GUDLAVALLERUENGINEERING COLLEGE
(An Autonomous Institute with Permanent Affiliation to JNTUK, Kakinada)
Seshadri Rao Knowledge Village, Gudlavalleru – 521 356.

Department of Civil Engineering

LEARINING MATERIAL

on

CONSTRUCTION MANAGEMENT

UNIT-1

ORGANISING FOR CONSTRUCTION

IMPORTANCE OF ORGANISATION

The plans and specifications of any construction are to be finally converted into physical structures and facilities. This involves the organisation and coordination of all the resources required for the project. The organisation or organisational structure is the system or process which helps in achieving this goal. This organisation helps the manager to relate tasks to people and to other agencies in order to achieve an economical and timely completion of the project.

In executing a construction project, we need the coordinated efforts of all the three wings viz; the administration, management and organisation. The administration lays down the general policies and these policies are executed by the management with the help of the organisation. Organisation is the machinery through which coordination is brought about between the administration and the management.

To develop an efficient organisation, the manager has to deal with the following factors

(i) developing the structure for the organisation

(ii) delegation of responsibility

(iii) relationship between individuals and groups, and

(iv) developing a sound communication system in the organisation.

GENERAL PRINCIPLES FOR FORMING AN ORGANISATION SYSTEM

Span of Management

The number of managerial levels should be kept at the optimum level. Lesser managerial levels will exceed the manager's effective span of control and too many levels will create confusion and disorder. There is a limit to the number of subordinates that an executive can supervise effectively. At the higher levels of management, the ratio can vary from I : 3 to I : 5, but at the lower formations it can be as high as 1: 15 or 1 : 20.

Scalar Principle

There should be a clear line of authority from top to bottom levels of management. This will result in effective functioning of the arrangement. If this principle is used, the understanding of authority relationships within an organisation is made easier.

Unity of Command

Every individual in an organisation should be clear as to whom he has to report and from whom he should take the orders. For example, a junior executive, should know to whom he has to report about the progress achieved, difficulties encountered and to whom he can approach for any consultation required. Each subordinate should be made reportable to only one superior — this is the principle of unity of command. Otherwise, it will create confusion, delay and disorder in the organisation.

Delegation of Authority

Whenever any one is expected to shoulder the responsibility of completing a particular job, he must be given sufficient authority to achieve this responsibility. Thus, responsibility and authority go hand in hand. Therefore, to enable the managers to carryout their duties effectively, they must be delegated with adequate authority in proportion to their responsibilities.

Principle of Division of Work

Any major work is to be suitably divided and allocated to individuals such that each person has the

qualification and capacity to perform the assigned work in the most efficient manner.

Principle of Separation of Work

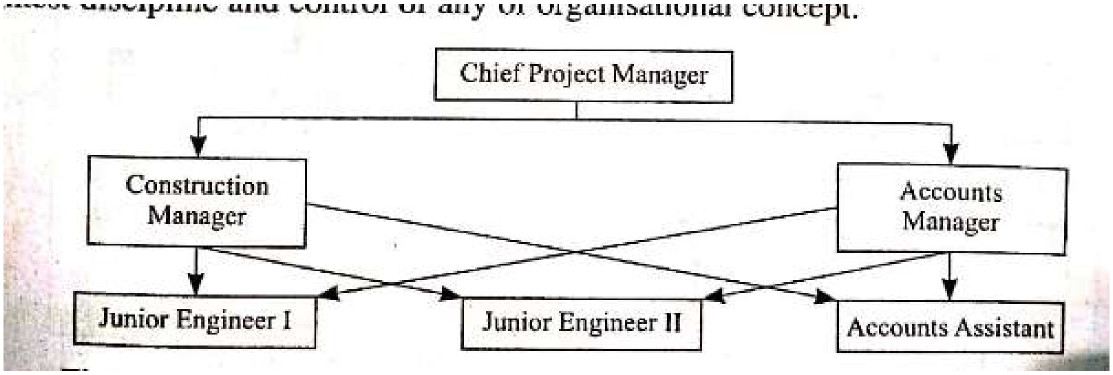
The works carried out by an individual or team should be checked and controlled by people other than those who executed the work. This helps in identifying the mistakes and taking timely collective actions.

There are many organisation structures that are employed depending on the magnitude and type of construction.

TYPES OF ORGANISATION STRUCTURES

Functional Organisation

In this type of organisation, the whole work is divided in such a way that each person has to perform a minimum number of functions and is responsible for those functions. All similar and related work is grouped together under one person. However, a subordinate any where in the organisation will be commanded directly by a number of superior officers who have the authority in their own area of specialisation. An overall functional organisation can be helpful when the owner acts as the project manager with a minimum staff, depending on others for the functional expertise. This type of organisation permits tightest discipline and control of any of organisational concept.



Functional Organisation

Advantages

(i) The entire work is divided on the basis of functional specialisation and hence the efficiency will be increased.

(ii) Mental work is separated from manual work.

(iii) (iii) The work will be completed with better quality due to the services of functional specialists,

Disadvantages

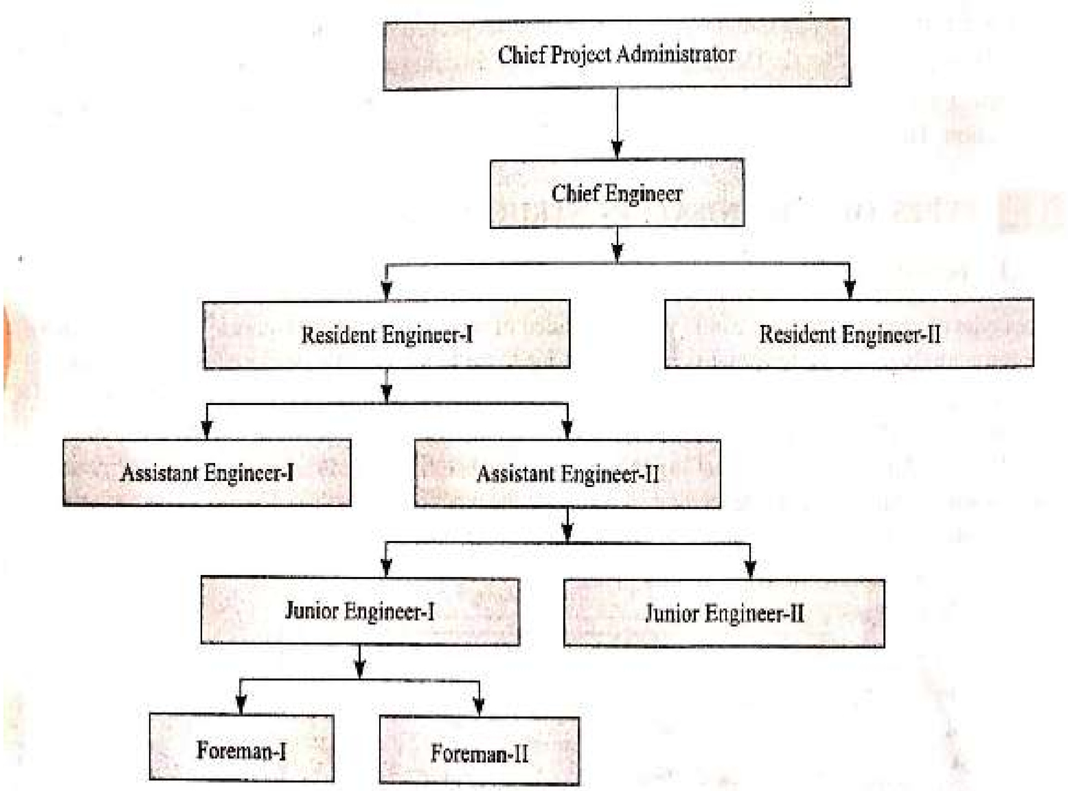
(i) The main disadvantage is that there is no clear cut Jine of authority and each subordinate is accountable to a number of specialists/supervisors. This leads to confusion among the subordinates.

(ii) Coordination becomes more difficult.

(iii) Individual specialists may try to overemphasize their particular speciality to the detriment of the overall project.

Line Organisation

This is the oldest and simplest form of organisation adopted in construction projects. This is similar to the military organisation structure. Here, there is a clear line of authority and the responsibilities between the superiors and subordinates are clearly fixed. This type of organisation is practised in many private construction programmes and in Government construction projects.



Advantages

(i) Discipline among the employees is enhanced.

(ii) It is simple, easy to understand and there is a clear line of authority.

(iii) Facilitates quick decision making and responsibility for any mistakes can be easily fixed.

Disadvantages

(i) Communication from the lower level to the top management is very much handicapped.

(ii) There is too much concentration of authority at the top levels leading to partiality or favouritism.

(iii) Innovation and creativity are hampered. This is because, many of the departmental heads are overburdened with all the decision making.

Line and Staff Organisation

This type of organisation has worked successfully in the manufacturing industries. Many construction companies evolved from a functional organisation to a line and staff organisation as growth required additional management strengths. As the name indicates, this organisation is a combination of line and functional organisation. The staff responsibility is carried out by the functional specialists with their knowledge and experience, while the line authority maintains discipline and stability in the organisation.

Advantages

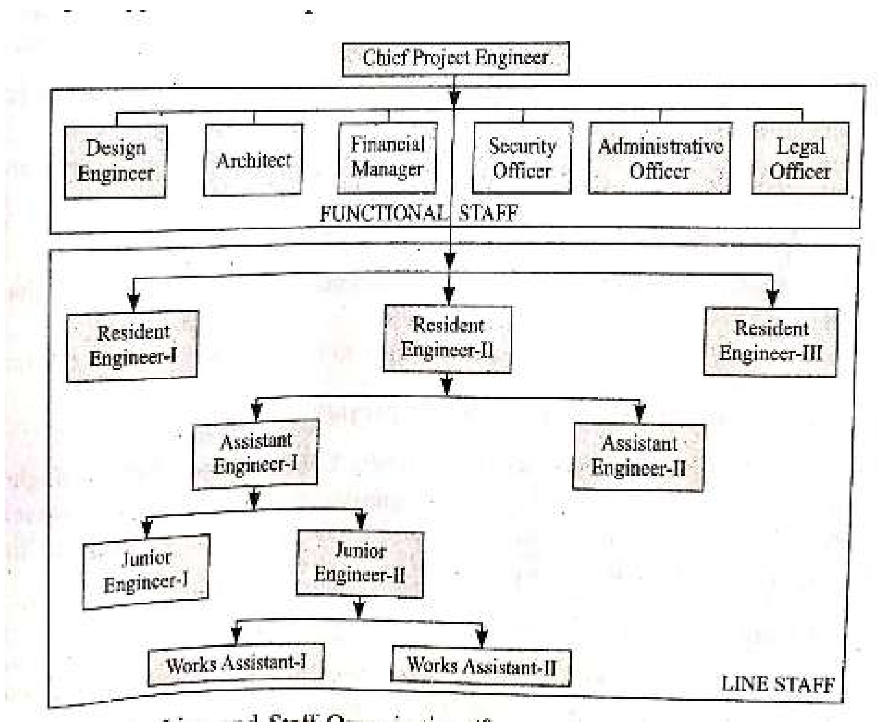
(i) Good combination of specialist services with the project construction team.

(ii) The project will be executed with better quality,

(iii) The line personnel can devote their entire time to achieve their targets of the project.

(iv) The staff personnel carryout all the specialised work due to their skills and experience.

(v) More job opportunities are provided.



Disadvantages

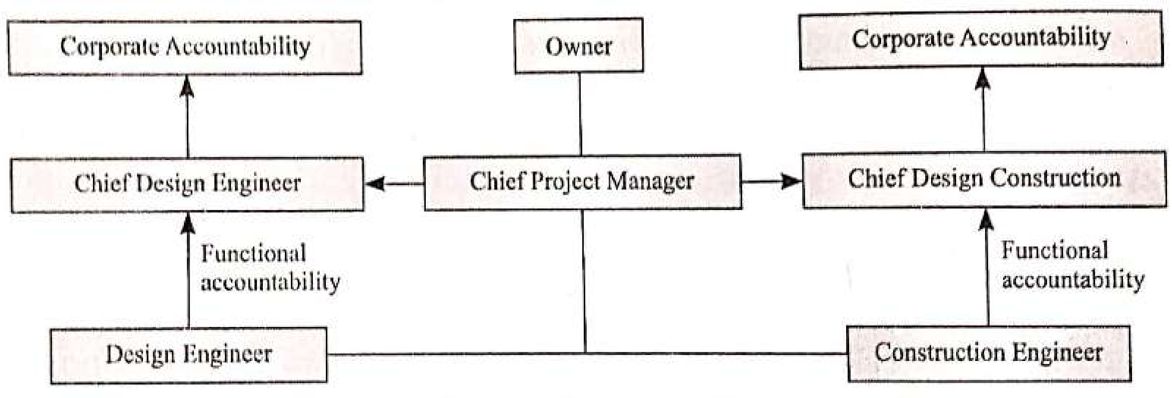
(i) Possibilities of conflict between line staff and functional staff.

(ii) Staff personnel do not have direct authority to enforce their decisions,

(iii) Overhead costs will increase due to hiring the services of the specialised staff

Matrix Organisation

In this type, an attempt is made to preserve the strong points of both the line personnel and the staff personnel. A balanced matrix organisation divides the power into functional and project responsibilities. This organisation structure endeavours to solve the conflicts between the line personnel and the functional staff by opening up lines of communication at all levels through the assignment of dual reporting responsibility to the subordinate managers. The project responsibilities such as scope, cost and schedules come under the responsibility of the chief Project Manager. Functional responsibilities such as design, quality assurance and internal company policies come under the functional staff.



Advantages

(i) The functional staff are having equal powers to enforce the compliance of the project with their specialised skills in design, quality, etc.

(ii) Best suited when the project authority and functional authority are well defined and divided.

(iii) Removes some of the weaknesses of the line and staff organisation.

Disadvantages

(i) As compared to the other organisations, the overall management and administrative costs will be higher.

(ii) Difficulty in precisely defining the accountability to the functional and project managers.

FORMS OF BUSINESS ORGANISATIONS

To carryout different types of construction activities, construction managers either as a single individual or in association with other persons have to form organisations. Many construction managers form consultancy organisations. In this connection, it will be useful to have a knowledge of the different categories of business organisations. These organisations are now discussed.

Sole Proprietorship

This is the oldest and natural form of business organisation. In this, the individual invests his own capital, uses his own skills and intelligence in the management of the business. He may obtain the employees.

The main features of this organisation are: single ownership, takes his own decisions, bears the entire risk, gets the total benefit, and no government regulation.

Advantages of one-man business are: ease of formation and dissolution, flexibility of operation, quick decision making, maintenance of secrecy, and favourable credit standing among suppliers and other firms.

Some limitations of this system are: limited finances and managerial skills, unlimited liabilities, and uncertainty of the duration of the firm which depends to a large extent on the health of the owner. This form of organisation is well suited for a single owner consultancy firm.

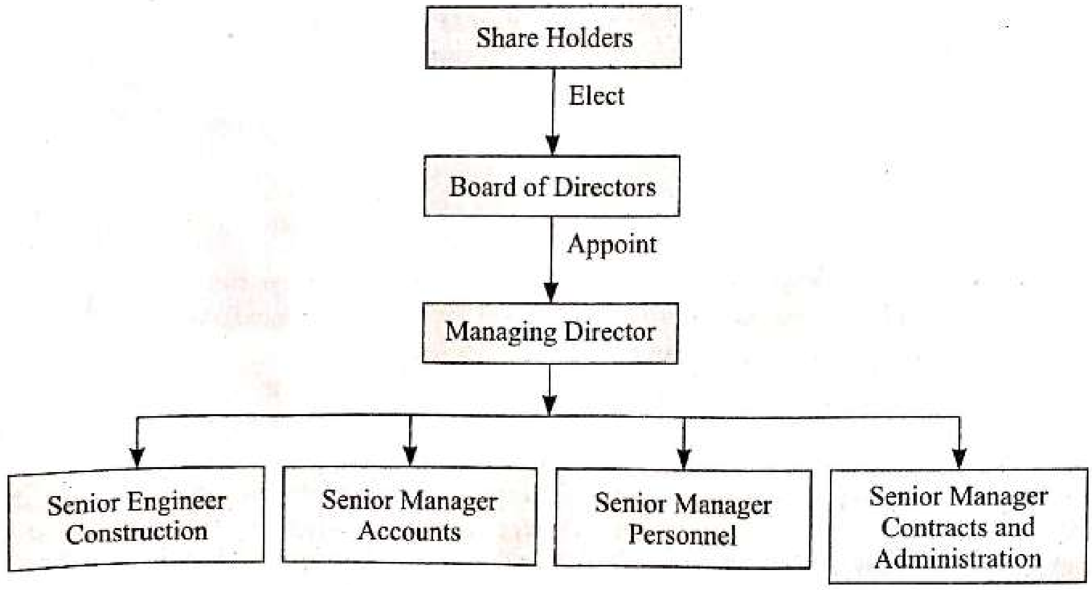
Partnership Business

This form of organisation is well suited when the construction programme is of medium size. Partnership is made between individuals and the entire work is carried out harmoniously. The partners agree to share the profits and a contract enunciating all the conditions of the partnership is signed between the partners. All disputes between the partners should be settled amicably.

