Certified Construction Associate
Educational Program

Construction Principles

NAWIC Education Foundation

NAWIC EDUCATION FOUNDATION
P. O. Box 37069
Raleigh, NC 27627

Toll Free 866-277-2883

WEB Page: http://www.nawiceducation.org

CERTIFIED CONSTRUCTION ASSOCIATE℠
Educational Program

NAWIC EDUCATION FOUNDATION

Construction Principles

Prepared by
Cogswell College, San Francisco, California
General Editor: Gary M. Gerdes, M.A.
Written by
Judy Moss, Coordinator of Staff Development
Stanford University
Illustrations: Charles Nanco
Updated by
Chris Piper, Clemson University

PREFACE

The CERTIFIED CONSTRUCTION ASSOCIATE program is an advanced, six-part home study course in construction terminology, procedures and processes. To give further merit to the title CCA in the construction industry, The NAWIC Education Foundation (NEF) made CERTIFIED CONSTRUCTION ASSOCIATE Foundation available to the public in 1982. Now, any person interested in moving into positions of management and administration in the construction industry may enroll in the program. The CERTIFIED CONSTRUCTION ASSOCIATE will learn to exercise judgment and expertise in administrative affairs when dealing with employees, governmental units, professional associations, contractors, the public and customers

Certification examinations are administered under the auspices of local NAWIC chapters Clemson University is responsible for preparing examination booklets, handling security and scoring exams. After successfully passing certification exams in all six parts, enrollees receive a CERTIFIED CONSTRUCTION ASSOCIATE certificate and may use the letters CCA after their name.

Such educational programs are an important part of NAWIC. In 1971, NAWIC's president surveyed the construction industry and recognized the need for a guided study series for those interested in moving from secondary to management positions. The NAWIC Education Committee was appointed in 1972 to develop educational programs, among them, CCA.

The program was originally designed over an eight-year period by Northeast Louisiana University. In 1981, Cogswell College in San Francisco, California, began revising the program to lessen the dependency of the courses on textbooks and enable participants to qualify for accreditation. In 2005, the books were updated and revalidated by Clemson University.

The NAWIC Education Foundation gratefully acknowledges Northeast Louisiana University, members of the NAWIC Education Committee, Cogswell College, and those writers who were instrumental in making this six-part series a valuable tool for the entire construction industry.

STUDY TOPICS

Construction Environs

Effective Communications

Management Techniques

Labor Relations

Business Analysis

Construction Principles

CONSTRUCTION PRINCIPLES
Table of Contents

Section E – Planning, Scheduling and Controlling A Project

Section F – Safety in Construction

Section G – Security

Section H – Quality Control

CONSTRUCTION PRINCIPLES
SECTION A – THE CLIENT, THE ARCHITECT, THE ENGINEER AND THE CONTRACTOR

INTRODUCTION

Objectives

After completing this Section, you will be able to:

- Read a contract for professional services for an Owner-Architect, Owner-Engineer and Architect-Engineer.

- Evaluate the ethical considerations in force for the construction industry

Introduction

Section A of the Certified Construction Program for the NAWIC Education Foundation, The Client, The Architect, The Engineer and the Contractor, deals with the study of ethics, definitions, forms of contracts, the general conditions and special conditions of contracts. To facilitate this study, publications and sample contract document forms, published by the American Institute of Architects (AIA) will be used. You will need to acquire these documents on your own.

Most Sections of this Study Guide give you a brief overview of a particular subject followed by questions which continue the overview. You are encouraged to answer these questions for yourself, when necessary looking up in-depth treatments of the subjects in the index or another of the reference books included in the Bibliography. Compare your answers to the suggested answers that are given in the "Answers to Questions". Consider all material in the overview as well as the "Answers to Questions" as study material for your exam.

The documents and forms are pathways to understanding the processes of contracting principles and their relationships to the performance of work. The materials aim: (1) to interest and involve the student in the administration and management of contracts; (2) to define the terms of contracts and their meaning; (3) to guide the principals to a contract through acceptable and ethical behavior under the contract. The materials are only pathways which the student can walk along while learning to prepare, administer and/or manage contracts of any complexity or magnitude.

Thus, the specific major goals of this guide and the selected materials are to help the student to acquire:

1. A lasting interest in the elements of contracts and contracting as they are used in on-site construction.

2. An understanding of and an appreciation for the role of each part to the contract; the responsibilities of each and the inter-relationships.

3. The ability to prepare, negotiate, interpret and manage any of the many forms of contracts.

The method of the lesson assignments in this section springs from the theory of self instruction. The evidence is overwhelming, however, that you will retain very little of what you teach yourself unless you become interested enough to continue to use your knowledge while reading the newspaper or trade journals, while banking or obtaining a loan for the purchase of a car or home in the world of business and construction beyond the classroom or desk.

Each of the people listed in the title of this section have an important role to play in the establishment of a contract, or a project. It takes at least two of the four to cause anything to happen.

The Client is the person or the corporation that initiates a project or a dream. This person or the corporation will eventually pay for all the work to be performed by any or all of the others. He or she may be an individual, a company, a partnership or a giant corporation. The Client cannot do what needs to be done alone.

The Client hires an engineer, a consultant, an architect or a contractor; one who can design and construct the project. The project may be a building, a bridge, a road; it may be a process, a publication or a commission to develop some idea or program. It really makes no difference whether the project is large or small. It all begins with the Client.

The Architect and/or the Engineer may accept a commission to do work for the Client. The function of the Architect/Engineer is manifold and varied. The function may be that of a consultant or advisor suggesting solutions and developing ideas; a representative or agent of the Client. The function may be complete project development and design, including detailed drawings and specifications, contract documents, bidding, review, contract award, construction supervision to project completion. At every step the Architect/Engineer acts for and represents the Client. The relationship between the two needs to be at the highest level to avoid mistrust, confusion or even big mistakes. There must be an understanding and agreement at each phase of the work. The end result must be what the Client has paid for and within the Client's budget. The Architect/Engineer may be placed in the role of Client if any of the work is subcontracted to other engineers, architects, suppliers, etc.

The Contractor, even though named last in our title, is not to be defined as the last in the chain of a project. The Contractor (manufacturer, vendor, and supplier) may be called into the project from its inception. It must be repeated that the relationship between the Contractor and the Client must be of the highest order. The Contractor may deal only with the Architect/Engineer, but works for the Client (owner, agency, etc.).

Glossary of Organizations

The following acronyms are used for designated organizations throughout the text.

1. ACEC = American Consulting Engineers Council
2. AIA = American Institute of Architects
3. ASCE = American Society of Civil Engineers
4. AGC = The Association of General Contractors of America
5. CSI = Construction Specifications Institute
6. NSPE = National Society of Professional Engineers

These initials are used to identify the organizations as well as publications from the organizations. The format of this identification follows a regular pattern: initials succeeded by numbers. Thus, AIA C141 is publication C141 published by the American Institute of Architects.

How to Use Section A

Locate and review the following documents:

1. The document defining General Conditions of the Contract for Construction.
    a. General Conditions of the Contract for Construction (AIA A201)

2. Two Standard Forms of Agreement:

    a. Standard Form of Agreement Between Owner and Architect for Designated Services (AIA B-161)
    b. Standard Form of Agreement Between Architect and Engineer (AIA C-141)

3. The document defining responsibility and limiting the scope of Standard Forms of Agreement:

    a. Statement of Scope of Designated Services (AIA B-162)

4. Three documents appended to this Section concerning ethics:

    a. Code of Ethics for Contractors
    b. Code of Ethics for Architects
    c. Code of Ethics for Engineers

These documents, which are updated periodically by the responsible organization, are standard in the construction industry, and they constitute the bulk of the material in this section. After you are thoroughly familiar with them proceed with Lesson 1.

CONSTRUCTION PRINCIPLES
SECTION A – THE CLIENT, THE ARCHITECT, THE ENGINEER AND THE CONTRACTOR

LESSON 1
Reading Contracts

Read this document:

- General Conditions of the Contract for Construction (AIA A201)

Using what you've learned from the contract documents listed above, answer the following questions:

1. For engineering or architectural services:
    a. Determine and list the responsibilities of the Architect/Engineer.
    b. Determine and list the responsibilities of the Owner.
    c. Determine the desired end result
    d. List any special conditions or restrictions placed on either party.
2. For construction services:
    a. List qualifications of a Contractor to perform the required tasks.
    b. What is the end product?
    c. What are the special requirements?
    d. What are the methods suggested in the contract for settling disputes or conflicts?
    e. Is the Architect/Engineer named as the agent of the Client? If so, in what function?

Note: All companies can enter a contract as a Client, even a construction or manufacturing company.

CONSTRUCTION PRINCIPLES
SECTION A – THE CLIENT, THE ARCHITECT, THE ENGINEER AND THE CONTRACTOR

LESSON 2
Ethics

Read these documents:

- AGC Standards of Ethical Conduct (See page A-11)
- AIA Document J330 Code of Ethics and Professional Conduct (See page A-13)
- NPSE Publication No.1102 Code of Ethics for Engineers (See page A-21)

It is to be noted that some organizations require compliance with a code of ethics and others only suggest compliance (voluntary). Review the three ethical codes on standards and then answer the question: “Should compliance be mandatory or voluntary?"

Application for membership into the AIA used to require that any applicant would agree to comply with or subscribe to the Code of Ethics. In August 1980, the Board of Directors repealed the AIA Code of Ethics and Professional Conduct and terminated all enforcement proceedings (see page A-20). Reread Part 4 of AIA Doc. J 330 "Code of Ethics and Professional Conduct" (see page A-15). This is the item repealed. List possible reasons why this document might be offensive to individuals. How would you change the document? In its present form, can this document be acceptable as a voluntary system of ethics? Explain.

CONSTRUCTION PRINCIPLES
SECTION B – CONSTRUCTION STANDARDS

LESSON 1
Building and Zoning Codes

Objectives

After completing this lesson, you will be able to:

- Understand some of the regulatory agencies and better evaluate their effect on the total cost of construction
- Communicate more knowledgeably within the construction industry
- Better understand who controls building, while becoming acquainted with the regulatory agencies.

Building and Zoning Codes

In this unit we will discuss some general concepts and topics concerning the construction industry, but our main investigation will concern only two of the many regulatory agencies which must be included in the long list of those controlling construction.

We will first attempt to develop an idea of the role building codes play in the total picture of construction.

Let us start by defining a building code. Building codes are assemblies of standards and specifications that are designed (1) to establish safeguards in design and construction of buildings, (2) to protect people who use the buildings from fire and other hazards, and (3) to further protect the health and safety of the public.

For thousands of years the civilized world has had some limited control over construction and utilization of buildings and structures. Many major cities were devastated by fires that took unrecorded numbers of lives. A combination of building inspection and fire prevention, along with zoning controls, proved effective weapons in the reduction of fire losses.

