V. How to Fill Out the Log

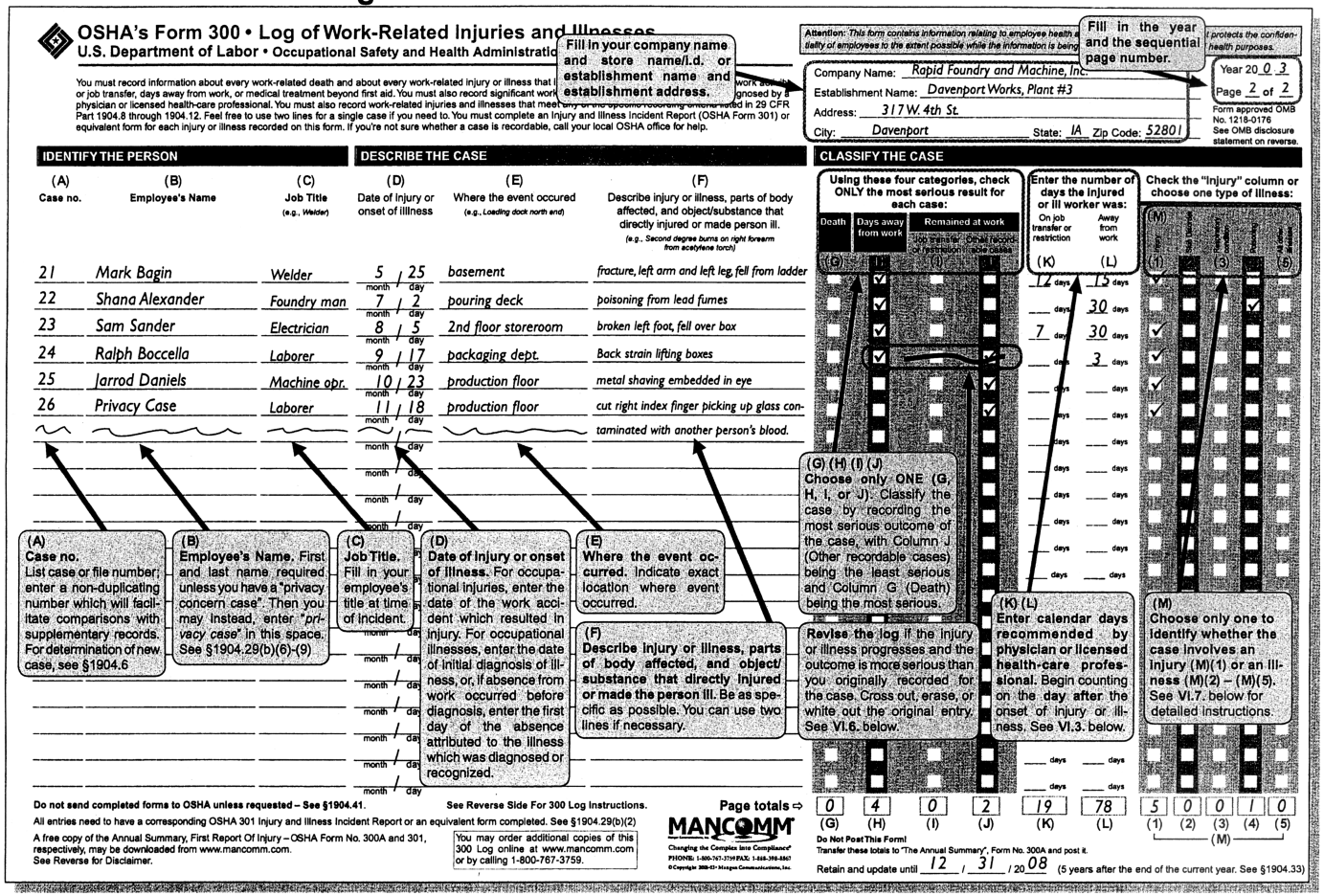


Figure 17.3 OSHA Form 300.

Indiana Worker's Compensation
First Report of Employee Injury/Illness

FOR WORKER'S COMPENSATION BOARD USE ONLY		
JURISDICTION	JURISDICTION CLAIM NUMBER	PROCESS DATE

Please Return Completed Form to: 402 W. Washington St., Room W196
Indianapolis, IN 46204-2753
(317) 232-3808

PLEASE TYPE or PRINT IN INK

NOTE: Your Social Security Number is being requested by this state agency in order to pursue its statutory responsibilities. Disclosure is voluntary and you will not be penalized for refusal.