Some of the advantages of this category are : easy formation, larger resources, promptness in decision making, balanced judgement, flexibility and reduced risk. Some limitations are : lack of harmony, instability and limited resources (since the number of partners are limited).

Joint Stock Company

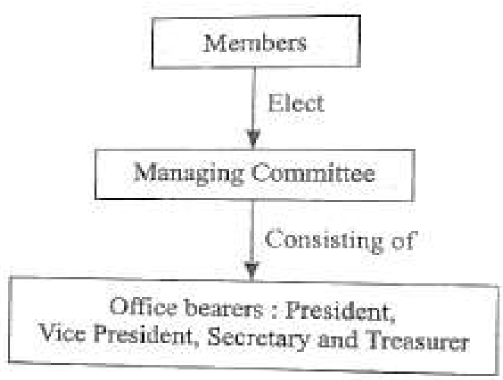
This is an artificial body created by law for carrying on some business by an association of persons. The main features are: common seal, limited liability of members (share holders), perpetual succession, separate legal entity and separation of ownership from management. The main organs of a company management for construction are shown in the following flow chart:



Co-Operative Society

This is an association of persons who have voluntarily joined together to achieve a common economic interest. As an example, a group of persons may join and start a co-operative society for building a housing colony. The structure of a co-operative organisation is as shown below:

The advantages are: can pay better wages to workers, produce better quality of goods and facilities, removes the middle agents and brokers and no necessity for publicity and advertisements. Some of the limitations are: limited finance, services of experts not available and not having fulfilled the expectations of the community or the members.



State Enterprise

Major construction projects like, multi-purpose hydel projects, thermal power projects, fertiliser and chemical industries, nuclear power projects, steel industries, and many of the mega projects have been executed either by the State or Central Governments. Any business owned and run by any public authority is known as a State Enterprise. The State Enterprise may be a Zilla panchayat, municipality, State Government or Central Government.

Some of the advantages of this type are: better management, larger financial resources, profits to be used for public welfare and security of service for personnel employed.

Some disadvantages are: bureaucracy, delays in execution, lack of personal interest and lack of responsibility.

Now-a-days, the private sector and the Government sector are joining hands with each other to establish a joint sector to execute huge projects for national development.

Planning, Scheduling & Controlling:

In the process of planning, alternatives are examined and the best alternative is chosen. The goal of planning is to minimize resource use (cost) while satisfactorily completing the task. Efficient use of equipments, material, labor and ensuring coordinated effort are the basic aim . The outcome of planning is predetermined course of action. Thus, the planning creates an orderly sequence of events, defines strategies to be followed in carrying forth the plan and describes ultimate disposition of the result. Putting the various activity of the project in the sequence on the time frame is the process of scheduling. Scheduling is required for continuous checking of the project (control), for resource mobilization, to minimize the cost and use of resources optimally.

Various scheduling techniques have been employed to plan the activity in sequence in project management. In construction project, bar chart and critical path method (CPM) have been widely used. During the planning process, a manager builds the facilities on paper, thus identities each of the various tasks and time .During construction, this predetermined course of action form the basis for monitoring and the checking the progress of the work. Following steps are followed during planning, scheduling and control.

a. **Identifying and defining activity**- Activity is well defined task which consumes time and resources. The identification of activity depends upon the level of details and the requirement of management .Different levels of leaders requires different detail in the project planning. For example, the cost of beam can be an activity in building construction or it can be further split into different activities such as bar scheduling, making form work, concrete mixing and casting, curing the beam etc . Generally tasks to be performed in break down using 'Top-Bottom Design'. The work break down structure (WBS) forms the useful tool to identify the activity. The outcome of this phase is the complete list of activity to perform the project.

b. **Defining activity interdependence**: In this step, each of the activity is considered. It is argued which activity will succeed the activity under consideration. Thus, we obtain the immediate succeeding activity or immediate successor. This way of thinking is called forward planning. We can also think which activity will precede the activity under consideration and similar manner we can prepare immediate precedence list. This way of thinking is called **Backward Planning** Outcome of this step is list of activity together with immediate preceding or succeeding activity. This step is carried out by most knowledgeable persons of the team. Generally these steps are carried at the senior/experience persons in the department or contractor's company

d. **Estimate time and resources for each activity**: - The estimation of activity duration without bias is very important. To avoid bias in the estimate, we can follow some guidelines which are described as follows -

   i. A group of experts should estimate the time and resource of the activity.
   ii. The estimate of activity duration should be done activity by activity and time estimate of one activity should not affect that of the other
   iii. The estimate should be based on normal level of work for labour and equipment
   iv. In the schedule, normal days should be considered ; weekends and holidays should be specified in the project .

Construction Scheduling:-

scheduling is the allocation of resources. These resources, in conceptual sense, are time and energy, but in practical sense are time, space, equipment and effort applied to material. More specifically, scheduling is the mechanical process of formalizing the planned functions, assigning the starting and completion dates to each part (or activity) of the work in such a manner that the whole work (or project) proceeds in a logical sequence and in an orderly and systematic manner. In other words, scheduling is the laying out of the actual activities of the project in time order in which they are to be perfomed, and calculating the man power and material requirements (or resources requirements, in general) needed at each stage of production, along with the expected completion time of each of activity.

	A	B	C	D
1		Schedule		
2		Two Story Home with a Basement		
3				
4	Activity	Duration(days)	Date	
5	Clear Lot	1	25-Oct	
6	Stake Lot	1	26-Oct	
7	Excavation	1	29-Oct	
8	Soil Check	1	30-Oct	
9	Form Footings	1	31-Oct	
10	Footing Inspection	1	1-Nov	
11	Pour Footings	1	2-Nov	
12	Pour Foundation Walls	3	11-5 thru 11-7	
13	Strip Foundation Walls	1	8-Nov	
14	Waterproofing & Foundation Drainage System	1	9-Nov	

Steps in project scheduling phase:

Scheduling is done in following steps:

1. CALUCLATE : detailed control information.
2. ASSIGN : timings to events and activities.
3. GIVE : consideration to the resources. The manager is generally concerned

   With those resources whose availability is limited and which there-by impose a constraint on the project. The important ones are usually skilled, technical and supervisory man power and capital investment.

4. ALLOCATE : the resources.

In traditional techniques, the term scheduling a project is some –what misleading because actual some attempt at planning and scheduling are performed at one step.

CONTROLLING:

As stated earlier, the planning and scheduling phases of a project are undertaken before the actual project starts while the controlling phase is undertaken during the actual project operations . Controlling consists of reviewing the difference between the scheduling and actual performance once the project has begun. Project control is the formal mechanism established to determine deviations from the basic plan, to determine the precise effect of these deviations on the plan, and to replan and reschedule to compensate for the deviations.

Steps in control process:

Controlling is accomplished in the following well recognized steps:

1. ESTABLISH : standards or targets. These targets are generally expressed in terms of time.

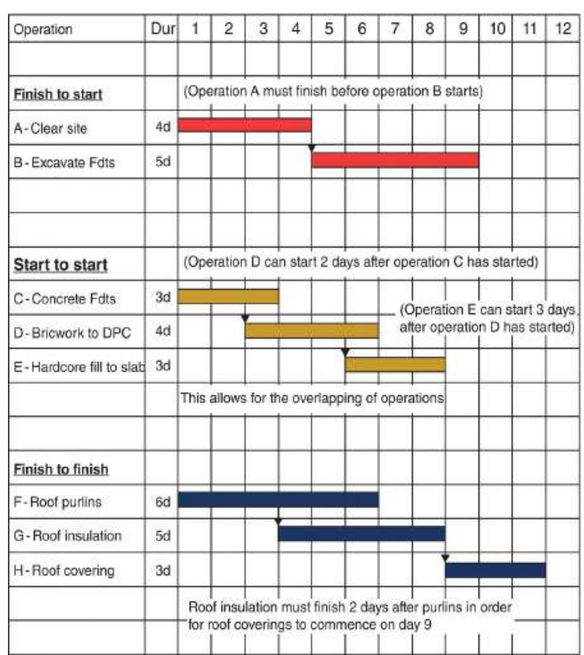
2. MEASURE : performance against the standards set down in the first step.

3. IDENTIFY: the deviations from the standards .

4. SUGGEST AND SELECT: correcting measures. This will involve all the problems-identifying, decision-making and organizing and leadership skill of the decision maker.

Bar charts and milestone charts:

Bar charts are introduced by HENRY Gantt around 1900 AD bar charts represent pictorial representation in two dimensions of a project by breaking it down into a number of manageable units or activities for planning and control shown on one dimension or axis and durations assigned to these activities on the other dimensions or axis. Bar charts were later modified to yield the milestone charts. While the bar chart represents the activities, a milestone chart represents the events which mark either the beginning or the end of activity. The bars of the bar chart are broken into a number of pieces, each one of which represents a identifiable major event. It should be noted that each event is a point in time which the management has identified as important reference point during the completion of the project.



DEVELOPMENT OF BARCHART

The following are important stages in developing a bar chart

1. BREAKE DOWN : THE project in to its various activities or jobs or operations, each representing manageable unit for planning and control.

2. DECIDE : THE method to be employed in execution of the project, as well as for each activity or operation or task; also decide above the sequence in which the activities are to be completed.

3. ASSIGN : Duration of time for the completion of each activity. Once the activities are separated and choice of method is made, it is possible to estimate the time required for the completion of each activity.

4. REPRESENT : THE above information in the bar chart, indicating the relative positions of the each activity.

TIME ESTIMATES

Time is the most essential and basic variable in PERT system of planning and control. We have seen that PERT is mostly used for research and development type projects which are referred to as once-through. In these projects, there is uncertainty about the times required for the completion of various activities. Exact estimation of times of completion for various activities is difficult. In the PERT network an estimate is made of not only the *most probable time* required to complete the activity, but some measure of uncertainty is also *incorporated* in this estimate to consider two more time estimates: the *pessimistic estimate* and the *optimistic estimate.*

Thus, to take the uncertainties into account, PERT planners make three kinds of time estimates:

i) The optimistic time estimate,
ii) The pessimistic time estimate, and
iii) The most likely time estimate.

1. **The Optimistic Time Estimate**
   This is the shortest possible time in which an activity can be completed, under ideal conditions. The particular time estimate represents the time in which we could complete the activity or job if everything went along perfectly, with no problems or adverse conditions. Better than normal conditions are assumed to prevail. This time estimate is denoted by t_o.
2. **The Pessimistic Time Estimate**
   It is the best guess of the maximum time that would be required to complete the activity. This particular time estimate represents the time it might take us to complete a particular activity if everything went wrong and abnormal situations prevailed. How-ever, this estimate does not include possible effects of highly un-usual catastrophes' such as earthquakes, floods, fires etc. This time estimate is denoted by t_p.

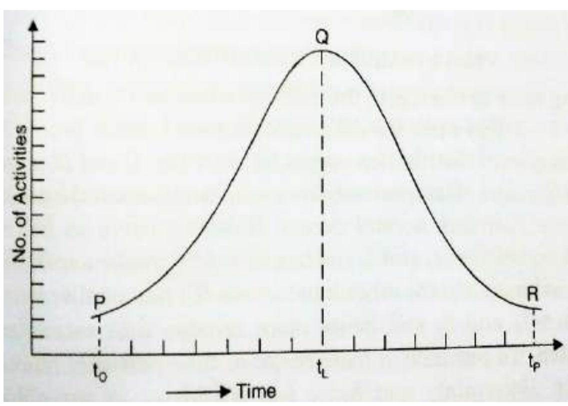
3. **The Most Likely Time Estimate**
   The most likely time or *most probable time* is the time that, in the mind of the estimator, represents the time the activity would most often required if normal conditions prevail. This time estimate lies between the optimistic and pessimistic time estimates. This time estimate reflects a situation where conditions are normal, things are as usual and there is nothing exciting. This time estimate is denoted by $t_{L.}$

   These time estimates, though look simple, are not always easy to prepare. However, they give useful information about the expected uncertainties in an activity. These time estimates are usually expressed in days, weeks or months, and represent calendar dates and not actual working days.

FREQUENCY DISTRIBUTION

If a curve is now plotted between the 'time' of completion and the number of jobs completed in that 'time', a *frequency distribution curve,* such as the one shown in Fig will be obtained. From the curve, it is clear that there are large number of cases of the activity that are completed in the *most likely time.* Point **P** corresponds to the optimistic time (t_o), point **R** corresponds to the pessimistic time (t_p) while point **Q** corresponds to the most likely time (t_L). Such a curve is also called *unimodal curve,* since it has single hump.

Fig. FREQUENCY DISTRIBUTION CURVE



EXPECTED TIME

The three time estimates t_o (optimistic time), t_p (pessimistic time) and t_L (most likely time) are identified on the Beta-distribution. The variance and standard deviation can be computed using t_o and t_p. However, one must combine the three time estimates into one single time – the average time taken for the completion of the activity or job. This average time or single workable time is commonly called the *expected time* and is denoted by t_E. If the exact shape of the probability distribution curve is known, the average time or expected time could be accurately calculated. However, since the precise curves are never available (specially for non – repetitive jobs) We must use *approximation.* This is done algebraically, using a weighted average derived by statisticians. In computing the expected time, a weightage of 1 is given to the optimistic time t_o, weightage of 4 to the most likely time (t_L) and weightage of 1 to the most pessimistic time (t_p).

$$t_E = \frac{t_o+4t_L+t_P}{6}$$

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Department of Civil Engineering

LEARINING MATERIAL UNIT - 2

on

CONSTRUCTION MANAGEMENT

Importance of quality:

Quality can be defined as meeting the legal, aesthetic and functional requirements of a project. Requirements may be simple or complex, or they may be stated in terms of the end result required or as a detailed description of what is to be done. However, the quality is obtained if the stated requirements are adequate, and if the completed project conforms to the requirements. Some design professionals believe that quality is measured by the aesthetics of the facilities they design. According to, this traditional definition of quality is based on such issues as how well a building blends into its surroundings, a building's psychological impacts on its inhabitants, the ability of a landscaping design to match the theme of adjacent structures, and the use of bold new design concepts that capture people's imaginations. Quality can also be defined from the view point of function, by how closely the project conforms to its requirements. The concept of quality management is to ensure efforts to achieve the required level of quality for the product which are well planned and organized. However, In the construction industry, quality can be defined as meeting the requirements of the designer, constructor and regulatory agencies as well as the owner.

Elements of quality:

- Leadership responsibilities for quality within the firm.
- Relevant ethical requirements.
- Acceptance and continuance of client relationships and specific engagements.
- Human resources.
- Engagement performance.
- Monitoring

Organization for quality control:

Setting up the quality organization is as important a task as anything we have discussed earlier. However, titles in the quality organization are not as important as the job descriptions of the individuals assigned to assure that quality systems are followed. Medium to large organizations will find it beneficial to have a separate group in the organization responsible for maintaining the systems. Smaller companies will have many key individuals who perform multifunctional tasks. Even if the quality organization is a separate group or is an individual who has other duties, the checks and balances should be in place.

There should not, for instance, be conflict between producing the product and making the product to customer requirements. With this in mind, there are a few guidelines that should be observed. An individual responsible for assuring that the product is shipped on time is not always a good choice for quality manager. When organizing, conflicts of interest must be identified and avoided. Obviously this is easier to accomplish in medium to large companies than in smaller ones. Before assigning responsibility for quality, look at what the primary duties are for those in the quality function. There are two main responsibilities. First and most important is preventing nonconforming products from reaching the customer. The second is finding ways to improve all functional activities.

Quality assurance technique

1. Management Responsibility: Company management is responsible for communicating the Company's Corporate Quality Policy throughout the organization. Corporate and facility management are responsible for assuring that this policy is understood and implemented.

2. Quality System: Company's Quality system is documented and implemented through the following documents:

- Corporate Quality Manual-Defines the scope of the corporation's Quality System and provides overall direction to the development of corporate and facility procedures.
- Corporate Procedures-Provides direction to help manufacturing facilities comply with the Quality Manual by defining specific corporate requirements or providing general technical guidance.
- Facility Procedures--Defines the standard operating practices at each manufacturing facility. Facility procedures satisfy corporate procedure requirements and the Corporate Quality Manual.
- Company Facility Work Instructions--Provides specific directions for the completion of tasks affecting quality.