Some form of building construction and health laws have always been a part of recorded history. The Pentateuch, the first five books of the Old Testament contain the early laws of the Hebrew people. These laws governed not only man's relationship to God but also man's relationship to one another, and included specific provisions with respect to health, safety, and sanitation. The Hammurabi Code, an early Babylonian edict, prescribed strict penalties, even death, to the builder for failure to construct safe and durable houses.

The Egyptians regulated building construction and materials as well as building design in the erection of the Pyramids and religious temples. They employed building construction methods and building technology not entirely rediscovered by modern man. The Romans, in their

CONSTRUCTION PRINCIPLES
SECTION C – THE BIDDING AND NEGOTIATING PROCESS

INTRODUCTION

Objective

After completing this Section, you will be able to:

- Program and monitor the necessary negotiating and bidding process for most building projects.

Section C of the certification program for the NAWIC Education Foundation addresses the bidding and negotiating process used in the award of construction contracts. Basic concepts, documents, and general procedures, from advertisement to award of the competitively bid contract, are discussed in detail in Lessons 1 through 4.

Fundamental concepts and procedures involved in the award of negotiated contracts are presented in Lessons 5 and 6.

The exhibits referred to in the Lessons provide you with general information as to typical standard forms used for construction contracting. These standard forms are not up-to-date in detail as they are constantly changing. They do, however, acquaint the student with the general environment for construction contracting.

CONSTRUCTION PRINCIPLES
SECTION C – THE BIDDING AND NEGOTIATING PROCESS

LESSON 1

Basic Documents

The contract between the governmental agencies or private concerns desiring construction to be performed and the Construction Contractor is not a single document. A set of contract documents may include the following:

1. Advertisement or Notice to Bidders
2. Instructions to Bidders including bond requirements (exhibit 1)
3. The Bid or Proposal forms (exhibit 2)
4. The Contract with the Agreement and General and Specific Conditions (exhibits 3 & 4)
5. Plans and Specifications

The Advertisement or Notice to Bidders, Instructions to Bidders and Bid or Proposal forms are preliminary to the contract, but they, together with other contract documents, are commonly considered to constitute the construction contract.

In order to understand construction contracts, certain terms require definition:

1. The specifications give a detailed description of every item to be provided by the Contractor. Where pertinent, they also give the method of installing the items, supplemented, of course, by the plans. Reference is freely made to the standard specifications written by and available from various government agencies and the various engineering, architectural and technical societies. Usually these standard specifications can be included by reference without a verbatim repetition. Private testing agencies such as A.S.T.M. (The American Society for Testing Materials) also provide specifications for the various items tested. In case of a difference between the specifications and the drawings, the Contractor should request clarification prior to bidding.

2. Technical specifications can cover in detail any temperature, pressure, strength, abrasion or corrosion resistance standards to be met. They also cover the quality and appearance standards to be maintained.

3. Installation specifications detail the method by which the work must be done to assure proper performance. They are explicit in pointing out the required finished result. Care must be taken that the specification is not so restrictive as to increase the cost beyond all reason or prevent the contractor from properly completing the work.

4. Material and workmanship specifications denote exactly what the names imply. The materials must be adequate in strength and usability. The workmanship must meet the quality and appearance standards of the owner and of the particular craft doing the work. Using certified welders is an example of a workmanship standard.

CONSTRUCTION PRINCIPLES
SECTION C – THE BIDDING AND NEGOTIATION PROCESS

LESSON 2

Competitive Bidding

Lump Sum and Unit Price construction contracts in both the government and private sector are generally awarded using the competitive bid process.

Procedures used in the advertisement and solicitation of bids for construction work are outlined in detail in various reference books.

Care should be taken to insure that all parties, including Subcontractors and material suppliers, who plan to bid a significant part of a project, are provided with all contractual documents to include addenda.

Adequate time in which to prepare estimates is essential to effective price competition.

The bidding should be modified as necessary to provide adequate time for the Contractors to price out the impact of addenda to the initial bidding documents. The American Institute of Architects and the Associated General Contractors of America have published a "Recommended Guide for Bidding Procedures and Contract Awards" for use when competitive lump sum bids are requested in connection with building and related construction. This guide, available through local chapters of either the AIA or AGC, provides a very excellent tool to establish a spirit of understanding and an ethical basis for contracting between parties to a construction contract. The student is urged to read this document.

There is an orderly progression of events leading up to the contract award:

1. The Invitation to Bid. This is the Owner/Architect/Engineer's responsibility.

2. Securing Documents. All parties are responsible; The O/A/E to state the location and availability; The Contractor to make a timely pick up of the necessary Documents.

3. The Proposal. This is the Contractor's responsibility to make a timely submittal of the bid.

4. The Agreement. Again this is the responsibility of all three parties concerned; The O/A/E and the Contractor to sign and date the agreement in the legal manner to make the contract valid.

5. The Bid Opening at a specified time, date and place. The O/A/E opens the bids. Usually each of the bidders sends a representative to report back to the Contractor who is the successful bidder.

LESSON 3

Preparing Bids

It is the responsibility of the Contractor to deliver the bid together with the bid security and other information required by the Instruction to Bidders to the proper place before the closing time designated. Failure to do so by the appointed time is cause for non-acceptance of the bid. Therefore it is prudent for a Contractor who becomes involved in the competitive bid process on a repetitive basis to establish a check list to insure complete compliance with the Instruction to Bidders.

Public contract policy requires that all bids be opened at the appointed time in a public place and read aloud. Although not required, this general procedure is almost always used in the competitive award in the private sector. As each bid is opened, each bidder's response to the requirements of the Instruction to Bidders is announced publicly and recorded as part of the record of the proceedings.

It is customary for the "apparent" successful bidder to be announced at this time and all bids to be taken under advisement in order that they can be evaluated for complete compliance. Only after careful study and the evaluation of the bid received can an official announcement as to the identity of the successful bidder be made. Bidding information obtained at public bid openings is available to anyone seeking the information. Some Contractors have found that the analysis of past bids can provide much useful information in making decisions in the face of uncertainty. Analysis of this type can be used to identify relationships among the many variables involved in competitive bidding. Some significant relationships that can be determined through analysis are the number of bidders per job, distribution of bids, the impact of the number of bidders on the low bid, and the bid spread for each job.

Analysis of this type is also being used by some Contractors to develop a bidding strategy for their firm. The optional reading assignment for this lesson addresses one approach to the development of such a strategy.

Without question, analysis of one's past bidding experience can provide useful information in arriving at the optimum mark-up for future work. However, it must be kept in mind that there are many factors which affect the competitive bidding climate at a given point in time. The development of a bidding strategy can also become a very useful tool, but precedence dictates that it must be used in conjunction with the other factors which influence the competitive bidding climate if an optimum mark-up is to be obtained.

CONSTRUCTION PRINCIPLES
SECTION C – THE BIDDING AND NEGOTIATING PROCESS

LESSON 4
Negotiated Contracts

Very little material has been written on negotiating construction contracts. The competitive bid process for award of contracts, used primarily in the public sector, remains dominant. However, in recent years, particularly in the private sector, more and more awards are made to General Contractors on a negotiated basis. In fact, it seems prudent for a General Contractor to strive to do as much work by negotiation as possible in order to realize a reasonable profit in the long run.

Traditionally, the primary reasons for entering into a negotiated contract between the Owner and General Contractor have been: (1) the drawings and specifications on which to base a firm price have not been completed in sufficient detail, and (2) the manner in which the work must be done is subject to considerable change in order to accommodate existing or developing situations. Some typical examples where a negotiated contract has proven to be appropriate are:

1. Situations where time is of the essence and, to accommodate the urgency, design must proceed concurrently with construction.

2. To provide immediate construction service to repair damages from fire, floods, earthquakes or other disasters.

3. Situations requiring continuation of operations at the same time construction is in progress – for example, additions to retail establishments or manufacturing plants.

4. Situations where the Owner and Architect want to be furnished continuing cost information with respect to construction alterations, type of material used, etc., as construction proceeds.

5. Situations where the Owner has a general concept of the facility desired which must be constructed within a given budget limitation, and seeks proposals from builders as to what they can do within budget limitations.

6. Situations where the Owner and Architect want to use a Contractor who, through past experience or reputation, has proven to be competent and responsive to their needs.

Negotiated contracts may be Stipulated Sum (fixed price) Contracts, Unit Price Contracts or one of several types of Cost-Plus Contracts. In recent years, Design-Construct, Turnkey and Construction Management Contracts have emerged as major types of negotiated contracts. Design-Construct Contracts have been used for many years for industrial construction, but it has been only in the past few years that it has been used with significant degree of regularity for other types of construction. Another approach to Construction Management, which lends itself to negotiated contracting, is Fast Tracking or Phased Construction. Basically this method

CONSTRUCTION PRINCIPLES
SECTION D – CONTRACT ADMINISTRATION

INTRODUCTION

Objectives

After completing this Section, you will be able to:

- Name the various types of construction contracts
- Understand the purpose for and function of Construction Managers
- Define Bids, Bonds, Contract Payments, Specifications, Design Drawings, Change Orders and the term "Value Engineering"
- Define the term arbitration, negotiation and the procedure for settling contract disputes
- Outline the various procedures involved in Contract Administration
- Define the relationship between a General Contractor and various Subcontractors

Time and cost are the principal areas of interest in the control of a construction project. This Section of the Certification Program for the National Association of Women in Construction addresses contractual relationships in construction contracting. The student is encouraged to read reference material listed in the bibliography, checking the index of each book for pertinent material carefully before attempting to answer the study questions. Some of these questions can be answered quickly by using the references. Others will require assembly of basic data and evaluation of this data to answer the question. Suggested answers are given to the questions but you are encouraged to explore beyond them in depth.

The purpose of the twelve lessons presented in this section of the course is to provide the student with a broad overview of contractual relationships between contracting parties for contract construction. Specific subjects discussed by lesson are:

Lesson 1 – Basic Types of Contracts Used for Construction Contracts
Lesson 2 – Modern Trends in Construction Contracting and Management, Design Construct, Turnkey, Fast Tracking and Construction Management.
Lesson 3 – Identification and Discussion of the Basic Contract Documents
Lesson 4 – Contract Documents: the General and Supplementary Conditions, Technical Specifications, Plans and Drawings
Lesson 5 – Bid, Construction and Payment Bonds
Lesson 6 – Construction Insurance.
Lesson 7 – General Conditions, Progress and Final Payment, Retainage, Warranty, Contract Time, Time Extensions and Liquidated Damages

Lesson 8 – General Conditions, Changes, Change Orders, Changed Conditions, Supervision of Work, and Termination of the Contract
Lesson 9 – Claims and Disputes
Lesson 10 – Organizing for Contract Construction with Proper Attention to Contract Administration
Lesson 11 – General Contractor/Subcontractor Contractual Relationships
Lesson 12 – Value Engineering/Management as an Innovative Approach to Cost Reduction

CONSTRUCTION PRINCIPLES
SECTION D – CONTRACT ADMINISTRATION

LESSON 1

Types of Contracts

There are three major types of contracts used in the construction industry. These are:

1. The Stipulated Sum or Lump Sum Contract (Also sometimes referred to as a Fixed-Price Contract)
2. The Unit-Price Contract
3. The Cost-Plus Contract

Virtually all Contract Construction is accomplished using these basic types of contracts, either in a modified or combined form. All are either competitively bid or negotiated.

