNED MANAGER DATE



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CAPITAL COST CONTROL

FORM 6100-15

PROGRESS CLAIM FOR WORK COMPLETED  
(Cost Plus Items)

1. Purpose

To provide payment for Cost Plus Work completed.

2. Prepared by

Contractor. In case of disagreement by the Site Manager, the form will be recalculated by the Contractor and resubmitted for approval to the Site Manager.

3. Contents

This form is to be used in conjunction with and attached to Form 6100-13. Items on this form will be entered using the breakdown established by the Cost Controller and the various Cost Plus Change Orders.

- Col. 1 Cost Code entered from breakdown by Cost Controller or from Change Orders.
- Col. 2 Description of Contract items or Change Orders.
- Col. 3 Change Order number(s) distributed by Cost Code Items.
- Col. 4 Direct Cost Breakdown: entered from supporting documents submitted by Contractor and attached to his Progress Claim to cover the Cost Plus Work for the current period only. These supporting documents will include at least material invoices, equipment rental invoices, or equal and daily time sheets.
- Col. 5 Amount of this Claim: sum of entries in column 4.
- Col. 6 Amount previous Claim: comparative total entered from Column 5 of Form 6100-15 from the previous Claim.
- Col. 7 Total claimed to date: addition of Columns 5 & 6.

**NOTE:** The Contractor will enter only his direct costs in Col. 4 for each item. All his indirect costs to cover additives overhead and profit, will be entered at the bottom of the sheet after he has completed listing and summarized his direct costs in each column. The indirect and direct costs will be detailed on the back-up sheets submitted with the Progress Claim for Payment.

If more than one sheet is required, the amount transferred to Form 6100-13 will be the sum total of all the sheets.



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CAPITAL COST CONTROL

FORM 6100-15

PROGRESS CLAIM FOR WORK COMPLETED (Cont'd)  
(Cost Plus Items)

4.

Distribution

Cost Controller	1
Site Manager	1
Owner	1
	<hr/>
	3



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FROM

**CAPITAL COST CONTROL**

6100-155/0



**The SNC Group**  
Corporate Headquarters  
Montreal, Canada H5B 1C8  
(514) 282 9661

**PROGRESS CLAIM FOR WORK COMPLETED  
(COST PLUS ITEMS)**

CONTRACT SUBDIV SUBJECT SERIAL

DATE

OWNER

CONTRACTOR

CLAIM NO.

PROJECT

CONTRACTOR'S REFERENCE

COVERING WORK  
PERFORMED TO

LOCATION

SNC INC REF NO

(DATE)

PAGE

OF

THIS IS TO CERTIFY THAT THE ABOVE NAMED CONTRACTOR  
HAS COMPLETED WORK UNDER THIS CONTRACT AS FOLLOWS

ITEM NO	COST CODE	DESCRIPTION	CHANGE ORDER	DIRECT COST BREAKDOWN			AMOUNT THIS CLAIM	AMOUNT PREVIOUS CLAIMS	TOTAL CLAIMED TO DATE
				LABOR	MATERIALS	EQUIPMENT			
	(1)	(2)	(3)				(4)	(5)	
1									
2									
3									
4									
5									
6									
7									
8									
9									
10									
11									
12									
13									

TOTAL DIRECT COSTS

INDIRECT COSTS

TOTALS

AMOUNT CERTIFIED AND CARRIED FORWARD TO FORM 6100-135, ITEM 1

WE HEREBY REQUEST PAYMENT OF THE AMOUNT  
CLAIMED HEREIN PURSUANT TO THE CONTRACT.

CONTRACTOR

(PER)

(DATE)

I HEREBY CERTIFY THAT THE ABOVE WORK HAS  
BEEN PERFORMED. THE GOODS SUPPLIED OR THE SER-  
VICES RENDERED AS THE CASE MAY BE, AND THAT THE  
PRICE CHARGED IS ACCORDING TO CONTRACT AND I RE-  
COMMEND PAYMENT IN THE AMOUNT CLAIMED.

S.N.C. INC. RESIDENT ENG SITE MANAGER

DATE



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CAPITAL COST CONTROL

FORM 6100-12

PROGRESS CLAIM FOR MATERIALS ON SITE

1. Purpose

To provide for payment for construction materials on site but not yet incorporated in the work in cases where such payment has been authorized in the Contract, General or Special Conditions.

2. Prepared by

Contractor. In case of disagreement by the Site Manager, the form will be recalculated by the Contractor and resubmitted for approval to the Site Manager.

3. Instructions

Form 6100-12 should be used to pay for material delivered to the site in bulk, and which will not be incorporated into the work in the next billing period.


Upon incorporation of the material into the work payment will be requested on Form 6100-10 (Lump Sum Items) or Form 6100-11 (Unit Price Items) on Form 6100-15 (Cost Plus Items) and will be dropped from Form 6100-12.

Each Progress Claim which includes a payment for materials requires preparation of an additional form 6100-12 to indicate the balance of materials on site at that time. This avoids overpayment on Form 6100-13.

Wherever possible, however, it is preferable to evaluate materials as a percentage of work done and pay for them on Form 6100-10 or 6100-11 instead of Form 6100-12.