3. Order Review: New products are reviewed for manufacturability and to assure that adequate production capacity and tooling are available for product introduction

4. Product Design and Development Control: The design and/or development of new standard products is the responsibility of corporate product engineering. Quality system requirements for the design and development of standard products are documented in their procedures Manual:

5. Document Control: Manufacturing facilities maintain procedures which describe the approval process for all product drawings generated within their facility. These procedures also cover the approval of drawing revisions

7. Inspection and Test Status: Quality Assurance is responsible for the control and calibration of measurement and test equipment and fixtures, including employee owned gauges, which are used to verify product quality.

8. Handling, Storage, Packaging and Delivery: Manufacturing follows procedures which protect product from damage, contamination or deterioration during storage and manufacture.

9. Quality Records: Quality records are retained and maintained for the time periods specified in written corporate procedures. Quality records consist of documentation generated during purchase, manufacture, or testing which demonstrates that the required quality levels were met or that the quality system in place was effective. Quality records are stored in a manner which assures legibility and facilitates sorting. Adequate storage facilities are provided which prevent deterioration or loss.

10. Internal Quality Audits: Corporate Quality Assurance conducts periodic audits at manufacturing facilities to ensure conformance to the Quality Manual and selected procedures. In addition, Corporate Quality Assurance conducts periodic product audits on material in inventory in accordance with approved Corporate Quality Assurance procedures.

11. Training: The Company maintains procedures for identifying training needs and provides for the training of personnel performing activities affecting quality.

12. Servicing: Where applicable, the company establishes and maintains procedures for providing appropriate levels of service to customers.

13. Quality Improvement Program: Corporate and facility management are responsible for developing the company's Quality Improvement Program. The Quality Improvement Program consists of a three-year strategic plan, as well as detailed annual quality improvement projects. This plan is submitted to the Board of Directors for final approval. Quarterly updates are issued to management to monitor progress.

Documentation:

The Contract documents specify the minimum requirements for the quality of Materials and Work to be furnished or performed under the Contract. The Project Manager (PM) must assure that the Materials incorporated and Work performed by the Contractor is in close conformance with Contract requirements.

Consult the following sources to determine the quality requirements for a Project:

•The Project Special Provisions, •The Project Plans •Standard Drawings •Contract Change Orders •The Standard Specifications •The Supplemental Standard Specifications The Nonfield-Tested Materials Acceptance Guide •The Manual of Field Test Procedures, which includes:

The PM will accept nonfield- tested Materials according to the individual Materials Specifications or to the Nonfield -Tested Materials Acceptance Guide (NTMAG) version in effect at the time of the Project Advertisement date. This
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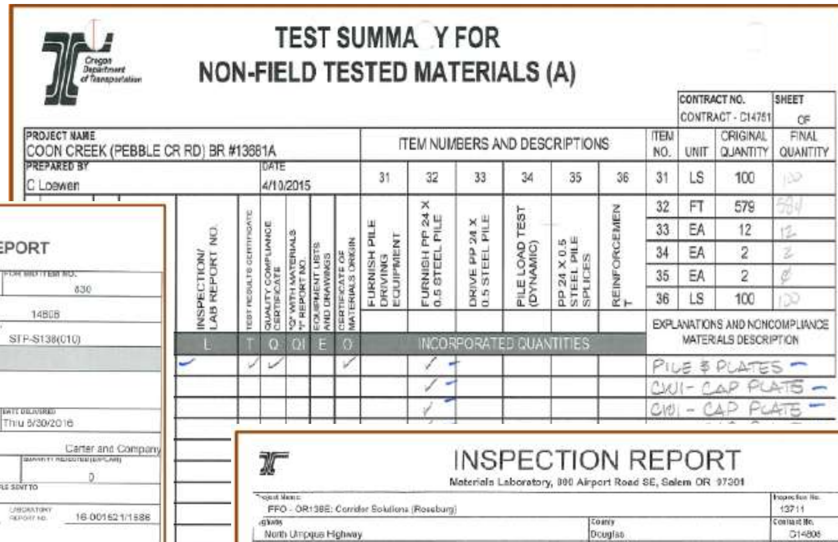
cument is to be used as a guide for documentation required for acceptance of Materials on ODOT construction Projects, but its use does not relieve the user from following the requirements specified in the Project documents. New Materials or Materials which are infrequently used may not be listed in the NTMAG. The NTMAG does not have precedence over the Special Provisions, Contract Plans, or Standard Specifications.



TEST SUMMA Y FOR NON-FIELD TESTED MATERIALS (A)

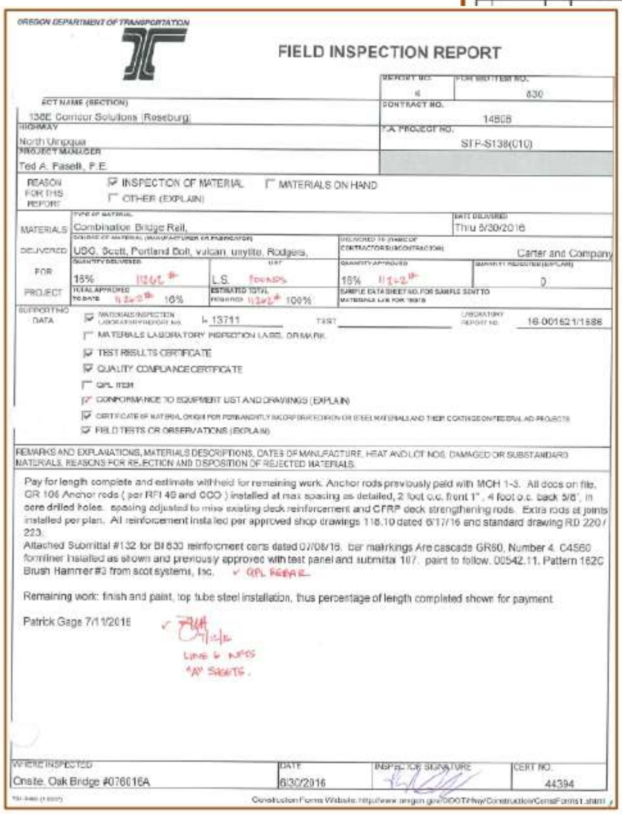
PROJECT NAME	PREPARED BY	DATE	ITEM NO.	UNIT	ORIGINAL QUANTITY	FINAL QUANTITY
COON CREEK (PEBBLE CR RD) BR #13681A	C Loewen	4/10/2015	31	LS	100	
			32	FT	579	
			33	EA	12	
			34	EA	2	
			35	EA	2	
			36	LS	100	

CONTRACT NO. CONTRACT - C14751

ITEM NUMBERS AND DESCRIPTIONS: 31 FURNISH PILE DRIVING EQUIPMENT; 32 FURNISH PP 24 X 0.5 STEEL PILE; 33 DRIVE PP 24 X 0.5 STEEL PILE; 34 PILE LOAD TEST (DYNAMIC); 35 PP 24 X 0.5 STEEL PILE SPLICES; 36 REINFORCEMENT

INCORPORATED QUANTITIES

EXPLANATIONS AND NONCOMPLIANCE MATERIALS DESCRIPTION: PILE & PLATES; CWI - CAP PLATE; CWI - CAP PLATE



OREGON DEPARTMENT OF TRANSPORTATION

FIELD INSPECTION REPORT

PROJECT NAME (SECTION): 138E Corridor Solutions (Roseburg)
HIGHWAY: North Umpqua
PROJECT MANAGER: Ted A. Paselk, P.E.
CONTRACT NO.: 14808
F.A. PROJECT NO.: STP-S138(010)
BID ITEM NO.: 830

REASON FOR THIS REPORT: ☑ INSPECTION OF MATERIAL ☐ MATERIALS ON HAND ☐ OTHER (EXPLAIN)

MATERIALS: Combination Bridge Rail — DATE DELIVERED: Thru 6/30/2016
DELIVERED: USG, Scott, Portland Bolt, vulcan, unylite, Rodgers — Carter and Company
FOR PROJECT: 16% — L.S. — 16% — 0
TOTAL APPROVED TO DATE: 16% — ESTIMATED TOTAL REQUIRED: 100%

SUPPORTING DATA: ☑ MATERIALS INSPECTION LABORATORY REPORT NO. L 13711 — LABORATORY REPORT NO. 16-001621/1586
☐ MATERIALS LABORATORY INSPECTION LABEL OR MARK
☑ TEST RESULTS CERTIFICATE
☑ QUALITY COMPLIANCE CERTIFICATE
☐ QPL ITEM
☑ CONFORMANCE TO EQUIPMENT LIST AND DRAWINGS (EXPLAIN)
☑ CERTIFICATE OF MATERIAL ORIGIN
☑ FIELD TESTS OR OBSERVATIONS (EXPLAIN)

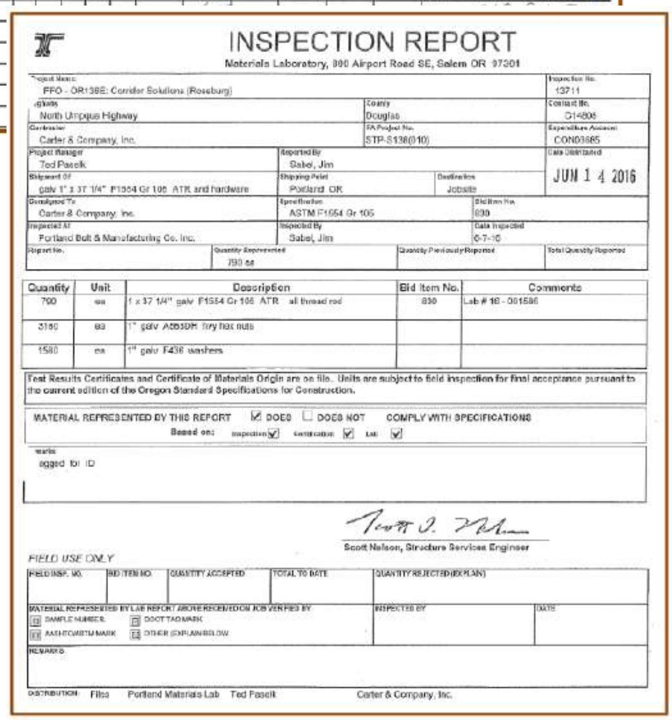
REMARKS AND EXPLANATIONS, MATERIALS DESCRIPTIONS, DATES OF MANUFACTURE, HEAT AND LOT NOS. DAMAGED OR SUBSTANDARD MATERIALS, REASONS FOR REJECTION AND DISPOSITION OF REJECTED MATERIALS

Pay for length complete and estimate withheld for remaining work. Anchor rods previously paid with MCH 1-3. All docs on file. GR 105 Anchor rods (per RFI 40 and CCO) installed at max spacing as detailed, 2 foot o.c. front 1", 4 foot o.c. back 5/8", in core drilled holes. spacing adjusted to miss existing deck reinforcement and CFRP deck strengthening rods. Extra rods at joints installed per plan. All reinforcement installed per approved shop drawings 118.10 dated 6/17/16 and standard drawing RD 220 / 223.
Attached Submittal #132 for BI 830 reinforcement certs dated 07/08/16. bar markings Are cascade GR60, Number 4. C4560 formliner installed as shown and previously approved with test panel and submittal 107. paint to follow. 00542.11. Pattern 162C Brush Hammer #3 from scot systems, Inc.

Remaining work: finish and paint, top tube steel installation, thus percentage of length completed shown for payment

Patrick Gage 7/11/2016

WHERE INSPECTED: Onsite, Oak Bridge #07601 6A — DATE: 6/30/2016 — CERT NO.: 44394



INSPECTION REPORT

Materials Laboratory, 800 Airport Road SE, Salem OR 97301

Project Name: FFO - OR138E: Corridor Solutions (Roseburg) — Inspection No.: 13711
Highway: North Umpqua Highway — County: Douglas — Contract No.: C14808
Contractor: Carter & Company, Inc. — FA Project No.: STP-S138(010) — Expenditure Account: COND3685
Project Manager: Ted Paselk — Reported By: Sabel, Jim — Date Distributed: JUN 1 4 2016
Shipment Of: galv 1" x 37 1/4" F1554 Gr 105 ATR and hardware — Shipping Point: Portland OR — Destination: Jobsite
Consigned To: Carter & Company, Inc. — Specification: ASTM F1554 Gr 105 — Bid Item No.: 830
Inspected At: Portland Bolt & Manufacturing Co. Inc. — Inspected By: Sabel, Jim — Date Inspected: 6-7-16
Quantity Represented: 790 ea

Quantity	Unit	Description	Bid Item No.	Comments
790	ea	1 x 37 1/4" galv F1554 Gr 105 ATR all thread rod	830	Lab # 16 - 001586
3160	ea	1" galv A563DH hvy hex nuts		
1580	ea	1" galv F436 washers		

Test Results Certificates and Certificate of Materials Origin are on file. Units are subject to field inspection for final acceptance pursuant to the current edition of the Oregon Standard Specifications for Construction.

MATERIAL REPRESENTED BY THIS REPORT ☑ DOES ☐ DOES NOT COMPLY WITH SPECIFICATIONS

Scott Nelson, Structure Services Engineer

FIELD USE ONLY

DISTRIBUTION: Files — Portland Materials Lab — Ted Paselk — Carter & Company, Inc.

Nonfield-tested Material Quality Documentation

Nonfield-tested Material quality documentation includes, but is not limited to, the following:1. FIR - Field inspection Report, form 734-3469. Examples of when this form is used are when materials are visually verified or when other supporting quality documentation is required.

Total Quality Management:

Total Quality Management (TQM) is the optimisation and integration of all the functions and processes of a business in order to provide for excited customers through a process of continuous improvement.

The 1990's is the decade of Globalisation. In order for companies to be competitive in this environment they have seen the imperative need for Quality. However through the decades leading to the 90's there have been many "gurus" who have explicitly underlined the need for Total Quality Management Systems in companies, but due to many factors these ideas have either gone unheeded, or been buzz word for a short time. It is possible that Total Quality Management (TQM), is once again a buzz word and a marketing tool, but nevertheless it is a tool that is being extensively used in the 90's to help companies gain and maintain a competitive edge over their rivals.

A Disciplined Approach for Management and Employees to Manage Quality

A Methodology for Problem Solving and Continuous Process Improvement

Apply to All Employees in Everything is done

Everyone has a Customer - Both Internal and External

Quality Defined is Conformance to Customer Requirements

Objectives of TQM:

Process improvement

Defect prevention

Priority of effort

Developing cause-effect relationships

Measuring system capacity

Developing improvement checklist and check forms

Helping teams make better decisions

Developing operational definitions

Separating trivial from significant needs

Observing behaviour changes over a period of time

TQM revolves around:

Commitment by Senior Management and all employees

Effective strategy, vision, mission and goals

Customer/ Supplier relationships

Communication

Tools and techniques for improvement

Team work

Systems to facilitate improvement and most of all TRUST

The quality system should apply to and interact with all activities of the organisation. It begins with the identification of requirements and ends with their satisfaction, at every transaction interface. The quality system must be a practical working document. Look for a document that is well fingered in use. A useful guide in the operation of any process is:

1. No process without data collection

2. No data collection without analysis

3. No analysis without decisions

4. No decisions without actions (which can include doing nothing)

This discipline is built into any good quality system primarily through the audit and review systems. The overriding requirement is that the systems must reflect the established practices

of the organisation, improved where necessary to bring them into line with current and future requirements. In implementing a quality system the established national standards such as the BS7850 series can serve as a useful guide and framework.

A systematic, functional, quality model like TQM should be genuinely explored and exploited.

Continuous improvements are probably the most powerful concept to guide management through the achievements of TQM Continuous improvements are based on systematic, incremental and habitual improvements of processes rather than on breakthroughs and innovative advances. The process concentrates on elimination of waste and non-value-added activities through collective and continuous involvement of all employees.

This systematic approach to quality management requires the following components:

Planning the processes and inputs

Providing inputs

Operating the processes

Evaluating the outputs

Examining the performances of the processes

Modifying the processes and their inputs.

TQM Tools

Quality Improvement Teams

These are small groups of employees who work on solving specific problems related to quality and productivity, often with stated targets for improvement. Quality improvement teams are proving to be highly successful at tracking down the causes of poor quality as well as taking remedial action.

Benchmarking

This is the process of identifying the best practices and approaches by comparing productivity in specific areas within ones' own company to other organisations both within and outside the industry.

Statistical process control

This is a statistical technique that uses periodic random samples taken during actual production to determine whether acceptable quality levels are being met or whether production should be stopped in order to take remedial action. Because most processes produce some variation, statistical process control uses statistical tests to determine when variations fall outside a narrow range around the acceptable quality level. The emphasis when using SPC is on defect prevention rather than trying to inspect the quality into the product.