The Stipulated Sum or Lump Sum Contract

In this type of contract, the Contractor agrees to perform work covered by the plans and specifications of a job for a fixed price. The Contractor assumes all of the risks. If the cost for accomplishing the work specified exceeds his/her price, he/she must absorb the loss. On the other hand, if the Contractor can complete the work for less than the estimate, profit is increased by the amount of the difference.

Most construction is contracted using this type of contract. The contract can be awarded by either the competitive bid process or negotiation, but is most commonly awarded by competitive bidding.

It is fundamental that the work to be accomplished using the Stipulated Sum Contract be defined in sufficient detail to permit the development of complete plans and specifications. The contract cannot be let and construction cannot begin until detailed plans have been completed.

The Unit-Price Contract

As the name implies, the Unit Price Contract states specific prices per unit of work to be done, for example, cost per cubic yard of earth excavations. This contract is applicable to those situations where precise bid quantities cannot be determined in advance of award of the contract. Much rock and earth excavation work is accomplished using the Unit Price Contract.

Invitations to Contractors to bid or submit proposals for work to be unit-priced usually give an estimate of the quantities of materials involved categorized by work item. The Contractor's unit price for each work item is expressed in relationship to these estimated quantities even though the Contractor's quantity estimate may differ. Profit and overhead are included in the unit price for each item. The total price for accomplishing the work is then determined by multiplying the

CONSTRUCTION PRINCIPLES
SECTION D – CONTRACT ADMINISTRATION

LESSON 2

Modern Trends in Construction Contracting: Design Construct, Turnkey, Construction Management Contracting, Fast Tracking and Construction by Force Account

The traditional sequence of events occurring in construction of a project involves several distinct steps. These are in order of sequence:

1. The Owner develops a basic concept of the facility desired and a budget for its construction.

2. The Architect/Engineer or In-House Designer develops the Plans and Specifications for the complete project in sufficient detail to permit either competitive bid or negotiated award of a contract to a Construction Contractor.

3. Contractors submit Bids or Proposals.

4. The successful Contractor initiates and completes the construction of the facility in general conformance with Plans and Specifications provided. Changes can be made during the conduct of construction, but these changes generally represent a small portion of the overall construction project, physically or monetarily.

5. The General Contractor subs out the specialty work to subcontractors and coordinates their efforts during construction

6. The Project, upon completion according to the Plans and Specifications, is accepted by the Owner and Final Payment is made. The Architect/Engineer serves as the Owner's representative. Although not a party to the contracts, he or she serves as a communication link between the Contractor and the Owner throughout the construction phase.

In recent years, several construction management approaches have been developed to:
- Shift traditional responsibilities in construction
- Attempt to overcome communication problems in the traditional Owner-Architect/Engineer and Contractor relationship
- Reduce the time involved in providing a complete and functioning facility

Several management techniques have been developed with these specific purposes in mind:
- Design-Construct
- Turnkey
- Fast-Tracking
- Construction-Management

Each of these approaches to contracting is presented to provide the student with a general background in this area.

CONSTRUCTION PRINCIPLES
SECTION D – CONTRACT ADMINISTRATION

LESSON 3

Contract Documents

The contract documents normally involved in Contract Construction include:

1. Advertisement or Notice to Contractors (Potential Bidders) – Invitation to Bid
2. Instructions to Bidders
3. The Bid or Proposal, including required bonds
4. The Contract Agreement
5. General and Special (Supplementary) Conditions
6. Specifications
7. Plans
8. Addenda

The first three documents listed above address matters of concern during the period prior to the award of the contract. They provide information needed to permit preparation, submission and evaluation of bids or proposals. In essence, these documents are preliminary to the contract. However, they set the stage for the contractual arrangement and are included in the contract by reference. In addition, the Performance and Payment Bonds are considered to be part of the Contract.

Advertisements or Notice to Bidders has been discussed in Part C, The Bidding and Negotiating Process. Further, a typical Instruction to Bidders is presented as the Appendix to Section C. The student should study the major items which are contained in the Instruction to Bidders inasmuch as they set the stage for the evaluation and the award of the contract.

The standard forms of General Conditions for a construction contract list the specific documents which constitute the contract from a legal point of view. Documents 4 through 8, as listed above, are generally included in this listing. Clauses contained in these documents enjoy precedence over clauses contained in the documents which are preliminary to the award of the contract.

Whenever possible, these standard forms should be used for construction contracting. They have been carefully prepared, and the clauses contained in them have been, for the most part, legally tested as to their meaning.

A "Letter of Intent", which includes the name of the project and the date to start for the project, is often used to allow the Contractor to proceed before the signing of the final Contract Documents. The "Notice of Award" must always formally authorize the Contractor to proceed. It differs from the "Letter of Intent" basically in the date on which construction may commence.

CONSTRUCTION PRINCIPLES
SECTION E – CONTRACT ADMINISTRATION

LESSON 4

Contract Documents
General and Specific or Supplemental Conditions
Technical Specifications, Plans and Drawings

Construction contracts contain many non-technical provisions that pertain to the general environment in which the work must be done. The General and Supplementary Conditions of the contract establish this environment. They are important to both the General Contractor and Subcontractor. Each Subcontractor should be completely aware of the General and Supplementary Conditions which have been established between the Owner and the General Contractor. To neglect this important consideration is paramount to inviting problems between the General Contractor and Subcontractor, at the very outset of construction.

The General Conditions or "Boiler Plate" addresses matters which involve the general environment in which the construction work is to be accomplished. They define the role of the Owner, the Architect, and the Contractor and attempt to establish the communication channel between these parties during the conduct of construction.

Some of the specific items included in the standard forms of the General Contract are:

1. A listing of the contract documents
2. Definitions and communication channels between the Owner, Architect and Contractor
3. Specific responsibilities of the Owner, Architect and Contractor
4. Subcontractor relationships
5. The Owner's right to award separate contracts and definitions of the interface between these separate Contractors and the General Contractors
6. Time and Cost relationship
7. Payment and Completion
8. Changes in work and changed conditions
9. Claims and Disputes
10. Insurance
11. Conditions for termination of the contract

Supplementary or Special Conditions of a construction contract attempt to adapt the General Conditions to the specific construction job at hand. They consider many items which are environmental in nature but which are specifically identified with the job at hand. Therefore, they are considered to be supplementary or special. These conditions should be carefully drawn to insure that they are not in conflict with the General Conditions.

Technical Specifications are designed to supplement Plans and Drawings. In essence they describe the specific requirements which must be met pertaining to materials to be used and the quality of construction.

CONSTRUCTION PRINCIPLES
SECTION D – CONTRACT ADMINISTRATION

LESSON 5

Contract Documents
Bid, Construction and Payment Bonds

Bonding is properly identified with Contract Administration.

Many construction projects, particularly in the governmental sector, require Contractors to be bonded. Surety bonds, issued by an insurance company, are assurance that the conditions of a contract will be fulfilled. They include Bid Bonds, Performance Bonds and Payment Bonds.

It speaks well of the financial standing and the performance record of a Construction Contractor in both the public and private sector for a Contractor to be able to be bonded by a reputable insurance company. The proven Contractor enjoys some advantage over the unproven Contractor in being able to obtain bond at reasonable premium rates. It is important for a Contractor to establish and maintain a reputation for financial solvency, excellence in performance and integrity in order to compete favorably in the bond market.

Bid Bonds

A Bid Bond is furnished by the Contractor along with the bid. The purpose of the Bid Bond is to guarantee under the penalty of law that the Contractor will:

1. Sign the Contract Documents if awarded the job
2. Appear for all pre-construction job conferences with the Owner/Developer and the Architect/Engineer.

The Bid Bond can be furnished by a bonding company who will pay the bond amount to the Owner/Developer if items (1) and (2) above are not complied with. The Bid Bond can be posted by cash or certified check by the Contractor, if that option is chosen.

The Bid Bond amount may vary, but it is generally five percent (5%) of the estimated construction cost as shown on the bid form.

Performance Bonds

The Performance Bond is posted by the Contractor after the Contract Documents are signed. The Performance Bond is posted by the Contractor's bonding company in the amount of the total contract cost. In case of default by the Contractor for any reason, the bonding company must pay the Owner/Developer the bond amount, less the value of any approved or accepted work done by the Contractor up to the day of default.

CONSTRUCTION PRINCIPLES
SECTION D – CONTRACT ADMINISTRATION

LESSON 6

Construction Insurance

Construction work is hazardous and contractual arrangements to accomplish the work are complicated at best. These contractual arrangements operate simultaneously between the many identities involved, establishing a very complicated structure of responsibility for damages. Consequently, the insurance programs of all parties involved should be carefully detailed to insure proper coverage against potential hazards during the job. A Contractor is faced with insurance requirements dictated by the contract, those dictated by law, and those which provide essential coverage against risks considered important in the conduct of the construction operation.

It is becoming more and more difficult for Contractors to obtain proper construction coverage at reasonable premiums. The market is uncertain at times with agents desiring to provide construction coverage but encountering difficulty in having the coverage underwritten. This situation is, in part, due to the completed operations clause that is now included in contracts.

A Contractor's reputation as to safety, reliability and integrity plays a major role in his ability to obtain proper insurance. More and more we are seeing Construction Contractors working more closely with their insurance companies to establish effective safety programs and to secure adequate coverage against potential claims from their employees, the public and the other parties to contractual arrangements for the construction work.

CONSTRUCTION PRINCIPLES
SECTION D – CONTRACT ADMINISTRATION

LESSON 7

General Conditions
Progress and Final Payments, Retainers, Warranty, Contract Time, Liquidated Damages and Time Extensions

Contract Time – Time Extensions

Most construction contracts are explicit regarding the time allowed for completion of construction. The Contractor is generally required to prepare a project schedule which is compatible with the contract time allowed. This schedule is submitted for approval of the Owner or his representative at the start of the job. It serves as a basis for measuring construction progress and is used in estimating the value of construction in place for Progress Payment purposes. Construction time is most often measured from the time the Notice to Proceed is issued to the Contractor. However, when a Letter of Intent is used to get construction underway prior to the time of signing a formal contract, it may specify the time for initiation of construction. Contract time may be measured in calendar days, but usually working days, excluding Saturdays, Sundays and holidays, are the basis.