4. Distribution

Site Manager	1
Cost Controller	1
Owner	1
	<hr/>
	3

 The SNC Group	<b>PROCEDURE</b>	CODE NUMBER <b>3401</b>		
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8100-12E/0



**The SNC Group**  
 1 Corporate Drive  
 Springdale, Canada H6B 1C8  
 (514) 762 9581

**PROGRESS CLAIM FOR MATERIALS ON SITE**

CONTRACT	SUBDIV	SUBJECT	SERIAL
DATE			

OWNER	CONTRACTOR	CLAIM NO.
PROJECT	CONTRACTOR'S REFERENCE	COVERING MATERIAL ON SITE AS OF
LOCATION	SNC INC. REF NO	(DATE)
		PAGE OF

THIS IS TO CERTIFY THAT THE CONTRACTOR HAS THE FOLLOWING MATERIALS ON SITE AS OF THE DATE SHOWN ABOVE READY FOR INCORPORATION IN THE WORK.

ITEM NO.	COST CODE	DESCRIPTION	QUANTITY	VENDOR'S INVOICE UNIT PRICE	AMOUNT CLAIMED BY CONTRACTOR	CERTIFIED BY ENGINEER

AMOUNT CERTIFIED AND CARRIED FORWARD TO FORM 8100-12E, ITEM 3

WE HEREBY REQUEST PAYMENT OF THE AMOUNTS CLAIMED HEREIN PURSUANT TO THE CONTRACT.

\_\_\_\_\_  
 CONTRACTOR

PER \_\_\_\_\_ DATE \_\_\_\_\_

I HEREBY CERTIFY THAT THE AMOUNT RECOMMENDED FOR PAYMENT SHOWN HEREIN REPRESENTS THE ORDER OF VALUE OF MATERIAL SUPPLIED AS OF THIS DATE AS DETERMINED BY ME OR UNDER MY DIRECT SUPERVISION, AND THAT THE PRICES CHARGED ARE ACCORDING TO THE CONTRACT AND I RECOMMEND PAYMENT.

S.N.C. INC. RESIDENT ENG. SITE MANAGER \_\_\_\_\_ DATE \_\_\_\_\_

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FORM

CAPITAL COST CONTROL

FORM 6100-13

ENGINEER'S PROGRESS CERTIFICATE

1. Purpose

To provide a summary sheet for SNC Forms 6100-10, 6100-11, 6100-12 and 6100-15, to show the amount payable, the holdback, previous payments and to record the approval of the Site Manager and Construction Manager or Project Manager for payment of the amounts shown.

2. Prepared by

Contractor. In case of disagreement by the Site Manager, the form will be recalculated by the Contractor and resubmitted for approval.

3. Signatures Required in Order of Processing

Contractor  
Site Manager  
Project Manager/Construction Manager

4. Content

This form will show the original contract value and the current revised contract value to date which will include all change orders issued to date. The form is also a summary of the value of the work claimed to date, previously claimed, currently payable, holdback adjustment and amount due.

Col. 1 Indicates the cumulative value of work performed and/or material-on-site up to and including the current progress claim.

Col. 2 Indicates the cumulative value of the previous progress claim for each of the line items 1 to 6.

Col. 3 The figures shown in this column will be the difference of the first two columns, or the current amount due for payment. Note that in the case of materials on site, this could be a negative amount.

5. Instructions

The Site Manager will be responsible for ensuring that the progress claim is correct, and will only approve payment if the work has been performed in a satisfactory manner. The Site Manager will then forward this form together with supporting forms 6100-10, 11, 12, 15, 19 etc., to the Cost Controller for processing of payment.





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CAPITAL COST CONTROL

FORM 6100-13

ENGINEER'S PROGRESS CERTIFICATE (Cont'd)

6. Distribution

Site Manager	1
Cost Controller <sup>A</sup>	1
Owner	<u>1</u>
	3



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FORM

CAPITAL COST CONTROL

6100-138/0



The SNC Group  
 Corporate Department  
 Montreal, Canada H3B 1C8  
 514 282-9561

ENGINEER'S PROGRESS CERTIFICATE

CONTRACT SUBDIV SUBJECT SERIAL

DATE

OWNER

CONTRACTOR

CLAIM NO.

PROJECT

CONTRACTOR'S REFERENCE

PERIOD COVERED

LOCATION

OWNER'S REF. NO.

SNC INC. CONTR. NO.