COMMITMENT

In order for the Eye on the Future Model to be a success, each member in an organisation must be committed to the change process. It cannot be viewed as the new flavour of the month, but should rather be regarded as an exciting life changing process. Too often peoples' enthusiasm wanes when they realise that the change process in an organisation is not likely to occur overnight People need to pledge their support to objectively analysing their job functions and procedures, and seeking new innovative ways to improve them. If necessary inspirational speakers should be employed to enthuse staff to a new attitude of commitment. Once again, people are led by example. If it appears that management is not committed to the change process, this is the attitude the people will develop. However, if commitment is perceived to be the attitude of management, then the people are most likely to follow.

TRAINING

Training must be a part of the organisations succession planning. In today's business environment any training which is less than visionary will not help the organisation meet its' future goals and objectives. Training objectives must be supportive of the company's vision and mission. In order to identify training, the employees must be involved. System deficiencies including non-conformance reports, customer complaints and job performance appraisals will highlight the most urgent areas for development. Training programmes must be devised and implemented to help bridge the gap identified previously. The results of the training must be evaluated to ensure that effective improvement has been achieved and that employees are competent to use the skills acquired.

Management must promote the need for continuous training, as it will facilitate the following:

1. Employees will be more confident and motivated in their work

2. Reduce staff turnover

3. Reduce errors

4. Improve productivity

5. Improve the organisation competitiveness.

Training must help each individual in the organisation to maintain a growing knowledge of their business environment. It must be implemented to each individual, from the directors to the cleaners.

The way of managing organization to achieve excellence

• Total – everything

• Quality – degree of excellence

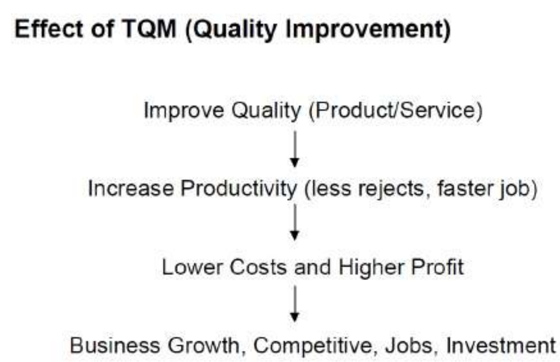
• Management – art, act (or) way of organizing, controlling, planning, directing to achieve certain goals

Definition of TQM

"A management philosophy embracing all activities through which the needs and expectations of the CUSTOMER and COMMUNITY, and the objectives of the organization are satisfied in the most efficient and cost effective manner by maximizing the potential of ALL employees in a continuing drive for improvement."

TQM Six Basic Concepts

1. Leadership
2. Customer Satisfaction
3. Employee Involvement
4. Continuous Process Improvement
5. Supplier Partnership
6. Performance Measures



GUDLAVALLERUENGINEERING COLLEGE
(An Autonomous Institute with Permanent Affiliation to JNTUK, Kakinada)
Seshadri Rao Knowledge Village, Gudlavalleru – 521 356.

Department of Civil Engineering

LEARINING MATERIAL UNIT - III

on

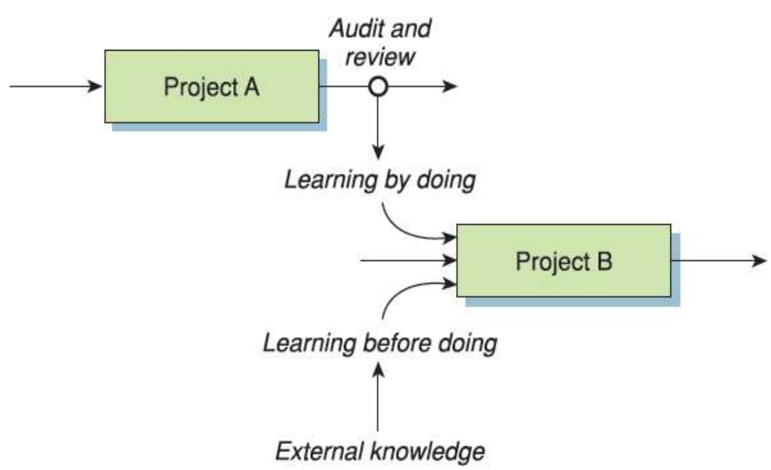
CONSTRUCTION MANAGEMENT

Project Review-

There is much written on the subject of process improvement from almost any perspective. This provides a degree of confusion for the practitioner, often leading to a kind of paralysis where everything looks possible so nothing gets changed. Management paralysis is often seen and can usually be linked to poor strategy and policy deployment on the part of senior management. With the focus of a clear strategy, the project manager can carry out activities that will improve the performance of future project processes on these criteria. A useful structure is to separate two elements

- learning before doing – ensuring that the necessary knowledge and skills are available in advance of their need in a project;
- learning by doing – those elements that can be learned from previous activities

The original intention of this structure was concerned with technical elements of processes, though they apply equally to the management elements of processes. It is the *management* of the process that we will be referring to here. The system is shown in Figure. Learning before doing is difficult to manage in practice. Identifying sources of ideas for changes that are likely to yield the results that you are seeking takes time and requires a very clear view of the available sources. Two sources for such ideas are the use of consultants (see the following section) and benchmarking .



Many world-class organizations, however, make far more use of the learning from their own projects. Research recently carried out at one of Hewlett-Packard's plants showed that the review information from previous projects provided a starting point for the planning of future projects. This had been done consistently over a long period, resulting in highly developed processes. This internal learning was often missing at firms that had less well-developed processes and tended to rely on external sources for their process development efforts. As a whole, these were less successful than those generated internally.

Project Completion & Handover: -

There are many reasons that work stops on projects. For some, it is because of the successful completion of the project's objectives. Some are stopped by their sponsors, due to changing needs or poor project performance, and others, as the skyline of Bangkok testifies, due to lack of the necessary resources to continue. Where projects are prematurely terminated it is usual for the staff to be dispersed with no provision for a review. Where projects are completed, there should be no reason for not reviewing. However, many firms do not allow staff time to review project activities, preferring them to stay busy and simply continue to the next project. Here, mistakes are repeated over and over again, and the rate of improvement of such organizations is poor or non-existent. For the individuals involved this presents much frustration. This is a very short-sighted view and the costs of hedgehog syndrome are enormous. The elements that will require the attention of the project manager during this phase are:

- Ensuring there is an incentive for the project to be finished and that activities are completed (all projects)
- Ensuring documentation of the process is provided to allow review, and of the outcome to facilitate any future support activities (all projects);
- Closing down the project systems, particularly the accounting systems (projects where there has been a medium–high organizational complexity and dedicated systems have been used)
- Constructing the immediate review of activities, providing a starting point for all improvement activities (all projects)
- Appraisal and relocation of staff who have completed their activities and disposal of assets that are surplus to requirements (some projects);
- Ensuring that all stakeholders are satisfied – sell your achievements and maximize the business benefit from your project (all projects) every time!

Completion:

The situation the project manager needs to avoid is where a project spends 90 per cent of its life

90 per cent complete. Finishing the activities so that resources can be released for other work and minimizing the costs incurred during the close-down phase are vital. There is a trade-off to be considered here: how much time and resource should be put into the closing of activities? At one extreme, there is a temptation to abandon the activities in a great rush to move on to other tasks. Such action risks undue haste and removes the possibilities for maximizing the benefit of the review, for example. At the other extreme, a close-down process can become drawn out, nothing is really finished and the overhead costs of the activities remaining keep escalating. Which approach is taken often depends on the success or otherwise of the project – it is clearly much more desirable to spend time closing a project which is an apparent success, whereas a disaster is more likely to be rapidly abandoned. In the kind of organization where people are brought in on contract for the duration of that project alone and are paid a time rate (according to the amount of time they spend working on it), there is little incentive for the work to be finished on time. Indeed, it is in their interests to ensure that things go mildly wrong and result in the plan of work being extended. The provision of some form of bonus for early completion should be considered where personnel have an active input to the result. Contractors and subcontractors should be treated as suppliers in this respect and be eligible for development effort.

Long Term Audit & Review:

The process of auditing and reviewing activities at a slight time distance from their execution is a part of normal life in some project organisations and an obvious omission from many others. Carrying out audit and review some time after the project has benefit as the results of the actions and the way in which they were undertaken become evident.

The return-on-development activities may take even longer to yield the benefits that were attributed to them during the planning process. This should form part of the normal project processes, just as planning does. The process itself requires:

a reason to exist;

- time;
- information;
- resources;
- credibility.

The auditing process involves:

- establishing the procedures – the formal statement of intent as to how activities should be carried out, whether financial, quality or environmental;
- checking documentation and other records of practice to show that they have been followed;
- presenting a report detailing the areas where there are deficiencies or irregularities.

An audit is often viewed as a negative process, i.e. it is trying to catch people out. However, it is responsible for identifying inconsistencies, double-checking information as well as seeking alternative viewpoints on the proceedings. There will regularly be conflict into which the players may try to draw the audit team.

The review process involves:

- studying overall performance relative to constraints;
- identifying areas where the procedures failed or have otherwise been shown to be inadequate;
- reporting on the areas and suggesting improvements

It is a real skill and art to carry out a worthwhile review process. Getting the truth, or many versions of it, and attempting to make sense of the conflicts (as for audits, but with a more open mandate) are common tests. It is always going to be a subjective exercise – this factor is worth remembering. Two different teams, given the same project, are likely to produce totally different reports. This will depend on the skills and biases of the individuals. The review should differ from the audit in one further dimension – that of the focus. Audits look internally, while reviews should take into account the impact of the project on the environment as a whole. The changes that were impressed by the environment should also be considered. The nature of the feedback will differ from the post-mortem type of review. Changes are rarely made to procedure-level events at this stage – procedures may have already been changed considerably and the context is unlikely to be completely the same again. Where the greatest impact will be felt is in strategic issues – the role of the project manager, of suppliers and the imposition or relinquishing of controls on activities can be examined. Above all, it is likely that a full picture of performance indicators will be available by this time and provide a more complete picture of the accuracy of forecasts and the veracity of other planning assumptions.

In the execution of a formal audit or review the criteria under consideration will to some extent determine who should be the auditor or reviewer. Expecting someone without accountancy skills, experience or qualification to carry out a financial audit is unlikely to produce usable or credible results. The criteria for the assessor also require a degree of independence. There is often the tendency in formal organisations that run projects in matrix form for one department or function to assess another's projects and vice versa. This arrangement, while being convenient and usually very cost-effective, can be counter-productive as there is the equal chance of complicity or hidden agendas as the departments have old scores to settle. This 'culture of distrust' is perpetuated by such arrangements and simply adds another degree of paying someone to check the work that you have paid someone else to do in the first place. Although it can expose incompetence, the audit/review procedure has to be seen as a value-adding activity rather than simply an opportunity to be negative about the work of others

Table shows the nature of both procedural audits and performance reviews that can be used to assess a project. It shows a variety of criteria and their methods of assessment. As stated during the work on control, if you measure only financial performance measures, do not be surprised if the focus of the project team rests on shortterm performance gains. Carrying out such assessment shows the team how seriously the organisation regards the criteria set out. If policy statements at senior management level are not backed up by the allocation of assessment effort and resources for improvement as a result of these assessments, the policies will become discredited.

Criteria	*Audit*	*Review*
Financial	Accounting systems	ROI, cost variance
Time	Conformance to plan	Customer satisfaction
Quality	Quality procedures	Customer perceptions
Human resources	Conformance to policy	Team spirit, motivation
Environmental	Conformance to policy	EI assessment
Planning	Conformance to plan	Cost, techniques used
Control	Systems for control	Basis for improvement

Long-term review

The case where a project was identified as a success at its completion but where the poor quality of the product of the project became recognised only later is not that unusual. Ongoing measurement of project outcomes has been established in the construction and engineering sectors for some time by identification of whole-life costs – the initial project cost with the ongoing maintenance and eventual disposal costs of the product. Given the level of many firms' dissatisfaction with their IT suppliers, this would be a useful measure to apply. Other forms of long-term review include individuals reflecting on their experiences of the project. This adds real validity to the concept of experience. It is a feature of many people who participate in regular training on this subject that the training time provides them with an opportunity for this reflection. Some professions require the compilation of a log-book. This type of diary could be highly beneficial to the project management professional as a means of facilitating review of personal experience. This can form a third element of the learning model – learning after doing.

Continuous Improvement

1. **Recognize the problem**. For most organizations, a change in behavior does not come naturally. Though one might think that continuous improvement would be a natural mind set for the PMO, in reality few PMOs have a culture of continuous not to mention processes or best practices to facilitate it. Sure, lessons learned are documented as part of project closing, but they are almost always filed away and forgotten rather than acted upon. The first step in establishing a continuous improvement mind set is to recognize the problem. That is, recognize the fact that your organization does not have or could do quite better exhibiting a continuous improvement mind set.
2. **Establish an enduring culture**. For continuous improvement to work, there must be a relentless focus on and commitment to getting things right. Adaptability and an action oriented leadership team are inherent components of a continuous improvement culture. Resistance to change exists in all organizations to a degree and it must be recognized for what it is, an impediment to improvement.
3. **Think Kaizen and Cross the Chasm**. Many people advocate Kaizen oriented thinking and behaviour where continual small, incremental improvements provide tremendous benefits in performance and end results achieved over time. Others advocate a Crossing the Chasm mind set where drastic change is introduced completely replacing inefficient

execution rather than slightly improving upon it. In a continuous improvement culture, there is room for both approaches. And often, after achieving the mega change that is made possible when Crossing the Chasm improvement initiatives are implemented, a Kaizen mind set is required to refine, sustain, and continually improve upon such change.

4. **Facilitate process-centric thinking**. Process-centric thinking does not have to be overly complex. Sometimes, all it takes is a thoughtful examination to uncover significant areas for improvement. Rather than tolerating mistakes and repeat errors, facilitate process-centric thinking to continually improve, correct, and overcome execution difficulties.
5. **Educate the workplace**. Like any other business strategy, ongoing education of the workplace is critical in establishing awareness, developing skills, and institutionalizing the needed mindset and behaviours to bring about effective change. It is no different with Continuous Improvement. Expect and overcome resistance to change with ongoing training, reinforcement of expected behaviours, and recognition of those who are learning and doing.
6. **Ensure a penalty-free exchange of ideas**. In many organizations, expressing one's opinion on how to do things better may not necessarily be a welcomed activity. Management can feel threatened or pressured to act resulting in immediate resistances. And, those expressing ideas may be viewed as complainers or trouble makers. In such an environment, it doesn't take long for the potential risks of making a suggestion to stifle enthusiasm and participation in improvement oriented thinking. Ensuring a penalty-free exchange of ideas is beneficial to both the giver and the receiver of new ideas and approaches and will ensure a safe two way exchange of thoughts and ideas.
7. **Use a consistent approach for projects**. A consistent and structured approach for project identification and execution will provide the organization with the ability to identify, select, and manage continuous improvement projects. The continuous improvement project process should also provide post-closing process steps to continually refine the improvement project methodology and to act upon the lessons learn from the project effort.
8. **Measure performance**. It is not possible to improve what is not measured. Determine in advance the approach and techniques to be used in measurements. Scorecards can be

useful to monitor the key performance indicators of processes that support capability and performance.

9. **Communication planning**. Ensure regular communications to foster collaborative interactions among leaders, stakeholders, and practitioners at all levels. Take advantage of communications techniques appropriate for the information being conveyed. Where needed, schedule face to face meetings and where not needed, use the communication and collaboration tools and capabilities of the enterprise to keep all members updated and involved.
10. **Establish core values**. Establish the core values that comprise the continuous improvement culture such as a focus on supporting the customer, teamwork throughout the extended enterprise, receptivity to evolving continuous improvement concepts and tools. These core values will create a sense of belonging and a common vision for all involved.

Bench Marking of Performance and Process:

Benchmarking is a method of improving performance in a systematic and logical way by measuring and comparing your performance against others, and then using lessons learned from the best to make targeted improvements. It involves answering the questions:

- Who performs better?"
- "Why are they better?"
- "What actions do we need to take in order to improve our performance?"

Types of Benchmarking

Benchmarking can be carried out against any organisation or target that is deemed to be 'best in class'. A full benchmarking exercise will involve not only the collection and comparison of data, but will include fact-finding studies to unearth the reasons for superior performance. Data driven benchmarking is made easy now that suites of KPIs are published nationally. Care must be taken to select the correct set. When an organisation wishes to carry out fact-finding studies as part of benchmarking, it can carry these out in one of three ways:

Internal – a comparison of internal operations such as one site (or project team) against another within the same company. Large companies will often have plenty of scope for this sort of benchmarking, and should aim to bring the level of performance of the whole company to the current ‘best in company.’

Competitive – a comparison against a specific competitor for the product, service or function of interest. This will provide data and information about what competitors are achieving. It is more difficult and complex to carry out. A number of benchmarking clubs have been established to allow collection and comparison of data from organisations which compete with each other.