Contract provisions regarding construction time are extremely important even though Liquidated Damages may not be assessed. During the life of the contract, many things can occur beyond the Contractor's control which will cause the project to be delayed. In those situations beyond the control of the Contractor, request for time extension should be processed promptly. Failure on the part of the Owner to recognize and honor legitimate request for time extension by the Contractor and his rigid insistence on adherence to the original completion date, even though time extensions are due, have often served to accelerate construction. Such acceleration has traditionally been recognized as a legitimate claim, by the Contractor, against the Owner.

When establishing a project schedule, the Contractor should identify those work items with dependencies which are time sensitive. CPM scheduling, which is discussed in Section D of this course, readily permits the Contractor to focus on those work items throughout the life of the contract. They are the activities or events on the critical path of the CPM network.

Another area which has often caused time problems is the timely approval of shop drawings and material to be used in construction. To avoid delays associated with submittal and approval of these items, it is incumbent upon the Contractor to establish a system which permits the determination of the status of approval at any time. The system should be sufficiently detailed to permit determination of responsibility in the event of delay and to permit timely action by the Contractor to minimize delay.

CONSTRUCTION PRINCIPLES
SECTION D – CONTRACT ADMINISTRATION

LESSON 8

General Conditions
Changes, Change Orders, Changed Conditions, Supervision of Work and Termination of the Contract

General Conditions

The General Conditions Section of a set of contract specifications is included at the beginning. These conditions are usually the same for every contract issued for bid. This is particularly true for all government agencies: federal, state, county, city and special districts. For private Owners and Developers the General Conditions may vary from one job to another, depending on the peculiar characteristics of a specific job.

Particular care should be taken to have attorneys review the wording of the General Conditions. The reason, of course, is that these same attorneys are often responsible for defending their validity in representing the Owner or Developer in case disputes should have to be settled in a court of law. The attorneys can assure themselves, and the Owner/Developer, that all ambiguities and loopholes have been removed to the best of their knowledge. Such assurance, in many cases, can remove liabilities which could result in very large judgments against the Owner/Developer. Judgments in the millions of dollars have been rendered, particularly when punitive triple damages are awarded by a court of law.

Changes and the Change Order

As a practical matter, it is virtually impossible to develop plans and specifications for a construction project, which during the progress of construction do not require a change. Normally construction contracts recognize this fact and give the Owner the opportunity to make changes in the work subsequent to the time the contract is signed and during the construction period. Such changes may provide for both additions and/or deletions to the work originally contemplated. Both parties of the contract must recognize this potential for change and be prepared to deal with it promptly and equitably. Fundamental to the acceptance of change is the recognition by the parties to the contract that change involves time and costs. The Contractor should not be required to proceed with a change unless it has been authorized in writing by the Owner or the Owner's representative. The written authorization of a change is the only business-like approach. However, it is not always practical to wait for written authorization of a change to proceed with the work without unduly delaying the job. Under the circumstances the Contractor usually proceeds on the verbal word of the Owner, Architect or his authorized representative pending issuance of a written change order. Most field changes are accomplished in this manner.

Change Orders should be settled as to time and costs as soon as practical by the parties to the contract. Delay in settlement only complicates the problem as it pertains to both parties' ability to

CONSTRUCTION PRINCIPLES
SECTION D – CONTRACT ADMINISTRATION

LESSON 9

Claims and Disputes

Disputes which result in claims in construction contracting are common. It seems to be impossible to develop a perfect set of contractual documents which eliminate the potential for dispute between the parties to the contract. In the absence of contractual provisions which define methods of settlement of disputes, disputes which cannot be settled between the parties may have to be decided by a court. There are many disadvantages to litigation. Some of these include: (1) substantial time delay due to crowded court calendars, (2) possible substantial attorney fees and (3) unwanted or damaging publicity.

To avoid litigation or to at least minimize the possibility of drawn-out litigation in the settlement of contractual disputes, most contracts of substance in the private sector provide for arbitration of claims and disputes. Opinions differ as to the desirability of arbitration of construction contracts. However, in spite of some criticism, arbitration does provide a reasonably efficient means for settling disputes. Arbitration is needed. Where contract clauses provide for arbitration, they stipulate that it shall be conducted using the Construction Industry Arbitration Rules. These rules are presented in Exhibit 1 to Section D, Construction Industry Arbitration Rules. General Contractors should include arbitration clauses in their subcontracts if these clauses are part of their contract with the Owner.

Arbitration does permit the dispute to be considered by professionals in the construction field in a timely manner.

Decisions can be appealed to the court by either party. However, generally the court does not examine the merits of the decision but rather addresses itself to whether the arbitrator has jurisdiction.

In the public sector, Federal Construction Agencies provide administrative channels for settlement of claims. Once the Contracting Officer has reached a decision, the Contractor can appeal the decision to Boards for Contract Appeals which have been established for each construction agency. These boards are composed of professionals in the field of construction, and they play a role similar to that of the arbitrator in the private sector.

In the long-run, it is to the advantage of all parties to a contract to administer the contract in a manner which minimizes the possibility of claims and disputes. Channels of communication should be kept open and differences between contracting parties should be settled as soon as possible after they occur, while the facts are fresh and readily ascertainable. Change Orders should be negotiated as soon as their full impact, as to time and costs, can be determined.

CONSTRUCTION PRINCIPLES
SECTION D – CONTRACT ADMINISRATION

LESSON 10

Organization for Contract Administration

Review the Architect/Engineer, Owner and Contractor relationships for most common types of construction contracts in the "Answers to Questions" in Lesson 9.

Contractual relationships established between Owner and the Architect/Engineer, the Owner and the General Contractor, and the General Contractor and Subcontractors dictate, to a large degree, the type of contract which is drawn up. Time allowed for construction also influences the Contractor's organization and mode of subcontracting.

A great deal of Contract Administration must of necessity go hand in hand with field construction operations. Much of this effort is customarily managed on a project basis with a Project Manager being made responsible for all aspects of the work. The form and extent of the Contractor’s organization depends greatly on: (1) the nature of the work, (2) the size of the project and (3) the type of construction contract and the contractual provisions of the contract.

The Project Management System must include provisions for:

1. Detailed planning of construction operations

2. Time scheduling of these operations

3. Control of time and costs through monitoring and periodic correction and adjustment of the construction plan

4. Coordination of the efforts of Subcontractors

5. Administration of the general contract and contracts with Subcontractors

To some extent, the General Contractor must be influenced by the Owner and Architect/Engineer’s plans for administrating the contract in the development of his/her organization for Contract Administration. Does the Owner plan to set up a field office and provide for full-time inspection? What authority will be delegated to the Owner/Architect's representative at the field level? Answers to these questions will influence Contractor field organization.

Many of the details are contained in the General Conditions and Supplementary Conditions of the contract, particularly those that pertain to the overall contractual and legal relationships between the parties. More specific information concerning the day-to-day contractual relationships during the conduct of work is contained in the general provisions of the Specifications. This specific information covers the definition of the work, progress of the work, the stages of the work in progress, and the context of the work in terms of the relationships

CONSTRUCTION PRINCIPLES
SECTION D – CONTRACT ADMINISTRATION

LESSON 11

General Contractor and Subcontractor Contractual Relationships

It is important that the student realize that there is no direct contractual relationship between the Owner and a General Contractor's Subcontractor, even though the contract between the Owner and the General Contractor may require advance approval of the Subcontractor or may insist all payments be made to the Subcontractor prior to the final payment for the construction work contracted. The contract for the construction work to be performed by the Subcontractor is solely between the General Contractor and the Subcontractor. Representatives of the Owner and the Architect/Engineer must keep this in mind during communications which direct the progress or change in construction work.

In recognition of these contractual relationships, the General Contractor would be well advised to insist that the provisions of the contract he/she has with his/her Subcontractor be completely compatible with the provisions of the contract he/she has entered into with the Owner. This concept is known as a “pass-through” clause. In other words, the owner’s expectations in terms of contractual responsibilities, of the general contractor are also “passed through” to the subcontractor. For example, if the owner is holding retainage on the general contractor, then the general contractor will hold retainage on the subcontractor.

Subcontractors generally are hired for the following specialty items:

1. Concrete
2. Reinforcing steel
3. Steel frame erections
4. Electrical, plumbing and air conditioning
5. Roofing

Many contracts, particularly government contracts, require that a specified percentage of the work must be done by the General Contractor. The usual figure is 25% based on the dollar value of the work. This eliminates the undesirable practice of contract brokering by which the General Contractor only acts as an intermediary. In such a case responsibility is difficult to place and enforce.

The Owner has no direct relationship with the Subcontractor. All communications in either direction must go through the General Contractor.

The General Contractor has freedom of choice in the selection of Subcontractors. They need only have the necessary state or city licenses and do the work according to the Plans and Specifications.

A Subcontractor can withdraw a bid because of an error in the calculations provided that action is timely and in writing.

CONSTRUCTION PRINCIPLES
SECTION D – CONTRACT ADMINISTRAT10N

LESSON 12

Value Engineering/Management

A great deal has been written about Value Engineering or Value Management, as it is sometimes called, in the recent past. However its basic concepts are not new inasmuch as its principles have been practiced by governmental agencies for a number of years. Perhaps it is receiving greater attention by the construction industry as a recognized means of achieving cost reduction as the cost of construction continues to rise.

Our purpose in discussing this approach to cost reduction in this course is to present its basic concept and some current practices. Without question it can and does provide an effective management tool to improve efficiency and reduce costs.

What is Value Engineering/Management? How does it relate to current design practices of Architect/Engineers? How can it be used to advantage during the construction phase of the work?

Value Engineering is a systematic approach to the evaluation of project design, materials, and construction methods to obtain the most value for every dollar of cost.

The basic approach defines in simple terms the function to be performed by a given design, a material or a construction method; then, to systematically evaluate alternatives for the accomplishment of this function and to select the alternative which, at minimum costs, will satisfy the functional needs. Not only are first costs considered, but also life expectancy costs of operation and maintenance of the finished facility and costs of replacement items. "Gold Plating" is avoided. Additional projected costs are avoided if these costs do not increase value, in terms of increased functional capabilities, in proportion to their costs.

The Architect/Engineer, in his/her normal role, is dedicated to the production of plans and specifications which are reasonable in cost.

However, Value Engineering/Management provides for a systematic approach to design for the sake of selecting the least expensive alternative which is completely functional.

Material technology is constantly changing with new materials coming on the market which must be evaluated as to their cost effectiveness during design. Potential economics in construction methods need to be considered in more detail during the design phase inasmuch as design influences the methods used to a great extent. Further, there is always a tendency to pull proven but not necessarily cost-conscious plans and specifications off the shelf and apply them to a new project.