FROM

TO

ORIGINAL CONTRACT VALUE

\$

FOR OFFICE USE ONLY

CHANGE ORDERS ISSUED TO DATE (FORM 6100-196)

\$

PRESENT REVISED CONTRACT VALUE

\$

TOTAL CLAIMED  
TO DATE  
(1)

LESS PREVIOUS  
CLAIM COL. 1  
(2)

AMOUNT  
THIS CLAIM  
(3)  
(COL. 1 - COL. 2)

1. WORK PERFORMED ON CONTRACT

- A) LUMP SUM WORK (FORM 6100-106)
- B) UNIT PRICE WORK (FORM 6100-118)
- C) COST PLUS WORK (FORM 6100-168)

2. TOTAL CONTRACT WORK PERFORMED

3. MATERIAL ON SITE NOT INCLUDED ABOVE (FORM 6100-128)  
 (ENTER THIS MONTH'S CLAIM IN COL. 1)

4. TOTAL CLAIMED (LINE 2 PLUS 3)

5. LESS HOLDBACK

6. PAYMENTS (LINE 4 LESS 5)

WE HEREBY REQUEST PAYMENT OF THE AMOUNTS CLAIMED HEREIN PURSUANT TO THE CONTRACT AND HEREBY DECLARE THAT ALL SUB-CONTRACTS, WAGES AND MATERIALS OF WHATSOEVER NATURE ENTERING INTO THE WORK COVERED BY THE ENGINEER'S PROGRESS CERTIFICATE NO. \_\_\_\_\_

DATED \_\_\_\_\_ HAVE BEEN DULY PAID, EXCEPT FOR HOLDBACKS TO SUB-CONTRACTS, WHICH AMOUNT IN TOTAL TO \$ \_\_\_\_\_ ON ALL SUB-CONTRACTS.

CONTRACTOR

PER

DATE

I HEREBY CERTIFY THAT THE ABOVE WORK HAS BEEN PERFORMED AND THE MATERIALS HAVE BEEN RECEIVED, AND THAT THE PRICES CHARGED ARE ACCORDING TO THE CONTRACT, AND I RECOMMEND PAYMENT IN THE AMOUNT CLAIMED.

SNC INC. RESIDENT ENG SITE MANAGER

DATE

SNC INC. PROJECT MGR CONSTR MGR

DATE



PROCEDURE

CODE NUMBER 3401

TITLE MONITORING & PROCESSING CONTRACTOR'S PROGRESS PAYMENT AND FINAL RELEASE OF HOLDBACK

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FORM CAPITAL COST CONTROL

FORM 6100-19

SUMMARY OF CHANGE ORDERS ISSUED TO DATE

1. Purpose

To provide an up-to-date summary of all Change Orders issued against a Trade Contract.

NOTE: Back Charges and debit memos are not included on this form, but will be handled directly by the Cost Controller.

2. Prepared by

Contractor. In case of disagreement by the Site Manager, the form will be recalculated by the Contractor and resubmitted to the Site Manager.

3. Content & Instructions

This form will be submitted by the Contractor with each Progress Claim and will record all the Change Orders issued to date against his contract.

- Col. 1 Change Order number(s) which have been processed and issued.
Col. 2 Abbreviated description to identify the Change Order(s) in a simple fashion.
Col. 3 Value of Change for Lump Sum Change Order(s) this value is fixed. For Unit Price or Cost Plus Change Order(s), the value is the best current estimate and will be revised until the final value becomes known.
Col. 5 Indicate method of payment, lump, unit price or cost plus.
6 & 7 Net
Total Combined value of all Change Order(s) to be transferred to Form 6100-13.

(bottom of col. 3 & 4)

Col. 8 Remarks

4. Distribution

- Cost Controller 1
Procurement Manager 1
Site Manager 1
Owner 1



**PROCEDURE**

CODE NUMBER **3401**

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TITLE

**CAPITAL COST CONTROL**

**MONITORING & PROCESSING CONTRACTOR'S  
PROGRESS PAYMENT AND  
FINAL RELEASE OF HOLDBACK**

6100-136/0



**SUMMARY OF CHANGE ORDERS  
ISSUED TO DATE**

CONTRACT SUBDIV SUBJECT SERIAL

DATE

OWNER \_\_\_\_\_ CONTRACTOR \_\_\_\_\_ CLAIM NO. \_\_\_\_\_

PROJECT \_\_\_\_\_ CONTRACTOR'S REFERENCE \_\_\_\_\_ DATE \_\_\_\_\_

LOCATION \_\_\_\_\_ SNC INC REF NO \_\_\_\_\_

ITEM NO.	CHANGE ORDER	DESCRIPTION	TOTAL VALUE		L.S.	U.P.	C.P.	REMARKS
			INCREASE	DECREASE				
			31	41	5	6	7	8
1								
2								
3								
4								
5								
6								
7	0							
8								
9								
10								
11								
12								
13								
14								
15								
16								
17								
18								
19								
20								
<b>TOTAL</b>								
<b>NET TOTAL</b>								
CARRIED FORWARD TO 6100-136								

1/2000-094/1



PROCEDURE

CODE NUMBER

3401

TITLE

MONITORING & PROCESSING CONTRACTOR'S  
PROGRESS PAYMENT AND  
FINAL RELEASE OF HOLDBACK

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CAPITAL COST CONTROL

SNC FORM 6100-28

STATUTORY DECLARATION FOR CONTRACTORS

1. Purpose

A notarized statement duly signed by the Contractor attesting to the fact that all work and material incorporated into his previous progress claim of which he received payment by S.N.C. or the Owner has been duly paid.

2. Instructions

This form, duly signed, must be in the Site Manager's possession prior to recommendation of payment of any subsequent claims.