Generic – a comparison of business functions or processes that are the same, regardless of industry or country. In a well-documented case in USA, a ready-mix concrete company compared its delivery performance against a pizza delivery company. Both were in the business of delivering products which had to arrive at the point of use promptly!

The key benefits of benchmarking to organisations are:

- Benchmarking focuses improvement efforts on issues critical to success
- It ensures that improvement targets are based on what has been achieved in practice, which removes the temptation to say ‘it can’t be done’.
- Benchmarking provides confidence that your organisation’s performance compares favourably with best practice.
- For organisations in the public sector, benchmarking provides an assurance that ‘Best Value’ is being achieved.

The role of Project Leaders in the World Class Projects.

The application of leadership and management in the project execution is usually dependent on the type of project and the life cycle stage that the project is in. For projects which are huge impact, large scale, complex and global in nature the standards to be achieved, the goals and the deliverables are constrained by the time frame, budgets and the market dynamics. These types of projects involve large and distributed project teams, comprising members from diverse disciplines. Also the implementation is going to be multi-phased. In such a situation the project success and business sustenance can be achieved only through an effective and smart leadership.

The leadership style should be flexible, sharing, and innovative so as to bring about the project success. At the same time the leader should emphasize on team building and motivation so that the divergent members can work together as a team.

During the planning phase of the project, the leader should lead the team and the stakeholders through a fine tuned project study so as to understand the project needs. This phase needs to be stressed so as to gain complete awareness of the requirements. Similarly the project leader has a pivotal role to play in change management. A good leader should be able to anticipate the change and address it effectively. The leader should be able to steer and direct the team members on the methods to cope with change and utilize change to one's advantage.

Most importantly the leader should be able to give credit, nurture creativity and support team members in taking calculative risks so as to deliver project success.

Network diagram is an outcome of the improvements in the milestone charts (see chapte2). The network technique is a major advance in management science. This technique is based on the basic characteristics of all projects that all work must be done in well - defind steps. For example, for completing a foundation, the various steps are: (1) layout, (2) digging, (3)placing side boards and (4) concreting. The network technique exploits this characteristic by representing the steps of the project objective graphically in the form of a network or arrow diagram. It would be difficult to find in the history of management methods any technique which has received such widespread attention as that accorded to network methods for planning, scheduling and controlling.

The network techniques are called by various names such as PERT, CPM, UNETICS, LESS, TOPS and SCANS. However, these and other systems have emerged from the following two major

Network systems:

(1) PERT

(2) CPM

The other systems, by and large, differ from their parents only in non-essentials.

- PERT

PERT stands for "Program Evaluations and Review Technique". The method was basically developed by the Navy Special Projects Office in co- operation with Booz, Allen and Hamilton, a management consulting firm and Lockheed Missile System Division for evaluating the feasibility of existing schedules on Polaris missile program and for reporting progress.

The PERT system uses a network diagram consisting of events which must be established to reach project objectives. An events is that particular instant of time at which some specific part of a plan is to be achieved. It indicates a point in time and does not require any resources. PERT uses event oriented network diagrams in which successive events are joined by arrows. For example, in a foundation construction project, the various events may be "foundation layout started" , "foundation excavated" ,"side boards fixed" , "concreting completed" etc. The approach of event-orientation in network diagram grew out of the desire to report on the project progress via discernible management milestones.

PERT system is preferred for those projects or operations which are of non-repetitive nature or for those projects in which precise time determination for various activities cannot be made. In such projects, managements cannot be guided by the past experience. They are referred to as once-through operations or projects. For example, the project of launching a space craft involves the work never done before. For such a project the range of possible technical problem is immense in such research and development projects, the times estimates made for use may be little more than guesses. PERT system is best suited for such projects.

CPM

CPM stands for "Critical Path Method". In CPM networks, the whole project consists of a number of clearly recognizable jobs or operations, called activities. Activities are usually operations which take to carry out, and on which resources are expended. Junctions between activities are termed as events. The CPM networks are often referred to as activity oriented diagram in which each activity is represented by an arrow, and the sequence in which the activities are performed is shown by the sequence of the arrows. For example, in a foundation construction project, the various activities may be; "lay out the foundation trench" , "excavate the foundation" , "put side boards" , "concrete the foundation base" , etc.

CPM network are generally used for repetitive type projects, or for those projects for which fairly accurate of time for completion of each activity can be made; and for which cost estimations can be made with fair degree of accuracy. For example, CPM is very useful for construction projects. However, it is not suitable for research and development projects.

EVENT

The commencement or completion of an activity is called an event. An event is that particular instant of time at which some specific part of a plan has been or is to be achieved. More specifically an event is a specific definable accomplishment in a project plan, recognizable at a particular instant of time.

Examples:

DESIGN COMPLETED : is an event

EXCAVATIONCOMPLETED : is an event

LATHE INSTALLED : is an event

PARTS ASSEMBLED : is an event

EXCAVATE FOUNDATION : is not an event

PIPE LINE LAID : is an event

An event has three basic properties:

(1) An event is either the start or completion of an activity.

(2) An event represents a noteworthy, significant and recognizable point in the project. Events act as control points in a project.

(3) An event is an accomplishment occurring at an instantaneous point in time, but requiring no time or resources itself.

An event must satisfy the following requirements :

(a) A significant event must be positive, specific, tangible and meaningful to the project.

(b) It should be definitely distinguishable as a specific point in time.

(c) It should be readily understood by all concerned with the project.

ACTIVITY

An activity is the actual performance of a task. It is the work required to complete a specific event. An activity is a recognizable part of a work project that requires time and resources (manpower, material, space, facilities etc.) for its completion.

Examples:

EXCAVATE TRENCH : is an activity

MIX CONCRETE : is an activity

PREPARE SPECIFICATIONS: is an activity

ASSEMBLE PARTS : is an activity

LATHE INSTALLED : is not an activity

DESIGN COMPLETED : is not an activity

PREPARE BUDGET : is an activity

Predecessor activity

Activity or activities that are required to be performed before another job or activity can begin are called predecessor activities to that activity. The activity or activities that are required to be performed immediately before another activity, without an inter vening activity are known as immediate predecessor activities to that activity.

Successor activity

Activity or activities that can be performed after the performance of other activity are known as successor activities to that activity. The activity or activities that immediately follow another activity, without any intervening activity are known as immediate successor activities to that activity.

A **C**

E

B **D**

EXPECTED TIME

The three time estimates t_o (optimistic time), t_p (pessimistic time) and t_L (most likely time) are identified on the Beta-distribution. The variance and standard deviation can be computed using t_o and t_p. However, one must combine the three time estimates into one single time – the average time taken for the completion of the activity or job. This average time or single workable time is commonly called the *expected time* and is denoted by t_E. If the exact shape of the probability distribution curve is known, the average time or expected time could be accurately calculated. However, since the precise curves are never available (specially for non – repetitive jobs) We must use *approximation.* This is done algebraically, using a weighted average derived by statisticians. In computing the expected time, a weightage of 1 is given to the optimistic time t_o, weightage of 4 to the most likely time (t_L) and weightage of 1 to the most pessimistic time (t_p).

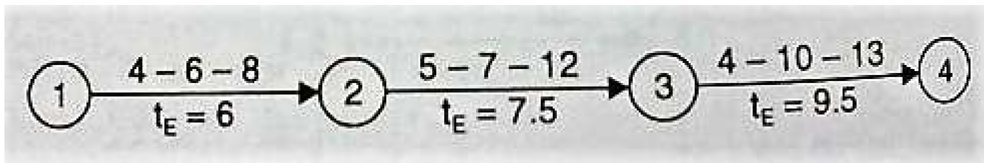
$$t_E = \frac{t_o+4t_L+t_P}{6}$$

EARLIEST EXPECTED TIME

The *earliest expected time* is the time when an event can be expected to occur. It is represented by symbol T_E and appear above or below the node (event circle) in a network.

The earliest expected time (T_E) is computed by adding the *expected times* (t_E) of all the *activities* along an *activities path* leading to that event. If more than one activity paths lead to that event, then the *maximum* of the *sum* of t_E 's along the varies paths will give the earliest expected time.

Let us first consider a simple network shown in fig. In which there is only one *activity path.* The three time estimates (t_o,t_L and t_P) of each activity are normally expressed above activity arrow while the activity expected time (t_E) is written below it.



Fig

Let us assume that event 1 is the initial event, which occur at zero time. The activity 1-2, which connects events 1 and 2, has t_E =6. Hence earliest expected time for event 2 will be

$$= 0+6= 6.$$

Event 3 is connected to event 2 by activity 2-3 which has t_E =7.5. Hence T_E for 3 = T_E for 2+t_E for activity (2-3)

$$= 6+7.5 =13.5$$

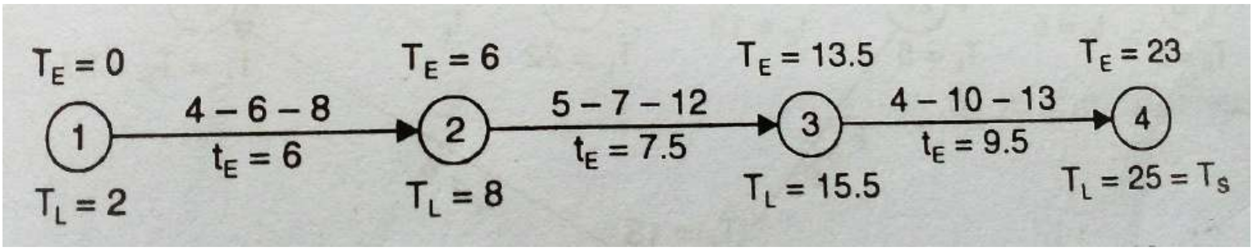
Similarly, T_E for the last event 4 = $(T_E)_3 + (t_E)_{3-4}$

$$= 13.5+9.5 = 23.$$

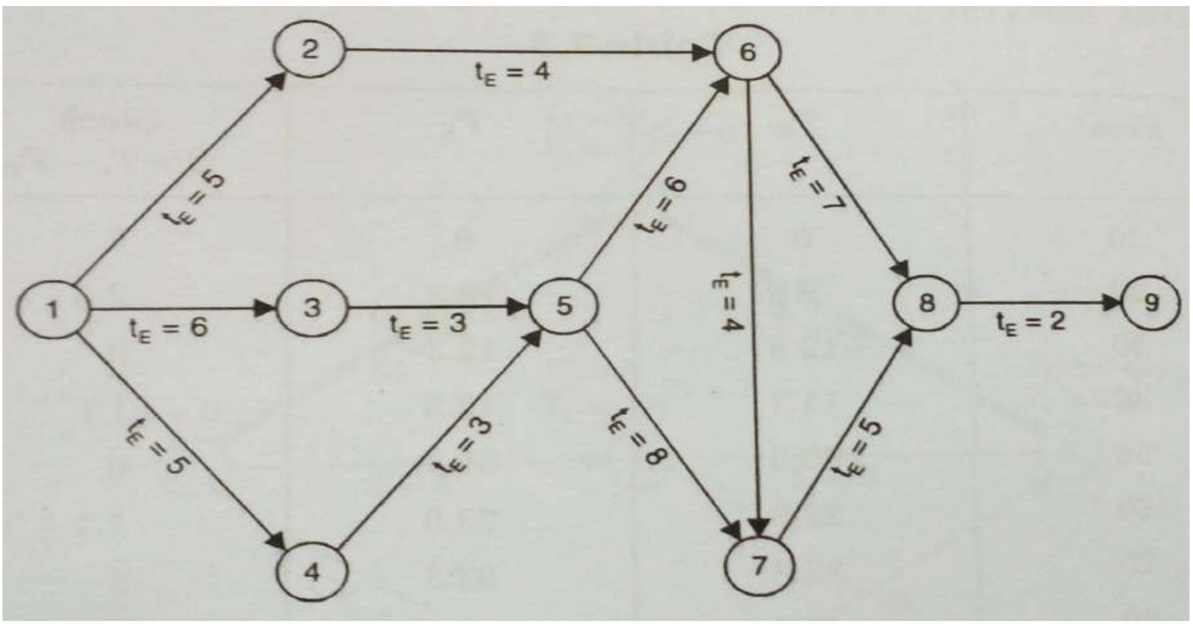
LATEST ALLOWABLE OCCURRENCE TIME

A Planner is equally concerned with the completion of the project with in the scheduled time. For each event, therefore, some time limit is allotted by which that event must occur. The latest time by which an event must occur, to keep the project on schedule is called the *latest allowable occurrence time.* It is denoted by symbol T_L. This is, therefore, another *event time.*

whenever a project is taken in hand, decision is made regarding the completion time of the project and the accepted figure is called the *scheduled completion time (*or *the contractual obligation time)* and is denoted by symbol T_S. Naturally, T_S refers to the latest time of the last event (i.e., $T_S = T_L$).



Example: Determine the critical path for the network shown in figure. Numbers indicate time in weeks.



	Earliest Expected Time Latest Occurrence Time								
Event No	**Predecessor Event (i)**	**t_E^{ij}**	**T_L^i**	**T_E**	**Successor Event (j)**	**t_E^{ij}**	**T_L^i**	**T_L**	**Slack $S=T_L - T_E$**
(1)	**(2)**	**(3)**	**(4)**	**(5)**	**(6)**	**(7)**	**(8)**	**(9)**	**(10)**
1	-	-	0	0	2 3 4	5 6 5	6 0 1	0	0
2	1	5	5	5	6	4	11	11	6
3	1	6	6	6	5	3	6	6	0
4	1	5	5	5	5	3	6	6	1
5	3 4	3 3	9 8	9	6 7	6 8	9 11	9	0
6	2 5	4 6	9 15	15	7 8	4 7	15 17	15	0

7	5 6	8 4	17 19	19	8	5	19	19	0
8	6 7	7 5	22 24	24	9	2	24	24	0
9	8	2	26	26	-	-	26	26	0

UNIT -IV

MATERIALS MANAGEMENT

IMPORTANCE OF MATERIALS MANAGEMENT

Economy is very important in the present day construction activities. The major resources in construction are: Machines, Materials, Men and Money — commonly referred to as the four M 's. These are the inputs of any activity and the output will be either goods or services. If the organisation is to remain in profit, then the output should be optimised with the given input.

The optimisation of the inputs can be on any of the M's. Reduction in the manpower is usually not entertained. Reduction in machines is also not easy since, due to inflation, there is a continuous increase in price of machines and in order to be competitive, old machines are to be replaced with new ones due to technological advances. Money is always scarce and we can not do much of optimisation on it. Hence, the only area in which considerable economy is still possible is with materials and the study related towards it is called "materials management".

Materials management deals with managing of materials along with costs. The materials can be the materials purchased which are the raw materials for inputs or semi-finished products or the final products called as the output, which is ready for sale. Construction materials and components contribute around 50-60% of the total value of construction. It is estimated that about 10-20% of all materials delivered to the site either end up as waste or illegally removed during the construction phase. Furthermore, it has been noticed that large quantities of building materials are allowed to be buried or burnt each year due to inadequate controls on project sites. Hence, proper materials management is imperative for effective construction management.

OBJECTIVES OF MATERIALS MANAGEMENT

The main task of materials management is to reduce the cost that is to be incurred on materials to the maximum extend such that, the final products are more competitive and to increase the profit of the organisation. The objectives are:

1. To ensure uninterrupted production or operation by maintaining steady flow of materials.
2. Right quality of materials in required quantity at an appropriate cost from proper place with right terms and conditions so as to reduce the expenditure on materials.
3. By adopting the latest techniques, economy is to be achieved.

4. Speedy disposal of materials which are no more required.
S. Losses due to pilferage, deterioration, obsolescence are to be kept at a minimum.
6. Reduction in capital through scientific inventory control.

COSTS

(i) Material: The substance from which a product is manufactured is called as material.

(a) Direct Material. All the materials which becomes an integral part of the finished product

and which can be conveniently assigned to specific physical units is known as Direct Material. Examples are all materials purchased, produced or consumed from stores, packing materials, purchased components etc.

(b) Indirect material. All materials which are used for the purposes ancillary to the business and which cannot be conveniently assigned to specific physical units is known as Indirect Material, e.g.: stationery and printing materials, oil and waste etc.

(ii) Labour : Human effort is required for converting the materials into finished goods and this effort is termed as labour.

(a) Direct labour. It is the labour that takes a direct as well as an active part in the manufacture of a particular commodity.

(b) Indirect labour. It is the labour employed for the purpose of carrying out the works which are incidental to the goods produced or the services provided, e.g; salaries for salesmen, wages for foremen, store keepers etc.

(iii) Expenses:

(a) Direct Expenses. These are the expenses which can be directly, easily and fully allocated to specific cost units, e.g; cost of redoing a faulty work, hire charges for special machinery to do particular job etc.

(b) Indirect Expenses. These are the expenses which cannot be directly, easily and fully allocated to specific cost units, e.g; electric charges, rent for the building, insurance etc.