CONSTRUCTION PRINCIPLES
SECTION E – PLANNING, SCHEDULING AND CONTROLLING A PROJECT

INTRODUCTION

Objectives

After completing this Section, you will be able to:

- Plan, schedule and control a major project
- Employ the Critical Path Method (CPM) both for construction scheduling and accounting for the delivery of every item listed in the contract, including the Lump Sum items for move-in and move-out expense
- Employ a CPM chart to log the job progress and make all the necessary updates
- Ensure that the project will run smoothly and finish on time as nearly as possible.
- Understand the usual accounting system used by both Owners and Contractors on construction projects
- The use of time cards, purchase orders, invoices and contract change orders, as they apply to construction accounting
- Understand the necessity for accurate records to monitor labor and material costs of a weekly and on a monthly basis
- Understand record keeping for equipment costs, both for depreciation and for maintenance cost factors
- Outline how an effective cost control system is essential in order for a General Contractor to make a reasonable profit

Time and cost are the principal areas of interest in the control of a construction project. Efficient control of time and cost requires advance planning, the use of carefully thought out and properly administered techniques, organized record keeping, teamwork, and decision making at appropriate levels of authority.

The primary objective of this section is to acquaint the student with some of the techniques which may be used to control time and to indicate the importance of cost awareness. The student should strive to achieve a general familiarity with the topic which will mesh properly with knowledge gained through the study of other sections of this part of the course, realizing that specific applications will be influenced by the nature of the project, the principals involved, and other factors.

A typical construction project involves many mutually dependent operations using materials, equipment and labor, and requiring time for accomplishment. Time and cost-control are often very complicated and difficult management functions. Furthermore there is an intimate relationship between the two facets of control. Project cost accounting and project planning and scheduling will be dealt with separately in order to best accomplish the organization and presentation of information and to facilitate its assimilation. Construction managers often have the foregoing responsibility, either as Engineers or Architects.

Preparation for project control begins, or should begin, prior to the contract award. For example, the system to be utilized in cost control of the on-going project should be operational prior to project inception, so that data will be available for preparation of bids for its acquisition. Also, the planning phase of the time-control system to be employed should proceed through the preliminary stage during project acquisitions (that is, preliminary determination of what is to be done and how it is to be accomplished). The emphasis of this section, however, is on control of the project during construction. The general utility of data generated by the control systems will become apparent to the student during study of the section.

Another important use of this data is its presentation as evidence in litigation proceedings. The ability to demonstrate that effective control measures are used in a project and the ability to provide data and support claims are often keys to winning court cases.

The utility of the data as input to future decision making processes is greatly enhanced by a thorough review of the project shortly after its completion. Broad participation should be encouraged in order to assure that project records are as good as possible. This is often difficult to achieve, or is omitted entirely, due to interest in other matters, such as other projects under construction. The products are then cost records and time data which are inaccurate or incomplete for future use, and are virtually useless.

CONSTRUCTION PRINCIPLES
SECTION E – PLANNING, SCHEDULING AND CONTROLLING A PROJECT

LESSON 1
History of Planning and Scheduling Systems And Introduction to CPM

The traditional basis for the planning and scheduling of construction projects has been the bar, or Gantt, chart. The typical chart lists items of work along the left side of the sheet (Site Preparation, Excavation, Foundations, etc.); vertical lines spaced at equal intervals across the sheet represent units of time (hours, days, weeks or whatever is appropriate for the project); a horizontal bar opposite each work item represents the beginning, duration and end of the work to be accomplished under that heading. The chart is thus both a plan (since it shows what is to be done) and a schedule (since it shows when certain items of work are to be accomplished). An additional bar is usually drawn parallel to each original bar as construction proceeds to indicate actual progress of each item.

Network-based systems are continuing to evolve; CPM and PERT are merging into a single technique, with variations. Probabilistic methods are seldom used in construction. The network-based systems may be summarized as follows:

1. Project planning.
2. Project scheduling.
   a. Phase I **--** Time assignment and computation
   b. Phase II **--** Calendar dating and resource allocation
3. Project monitoring and controlling

Lessons two through five of this Section will be organized according to this scheme.

CPM stands for "Critical Path Method" and PERT stands for "Program Evaluation Review Technique." The Critical Path Method is best suited for the control of construction projects because it breaks the job down into single components. These components can be evaluated both for sequence and time duration. Consecutive sequences are seldom encountered on a complex job. The CPM allows for simultaneous performance of various construction phases. It graphically portrays the start, time duration and finish of all operations. Thus the whole job can be shown on a single chart. Alternate methods with longer time duration can be easily shelved. The shortest and most economical path is readily apparent once the chart is constructed. PERT does not have the adaptability and clarity of CPM, nor does the old-style bar chart or its successor, the Time-Grid diagram.

CONSTRUCTION PRINCIPLES
SECTION E – PLANNING SCHEDULING AND CONTROLLING A PROJECT

LESSON 2
Project Planning and CPM Fundamentals

There are general considerations to be made in beginning the planning process. Preliminary study should take place during the estimating or negotiating process, though detailed planning usually follows the award of the contract. The data which results is only as good as the input information used; skill and judgment must be applied in using the data to make decisions.

Project Planning involves a group of people, such as estimators, field supervisors, key subcontractors, and possibly planning consultants. The group "talks the project through", developing a rough diagram as the project is divided into its constituent elements and the sequential order of the elements is determined. The plan which is developed should be the one which will actually be followed; therefore, those preparing it should have the authority to make appropriate decisions regarding methods, procedures, equipment and workers.

As discussed in the introduction, planning is the initial phase of network-based management systems. Planning involves the determination of what is to be done and how the project is to be pursued. (Note that the determination of when things will be done and how much time will be required for each element are not aspects of planning. This is part of the scheduling phase.)

The project must be broken down into "activities": time-consuming elements which are single, identifiable project work steps. Subdividing the project into activities involves consideration of the following factors:

1. Different areas of responsibility
2. Different categories of work by craft
3. Different categories of work by equipment
4. Different categories of work by material
5. Structural subdivisions
6. Work location
7. Owner’s breakdown for bidding or payment
8. Contractor's breakdown for estimating or cost accounting

Care must be exercised in the breakdown of activities. Avoid a breakdown so general that insufficient detail is obtained, or one so detailed that significant planning factors are obscured.

As activities are identified, it is necessary to make decisions regarding their sequential relationships. The time ordering of construction operations produces a result which is known as "job logic". The time sequencing process must also recognize practical limitations, known as "restraints", which can influence the start of certain activities. Restraints are usually treated as activities on the network diagram.

Network graphics of CPM employ "arrow diagrams" to designate activities and time duration.

CONSTRUCTION PRINCIPLES
SECTION E – PLANNING, SCHEDULING AND CONTROLLING A PROJECT

LESSON 3

Project Scheduling—Phase 1

As indicated in the introduction, scheduling will be broken into two phases. The first phase involves assignment of duration times to activities and computation of the network diagram node times. The second phase involves calendar dating and resource allocation. The scheduling process focuses on other matters.

The previous lesson focused on identification of activities and their sequential constraints (Planning). It begins with attention to the time requirements of each activity. Essential input information for project scheduling is:

1. A duration time estimate for each activity.
2. A computed network diagram.

Next comes the assignment of activity duration times; that is, the estimation of the time required to complete each activity and the notation of those times on the activity arrows of the network, usually below the description and below the arrow.

Activity durations are usually expressed as working days, though other time units (hours, weeks, shifts, etc.) can be used. Durations do not include holidays and weekends. Assignment of activity durations will frequently lead to further refinement of the network and redefinition of some activities. Much of the value of the CPM process depends upon accurate estimation of duration times.

Rules to be followed in estimating duration times:

1. Evaluate each activity independently assuming that resources will be available when needed (otherwise use a "restraint").

2. Assume reasonable (normal) resources for each activity.

3. Assume a normal workday (or other appropriate unit).

4. Ignore directed completion dates at this stage.

5. Use consistent time units throughout.

Information for use in estimating duration times can come from accounting data and estimating sheets, but experience is invaluable.

CONSTRUCTION PRINCIPLES
SECTION E – PLANNING, SCHEDULING AND CONTROLLING A PROJECT

LESSON 4

Project Scheduling-Phase 2
Calendar Dating and Resource Allocation

The project schedule can be generated once the network has been computed. First tabulate information for each activity. This will summarize activity data in workday time form. Note that since zero was used for the initial node time, each number implies the end of a workday. Activity completion times are, therefore, correct as stated. Activity start times must be advanced to the beginning of the next workday; this is usually not done until calendar dating is accomplished.

After determining the project completion date and project duration in working days, a calendar can be consulted to determine the actual date on which each workday will occur. A workday-calendar-day table is helpful, and should be attached to or written on the arrow network sheet for ready reference.

A calendar-date schedule can be made up, after the workday-calendar-date table has been completed. The schedule is part of the data of the earlier tabulation (working-day form) converted to calendar dates, with scheduling decisions made as appropriate. For example, use of float in scheduling certain activities. As pointed out earlier, start times are often adjusted in making out this schedule.

Several arrangements of the schedule are possible. The activities may be listed in order of start date, completion date, activity number (or id), or other arrangement. Each arrangement is useful for specific purposes by various parties. A project superintendent may prefer the scheduled starting-date order; a project monitor might prefer the completion-date order. It is helpful if the schedule points out critical activities through the use of an asterisk or other means. Schedules are subject to change; they should not be made out too far in advance.

The scheduling of resources includes materials, subcontractors, labor crews, and equipment. Adequate resources for each activity are required if the project schedule is to be workable. By consulting the schedule, the Contractor can determine when materials are needed at the job-site, allowing appropriate specification of delivery dates on purchase orders. Similarly, scheduling of subcontractor operations is facilitated.

With regard to labor crews and equipment, the schedule can be used to detect conflicting demands, as well as those uses discussed above. Floats of non-critical activities are used to smooth out demand for labor and equipment. (Time-scaled networks, to be discussed in Lesson 5 are particularly useful in detecting conflicting demands and working out solutions.) Sometimes it becomes necessary to shorten the length of a project by reducing the duration of critical activities. Such speed-ups increase the direct cost of the activities, due to the involvement of overtime work, multiple shifts, more equipment, materials/delivery premiums, reduced efficiency due to crew size, or other additional expense. Least-cost project shortening can be an important

CONSTRUCTION PRINCIPLES
SECTION E – PLANNING, SCHEDULING AND CONTROLLING A PROJECT

LESSON 5

Project Monitoring

The CPM-based plan and schedule must be monitored and updated as construction operations proceeds. The primary focus of updating is the effect of plan changes and schedule deviations on work remaining to be accomplished. Such changes will occur, since no project unfolds exactly as originally planned and scheduled.