3. Distribution

Cost Controller

1

Owner

1

(If called for in the Project Instructions)

2



MONITORING & PROCESSING CONTRACTOR'S  
PROGRESS PAYMENT AND  
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CAPITAL COST CONTROL

Statutory Declaration TO BE MADE BY PRIME CONTRACTOR TO ACCOMPANY HIS SECOND AND ALL SUBSEQUENT PROGRESS CLAIMS

CANADA

In the matter of a Contract entered into with .....

Province of

By

At: Project

Contract No.

File No.

TO WIT:-

Province of

of the City of

in the  
do solemnly declare:-

1. That I am .....  
(President, Secretary, Treasurer, Partner etc.)

of the contractor named in the contract above mentioned and as such have personal knowledge of the facts hereunder declared;

2. That all the sub-contractors, labour or materials whatsoever entering into the construction portion of the work covered by the said contract as set forth in Progress Claim No. .... immediately preceding this Progress Claim No. .... dated ..... attached hereto have been duly paid;

3. That the wages paid are in all cases the same as or above those set out in the Schedule of Wages attached to and forming part of said contract;

4. That a copy of the said Schedule of Wages and labour conditions is posted in a conspicuous place on the premises;

5. That the working hours of persons employed on the work covered by the said contract has not exceeded 8 hours per day and 44 hours per week, except where permission to exceed these hours has been obtained from the Minister of Labour, Government of Canada or from the Minister of Labor of the Province concerned.

AND I MAKE THIS SOLEMN DECLARATION conscientiously believing it to be true, and knowing that it is of the same force and effect as if made under oath and by virtue of the Canada Evidence Act.

DECLARED before me at the

of

in the

of

this

day of

A.D. 19

A Notary Public Commissioner for Oaths, etc.

Every one, who, not being a witness in a judicial proceeding but being permitted, authorized or required by law to make a statement by affidavit, by solemn declaration or orally under oath, makes in such a statement before a person who is authorized by law to permit it to be made before him, an assertion with respect to a matter of fact, opinion, belief or knowledge, knowing that the assertion is false, is guilty of an indictable offence and is liable to imprisonment for 14 years.

(Section 122 of the Canadian Criminal Code.)



PROCEDURE

CODE NUMBER 3401

MONITORING & PROCESSING CONTRACTOR'S PROGRESS PAYMENT AND FINAL RELEASE OF HOLDBACK

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CAPITAL COST CONTROL

FORM 6100-14

ENGINEER'S PROGRESS CERTIFICATE FOR PARTIAL RELEASE OF HOLDBACK

1. Purpose

To provide Contractor's Interim Release of Part of Holdback held against total Contract performance to date.

2. Prepared by

Contractor. In case of disagreement by the Site Manager, the form will be recalculated by the Contractor and resubmitted to the Site Manager.

3. Signatures Required

- Contractor
Site Manager
Project Manager
Cost Controller

4. Contents

- 1. Contract original value plus or minus change orders and revised contract value.
2. Total claimed to date for memo only.
3. Total Holdback retained.
4. Holdback released (column 1 minus column 2).

5. Instructions

This form is to be submitted by the Contractor to serve as the basis for Partial Release of Holdback. It should be accompanied by a Statutory Declaration - SNC 6100-28 attesting the fact that all work and material incorporated in the previous Progress Claim listed in Column 1 for which he received payment by SNC or the Owner, has been duly paid.

6. Distribution

- Cost Controller 1
Site Manager 1
Owner 1 (where applicable)



PROCEDURE

CODE NUMBER

3401

TITLE

MONITORING & PROCESSING CONTRACTOR'S  
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FINAL RELEASE OF HOLDBACK

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CAPITAL COST CONTROL

6100-14E/0

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The SNC Group

1 Corporate Offices  
Montreal, Canada H5B 1C8  
(514) 262-9851

ENGINEER'S PROGRESS CERTIFICATE  
PARTIAL RELEASE OF HOLDBACK

CONTRACT	SUBDIV	SUBJECT	SERIAL

DATE

OWNER

CONTRACTOR

CLAIM NO

PROJECT

CONTRACTOR'S REFERENCE

DATE

LOCATION

OWNER'S REF NO

CONTR NO

ORIGINAL CONTRACT VALUE

\$

FOR OFFICE USE ONLY

CHANGE ORDERS ISSUED TO DATE (FORM 6100-19E)

\$

PRESENT REVISED CONTRACT VALUE

\$

TOTAL CLAIMED  
TO DATE  
(1)  
MEMO ONLY

LESS PREVIOUS  
CLAIM COLL 1  
(2)

AMOUNT  
THIS CLAIM  
(3)  
(COL 1 COL 2)

1 WORK PERFORMED ON CONTRACT

- A) LUMP SUM WORK (FORM 6100-10E)
- B) UNIT PRICE WORK (FORM 6100-11E)
- C) COST PLUS WORK (FORM 6100-19E)