The indirect costs are generally termed as overhead costs.

FUNCTIONS OF MATERIALS MANAGEMENT DEPARTMENT

To achieve best results, it would be worthwhile to place all the functions related to materials under a single department known as materials management department. The functions of this department are:

(i) Planning : Estimating the type of materials, their actual quantities, and the time at which it is required.
(ii) Type of material to be purchased and to be prepared internally.
(iii) Providing proper storage and distribution systems so as to reduce wastage, deterioration, etc.
(iv)Arranging transportation in the most economical way for the incoming and outgoing materials.
(v) Disposal of excess stocks, surplus, scrap items and also salvage of materials.
(vi) To develop new sources of supply for purchases to remain competitive in the market.
(vii) Development of ancillary units.
(viii) Cost control of materials using various reduction methods.
(ix) To develop coordination between various departments.
(x) To form research and development with respect to materials cell.

USES OF MATERIALS MANAGEMENT

To achieve best results, it would be a right practice to follow an integrated approach in materials management. It's uses are:

(i) Provides coordination between various departments.
(ii) Helps in taking decisions speedily and accurately.
(iii) Keeps a right balance of various conflicting interests under different functions.
(iv) To obtain a clear cut accountability due to centralisation of authority. It will be easy to take corrective action.
(v) Easy to collect data and analyse for improved decision making.
(vi) Exposure of every individual to different aspects of material function.

STORES MANAGEMENT

Stores management is a part of materials management. Various types of buildings are used for storage depending on the type of materials to be stored, convenience, cost of land, climatic conditions, transportation facilities, etc. Two factors are of utmost importance in determining the layout of store house viz; economy and efficiency. If a store house is not fully used, it is a waste of capital and if it is the one that holds too much, is wasteful in terms of time and labour. The main consideration should be to maintain a workflow through the store house so that it can be used continuously without any hindrance for removing, storing, routine check ups, etc.

Taking into account the above factors, several possible stores layout can be considered to obtain a satisfactory flow of materials through the store house.

(i) Straight-through flow layout : This is the simplest form. As shown in Fig. 1, the materials enter through one door, are stacked in straight rows, and are picked up moving in one direction only along the length of the store house and finally move out through the exit. Speed of movement, need for extra areas for other functions and the need to place working areas together are not considered in this type.

(ii) Layout in terms of storage used : Depending on whether the materials are stored in bins, racks or pallets, the layout is arranged. This type considers only the materials coming inwards and those going outwards. Here, no attempt is made to group the working areas and also no provision is made to deal more economically with faster moving items.

(iii) Layout when materials are grouped: Three layouts are shown in this method [Fig 3a (b) (c)]. Here, all the work elements are grouped together and allowance is made for special treatment of materials according to their speed of movement In this arrangement, the flow of materials is preserved regardless of whatever activities are being carried out and also flexibility is maintained because each division shown on the plan is movable.

The following considerations are necessary in the storing and stacking of civil engineering materials:

(i) The materials should not be affected by impurities or by atmospheric agencies like the sun, wind or moisture. Hence materials like cement or lime must be stored in covered sheds and stacked on timber-raised platforms, Large deliveries of cement are stored at the site in silos which are included with the concrete mixing plant.

(ii) Reinforcing bars are to be stacked in yards away from moisture to prevent rusting and also away from oil and lubricants. For easy handling, each type of bar should be stacked separately.

(iii) Timber is affected by sun and also by poor ventilation. Hence they must be stacked in a well ventilated, shady place. Similar lengths should be stacked together.

(iv) Both fine and coarse aggregates are to be stacked on a clean hard surface separately.

(v) Bricks, tiles and concrete blocks are stacked at ground level limiting the height of stacking from 1 to 2 metres.

(vi) Framed panels, window frames and door frames are to be stacked, levelled and fully supported.

(vii) Drain pipes are to be stacked on timber platforms raising them clear off the ground, with the pipe sockets reversed in alternate rows.

(viii) Since sheet glass is extremely fragile, it should be stacked vertically with an inclination of 30 to 60 on a timber or hard board base covered with fibre board or similar material.

(ix) Materials which are highly inflammable should be stacked separately from other combustible material and in a place protected from the hazards of fire. Smoking should be strictly prohibited in such areas.

(x) Explosive materials should be stacked away from combustible and inflammable materials in safer places. They should be kept under lock and key and the statutory requirements regarding explosive materials should be fulfilled.

(xi) Very heavy items of materials should be stacked away from soft ground, trenches or other places of insecure support to prevent subsidence and accidents.

The important features to be considered in material storage are:

(a) An item should be found whenever necessary.
(b) Facility to issue the oldest stock without extra effort
(c) Item to be issued should be in good condition,
(d) Stored material should not deteriorate.
(e) Equipments used in storage should not cause any damage to men and material and should be easy to use.

MATERIALS PROCUREMENT

It is one of the important factors to be considered since it is the major source of expenditure that is incurred. It is the process that converts plans and programmes into commitments to utilise resources. Materials procurement directly affects operations and profits. Materials of poor standards and ineffective quality control will cause delay in the implementation of the project and the resources may also get wasted, thus increasing the overall cost of the project. These can be reduced by a sound procurement organisation, planning and procedures.

The following approaches to materials procurement will be highly beneficial:

(i) Proper and well defined specifications.

(ii) Choice of right suppliers.

(iii) Classification, coding and cataloguing process.

MAINTAINING STOCKS AT ECONOMIC LEVELS

An efficient material procurement system will include various ways to make sure that the stocks which are obtained and maintained should be at economic level and the quantities should be such that there should be uninterrupted flow of the required resources. There should not be excessive inventories since it will lead to excessive investment causing unnecessary piling of resources in terms of money and also it will require extra space for storing which may lead to deterioration, pilferage, etc.

Methods for Establishing Economic Stock Levels

Lead Time Analysis. This is the time that elapses between the ordering for the goods, receiving them and putting them into use at the point of need. This is called the lead time delay factor. This also includes the time required for assessing the needs and also the time taken to prepare and place the orders. For each item of stock, this delay factor should be carefully assessed so that the proper quantity of stock can be maintained.

ABC Analysis. This is a basic management tool enabling the top management to concentrate the efforts where the results will be maximum. This technique is called as the Always Better control or Alphabetical Approach. Here, effort is made to analyse the money value of the material to determine its priority. When we analyse the annual consumption of materials in an organisation, it will be noticed that a handful of items making less than 10% of the total stock will account for a substantial portion about 75% of the total expenditure on materials. These are called as 'A items' and needs the careful attention of the materials manager. In a similar manner, a large number of materials which are at the bottom line making about 70% of the stock are classified as 'B items'.

Those between the A and B items are called the 'C items'. This approach will help the materials to concentrate on the costly A items among the lakhs of stores items. By this approach, the manager is able to control inventories and show excellent results in a short period of time. Many organisations have benefited in reduced clerical costs and in better planning and improved turnover.

Safe Stock Level. This is dependent upon the rate of usage and the probability of shortage. Data are to be collected on the trends in demand and usage to provide the necessary guidelines for fixing the adequate level of stocks. Though safe stock levels can be calculated by various ways, one of the method is by making an arbitrary decision to fix the level based on unit of time. This unit of time may stretch from a few days to six months or longer depending upon the type and value of goods and the rate of usage. Also, the safe stock levels can be maintained under two categories — low and high stock margin —— depending on the lead time for that material.

MATERIALS HANDLING

This is the technique employed to move, transport, store or distribute materials with or without the help of mechanical appliances. We must get the right goods safely to the right place at the right time and at the right cost. Due to the several complexities in the construction process, managers and engineers must be aware of the materials handling techniques so that the unit cost of construction can be cut down.

Now-a-days, several types of materials handling equipment are available for doing various functions such as movement, lifting and placing, etc.

Before deciding on the type of equipment to be purchased, a careful analysis about the characteristics of the material to be handled, type and length of movement required and other factors are to be considered. All materials handling and storage activities should be planned to obtain maximum overall operating efficiency. The main objective of planning materials movement should be to save money, time and men. Since gravity is the most economical prime mover, this should be utilised to move the materials wherever practicable All materials handling activities are to be simplified by reducing, eliminating or combining unnecessary movement and/or equipment. Also, suitable methods and equipment are to be provided for safe handling of the materials.

UNIT-5

HEALTH & SAFETY

INTRODUCTION

Construction activity in India has travelled a long distance in a relative2761y short period of time. From the humble beginnings of building simple structures and roads and minor civil work projects, the industry has changed significantly particularly over the 50 years following independence. The construction industry in India today is very large in size and complex in nature.

The social concern of the safety of construction workers and their protection against injury arising out of their employment has been quite evident for a long term. However, the measures taken to translate this social concern into concrete programmes of action — legislative, administrative or educational — did not bring the desired results. This happened largely due to the peculiar nature of this industry, including the lack of formal organisation. Basically the rate of growth in this industry has been so rapid that the legislation and standards as well as their implementation could not keep pace with it. This gap has to be narrowed down to the extent possible and in the shortest possible time. Construction is a relatively hazardous undertaking.

IMPORTANCE OF SAFETY

The construction industry, employing the largest labour force in the country has accounted for about 11% of all occupational injuries and 20% of all deaths resulting from occupational accidents. The cost of accidents is expensive. However, economic cost is not the only reason for which a contractor should be conscious of construction safety. The reasons for considering safety include:

1. Humanitarian Concern. When the accident happens, the resulting suffering of the injured workers and their families is difficult to quantify in economic terms. The contractor should never ignore this even if he has insurance against accidents.

2. Economic Reasons. Even if a has insurance, he will find out that the cost of accidents will come out of his own pocket through an increase in insurance premiums. In addition, there are other indirect costs that result from accidents. The direct and indirect cost of accidents can be:

Direct Cost:

(a) Medical care expenses for injured.

(b) Workmen's compensation costs.

(c) Insurance premium increases.

(d) Replacement cost of equipment and material damaged in accidents.

(e) Facility repair and clean up.

(f) Fees for legal counsel.

Indirect Cost:

a) Slowdown in operation.
b) Decrease in morale which affects productivity.
c) Productive time lost by injured worker and fellow workers.
d) Administrative work associated Nith accident.
e) Loss of clients' confidence.
f) Overtime necessitated by work slowdown

3. Laws and Regulations. As per different acts and laws, the employer should look after the safety of the employee. Violation of these laws will be subject to punishment.

4. Organisational Image. A good safety record can produce higher morale and productivity and stronger employee loyalty. It will also improve the company's public image and therefore, make it easier to acquire negotiated jobs.

CAUSES OF ACCIDENTS

There are as many possible causes of accidents as there are occasions. Among these are : technical defects in equipment and methods of work, defects in organisation and dangerous acts by workers. to these have to be added those causes that come from the nature of construction operations themselves, defects in planning and construction, constant changes in workplace and task, and the friction often found when workers from different trades are working in close proximity to each other. In the following list, the causes of accidents have been grouped according to their nature.

1. Planning, Organisation

(a) Defects in technical planning;

(b) Fixing unsuitable time-limits;

(c) Assignment of work to incompetent contractors;

(d) Insufficient or defective supervision of the work;

(e) Lack of co-operation between different trades.

2. Execution of Work

(a) Constructional defects;

(b) Use of unsuitable materials;

(c) Defective processing of materials.

3. Equipment

(a) Lack of equipment;

(b) Unsuitable equipment;

(c) Defects in equipment;

(d) Lack of safety devices or measures.

4. Management and conduct of work

(a) Inadequate preparation of work;

(b) Inadequate examination of equipment;

(c) Imprecise or inadequate instructions from supervisor;

(d) Unskilled or untrained operatives;

(e) Inadequate supervision.

5. Worker's Behaviour:

(a) Irresponsible acts;

(b) Unauthorised acts;

(c) Carelessness.

CLASSIFICATION OF CONSTRUCTION ACCIDENTS

The construction accidents can be classified under the following three groups:

1. According to the cause of occurrence

2. According to the nature of injury sustained.

(a) Temporary disablement

(c) Total disablement

3. According to the severity of injury:

(a) Minor accident;

(c) Accident hazard.

RESPONSIBILITY FOR SAFETY

The basic question is — whose primary responsibility is it to ensure safety in construction? The obvious answer is that everyone involved in construction has to shoulder the primary responsibility of ensuring safety in construction. However, the responsibility of safety in construction is mainly that of the management. Management is the contractor who undertakes the execution of the work or the builder who promotes a project or the construction department/agency for whom the construction work has been undertaken. The overall management for all construction activities however vests with the government. Although one single individual or agency has to shoulder the primary responsibility of ensuring safety in construction, the close co-operation of all those engaged in construction is a matter of vital significance.

SAFETY MEASURES

Safety during the construction of a project is also influenced in large part by decisions made during the planning and design process. Some designs or construction plans are inherently difficult and dangerous to implement, whereas, other comparable plans may considerably reduce the possibility of accidents. For example, clear separation of traffic from construction zones during roadway rehabilitation can greatly reduce the possibility of accidental collisions. Beyond these design decisions, safety largely depends upon education and training, vigilance and cooperation during construction. Choice of technology can also be critical in determining the safety of a job site. Safeguards built into machinery can notify operators of problems or prevent injuries. For example, simple switches can prevent equipment from being operated, when protective shields are not in place. With the availability of on-board electronics and sensors, the possibilities for sophisticated machines controllers and monitors have greatly expanded for construction equipment and tools. Proper choice of materials also influences the safety of construction. For example, substitution of alternative materials for asbestos can reduce or eliminate the prospects of long term illness such as asbestosis. Educating workers and managers in proper procedures and hazards can have a direct impact on job site safety. The realization of the 'large costs involved in construction injuries and illness provides a considerable motivation for awareness and education. Prequalification of contractors aid sub-contractors with regard to safety is another important avenue for safety improvement.

ROLE OF VARIOUS PARTIES IN SAFETY MANAGEMENT

1. Designer: At the planning stage, the architects, engineers and designers, while designing, should give due consideration to the safety of the workers who will be subsequently employed in the erection of such structures. They should exercise proper care and not include anything in the design which would require the use of dangerous structural procedures and undue hazards. These could perhaps be avoided by proper modifications in the design. The structural designer and architect should take into account the safety problems associated with the subsequent maintenance of structures where, according to them, special hazards are involved. Special care should be taken at the time of designing the structure, particularly in the case of tall buildings, to cater for the cleaning of the window on the outside.

2. Employer: The employers should provide and maintain buildings, plant, equipment and work passages and should organise the work in such a manner that workers are protected against risks of accidents. While buying machinery, he should ensure that the specifications of equipment, etc. conform to the various safety regulations. The employer should ensure that

proper supervision is provided to workers to perform their work under the best conditions of safety. In case, there is a group of persons doing a particular item of job, they should be supervised by a competent person who knows the safety requirements. They should not engage workers who have physical defects or mental disorders such as deafness, giddiness, bad sight etc. There are some persons who get giddiness at greater heights. They should not be employed on tall structures. Proper instructions should be given to all workers about the safety requirements. Buildings, equipments and work places in which a dangerous defect has been detected should not be allowed to be used till such defects are rectified. The employer should establish a proper system of signalling for any danger, The signallors should not be assigned any other duty when they are signalling. The signalling equipment should be efficient, properly installed, regularly tested and should be kept in proper working order.

3. Workers: All workers should do everything within their power to maintain their own safety and the safety of their co-workers. At the start of the job, the workers should inspect their workplaces and the equipment to be used by them and report any dangerous defect to their supervisor or any competent person. They should use all safeguards and safety devices made available for their safety and not interfere with equipment for which they have not been duly authorised to operate or use. Workers should not be allowed to sleep or rest in dangerous places such as scaffolding, running machines or vehicles, heavy equipment or near fires and dangerous substances. They should not indulge in careless practices or actions which can endanger the lives of others. Workers should use protective equipment for their safety and make themselves conversant with safety instructions.

4. Manufacturer or Dealer: The manufacturer and dealers of equipment should ensure that the machines, vehicles and other equipment used in construction industry complies with the safety laws and regulations and that these machines are as safe as possible. In case of toxic, corrosive, explosive flammable liquids and other dangerous items, the manufacturers should ensure that these are not sent to the user without adequate instructions.

SAFETY BENIFITS TO EMPLOYERS,EMPLOYEES AND CUSTOMERS

Safety Benefits to Employees: Any accident that results in reducing a worker's physical Power, creates serious challenges to that worker's projected manhood. If the worker attempts to return to work in the construction industry with a permanent partial disability, he or she often resents the special concern exhibited by the other workers. Loss in wages alone creates a heavy burden for the injured worker. If this is coupled with the pain and anguish that the worker and his family experience, theloss cannot be compensated for.Special care must be afforded to the injured worker in both physical and mental rehabilitation.