EMPLOYEE INFORMATION

SOCIAL SECURITY NUMBER	DATE OF BIRTH	SEX ◯MALE ◯FEMALE ◯UNKNOWN	OCCUPATION/JOB TITLE / NCCI CLASS CODE
LAST NAME / FIRST / MIDDLE		MARITAL STATUS ◯UNMARRIED ◯MARRIED ◯SEPARATED ◯UNKNOWN	DATE HIRED / STATE OF HIRE / EMPLOYEE STATUS
ADDRESS (INCL ZIP)			HRS/DAY / DAYS/WK / AVG WG/WK / PAID DAY OF INJ ☐ SALARY CONT'D ☐
PHONE		# OF DEPENDENTS	WAGE $ PER ◯HR ◯DAY ◯WK ◯MO ◯YR ◯OTHER:

EMPLOYER INFORMATION

EMPLOYER (NAME, ADDRESS, CITY, STATE, ZIP)	EMPLOYER FEDERAL ID#	SIC CODE	INSURED REPORT NUMBER
	LOCATION #	EMPLOYER'S LOCATION ADDRESS (IF DIFFERENT)	
	PHONE #		
	CARRIER/ADMINISTRATOR CLAIM NUMBER		REPORT PURPOSE CODE
Actual Location of Accident/Exposure (if not on employer's premises):			

CARRIER/CLAIMS ADMINISTRATOR INFORMATION

CLAIMS ADMINISTRATOR (NAME, ADDRESS, PHONE NO)	CARRIER FEDERAL ID#	CHECK IF APPROPRIATE ☐ SELF INSURANCE
	☐ INSURANCE CARRIER	POLICY/SELF-INSURED NUMBER
PHONE:	☐ THIRD PARTY ADMIN	POLICY PERIOD FROM TO
AGENT NAME	CODE NUMBER	

OCCURRENCE/TREATMENT INFORMATION

DATE OF INJ/EXP	TIME OF OCCURRENCE __M	DATE EMPLOYER NOTIFIED	TYPE OF INJURY/EXPOSURE	TYPE CODE
LAST WORK DATE	TIME WORKDAY BEGAN	DATE DISABILITY BEGAN	PART OF BODY	PART CODE
RTW DATE	DATE OF DEATH	INJURY/EXPOSURE OCCURRED ON EMPLOYER'S PREMISES? ☐ YES ☐ NO	CONTACT NAME	PHONE NUMBER
DEPARTMENT OR LOCATION WHERE ACCIDENT/EXPOSURE OCCURRED		ALL EQUIPMENT, MATERIALS, OR CHEMICALS INVOLVED IN ACCIDENT		
SPECIFIC ACTIVITY ENGAGED IN DURING ACCIDENT/EXPOSURE		WORK PROCESS EMPLOYEE ENGAGED IN DURING ACCIDENT/EXPOSURE		
HOW INJURY/EXPOSURE OCCURRED. DESCRIBE THE SEQUENCE OF EVENTS AND INCLUDE ANY RELEVANT OBJECTS OR SUBSTANCES				CAUSE OF INJURY CODE
NAME OF PHYSICIAN/HEALTH CARE PROVIDER				INITIAL TREATMENT ☐ NO MEDICAL TREATMENT ☐ MINOR: BY EMPLOYER ☐ MINOR: CLINIC/HOSP ☐ EMERGENCY CARE ☐ HOSPITALIZED >24 HRS ☐ FUTURE MAJOR MEDICAL/ LOST TIME ANTICIPATED
WITNESSES (NAME, PHONE #)		DATE ADMINISTRATOR NOTIFIED		
DATE PREPARED	PREPARER'S NAME / TITLE		PHONE NUMBER	

An employer's failure to report an occupational injury or illness may result in a $50 fine (IC 22-3-4-13)

STATE FORM 34401 (R8 2/96)

Figure 17.4 Typical first report of injury/illness form.

Table 17.2 OSHA Standards Most Commonly Cited for Violations

Section	Subject	Section	Subject
1926.500	Guardrails, Handrails, Covers	1926.100	Head Protection
.451	Scaffolding	.552	Materials, Hoists, Personnel Hoists, Elevators
.450	Ladders		
.350	Gas Welding and Cutting	.50	Medical Services, First Aid
.401	Grounding and Bending	.501	Stairways
.550	Cranes and Derricks	.300	General Requirements, Hand and Power Tools
.25	Housekeeping		
.152	Flammable and Combustible Liquids	.651	Excavation
		.51	Sanitation
.400	General Electrical	.28	Personal Protective Equipment
.402	Electrical Equipment Installation and Maintenance	.102	Eye and Face Protection
.150	Fire Protection	.302	Power-operated Hand Tools
.652	Trenching	.351	Arc Welding and Cutting
.601	Motor Vehicles	.105	Safety Nets

commission, after a hearing and review, can affirm, modify, or vacate the citation, proposed penalty, and abatement period.