2. TOTAL CONTRACT WORK PERFORMED

3. MATERIAL ON SITE NOT INCLUDED ABOVE (FORM 6100-12E)  
(ENTER THIS MONTH'S CLAIM IN COL. 1)

4 TOTAL CLAIMED (LINE 2 PLUS 3)

5. LESS HOLDBACK

6. PAYMENTS (LINE 4 LESS 5)

HOLDBACK  
RETAINED

HOLDBACK  
RELEASED

WE HEREBY REQUEST PAYMENT OF THE AMOUNTS CLAIMED  
HEREIN PURSUANT TO THE CONTRACT AND HEREBY DECLARE  
THAT ALL SUB-CONTRACTS, WAGES AND MATERIALS OF  
WHATSOEVER NATURE ENTERING INTO THE WORK COVERED

BY THE ENGINEER'S PROGRESS CERTIFICATE NO. \_\_\_\_\_

DATED \_\_\_\_\_ HAVE BEEN DULY PAID, EXCEPT  
FOR HOLDBACKS TO SUB-CONTRACTS, WHICH AMOUNT IN  
TOTAL TO \$ \_\_\_\_\_ ON ALL SUB-CONTRACTS.

Contractor

PER

DATE

I HEREBY CERTIFY THAT THE ABOVE IS ACCORDING TO THE  
CONTRACT AND I RECOMMEND PAYMENT IN THE AMOUNT  
CLAIMED

Resident Eng. / Site Manager

Date

Project Mgr / Contract Mgr

Date

Cost Contractor

Date

6100-14E/0





PROCEDURE

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MONITORING & PROCESSING CONTRACTOR'S  
PROGRESS PAYMENT AND  
FINAL RELEASE OF HOLDBACK

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FROM CAPITAL COST CONTROL

FORM 6100-16

CONTRACTOR'S FINAL CLAIM FOR PAYMENT  
AND  
RELEASE OF HOLDBACK

1. Purpose

To provide a Contractor's statement listing the completion date of all his work, the final contract value, guarantee period and warranty and to provide the Client with a release against further claim.

2. Prepared by

Contractor. In case of disagreement by the Site Manager, the form will be recalculated by the Contractor and resubmitted to the Site Mgr.

3. Signatures Required in Order of Processing

- Contractor
- Site Manager
- Cost Controller

4. Contents

1. Contractor's acknowledgement of completion date of contract, to provide an official commencement date for the lien period.
2. Financial value of work done, payments made, deposits and warranties, and balance due to Contractor on the basis of the completed contract.
3. List of sub-contractors employed by the Contractor so that a check can be made to ensure that they are all paid.
4. Release to the Owner.

5. Instructions

This form is to be submitted by the Contractor after he has submitted his last normal Progress Claim when the work is 100% complete, to serve as the basis for his final payment and release of holdback. It is important that the entire form be completed, including date of completion of work, financial details and release to the Owner. Note that this form will not be signed by the Site Mgr. until he has carried out a final inspection accompanied by the Owner's representative and not until the Contractor's work has been found acceptable to the Owner, as evidenced by the Site Manager and the Owner's signature on Form 6100-08, Final Handing Over and Acceptance.

6. Distribution

- Cost Controller 1
  - Site Manager 1
  - Owner 1
- 3



PROCEDURE

CODE NUMBER

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MONITORING & PROCESSING CONTRACTOR'S  
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FROM

CAPITAL COST CONTROL

6100-168/0



The SNC Group

1 Commerce Boulevard  
Montreal, Canada H5B 1C3  
(514) 282-9881

CONTRACTOR'S CLAIM FOR FINAL PAYMENT  
AND  
RELEASE OF HOLDBACK

CONTRACT SUBDIV SUBJECT SERIAL

DATE

OWNER

CONTRACTOR

PROJECT

CONTRACTOR'S REFERENCE

LOCATION

SNC INC CONTRACT NO.

I HEREBY CERTIFY THAT ALL WORK CALLED FOR BY CONTRACT \_\_\_\_\_ HAS BEEN COMPLETED AS PER  
THE \_\_\_\_\_ DAY OF \_\_\_\_\_ 197 \_\_\_\_\_ AND CLAIM THE FOLLOWING MONEYS IN FINAL PAYMENT

- 1. AMOUNT OF ORIGINAL CONTRACT \$ \_\_\_\_\_
- 2. AMOUNT OF CHANGE ORDERS (SEE ATTACHED FORM 6100-198) \$ \_\_\_\_\_
- 3. TOTAL VALUE (1 PLUS 2) \$ \_\_\_\_\_
- 4. LESS PAYMENTS MADE TO DATE \$ \_\_\_\_\_
- 5. BALANCE CLAIMED (3 MINUS 4) \$ \_\_\_\_\_
- 6. SPECIAL CONDITIONS \$ \_\_\_\_\_