Safety Benefits to the Customer: As the expenses of industrial accidents are to be considered as cost of operation, and as such, are to be transferred from the worker and employer to the Customer, eventually, the customer will bear the cost of poor accident prevention programmes. It is very possible that the immediate cost will not affect the customer, particularly in the case of fixed bid contract construction, but the effect that losses due to injury creates within the cost of providing workmen's compensation insurance will eventually be felt. The cost of a project as viewed by the customer includes not only the price for construction but also — the time for which a project is the cost of non-productive capital. Accidents create time losses delayed while another piece of equipment is brought in to replace the damaged one, the time spent replacing an injured worker, and the training time to bring that worker to full production. Serious accidents can create delays that may never be overcome.

APPROACHES TO IMPROVE SAFETY IN CONSTRUCTION

There have been many rules and recommendation laid down as the result of research by societies, organisations and institutions on how to improve safety. Recognizing the importance of safety performance, a contractor can approach the problem in four different ways; organisational approach, physical approach, behavioural approach, and economic incentives.

1. Organisational Approach: A safety programme cannot be successful without an appropriate organizational setup. A company safety program should be a part of the contractor's business, just as scheduling and cost accounting. Several guidelines can be drawn.

(i) Safety Departments. A formal safety department is essential in. a company. This department should be incharge of the safety staff and jobsite representatives, recording and analyzing safety and other accident prevention programmes. The safety representative on each site should not be hired by the project management, since it may result in compromises in safety issues later. Safety personal should report to both the project manager and the safety director in the home office. He reports to the project manager so that timely corrections can be taken. The following model may be used for organising a safety department.

(ii) Committee. A safety committee should be set up to guide the operation of safety programs. The members of the committee should include all levels of workers and management to reflect opinions on safety from all levels. It should also review the company's safety programme periodically. This committee should be chaired by a Vice President or an executive Vice President.

(iii) Field Procedures. A system must be designed to process safety suggestions from workers, the people who carry out the daily construction process, since they are in the best position to detect any possible accidents. They should be reminded and encouraged to bring out any unsafe procedure detected in their daily routine. Timely responses and proper corrections should be made according to their suggestions.

(iv) Incentives. Field management and supervisors should be evaluated for promotions and salary increases in terms of safety record as well as productivity and cost. This will give them more incentive to carryout safety policies set up by the company.

(v) Safety Cost. The cost accounting system should be adjusted to encourage safety by allocating safety costs to company account and allocating accident costs to project accounts. Conventionally, project safety costs are treated as a project indirect cost, while the main office keeps a special account to take care of all cost resulting from accidents. This approach could make the project management reluctant to spend money in safety programmes in order to keep the project within budget.

2. Physical Approach: In physical aspects, a contractor can improve safety performance using the following guidelines:

(i) New workers should be given a safety orientation. Studies have shown that new workers usually cause more accidents. If new workers are given an orientation, the accident rate can be reduced.

(ii) For every project, the contractor must study in advance the possible accidents that the proposed construction methods, procedures and equipment may create. Then an accident prevention programme should be devised to take care of those accidents.

(iii) The contractor should enforce the use of approved equipment for personal protection such as hard hats (helmets), safety belts, safety glasses, goggles, hearing aids, gloves etc.

(iv) The contractor should integrate safety programs with other programs, such as scheduling and budgeting during preplanning procedures. This will help to identify possible accidents inherent in the work to be done, to suggest remedial training if necessary, to assure that proper tools and equipment will be available for the work, and to verify that the methods selected are safe, according to required standards,

(v) Periodic checking of tools and equipment is necessary in order to make sure that they are well maintained.

(vi) Conduct periodic safety meetings; such as tool box meetings, to provide safety education on the job.

(vii) Seek and obtain full cooperation from all subcontractors on the project. Many accidents occur just because of lack of coordination These kinds of accidents can be avoided easily by administrative effort.

3. Behavioural Approach: Studies conducted disclose that more than 80% of all accidents result from worker's unsafe acts, while only about 10% result from failure of equipment or improper procedures. Apparently, this is the area with the most potential for improving safety performance. Also, the behaviour of managers on every level has significant influence on workers', safety performance. The following guidelines will be found useful:

(i) Top management, while visiting job sites or meeting in the main office, should talk about Safety in the same way as they talk about schedules and costs, This will make the subordinates understand that safety is as important as cost and schedules, so that the importance of safety will not be ignored.

(ii) The project manager and the superintendents should not place unnecessary pressure on foreman, such as over emphasising the importance of meeting the estimated budget and schedule. Usually this will make foremen choose unacceptable methods that often lead to higher possibility of accidents.

(iii) Crafts foremen are the key persons in, behavioural approach as to better safety, because they are the persons who have daily contact with workers. They are also the persons in the best position to detect the workers abnormal behaviour.

(iv) The foremen along with project managers and superintendents should ü-y to create and maintain good relationships between members of craft crews. If workers have pleasant relationships with each other, they tend to be more concerned about their co-workers safety.

4.Economic Incentives: Owners as well as contractors should always bear in mind and take into consideration the economic benefits due to safety at the worksite. If a complete estimate should be taken into account for the cost of their safety programme as percentage of direct field labour costs, their estimates would result in some positive return for the amount spent on safety programme. The contractor should also reward workers for good safety performance. This creates perseverance on their part to learn. know, practice and strive towards a high level of safety at the job site.

MEASURING OF SAFETY

(i) Injury frequency rate. The term injury-frequency rate is defined as the number of disabling injuries per one lakh of man-hours worked. It is expressed by the following equation:

Injury frequency rate = (No. of disabling injuries x 1,00,000)/Total no. of man-hours worked

The disabling injury means an injury which causes a loss of working time beyond the turn, shift or day during which the injury occurred. Thus, injury-frequency rate denotes how frequently accidents occurred. But it does not take into account the time lost because of an injury.

(ii) Injury Severity rate, the term injury severity is defined as the number of days of lost time due to injuries for 1000 man-hours worked. It is expressed by the following equation:

injury-Severity rate = (No. of days lost x 1000)/No. of man-hours worked

(iii) Injury Index. It is expressed by the following equation:

Injury Index = (Injury frequency rate x Injury x Severity rate)/1000

iv) Equivalent time charge. The term equivalent time charge is used to indicate the number of days lost for partial or total disability of permanent nature. The equivalent time charge with respect to the importance of function of the member of the body can be framed and the members of the body are described as hand, thumb, arms, legs, combination of thumb and fingers, toes, eyes, ears etc.

PREVENTION OF FIRES AT CONSTRUCTION SITES

Construction activity affords numerous opportunities for out-break of fires because, the control of the sources of ignition as well as the measures to limit fire form spreading are often very poorly organised at construction sites. Even in the industries where fire is not a serious problem during the normal operation, the construction stage is the most vulnerable to fires. When there is a fire hazard in a construction project, it not only damages equipment and injures people, but also delays the project from being and this will result in cost escalation. Both the laymen and construction specialists continue to think that fire hazard is negligible during the construction stage. The feeling that concrete does not catch fire easily, pushes fire safety to a place of low priority. Hence, there is no pre-planning or continued management initiative for fire prevention. Now a days, with the increasing use of plastics as building materials, insulation, facades, piping etc, the spread of fires is very much enhanced. Again, open storage of materials in large quantities, ranging from scrap to sophisticated components adds to the fire hazard. In many situations, contractors are forced to establish large materials stores with almost no fire protection. The potential for fire hazards is increased due to climatic conditions, make-shift timber for scaffolding and formwork, the use of temporary electrical wiring and connections, the lack of training to the employees and supervisors to deal with a fire emergency, the non-availability of adequate public fire department services and lack of water supply. Alteration and rehabilitation measures to buildings present a greater fire risk than construction, since it is usually carried out with parts of the building still in use. In a particular incident, where a ware house for storage of cotton bales was being altered, cotton bales worth a few crores of rupees were damaged. From the experience gathered with fire hazards at construction sites, it is noticed that the frequent causes of fire are due to electrical short circuits, unauthorised smoking, inadequately controlled hot work such as welding etc. Other factors such as poor housekeeping and unsafe storage of materials have also been responsible for large amount of losses. It is observed that 60% of construction fires are caused due to the following main reasons.

Due to portable heating equipment....25%

Due to cutting/welding operations....20%

Matches and smoking...,15%

Proper planning and scheduling of fire preventive measures by construction managers, minimises fire outbreaks and contains the damage. Many insurance companies have lot of experience in fire safety measures. The Munich Reinsurance company has compiled a list of fire prevention features for fire protection on construction sites.

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Department of Civil Engineering

LEARINING MATERIAL UNIT - VI

on

CONSTRUCTION MANAGEMENT

CASE STUDY: THE PROJECT MANAGER AND MOLD REMEDIATION

Toxic mold is a growing concern as several states require remediation of this problem. The project manager faces many challenges in finding solutions to microbial abatement as illustrated in this case study. This chapter illustrates the multifaceted approach required by the project manager. The reader is urged to contemplate how to incorporate the principles of project management and leadership learned in this book to solve the abatement problem. Apply the principles of sound planning and use the computer tools presented to manage the schedule and other challenging aspects of this project.

ABSTRACT

A hotel constructed with an exterior insulation finish system (EIFS) had problems with water penetration of the building shell. This resulted in substantial mold growth in greater than 100rooms in the ten-story hotel. Microbial abatement was completed in about three months. Standard microbial abatement procedures were used. These included containment with critical barriers, airlocks, curtained doorways, the use of negative pressure, HEPA filtration, and worker protection. The hotel configuration and demands of this project created interesting abatement design problems. The problems included a bathroom in every guest room, abatement on multiple floors at a time, concurrent abatement and re-construction, and freezing temperatures. This presentation shows how these problems were dealt with to successfully complete the project.

INTRODUCTION

A 10-story hotel in a small mid-western city in the U.S. was constructed using the barrier exterior insulation finish system (EIFS). The hotel was constructed in the late 1970's. Since that time, many buildings, commercial and residential, have been constructed using this system. In the 1990's large-scale moisture problems have been discovered on buildings across the country as a result of the inability of intruding water to escape the wall cavity. Below figure is a typical barrier EIFS wall section. This hotel wall was not built with the cavity insulation or vapour retarder as shown in this figure.

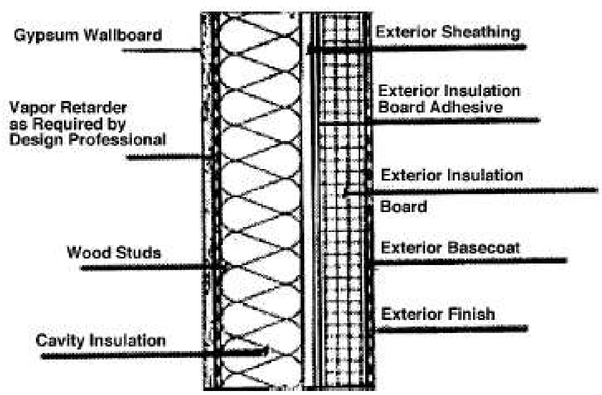
Over a period of several months, more and more guest rooms were found to have moldy wallboard behind vinyl wall covering. Eventually, over 100 rooms in the hotel were affected. Hotel management had an industrial hygiene consultant investigate the problem. Environmental sampling identified several different fungal species growing on the wallboard, including Penicillium sp., Aspergillus sp., and Stachybotrys sp. Air levels indicated that some of the spores from these molds were airborne. These are all molds that can cause health problems like allergy, asthma, and potentially more severe lung disease to exposed people. These problems eventually led to closing the hotel for exterior repair and mold abatement in the fall of 1998.

MICROBIAL ABATEMENT

An abatement contractor was hired and microbial abatement specifications were written. The abatement began on the 10th and 7th floors of the hotel in December 1998. It was completed in February 1999.

Microbial decontamination projects involve the disturbance of hazardous materials. Disturbance of microbial amplification sites can literally release millions of spores into the air. It is important to choose the abatement contractor carefully. They should know the basics of building containment systems, establishing negative pressure enclosures, have good health and safety plans, and a trained and reliable workforce. Appropriate training is required for respiratory protection, clean-up procedures, and potential health hazards associated with the microorganisms to be removed. Many asbestos abatement contractors have made the transition to microbial abatement because the work is similar and their workers have much of the required training.

Proper remedial project design is critical to prevent potential human and environmental impacts from the release of microorganisms. The first step in any microbial abatement project is the elimination of the source of water/moisture. The microbial abatement specifications contain components for worker safety, decontamination protocols, and environmental protection.



Worker Safety

1. Comply with appropriate OSHA Standards, e.g. hazard communication and respiratory protection.

2. Use appropriate respiratory protection, which normally includes full-face mask with HEPA cartridges. Use full-body protection, e.g. TYVEK® coveralls with hood and foot protection.

Decontamination Protocols

1. Collect appropriate environmental samples to identify the microorganisms present and to define the scope of work.
2. Remove contaminated porous materials and debris.
3. Dispose of all contaminated materials (waste may be regulated depending upon the substrate and local regulations).
4. HEPA vacuum all vertical and horizontal surfaces
5. Wipe all non-porous surfaces with a cloth dampened with water: bleach solution (10:1).

6. Ventilate the area with clean air with at least 96 air changes (i.e. 4 air changes per hour for 24 hours).
7. Visually inspect the area and, if clean, conduct appropriate clearance sampling (air spore counts, surface spore counts, etc.).

Environmental Protection

1. Determine the need for regulated areas, negative pressure containment systems, and occupant relocations.
2. Shut down ventilation systems serving the work area and install critical barriers. Seal all return air openings from the area.
3. Construct an appropriate work area containment system. This system could be a simple regulated area with critical barriers or a fully contained area with double layers of polyethylene sheeting on walls, floors, decontamination units, and negative air filtration devices for depressurization.
4. Employ a continuous pressure differential monitor between the inside and outside of the contained area. The monitor should have a printout of the pressure differential and an alarm to warn of a loss of pressure differential. The target AP should be -0.02 inches of water gauge.
5. Control access to the regulated area.
6. Double-bag or wrap all waste material and dispose through the decontamination unit.
7. HEPA vacuum all material removed from the regulated area.
8. Collect environmental samples for quality control.

A case study may be understood best as a narrative, based on actual events, that creates an opportunity for conversation, problem analysis, and virtual decision-making. An effective case study transfers specific knowledge by placing the student or workshop participant in a position to think through choices faced by decision-makers in real-life situations. By confronting actual scenarios, participants develop and refine analytical skills for solving similar problems in their own projects (NASA, 2008).

The Practice Standard for Project Risk Management published by the Project Management Institute (PMI, 2008b) describes standards for risk management that are recognized as good practice on most projects most of the time. Do complex projects require any different or additional processes or procedures than the standard describes?

In A Guide to the Project Management Body of Knowledge – Fourth Edition (PMBOK Guide), "project risk is an uncertain event or condition that, if it occurs, has a positive or negative effect on at least one project objective." The definition for Project Risk Management, as defined in the PMBOK Guide, is "Project Risk Management includes the processes concerned with conducting risk management planning, identification, analysis, responses, and monitoring and control on a project." PMBOK Guide also states: "The objectives of Project Risk Management are to increase the probability and impact of positive events, and decrease the probability and impact of negative events in the project."

Practice Standard for Project Risk Management identifies three critical success factors for risk management:

- Identify and Address Barriers to Successful Project Risk Management

- Involve Stakeholders, and
- Comply with the Organization's Objectives, Policies, and Practices.

Oil and gas joint ventures (JV) sometimes do not have fully developed policies and procedures in their early stages. If risk management procedures are not part of the procedures the JV has compiled, effective and practical risk management procedures need to be put in place.
The standard also identifies ten critical success factors for identifying risks:

- Iterative Identification
- Early Identification
- Emergent Identification
- Comprehensive Risk Identification
- Explicit Identification of Opportunities
- Inclusion of multiple perspectives
- Fully described risk statements
- Risks should be related to at least one project objective
- Assignment of an owner to a single risk, and
- Maintaining an objective view and exposing bias.

Using multiple risk identification techniques is recommended (PMI, 2008b). A project may choose to use a risk universe checklist (historical review), together with assumptions analysis (current assessment) and brainstorming (creativity).

The Context – Risk in Oil & Gas / Complex Programs

The design and construction of a refinery is inherently complex. The FEED (front end engineering and design) is the most critical stage where it's easy to influence the design at a relatively low cost. However, risk can occur at any project stage. One refinery in India, for example, experienced financing problems, design issues, was partially destroyed during construction, and was underinsured. Eventually it was completed in 13 years. The original schedule was 4 years

This case study views risk from the owner's rather than the contractor's perspective.

Oil Refinery Program Background

Developed by Wilbur L. Nelson in 1960, the Nelson complexity index (NCI) describes a measure of the secondary conversion capacity of a petroleum refinery relative to the primary distillation capacity.