Updating involves periodic review of the plan and revision of the schedule of remaining work. At the time of the update, work previously accomplished is considered only to the extent that it has affected work to be accomplished. Completed work is either deleted from the updated plan, using a "base line" dated as of the day of the update, or is represented as one arrow with duration equal to the total elapsed time. The primary objective of updating is to obtain corrected activity start and finish times, revised floats and an indication of projected critical activities. A new projected completion date can result.

The most common method is updating the % complete for each activity in the schedule. As the activity nears completion, modifying the remaining duration is used to more accurately portray the progress of the activity. Other methods for updating include comparing worker-hours actually used against the estimate and measuring installed quantities against the schedule.

Schedules are updated at least once a month to coincide with payment applications or every two weeks. However, the schedule should be updated more frequently if:

- Project time frame shortens
- Job becomes more critical
- Risk of missing a deadline increases
- When an unexpected event occurs

Monitoring occurs daily at lower levels of management. The frequency of middle-level monitoring and reporting varies with project type and magnitude, contract requirements, the contractor's mode of operation and other factors. The frequency of updating may be predetermined, updating may occur as warranted by major changes in the plan or schedule, or a combination of both approaches may be used. Updating can be costly and should not be accomplished unless warranted; on the other hand, trying to force a project to fit an obsolete plan and schedule will nullify the benefits of the system.

A very useful management tool is the time-scaled network. Such a diagram is an arrow or precedence diagram drawn to a horizontal time scale. The horizontal time scale can be in working days, calendar days, or, preferably both.

The time-scaled diagram is a combination of the bar chart and the arrow or precedence network. It is both a project plan (since project logic, or activity dependencies, is portrayed) and

CONSTRUCTION PRINCIPLES
SECTION E – PLANNING, SCHEDULING AND CONTROLLING A PROJECT

LESSON 6

The Cost Accounting System

Construction Contractors frequently enjoin construction educators to emphasize cost control in their curricula to insure that their graduates are construction cost-conscious. Effective cost control is essential in every competitive business. However, inflationary pressures on construction costs further emphasize the need for an adequate and responsive cost control system.

One primary purpose of cost control is keeping costs within the limits established by the project cost estimate. The need for quality estimating practices cannot be over-emphasized. The project cost estimate becomes the project budget and serves as the basic document against which progress is measured. At the same time a good project cost control system can provide cost data based on actual experience which is extremely useful to the estimator in preparing cost estimates for future jobs. This is particularly true of those costs which are production oriented i.e., labor and equipment costs.

The development of an adequate cost control system requires detailed planning of the construction operation and cooperation of all who are required to implement it. The project estimate must be compiled and cost coded in terms of the same items of work to be used for the construction schedule so that actual progress can be measured and compared to that planned. Finally the system must provide for measuring and reporting progress in work units which are compatible with those used for the project estimate and schedule. Progress reports should be timed to permit identification of significant deviations from expected performance in order that approximate corrective action can be taken.

Cost control uses typical business records, cost accounting codes, and progress reports in its presentation covering cost accounting. The general principles emphasized are common to all cost control systems. Examine carefully the typical business records used by a Contractor, preferably the company you work for, and ask for explanations of records you do not understand. Observe as well the illustrations at the end of this lesson.

Labor Costs and Time Reporting

It should be noted that all labor unit costs are derived using base wage rates (direct labor cost) only. Indirect labor cost can be substantial and must be included in the overall project cost estimate (budget) also. Some Contractors include an amount expressed as a percent of the direct labor costs for each major work item. Those costs can be prorated, if it is desired, to compute labor unit costs which include both direct and indirect costs. Care must be exercised to insure, however, that the indirect costs thus prorated are appropriate to the craft employed.

CONSTRUCTION PRINCIPLES
SECTION F – SAFETY IN CONSTRUCTION

INTRODUCTION

This course has been written with the thought that the "Certified Construction Associate" will either occupy (or be in line to occupy) a managerial position in the construction industry. The material presented will, therefore, be aimed at persons in a position of responsibility – people who will be charged with setting up a safety program or supervising and improving an existing program.

An important part of any course on safety must be its treatment of the Occupational Health and Safety Act (OSHA). Since the passage of this legislation in 1970, it has roused controversy. The Congress has in the past, and it seems probable that it will in the future, effect changes in the law, to the extent that any attempt for a book publisher to keep up with the changes will be futile. It therefore appears that persons responsible for keeping up with the latest OSHA changes and rulings can best do so by consulting periodicals, such as “Job Safety and Health Magazine", published monthly by the U.S. Department of Labor. Some private publishing companies also provide a service whereby subscribers receive periodic updates as to the latest changes in the law and its interpretation by the courts. Some examples of this type of service are the OSHA Compliance Guide, published by the Commerce Clearing House, 4025 West Peterson Avenue, Chicago, Illinois, and the OSHA Compliance Manual, published by McGraw-Hill, New York. Both are by subscription only. Subscribers are kept up to date with the latest changes by periodic supplements. The cost of such a service would not appear to be negligible in view of the possible penalties involved in non-compliance, but this decision is one for the individual company.

Students are also encouraged to get the two-volume "Accident Manual for Industrial Operations", Eighth Edition, published by the National Safety Council, which is an excellent reference book. It covers many subjects and situations which, while they may fall outside the scope of this Section, will be extremely valuable in the course of a career in construction, and more particularly, in the field of safety in construction.

CONSTRUCTION PRINCIPLES
SECTION F – SAFETY IN CONSTRUCTION

LESSON 1

History of Industrial Safety

Objectives

After completing this lesson, you will be able to:

- Understand the development of the safety movement.
- Name the objectives and major characteristics of the Workers' Compensation Act.
- Allocate responsibility for safety on a construction project between the owner, architect, builder and workmen.

History of Industrial Safety

The idea of safety on a construction site has been with us for a long time. Everyone has given it lip service; relatively few have gone any further with it except to insist that safety posters be posted and that everyone on the site wear a hard hat.

This attitude has not been the result of hard-heartedness. Management for the most part is not, and never has been, indifferent to human suffering. It is simply that management has assumed that it is each worker's individual responsibility to look out for himself, just as it was his own responsibility to provide himself with a warm coat in cold weather.

This attitude answered reasonably well a hundred years ago, when most projects were relatively small and the equipment used was uncomplicated, being mule-powered for the most part. If Smith, for instance, got kicked by a mule, the attitude of management was probably summed up by the thought that if Smith didn't know any better than to come up behind a mule, then a good swift kick was a part of Smith's education. It would teach him not to do it again. It must be admitted that this approach had a certain value. Provided Smith got away with nothing worse than a bruise, he undoubtedly learned to approach a mule eyeball to eyeball rather than from a point abaft the beam unless, of course the quadruped in question happened to be a biter as well as a kicker, in which case Smith was left with only two alternatives: (a) stay away from mules or (b) become an expert.

Which is precisely the point missed for so long by management. Alternative (a) means quitting his job and going into some other line of work where, sooner or later, he would no doubt be faced with the same alternative; i.e., an unsafe condition which Smith himself could do nothing to correct. Alternative (b) means learning how to approach a mule, and worked well as long as equipment remained uncomplicated. However, this is the United States of America in the 21st century, and nothing is unsophisticated.

CONSTRUCTION PRINCIPLES
SECTION F – SAFETY IN CONSTRUCTION

LESSON 2

The Occupational Safety and Health Act of 1970

Objective

After completing this lesson, you will be able to:

- Articulate the purpose, administration and major provisions of the Occupational Safety and Health Act of 1970.

The Occupation and Health Act of 1970

Workers' Compensation laws provide for the payment of benefits to workers injured on the job and to the families of workers killed on the job. A by-product of these laws was a push to improve safety conditions, but the push was largely economic and came from private insurance companies. They realized that the obligation to payout benefits diminished as the accident rate decreased. Also forward looking employers realized the economic advantages of a good safety program.

But, as we have seen, Workers' Compensation laws are not uniform from state to state, which means, among other things, that the impetus toward job safety is not uniform. Accordingly, the Congress passed the Occupational Safety and Health Act of 1970, which was signed to law on December 29, 1970. This highly controversial act makes it mandatory for all employers to meet certain safety and health standards and provides for penalties for those who do not meet these standards.

OSHA is applicable to every employer who in engaged in a business affecting commerce, in all 50 states and the District of Columbia, as well as all U.S. possessions. The Act does not cover federal, state and local government employees, although provision has been made for their eventual coverage. Other minor exclusions were also stipulated by the Congress.

Basically the Act requires two things from an employer:

1. An employer has a general duty to furnish each employee a place of employment which is free from recognized hazards which are likely to cause death or serious physical harm.

2. An employer has a specific duty to comply with safety and health standards published under the Act.

CONSTRUCTION PRINCIPLES
SECTION F – SAFETY IN CONSTRUCTION

LESSON 3

Safety Program Organization

Objectives

After completing this lesson, you will be able to:

- Appreciate the desirability of a workable safety program and
- Learn suggested steps to set one up.

Safety Program Organization

The Occupational Safety and Health Act of 1970 directs the Secretary of Labor to establish and supervise programs for the education and training of employers and employees in the recognition, avoidance and prevention of unsafe conditions in employment.

Part 1926 of the Act (which deals specifically with the construction industry) states that it shall be the responsibility of the employer to initiate and maintain as many programs as may be necessary to comply. It also goes on to say that employers shall instruct each employee in the recognition and avoidance of unsafe conditions and the regulations applicable to his work environment.

A satisfactory safety program in a particular company depends on a number of factors: size, number of employees, work site location, type of work and so on. There is no one program best suited for all companies. The program must have a guiding policy from top management. It is best when this policy is written so that any and all personnel may read it, and management is prepared to back up the policy with action, even when such back-up is:

a. unpopular
b. expensive

Until everyone knows that management will take action, written policies are nothing but words on piece of paper.

Such a policy might make the following points:

1. The safety of company employees is the paramount consideration of the company policy.

2. Safety will <u>always</u> take precedence over expediency or short cuts.

CONSTRUCTION PRINCIPLES
SECTION F – SAFETY IN CONSTRUCTION

LESSON 4
Safety Training

Objective

After completing this lesson, you will be able to:

- Identify the fundamentals of a sound safety training program.

Safety Training

In developing an overall safety program for a construction company, two things should always be kept in mind:

1. No program, no matter how well conceived and administered, can succeed unless it has the backing of everyone connected with the company.

2. Most employees are willing to do the right thing. The trick is to make sure they know the right thing.

In other words, if employees are sold on the idea of safety and if they have been trained properly to do their jobs, they will perform in a safe manner.

In most construction companies, this means that the burden of safety falls, in the final analysis, on the employee's immediate supervisor; that is, on the foreman. The chances are that anyone who has progressed to the status of a foreman has already been exposed to safety rules to the point of boredom. It is, however, not enough that he or she be familiar with the rules. He or she must also know how to supervise and train his or her people which, in many cases, means that the supervisor must be put through a course of training.