THE FOLLOWING DOCUMENTS ARE ATTACHED

"PRIME CONTRACTOR'S STATUTORY DECLARATION" (FORM 6100-308) DATED \_\_\_\_\_

"SUB-CONTRACTORS' STATUTORY DECLARATIONS" (FORM 6100-298) AS PER ATTACHED LIST

PURSUANT TO THE TERMS OF THE ABOVE REFERENCED CONTRACT WE HEREBY CERTIFY AND BY THESE PRESENTS AGREE THAT, UPON RECEIPT BY US OF THE BALANCE CLAIMED ABOVE, WE WILL HAVE BEEN PAID IN FULL FOR ALL WORK DONE BY US IN RELATION TO THIS CONTRACT, EXCEPT FOR AGREED AMOUNT RETAINED AS STATED ABOVE, AND SUBJECT ONLY TO OUR RECEIPT OF SUCH PAYMENT WE HEREBY RELINQUISH ALL OUR RIGHTS AND PRIVILEGES FOR OURSELVES, OUR SUCCESSORS OR ASSIGNS TO ALL ACTIONS, RIGHTS OF ACTION OR CLAIMS OF ANY SORT PRESENT AND FUTURE HAVING TO DO WITH THIS CONTRACT AND OR THE WORK EXECUTED THEREUNDER, BUT SUCH FINAL PAYMENT SHALL NOT AFFECT ANY OF OWNER'S RIGHTS IN THE SAID CONTRACT INTENDED TO SURVIVE COMPLETION OF THE WORK AND FINAL PAYMENT.

NAME OF CONTRACTOR

DATE

PER

APPROVED FOR SURVEYER, HENNIGER & CHENEVERT INC.

RESIDENT ENG SITE MGR

COST CONTROLLER

PROJECT MANAGER CONSTR MGR

DATE

DATE

DATE



PROCEDURE

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MONITORING & PROCESSING CONTRACTOR'S  
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FROM

CAPITAL COST CONTROL

~~FORM 6100-09~~

ENGINEER'S FINAL CERTIFICATE &  
RECOMMENDATION FOR RELEASE OF HOLDBACK

1. Purpose

To provide a summary sheet for the completion of a project to show the final value for the total contract, including all sub-contractors to the contractor who entered into contract with SNC. It also authorizes the Release of Holdback.

2. Prepared by

Resident Engineer or Site Construction Manager.

3. Signatures Required in Order of Processing

Resident Engineer or Site Construction Manager  
Project Manager  
Owner's Representative

4. Content

This form will show the final contract value including all change orders issued to date. The form is also a summary of the value of the work claimed and paid to date, holdback payable, security deposit payable if any, and the total currently payable.

Warranty period will be indicated by the date of expiry.

The attachments will be:


1. Statutory Declaration form 6100-30 from Prime Contractor.
2. Workman's Compensation Certificate of Good Standing.
3. All Sub-Contractors' Statutory Declarations Form 6100-29 and their W.C.B. Certificate.

5. Instructions

The Resident Engineer or Site Construction Manager will be responsible for issuance of this form and will obtain all other approvals such as Project Manager and Client. The approved documents will then be forwarded to the Project Cost Controller for processing of payment. This form should follow Contractor's Final Claim for Payment and Release of Holdback (Form 6100-16).

6. Distribution

Site Manager	1
Cost Controller	1
Owner	1
	<hr/>
	3

	PROCEDURE	CODE NUMBER <b>3401</b>		
	<small>TITLE</small> <b>MONITORING &amp; PROCESSING CONTRACTOR'S                  PROGRESS PAYMENT AND                  FINAL RELEASE OF HOLDBACK</b>	<small>PREVIOUS REVISION</small>	<small>CURRENT REVISION</small> <b>Nov. /78</b>	<small>PAGE</small> <b>36</b>
		<small>FORM</small> <b>CAPITAL COST CONTROL</b>		

6100-086/0

	ENGINEER'S FINAL CERTIFICATE AND RECOMMENDATION FOR RELEASE OF HOLDBACK	<small>CONTRACT</small>	<small>SUBDIV</small>	<small>SUBJECT</small>	<small>SERIAL</small>

<small>OWNER</small>	<small>CONTRACTOR</small>	<small>DATE</small>
<small>PROJECT</small>	<small>CONTRACTOR'S REFERENCE</small>	
<small>LOCATION</small>	<small>SNC INC. CONTRACT NO.</small>	

I HEREBY CERTIFY THAT ALL WORK ON THE ABOVE REFERENCED CONTRACT HAS BEEN COMPLETED IN ACCORDANCE WITH THE CONTRACT DOCUMENTS TO MY SATISFACTION AND I HEREBY RECOMMEND RELEASE OF THE HOLDBACK AND/OR SECURITY DEPOSIT AS NOTED BELOW.

- (1) TOTAL VALUE OF CONTRACT IN ACCORDANCE WITH  
FINAL PROGRESS CERTIFICATE NO. \_\_\_\_\_  
INCLUDING CHANGE ORDERS NO. \_\_\_\_\_ TO \_\_\_\_\_ INCL. \$ \_\_\_\_\_
- (2) PROGRESS PAYMENTS MADE TO DATE \$ \_\_\_\_\_
- (3) HOLDBACK CURRENTLY PAYABLE (1 MINUS 2) \$ \_\_\_\_\_
- (4) SECURITY DEPOSIT PAYABLE SUBJECT TO RETAINAGE OF WARRANTY DEPOSIT AS STATED BELOW.
- (5) TOTAL CURRENTLY PAYABLE \$ \_\_\_\_\_

THE WARRANTY PERIOD ON THIS WORK WILL EXPIRE ON \_\_\_\_\_  
AND PURSUANT TO THE TERMS OF THE ABOVE REFERENCED CONTRACT THE SUM OF \$ \_\_\_\_\_  
IS TO BE RETAINED UNTIL THIS DATE. THIS SHALL NOT RESTRICT ANY WARRANTIES AFFORDED BY LAW.