The index indicates the investment intensity of the refinery and its potential value addition; the higher the number, the greater the cost of the refinery and the higher the value of its products.

The refinery in this case study has a Nelson complexity Index of 10.6. As a comparison, the average NCI of the United States refining industry is 10.9. Europe refineries have an average rating of 6.5. So while the Refinery can be considered complex, it is comparable with the average US refinery.

The refinery will process low cost Arabian heavy crude oil to produce high value refined products, Liquified Petroleum Gas (LPG), petroleum coke, liquid sulfur and petrochemical products (paraxylene, benzene and propylene) that meet the global market's most stringent product specification s. It will benefit from close proximity to the Arabian heavy crude supply system in the Arabian Gulf and from the facilities of the Jubail Industrial City, including water, power, other utilities, infrastructure and a residential section. It will also benefit from the facilities at the King Fahad Industrial Port.

“The Refinery will be located on a 480 hectare site in the industrial area of Al-Jubail known as Jubail 2 in the Kingdom of Saudi Arabia (KSA). This is a newly developed area of Jubail that will be equal in size to the presently developed industrial city (now termed Jubail 1). Jubail 2 lies inland from Jubail 1 on the opposite side of the main E-W highway and pipeline. The Project will be the major new project on the Jubail 2 site, and is the first expansion of the industrial city since it was originally laid out in the early 1980s..

In addition to the site in Jubail 2, SATORP has been allocated 17 hectare of land in the King Fahd Industrial Port for storage as well as access to 5 berths at the port for the shipment of its products, including petroleum coke.

Project Objective

“The competitive advantages of the Project from a technical perspective are:

- Large-scale capacity (400,000 barrel per day capacity)
- Access to low cost utilities and infrastructure in the Jubail Industrial City
- Strategic location with reach to the European and other markets
- Full conversion of fuel oil into high value distillates with rejection of carbon as coke)
- Use of lower-cost heavy crude feedstock (Arabian Heavy crude)
- High value petrochemical production (equivalent to 5 wt% of crude oil feedstock)
- Competitive modern process technology, with proven plant design, supplied by the leading licensors
- Secure long-term supply of a single crude oil from Saudi Aramco”.

“Process technology has been licensed from reputable licensors and all technology is commercially proven in operation of a similar scale and duty in other operating plants. The key licensors are:

- Axens—NHT/CCR (Naphtha Hydrotreater/ Continuous Catalytic Regeneration), Aromatics, FCC (fluid catalytic cracking)
- Chevron-Lummus Global—Hydrocrackers
- DuPont —Sulphuric Acid Alkylation

- Foster Wheeler—Delayed Coker
- UOP—Middle Distillate Hydrotreaters”.

Joint Venture Partners

The refinery is owned 62.5% by Saudi Arabian Oil Company (Saudi Aramco) and 37.5% by TOTAL Refining Saudi Arabia SAS Limited (TOTAL) registered in France, a wholly owned subsidiary of TOTAL S.A.

Key Stakeholders

The Saudi Royal family is a key stakeholder as the refinery is to be constructed on land leased under a 30 year operating lease agreement with the Royal Commission. The lease is renewable by the Company for similar periods under mutually agreed terms and conditions for the benefit of the Company.

Other stakeholders include the executives of the two joint venture partners and team members including internal contractor staff. Commercial tenants in the Jubail Industrial City will be stakeholders as well.

Cost and Financing

The refinery is estimated to cost about $12 billion. Refinery Management plans to use commitments from Export Credit Agencies and certain international and commercial banks to provide the company with senior secured term loan facilities at favorable pricing and loan guarantees. These include the Public Investment Fund of Saudi Arabia and the Export Credit Agencies:

- SACE - S.p.A. Servizi Assicurativi del Commercio Estero - Italy
- JBIC - Japan Bank for International Cooperation
- NEXI - Nippon Export and Investment Insurance - Japan
- KEXIM - Export-Import Bank of Korea
- KEIC - Korea Export Insurance Corporation

The refinery will be funded in the early stages through shareholder loans. Expenses to date are about US$100 million, which include FEED costs.

Market and economic context

Oil demand has been relatively soft since the global economy went into recession in 2009. The Project refinery is an export oriented facility, processing Arab Heavy crude oil to produce gasoline and diesel.

“There is ample feedstock available for the Project from Saudi Aramco, one of the two joint venture partners. The future sustainable capacity for Arab Heavy production is estimated to be at least 2.4 million barrels per day (b/d), whereas domestic demand (including the Project) is not expected to exceed 1.3 million b/d”.

Wood MacKenzie performed an analysis of the Project using a Net Cash Margin (NCM) approach and found it placed very competitively when compared with other refineries. NCM captures most of the critical elements of a refinery's performance that define its competitive position in the short / medium term; NCM is defined as:

“NCM ($/bbl) = Product Worth ($/bbl) - Cost of Crude ($/bbl) - Cash Operating Expenses ($/bbl)

NCM multiplied by annual crude refinery throughput is effectively equivalent to EBITDA (Earnings before Income Taxes, Depreciation and Amortization). EBITDA is a metric used by loan covenants and investors.”

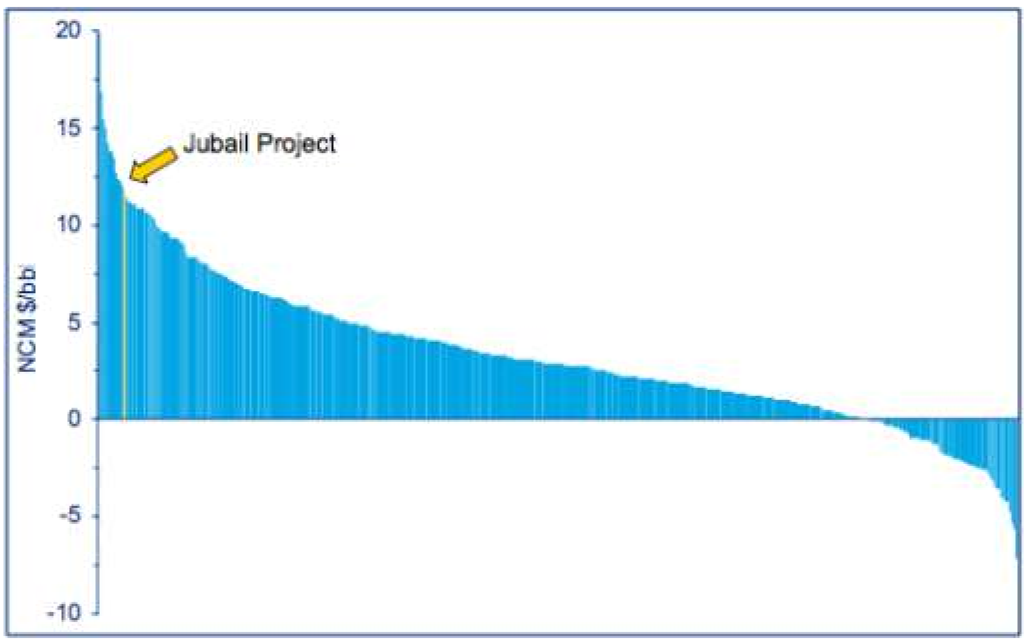


Exhibit 1 Future Competitive Position of the Project vs other Global Conventional Fuels Refineries

Your role

You are a contractor who has been brought into the project as the Program Risk Engineer. The Joint Venture does not have specific Risk Management procedures in place, but wants to follow good practices for project risk management.

Project Timeline Overview

Level 1 Schedule – Contract Time Frame

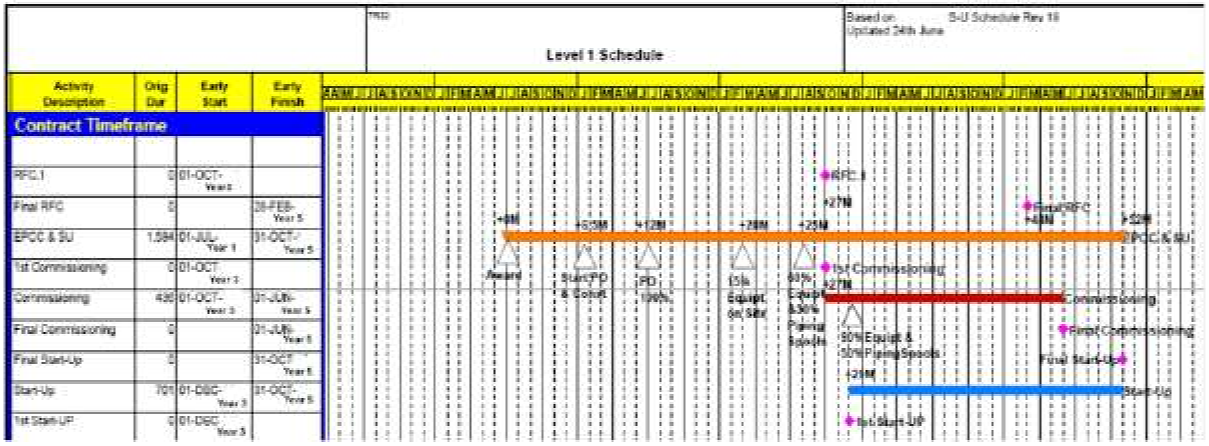


Exhibit 2 - Project Timeline Overview

Key Milestones
June, Year 1, Award of contracts
January, Year 2, Start Construction
March 1, Year 3 15% Equipment on site
July, Year 3 60% equipment and 30% piping | Spools
October 1, Year 3 1st commissioning
December, Year 3 90% equipment 50% piping Spools
May 31, Year 4 Final Commissioning
October 31, Year 4, Final Startup

Current Phase – Procurement and Tender Timing
The project has completed the FEED phase, and the procurement stage is almost complete. The FEED divided the work into 15 packages, and all have been put out to tender. However, there are two major concerns: price and number of contractors. Negotiations are underway with the contractors for their best and final offers. But preliminary results show the refinery costs are likely to slightly over US $12 billion. Management wants the cost reduced. The current engineering, procurement and construction (EPC) market is relatively soft due to the global recession. Management is asking whether any positive opportunities exist because of the global recession, and whether retendering should be done.

Some analysts say cost savings from retendering may not be as dramatic as executives would like. Matthew Nathan, a Middle East associate director of project finance at UK bank HSBC, argues that the savings on project costs may not be as dramatic as clients would have hoped for. "I would question whether people truly believe contract prices for lump-sum turnkey contracts have come down," he says. "Our view is that the EPC contractor market has softened, but the prices have not really come down." (Oil and Gas News, 2009, ¶11)

The second management concern is number of contractors. The FEED divided the work into 15 packages. However, management realizes this is a large number of separate packages, and coordination among the different contractors could create problems. When tendering was done, all 15 packages were separate and no prime contractor role was designated.

Two options that have been discussed were arranging a tender for a prime contractor to manage the work or use an EPCM (Engineering Procurement Construction Management) contract. Another option would be to consider how management of packages can be simplified. A third would be reorganizing and reducing the number of packages and retendering.

Package	Description
1	Distillate and Hydrotreater Package
2	Conversion Unit and Sulphur Package (Part 1)
3	Conversion Unit and Sulphur Package (Part 2)
4	Aromatics Package
5	Coker Package
6	Interconnection, Gas Flaring and Electrical Systems Package
7	Plant Utilities Package
8	Auxillary Plant Utilitiies
9	Crude Storage Tanks Package 1
10	Construction Facilities Package
11	Pipelines and Offsites Package
12	Crude Storage Tanks Package 2
13	Permanent Communications Facilities
14	Temporary facilities
15	Permanent Infrastructure/general building works

Exhibit 3 – List of Packages

A third concern is the completeness of the FEED. The leading practice is to conduct structured technical reviews to gauge the quality and completeness of the design work done during the FEED. These structured technical reviews may be based on the Project Definition Rating Index, peer reviews, or a mix of methods.

Performance to Date

Retendering may take 10 to 12 months. But even if only 5% could be saved, it would result in reduced Capital expenditures (CAPEX). On a 10 to 11B project, 5% savings would be US$500 million.

Challenges

The project schedule can be an area of contention. Contractors frequently complain of clients who demand under budgeted timeframes by as much as 25%.

The number of qualified EPC contractors has been reduced in the last decade through mergers. Even though the recession has decreased global demand for EPC services, the Saudi Arabian market has many ongoing projects that last multiple years. These projects can peak at the same time in construction, resulting in bottleneck. As one European contractor said, "Visas, general bureaucracy, logistics, supplies, a lot of us are going to be fighting for the same limited resources". Contractors and subcontractors can't always find experienced engineers, especially when relocation to Saudi Arabia for months or years is required.

Decisions

Procurement Strategy and Objectives

The owner's priorities are to reduce capital expenditures to the greatest extent possible, while still building a highly complex full-conversion refinery. They also wish to put the onus on the contractor / EPC to the greatest extent possible, and prefer using lump sum, turn key contracts whenever possible. The Saudi government wants to build capabilities of local firms. The joint venture also wants to encourage local firms to compete for the EPC contracts in line with the JV's policies and objectives.

Organizational Structure of Program

The Project Director has full responsibility for Engineering, Procurement, Construction and Commissioning (EPCC) execution of the Project reporting to the CEO of the JV and supported by a temporary Project Management Team (PMT) for the period of EPCC execution.

The PMT is estimated to peak at 300 plus personnel during the engineering phase and to be approximately 400 plus personnel at the peak of construction phase. Staffing of the PMT will be by secondees from the JV partners supplemented by temporary personnel from staffing agencies.

Risk Management Strategy and Tactics

The following risks have been observed:

1. Lack of a prime contractor may lead to poor coordination and ultimately a longer schedule.
2. The number of packages, 15, may lead to more efforts in coordination and communication.
3. The standard EPC contract has no requirement for the contractor to perform risk management.
4. The joint venture has policies and procedures, but does not have risk management procedures yet in place.
5. Retendering could produce lower contract offers, which would be a positive risk. It would also delay the project by several months however.

Do you see any other risks not in the list above? When considering risks, use a 5 by 5 matrix for likelihood and impact, where 5 is high and 1 is low, as shown in Exhibits 4 and 5 below. Exhibit 5 quantifies the risk in terms of effect on cost, schedule, scope, quality and safety.

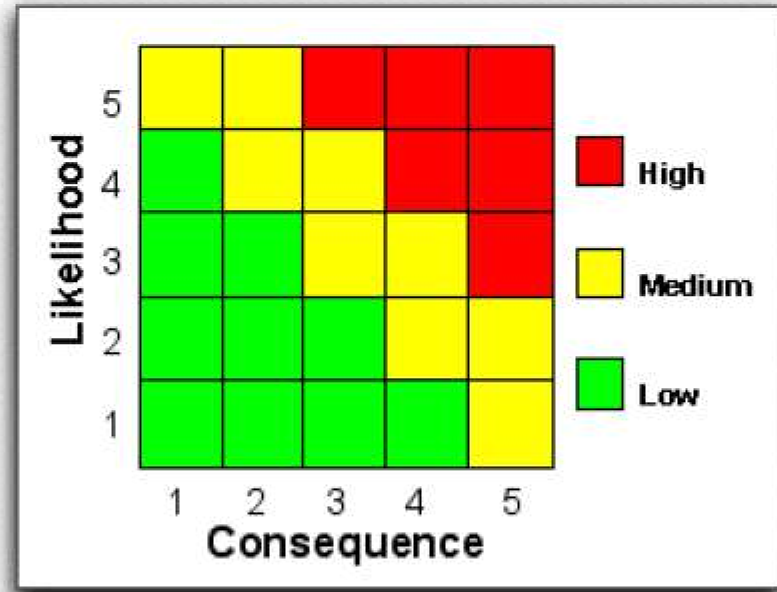


Exhibit 4 –Simple Risk Matrix

	1	2	3
Project Objective	Low (10%)	Medium (40%)	High (80%)
Cost	<1% cost increase	< 3% cost increase	> 3% cost increase
Time	< 1 week delay	1-3 week delay	> 3 week delay
Scope	Minor areas of scope affected	Moderate areas of scope affected	Major areas of scope affected
Quality	Minor quality degradation	Quality reduction requires special approval	Project quality reduction unacceptable
Safety	Minor safety degradation	Moderate safety degradation	High level of safety degradation

Exhibit 4– Risk Quantification Matrix

What mitigation(s) would you recommend for each risk?

Potential Unintended Consequences

Are there any potential consequences that need to be addressed as a result of the mitigation strategy taken? For example, retendering could be viewed negatively by an EPC firm, causing them not to bid again. What efforts would you recommend considering in this case?

Conclusions

Risk can have both positive and negative consequences. Good risk management practices can increase the probability of project success, and should be performed throughout a project's life.

An effective case study does five things:

- Leaves important issues unresolved;

- Allows for multiple levels of analysis;
- Captures a tension between courses of action;
- Generates more questions than answers;
- Fosters decision-making thinking