OSHA requires a competent person in every job-site. According to the OSHA CFR 1926.32(f) a competent person is defined as “one who is capable of identifying existing and predictable hazards in the surroundings or working conditions which are unsanitary, hazardous, or dangerous to employees, and who has authorization to take prompt corrective measures to eliminate them.”

The absence of a competent person is one of the most cited violations on jobsites. The competent person must be selected by the employer and his/her title should be known to all the people working in the site. There are no specific qualifications required for being selected as a competent person; however it is expected that the competent person has had prior safety training, knowledge in the task being performed, general and task-specific safety present or

CONSTRUCTION PRINCIPLES
SECTION F – SAFETY IN CONSTRUCTION

LESSON 5
Safety Inspections

Objectives

After completing this lesson, you will be able to:

- Recognize the need for periodic safety inspections
- Name the procedures for making safety inspections

Safety Inspections

Safety inspections have one basic objective: to detect hazardous conditions so that they may be corrected before an accident happens.

It goes without saying that every supervisor is responsible for making safety inspections in his or her area periodically. In fact, the procedure should never cease. As he or she moves about the job on daily business, a part of his or her mind should always be alert for unsafe practices and conditions. This method is useful and spots many unsafe conditions, but it has limitations. For one thing, it usually misses the things that take extra effort to see. It does not normally extend to out of the way places, and has a tendency to be superficial and erratic. Since the supervisor has a number of things to occupy him or her, the eye may see but the mind is usually preoccupied.

Therefore, the supervisor's daily "look-around" needs to be supplemented by periodic, systematic inspections carried out by disinterested parties. It is a fact of human nature that no person can be his or her own judge. He or she tends to get too close to the forest to see the trees. It is not necessary to hire a professional inspector to do this. There is no reason why the concrete foreman cannot perform a safety inspection of the carpenter shop, for example, and the carpenter foreman cannot return the favor. With the use of a little tact, the carpenter foreman and the concrete foreman can avoid coming to blows, and the company will benefit. The inspector need not be an expert to recognize an unsafe condition. Basically, there are only two causes of unsafe conditions. First, machinery and equipment wear out. Cable strands break, ropes fray, insulation cracks, hand and power tools develop defects, and scaffolding splits and cracks. Second, workers, for one reason or another, commit unsafe acts. They stack building materials in the way, guards are removed and not replaced, and tools are abused.

For these reasons, inspections should be planned and conducted to find not only unsafe physical conditions but also unsafe work habits. Often the two are inseparable, as in the case of workers using a portable electric drill with frayed wiring.

CONSTRUCTION PRINCIPLES
SECTION F – SAFETY IN CONSTRUCTION

LESSON 6
Office Safety

Objective

After completing this lesson, you will be able to:

- Identify the need for an active accident prevention program for office workers

Office Safety

The construction industry has long been aware of the dangers to life and limb which exist on the job-site. Any set of conditions which exposes workers to the weather and using heavy equipment to deal with loads which frequently run into thousands of pounds is bound to create dangers. Consequently, the main emphasis of the safety programs in the construction industry has been directed at the job site. This is understandable, but it ignores the dangers which are present in the office. These dangers are not very glamorous, true. The steel worker wrestling beams on the 18th floor of a new skyscraper usually does not have to be convinced that danger is present. But nobody gives a thought to what can happen if one attempts to sit down without paying sufficient attention to the location of a chair. Back injuries are no joke. An injury to an office worker is just as painful to the worker and expensive to management as if it happened on the construction site.

A safety program cannot be fully effective if it covers only a portion of the company employees. And a number of studies show that office workers are just as apt to be hurt as workers on the construction site; though it is true that the incidence of fatal accidents is undoubtedly higher on a job site than in the office. When our steel worker on the 18th floor makes a slip, it is likely to he his or her last one, or when a crane operator swings the boom around a high voltage line, he or she is not likely to survive, whereas the office worker who misjudges his or her chair while sitting down will probably not die. But the office fall is still an accident which is preventable.

The chief cause of office accidents seems to be that people cannot convince themselves that danger exists in the office. Figures help to dispel this notion. The California State Department of Industrial Relations conducted an analysis which, when adjusted to reflect a nationwide scale, indicates that some 40,000 disabling injuries happen each year in offices, at a cost of about one hundred million dollars. These figures do not reflect injuries which were not disabling. It seems reasonable to postulate 100,000 office injuries a year. Now, it is possible to overdo this. We can proceed along these lines until we show that it is more dangerous to be a typist in Des Moines than in was to land in the assault wave on Omaha Beach. Nevertheless, it should be clear that the office worker is by no means as safe as he or she thinks.

CONSTRUCTION PRINCIPLES
SECTION F – SAFETY IN CONSTRUCTION

LESSON 7

Accident Investigation and Required Record Keeping

Objectives

After completing this lesson, you will be able to:

- Identify the reasons for and the methods of conducting an accident investigation.
- Name the reporting and record keeping techniques required by the Occupational Safety and Health Act of 1970.

Accident Investigation and Analysis and Required Record Keeping

The aim of every safety program should be the prevention of accidents. But humans will probably never reach the goal of zero accidents. This is no reason not to try to reach the goal, of course. The harder we try, the more apt we are to reach it, and we will probably get an additional dividend in that the results of the accidents that do happen will show a tendency to be minimized.

A safety program, to be successful, should concentrate on the following operations:

1. Keep a close watch on all working areas to spot physical hazards and get them corrected before they cause an accident. This can range all the way from simple good housekeeping to periodic checks of complicated (and dangerous) machinery to be sure that the safety attachments are in working order. Good housekeeping is very important and is hard to stay on top of because it is hard to make people believe that a neat shop is actually safer.

2. Operating methods and procedures should be checked periodically, to be sure that unsafe practices have not developed. A procedure which is safe with one type of equipment may be dangerous with another type of equipment.

3. The human factors (which cause most accidents) need to be kept in line by constant attention to the three E's, Engineering, Education and Enforcement.

4. The three operations discussed above are all aimed at preventing accidents before they have a chance to happen. Once an accident has happened, it should be investigated and analyzed in order to find out exactly what happened and why it happened. Once this is known, constructive steps can be taken to be sure it won t happen again. A valuable part of investigation and analysis involves a close look at almost-accidents. If a cable breaks and drops a steel I-beam, the circumstances merit investigation even if no one was injured and no damage was done. You might not be lucky the next time, and if the incident gets proper attention, maybe there won't be a second time.

CONSTRUCTION PRINCIPLES
SECTION G – SECURITY

Lesson 1
Construction Job Security Considerations

Objectives

After completing this lesson, you will be able to:

- Identify problem areas created by theft, vandalism and other crimes
- Observe the necessity for including the price of security in the total cost of a construction project
- Contribute to the solution of problems caused by theft and other crimes at the construction site

The area of personal and property security has not been developed by any of the major code writing organizations. Theft and vandalism cost the public (through added contract costs and through our law enforcement agencies) millions of dollars each year. A few communities are beginning to incorporate a section on security in their codes, but the scope of the problem is so complex and widespread that it has been difficult to find a workable approach. Historically, the building code was written to protect the health and safety of the public through requirements relating to structural soundness, fire protection and prevention of health hazards. The area of protecting people and property against crimes was not necessary in the early part of this century, when most codes were written. The need to secure property and persons against crime is now critical. Losses of property and bodily injuries resulting from crime around residences are many times much greater than from fire. It is estimated theft and vandalism cost the construction industry in excess of $150 million annually and the amount of stolen or damaged tools, heavy machinery, office equipment and other property is rising daily.

Published materials and resources are very scarce in the area of security. The booklet, "Model Security Code for Residential Areas", written by the staff of the Institute for Community Design Analysis, 853 Broadway, New York, New York 10003, is very good and many companies manufacturing safety devices are now making their products known by way of brochures and specification sheets. As the title of the above mentioned booklet implies, this is for residential security and does not encompass the problems of the contractor and the on site problems of theft and vandalism; however, there are many good ideas for securing a building or area in the booklet.

Many contractors view the problem of theft and vandalism as being unsolvable. Many say the cost is too high in relation to the inconvenience caused. There seems to be little the police can or will do and any report to the insurance company will, many times, result in an increase in insurance rates. Police officials and contractors do agree that the cost of prevention, detection and prosecution is high and time consuming. Many contractors fail to realize that failure to take precautions to prevent loss from theft and vandalism, failure to report losses through theft and

CONSTRUCTION PRINCIPLES
SECTION H – QUALITY CONTROL

Introduction

Objective

After completing this Section, you will be able to:

- Define quality control
- Identify personnel problems associated with quality control
- Investigate the contribution of methods of purchasing and subcontracting to quality control
- Identify effects of supervision on quality control

Webster defines "quality" as "class, kind, or grade, properties or attributes". The quality of particular goods or services can be described as "attributes (or characteristics) required for some desired grade level".

The word control suggests "direction, guidance, or restraining power over" a process. The purpose of Quality Control is to insure that, if one takes specified ingredients and causes them to be combined in certain ways, it may be confidently expected that the end product, whether it be an 80 story skyscraper or a chicken coop, will have the desired level of performance. In the construction business, both the seller (the builder) and the buyer (the owner) have an interest in Quality Control. The buyer wants to be sure he/she is getting what he paid for, and the seller wishes to be sure the buyer gets what he/she paid for (but not a whole lot more).

The approach to Quality Control in the past tended to polarize into two focal issues, Statistical Quality Control and the 100% inspection approach. The statistical method has been (and still is) useful in assuring quality of product in industries which turn out large numbers of practically identical products. Consider, for example, a manufacturer of shotgun shells. Obviously, 100% testing would give the best chance of preventing a defective product from leaving the factory. But a 100% testing program would involve the actual firing of every shell produced, which would be expensive, in addition to leaving nothing to be sold. Consequently, the statistical approach is often used, in which random samples are taken from the production line and tested. Failure of the sample to meet certain specifications might mean the condemnation of a certain "lot" or production run, but would not mean the destruction of the entire plant output.

The frequency and size of this random sample is a course of study all by itself. To make a complex subject brief, such selections are based on the laws of probability, which suggest that random happenings can be predicted in advance. The laws of probability can tell you your chances of drawing an ace in a game of five card stud. If you come to the game forearmed with your very own ace up your sleeve, you are interfering with the laws of probability, and your drawing the ace is not a random happening.

Statistical quality control has some use in the construction business in those instances where repetitive actions take place. A good example is in the placement of concrete. Random samples can be taken, properly cured for the prescribed length of time, and tested to indicate the quality of concrete actually placed in the structure. This, of course, is an after-the-fact test. It doesn't tell you what to do when tests show that part of a concrete beam floor poured on the eighteenth floor seven days (or fourteen or eighteen days) ago is definitely not up to scratch. It is, however, better to know this unhappy fact now, rather, than much, much later, when the ABC Mousetrap Company's Univac computer ends up in the basement rather than on the eighteenth floor, where it belongs.