THE FOLLOWING DOCUMENTS ARE ATTACHED:

- 1. PRIME CONTRACTORS STATUTORY DECLARATION (FORM No. 6100-206) DATED \_\_\_\_\_
- 2. PRIME CONTRACTORS WORKMENS' CERTIFICATE DATED \_\_\_\_\_
- 3. SUB-CONTRACTORS' STATUTORY DECLARATIONS (FORM No. 6100-206) AND WORKMENS' COMPENSATION CERTIFICATE AS LISTED BELOW:

NAME OF SUB-CONTRACTOR	DATE OF FORM 6100-206	DATE OF WORKMENS' COMPENSATION CERT.

APPROVED FOR SURVEYER, NENNIGER & CHENEVERT INC.

<small>RESIDENT ENG. FIELD MANAGER</small>	<small>CHIEF SUPERVISION ENG.</small>	<small>PROJECT MANAGER</small>
<small>DATE</small>	<small>DATE</small>	<small>DATE</small>

APPROVED FOR OWNER

BY \_\_\_\_\_ **TABLE: A 12** \_\_\_\_\_  
DATE \_\_\_\_\_



PROCEDURE

CODE NUMBER 3401

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FORM 6100-08

FINAL HANDING-OVER AND ACCEPTANCE

1. Purpose

To make sure that the work contained in the Contract has been completed according to the terms and conditions of the Contract and to SNC and Owner's satisfaction.

2. Prepared by

Site Manager.

3. Content

Contract information and reference.

Description of work performed in detail.

Acceptance by SNC and the Owner.

4. Instructions

The Site Manager or Resident Engineer is responsible for ensuring that the description of work, terms and conditions have been completed in a satisfactory manner. The Site Manager, Construction Manager and Project Manager will sign the form and the Site Manager will obtain the acceptance from the Owner. He will then forward a copy to the Cost Controller who will proceed with Contractor's Final Claim for Payment and Release of Holdback Form 6100-16.

5. Distribution

Cost Controller	1
Site Manager	1
Owner	<u>1</u>

3



PROCEDURE

CODE NUMBER 3401

TITLE MONITORING & PROCESSING CONTRACTOR'S PROGRESS PAYMENT AND FINAL RELEASE OF HOLDBACK

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6100-088/0



The SNC Group 1 Compagnie Descriptive Montreal, Canada H3B 1C2 (514) 282-8881

FINAL HANDING-OVER AND ACCEPTANCE

Table with columns: CONTRACT, SUBJ, SUBJECT, SERIAL, DATE

OWNER, PROJECT, LOCATION, CONTRACTOR, CONTRACTOR'S REFERENCE, SNC INC. REF NO

THE WORK DESCRIBED BELOW HAS BEEN COMPLETED IN ACCORDANCE WITH THE TERMS OF THE ABOVE REFERENCED CONTRACT AND IS FREE OF DEFICIENCIES. ALL "AS BUILT" DRAWINGS OR SPECIFICATIONS AND ALL OPERATING OR MAINTENANCE INSTRUCTIONS AND OTHER DATA REQUIRED TO BE FURNISHED BY THE CONTRACTOR HAVE BEEN RECEIVED. THE WORK IS HEREBY OFFICIALLY HANDED OVER TO THE OWNER.

DESCRIPTION OF WORK

DATE MANAGER'S SIGNATURE

CONSTRUCTION MANAGER

PROJECT MANAGER

SURVEYOR HENNINGER & CHENEVERT INC.

ACCEPTANCE

THE ABOVE PROJECT IS HEREBY ACCEPTED BY

OWNER

DATE

OWNER'S REPRESENTATIVE



**PROCEDURE**

CODE NUMBER **3401**

TITLE **MONITORING & PROCESSING CONTRACTOR'S  
PROGRESS PAYMENT AND  
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FROM **CAPITAL COST CONTROL**

SNC FORM 6100-30

STATUTORY DECLARATION FOR CONTRACTORS

1. Purpose

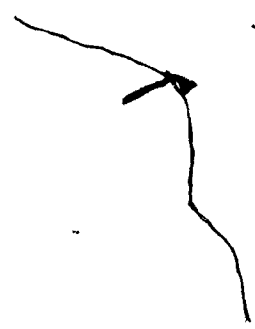
A notarized statement duly signed by the Contractor attesting to the fact that all work and materials incorporated into the contract are paid in full.

2. Instructions

This form duly signed must be in the Site Manager's possession prior to the preparation of the Final Payment Certificate and recommendation for Release of Holdback.

3. Distribution

Cost Controller  $\frac{1}{2}$   
Owner  $\frac{1}{2}$  (if called for in the Project Instructions).





PROCEDURE

CODE NUMBER

3401

TITLE

MONITORING & PROCESSING CONTRACTOR'S  
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CAPITAL COST CONTROL

Statutory Declaration

TO BE MADE BY PRIME CONTRACTOR TO ACCOMPANY THE  
ENGINEER'S FINAL CERTIFICATE TO EFFECT RELEASE OF  
CONTRACTOR'S HOLDBACK AND SECURITY DEPOSIT

CANADA

In the matter of Contract entered into with .....

Province of

By

At Project

Contract No.

File No.

TO WIT:—

I, \_\_\_\_\_ of the \_\_\_\_\_ of  
in the Province of \_\_\_\_\_ do solemnly declare:—

1. That I am \_\_\_\_\_  
(President, Vice-President, Secretary, Treasurer, Director or Partner)  
of the contractor named in the contract above mentioned and as such have personal knowledge of the facts hereunder declared;
2. That all sub-contractors, labour, and accounts for materials and equipment whatsoever entering into the construction of the project built under the said contract have been duly paid;
3. That all assessments and levies under the Unemployment Insurance Acts, the Workmen's Compensation Acts or other social or labour legislation in respect of the said contract have been duly paid;
4. That the following is a complete list of all sub-contractors who have been employed under the said contract

AND I MAKE THIS SOLEMN DECLARATION conscientiously believing it to be true and knowing that it is of the same force and effect as if made under oath and by virtue of the Canada Evidence Act.

DECLARED before me at the

of

in the

of

this

day of

A.D. 19

A Commissioner, Notary Public, Justice of the Peace.

NOTE 1. When contractor is an individual, he must make the declaration himself. When contractor is a partnership, the declaration must be made by one of the partners. When contractor is an incorporated company, the declaration must be made by the President, Vice-president, Secretary, Treasurer or Director. If any other person makes the declaration, two copies of the by-laws issued under the Corporation seal, authorizing said person to execute the documents, must be submitted with the first declaration on each contract.

NOTE 2. The name of the partnership or of the Corporation and the declarant's position must be clearly shown in article 1. Where contractor is the person who makes the declaration, strike out the word "of" in the 2nd line of art. 1.





PROCEDURE

CODE NUMBER

3401

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CAPITAL COST CONTROL

SNC FORM 6100-29

STATUTORY DECLARATION FOR SUB-CONTRACTORS

1. Purpose

To provide a Sworn Statement whereby a Sub-Contractor agrees to the amount that has been paid by him by the Prime Contractor as being correct and final.

2. Content

This Statutory Declaration is a legal document whereby the Sub-Contractor assures the Client that he has paid all his bills pertaining to the contract in question, and that he, in turn, has been paid in full by the Prime Contractor and that he has complied with all the legal aspects pertaining to construction work, such as wages, unemployment insurance, workmen's compensation and the like.

3. Instructions

This form will accompany the Contractor's claim for final release of holdback and/or security deposit. This form must be completed by every Sub-Contractor before the Contractor's claim for final release is processed.

4. Distribution

Cost Controller 1  
Owner 1 (if called for in the Project Instructions).



PROCEDURE

CODE NUMBER

3401

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MONITORING & PROCESSING CONTRACTOR'S PROGRESS PAYMENT AND FINAL RELEASE OF HOLDBACK

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CAPITAL COST CONTROL

Statutory Declaration

This Statutory Declaration must be executed by the Sub-Contractor, and accompany the Prime Contractor's Statutory Declaration for release of Holdback and/or Security Deposit.

CANADA

Province of

In the matter of a Sub-Contract under the Prime Contract entered into with

(NAME OF PRIME CONTRACTOR)

At Project Contract No.

File No.

TO WIT.—

I, of the in the Province of do solemnly declare:—

1. That I am of (President, Secretary, Treasurer, a Partner, etc.)

the Sub-Contractor named in the sub-contract above mentioned, and as such have personal knowledge of the facts hereunder declared.

2. That all my sub-contractors, labour, and accounts for materials and equipment whatsoever entering into the work covered by the said sub-contract have been paid in full.

3. That: (a) Final Payment has been received by me from the Prime Contractor constituting discharge in full of his indebtedness for all work done and/or materials supplied by me.

(b) Full Payment has been received by me from the Prime Contractor except for Holdback which amounts to \$ provided in my sub-contract.

(c) The Prime Contractor has not paid me the sum of \$ which includes the Holdback.

4. That the wages paid are in all cases the same as or above those set out in any applicable legislation and/or current local labour agreements governing the site.

5. That all assessments and levies under the Unemployment Insurance Acts, the Workmen's Compensation Acts or other social or labour legislation in respect of the said sub-contract have been fully paid and/or deducted according to law.

AND I MAKE THIS SOLEMN DECLARATION conscientiously believing it to be true and knowing that it is of the same force and effect as if made under oath and by virtue of the Canada Evidence Act.

DECLARED before me at the

of

in the

of

this

day of

A.D. 19

A Commissioner, Notary Public Justice of the Peace.

Every one, who, not being a witness in a judicial proceeding but being permitted, authorized or required by law to make a statement by affidavit, by solemn declaration or orally under oath, makes in such a statement before a person who is authorized by law to permit it to be made before him, an assertion with respect to a matter of fact, opinion, belief or knowledge, knowing that the assertion is false, is guilty of an indictable offence and is liable to imprisonment for 14 years.

(Section 122 of the Canadian Criminal Code.)

6100 281/0

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REFERENCES

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