The term "quality assurance" is often used interchangeably with "quality control". Strictly speaking, this is an erroneous use of terms. Quality Assurance refers to a total system of activities, the purpose of which is to make sure that quality is what it ought to be. Quality Control is only one of these activities. Some of the others are planning, design, plans and specifications, method of contract award and construction.

The purpose of planning is to survey needs and desires, and to establish a goal to meet them. A certain city, for example, because of population growth, may decide that educational needs exist which can best be met by construction of a new high school. Thus, basically, the level of quality desired begins to be set.

Design begins the process of balancing what the city would like to have against what it thinks it can afford. In other words, quality levels versus resources available. The quality of the end product will be determined in large measure by the design.

Plans and specifications translate the design by specifying the quality levels required. The plans and specifications must be clear and concise to yield the desired product.

The contract award process sets the price which must be paid for the quality level the owner desires, which is set out in the design, and is crystallized in the plans and specifications. The contract binds the builder to provide a certain level of quality and the buyer to pay a certain price for that level of quality.

The builder then proceeds to transform plans and specifications on paper to a physical reality on the ground. It is in this phase of quality assurance that quality control comes into play. The buyer wishes to be sure he/she gets the quality he/she is paying for. The builder wishes to meet the terms of this contract.

The builder seldom has much chance to contribute to the planning, design and plans and specs phase of the quality assurance program. He/she comes into it only at the contract award phase, at which time (theoretically) the buyer has stated clearly and concisely what he/she wants. The builder states that he/she will provide what is wanted at a stipulated price, and the bargain is made. At this point, we enter the Quality Control phase of the Quality Assurance program. The specifications, supplemented by the approved drawings, are the control instrument for the Architect/Engineer.

Quality Control may be thought of as (1) control of the building process and (2) inspection, which includes sampling and testing, if applicable. The builder is in control of the construction process, the aim of which is to provide the owner (buyer) with a product which meets the terms of the contract. The buyer has the right to assure himself/herself that these terms are being met. He/she normally exercises this right by inspecting the job in process, and by performing such

tests as may be called for. It follows that the wise builder will attempt to exercise such controls on his/her construction process as will enable him to produce a product of such quality that will meet the terms of the contract.

You will find a number of texts in your local library that can give you an in depth treatment of the field of quality control. One such text is Quality in Construction, by Lee S. Evans and William R. Smolkin, published by the National Association of Home Builders, Washington, DC. It was written primarily for contractors in the housing construction field, but the treatment of the approach to a high quality product is applicable to contractors in any field, not merely housing.

Those students who wish to go deeper into the statistical quality control field are referred to Statistical Quality Control, 4th edition, by Eugene L. Grant and Richard S. Leavenworth (McGraw-Hill Book Company), which is the classic text in the field.

For those who wish to consider quality control from the standpoint of the buyer (owner) rather than the builder (contractor), an excellent reference is Construction Project Administration, John Wiley & Sons, New York.

Not all of the answers to the questions for each lesson in this Section appear in the body of this Section. The questions are answered, but the student is encouraged to explore the questions and their implications in the books mentioned above, or in the bibliography.

CONSTRUCTION PRINCIPLES
SECTION H – QUALITY CONTROL
LESSON 1
Management

It often goes without saying that management has as high a stake in a quality finished project as does the owner. Furthermore, management is responsible for turning out a quality product, both morally and legally (by the terms of the contract).

Anyone who has spent any time at all in the construction industry can no doubt supply a quota of horror tales concerning failures of quality control. Lives can depend upon work being up to specification.

It is very tempting to lay the blame for failure on labor unions, or on "Government interference", or on sociological theories that no one takes any pride in a job well done or on one or another cause. However, the builder is legally responsible to carry out the terms of the contract, not the unions, the "Government", or sociologists.

Labor unions and bureaucrats are a fact of life. They are not going to go away. The question of whether or not their long term effect will be good or bad is interesting, but completely beside the point. They exist, and the problems for the builder caused by their existence are like those caused by unseasonable rain and snow. They must be overcome if the project is to be turned over, on time, and with the quality called for under the terms of the contract. .

The builder is legally responsible for all aspects of the contract until the project is turned over and, depending on warranties, etc., for some time after that. In order to meet his/her responsibilities the builder must perform the following functions:

1. Plan
2. Organize
3. Staff
4. Control

And finally:

5. Deal with customers, satisfied (hopefully) or otherwise, after the project has been completed

CONSTRUCTION PRINCIPLES
SECTION H – QUALITY CONTROL
LESSON 2
Planning and Organization

The quality which a builder is required to provide in a construction project is normally carefully spelled out in the contract, which references plans and specifications. Insofar as this course is concerned, it is taken for granted that the contractor begins the job with the objective of meeting these obligations. The big question is, "How"?

All too many builders approach this question of "how" with a standard answer. We'll do it the same way we did it on the last job. All well and good, but experience tells us that there are never any two days alike, let alone two jobs in the construction industry. They may look the same on the surface, but major differences are almost certain to develop. Weather, for example, is almost certain to vary. Material cost and availability represent another built-in variable. Skill of the work force may stay fairly constant if the company has a good relationship with its people and they stay with the company. However, you have to take what the union sends. Quality of supervision may change. Certainly your superintendents and quite possibly your foremen are company men, but there are promotions and retirements to change even this picture. How about the quality of the subcontractors? The job site itself? All of these challenges must be met responsibly by a successful contractor.

No matter how alike jobs may seem at the start, there are bound to be differences, some of them significant. Past experience is invaluable. There is no substitute for it, but it cannot replace planning. Planning answers the question: exactly how are we going to go about skinning this cat?

Identify standards against which quality will be measured or evaluated. Use the project specifications as a start to determine name brands, level of workmanship, construction procedures, etc.

Items to look for by CSI division in specifications:
- Inspections
- Testing
- Sample panels
- Construction procedures
- Brand names
- Particular suppliers

Performance standards serve as a guide to let management know whether quality requirements are being met as the job progresses, and in time for corrective action in case they are not. Budgets, company standard procedures and company policy are essential points of planning.

Most specs provide that all workmanship, equipment, materials and articles incorporated in the work are to be of the best available grade. This puts an added burden on the inspector to interpret the terms "best" and "quality". Phrases such as "workmanship shall be of the highest quality" are almost useless because they can't be precisely defined.

CONSTRUCTION PRINCIPLES
SECTION H – QUALITY CONTROL
LESSON 3
Purchasing and Subcontracting

Purchasing materials and selection of subcontractors have many points in common. The objectives of both are to obtain desired quality in a timely fashion.

The words "desired quality" should receive some thought before the actual commitments are made. They do not always mean "highest quality". A contractor who makes a point of providing quality over and above that required by the contract will shortly need the services of an understanding banker.

The contractor must allow sufficient time to notify the architect/owner so that technical data can be properly reviewed. On private projects, the architect may specify a single proprietary item for every item on the project if he/she chooses to.

On public projects, all specs are required by law to name at least 2 brand names and the words "or equal" if a product is called for by brand name. The 2 exceptions are:

- If the project specified is required to be compatible with existing facilities
- If the product specified is unique and no other brand is made

One of the inherent dangers of the "or equal" concept is that the products may not be equal at all. A product may be judged as not equal on the basis of physical or chemical properties, performance, selection of materials, or dimensional incompatibility with the design of the finished structure.

The words "timely fashion" deserve consideration, too. Obviously goods and services ordered should be provided to fit the construction schedule. If not, costly labor is standing around doing nothing while awaiting supplies. But supplies delivered too soon are almost as bad. This puts the contractor in the warehousing business, and the "warehouse" all too often is the job site, which brings all the attendant problems of damage from equipment, weather, loss and theft.

The project manager or superintendent must also develop, or at least implement, a procedure for handling additional purchases needed to cover shortages and acquire miscellaneous items needed during the course of the job. When such purchases are required, the project manager is responsible for seeing that the materials are properly ordered, delivered on time, and charged against the correct cost code. He/she must also be sure that the additional charges do not bring the final cost of a specific material over the estimate.

Quality issues that a project manager or superintendent should have procedures to handle:

- How is the material received, inspected, unloaded? Who will do this?
- Is there adequate lay down and staging areas?
- How will the material be protected before it's installed
- What are the procedures for quantifying and returning damaged or missing material?

CONSTRUCTION PRINCIPLES
SECTION H – QUALITY CONTROL
LESSON 4
Supervision, Control and Monitoring

Quality management is controlling the day-to-day use of job resources in such a manner that a project is built in accordance with the plans and specs. Quality involves a lot more than the work being accepted by the architect/owner. It is an ongoing process of performing in the best and most cost-effective way possible. It is doing the job right the first time, thus saving rework and warranty costs.

In any construction company, quality should be the responsibility of everyone from the president to the craftworker. Total Quality Management (TQM) is a structured system for creating project-wide participation in planning and implementing a continuous improvement process to meet or exceed customer needs. It is up to the project manager to oversee the implementation of quality management on the project.

Only the larger companies can afford the expense of a separate quality control branch. Likely, if a company has anyone assigned to quality control at all, it is an additional duty for one of the company executives. As we have discussed in previous lessons of this study guide, this is probably not the best possible way to approach the problem, but if it works, use it. If your company is having quality problems, it just might pay to set up a separate branch.

The person responsible for the day-to-day conduct of the work at the job site is normally the superintendent. The superintendent must produce a given quantity of work at a given standard of quality on a timely basis within cost guide lines, which is a little like trying to drive four horses at once. In a situation like this, the tendency may be to shirk one or more of the horses.

Cost and timeliness are not apt to be overlooked, because shortcomings in these areas are immediately apparent. The job either is or is not hitting the time schedule, and the costs are a matter of record in the head office, because they prepare the paychecks and pay the bills. Quantity of work produced is reported from the job site. Minor discrepancies between planned and actual progress can be camouflaged or explained, for a time, at least, although eventually chickens come home to roost.

The temptation to gloss over quality can become bad news, because all of the quality assurance plans in the world and all of the written policy statements in the world will do no good if those in charge at the job site cannot or will not give quality its fair share of time. And loss of quality can spell disaster. The average cost of rework to the contractor is 5% of the total installed project cost, which comes from the contractor's potential profit. Therefore, any reduction in rework can result in a higher profit margin, more repeat business from the same client, and being more competitive in the marketplace.

Prior to the start of any project, it is important that all quality-related requirements or standards be identified to ensure all work is carried out in accordance with them. Review the technical specifications and drawings, starting at the first relevant division and abstract every quality-related requirement and place it in a checklist format. An example of a project quality checklist is included at the end of this lesson.