Table 17.2 is a list of OSHA standards representing job site physical hazards that are commonly cited as violations. In addition to those listed, the 1988 provision requiring firms to inventory and label hazardous materials is the most highly cited violation. This Hazard Communication (HazCom) Standard also requires that employees be trained in the safe use of such materials. Material Safety Data sheets (MSDs) must be maintained for each hazardous substance. The program addresses the need to make employees more aware of the chemical hazards in the work place.

If, during the course of an inspection, a violation is noted, a written citation is given to the employer and the area where the violation occurs will be posted. A reasonable length of time shall be granted the employer for correction of the violation.

These violations, and failure to abate in the given time, incur monetary violations up to $70,000. Serious violations incur a mandatory fine of $7000. Failure to abate within the given time period can result in a fine of $7000 a day for the period the violation persists.

17.8 SAFETY RECORD KEEPING

Documentation under the Williams–Steiger Act is required as follows: “Every employer who is covered under this act must keep occupational injury and illness records for his employees in the establishment in which his employees usually report to work.”

The OSHA laws require employers to keep both a log of recordable occupational injuries and illnesses and a supplementary record of each injury or illness. These records must be kept up to date and should be available to government representatives.

These records are also used to compile the annual accident report (OSHA 300), which must be posted in a prominent place in the establishment available to the employees.[2] Also

[2] The OSHA 300 (or equivalent) must be kept up to date at all times.

the poster entitled "Safety and Health Protection on the Job" shall be posted in a similar manner.

The only employers excluded from this portion of the act are those who are already reporting this material under the Federal Coal Mine Health and Safety Act or the Federal Metal and Nonmetallic Mine Safety Act.

Recordable occupational illnesses and injuries are those that result from a work accident or from exposure to the work environment and lead to fatalities, lost workdays, transfer to another job (temporary or permanent), termination/limitation of employment, or treatment beyond simple first aid measures. Also, those cases involving loss of consciousness or restriction of work or motion are recordable.

Reporting at the job site level breaks into six reporting levels as follows:

1. First aid log
2. First report of injury log
3. Supervisor's accident investigation report
4. Project accident report
5. OSHA required Injury Report (OSHA 300)
6. Fatality or major accident report

The first aid log is kept on the job and lists every treatment given. The first report of injury log is required by the workmen's compensation laws in most states. It is prepared to record every personal injury that requires off-site medical treatment regardless of whether the employee lost time from work or not. The supervisor's accident investigation report is prepared by the foreman for each recordable accident and places special emphasis on identifying methods by which the accidents could be prevented in the future. A typical project accident report form is shown in Figure 17.5. It is a monthly summary of disabling injuries and lost time sent to the home office. The form shown is a report of information on each disabling injury required by OSHA and kept at the job site. Finally, as noted above, any fatality or accident that hospitalizes three or more employees must be reported to the OSHA area director within 8 hours.

17.9 SAFETY PROGRAM

A good job site safety program should be founded on:

1. Safety indoctrination of all new personnel arriving on the site
2. Continuous inspection for possible safety hazards
3. Regular briefings to increase the safety awareness of personnel at all levels
4. Written programs and documentation specifying all safety activities

If workers or supervisors flagrantly neglect safety rules and regulations, warnings should be considered.

It is good practice to personally brief each employee arriving on site regarding job procedures. A briefing sheet such as the one shown in Figure 17.6 is an effective aid for conducting this type of briefing. This focuses the worker's attention at the outset on the importance of safety and indicates management's interest in this phase of the job. Safety rules and regulations such as those shown in Figure 17.7 should be available in "handout" form and be conspicuously posted around the job site.

General safety meetings conducted by the safety engineer should be held at least once a month with supervisors at the foreman and job steward level. A typical report for such a

Job Name Peachtree Shopping Mall Job No. 10-100 Location Atlanta, Georgia Month April 20xx

This report should be completed and mailed to the Safety Branch of the Industrial Relations Department in the Atlanta office by the fifth day of the month.

Project Superintendent _____

This figure may be taken from payroll records. In the case of fractions use the nearest whole number. Do not include subcontractors or others.

1. Average number of employees _____

Figure actual hours worked whether straight time or overtime. Includes only those on our payroll.

2. Total hours worked by all employees _____

Record only those injuries that cause death, permanent disability (loss of a finger, etc.), or loss of time beyond the day on which the accident occurred. No matter what time of day the injury may occur, if the employee returns to his regular job at the start of his next regular shift, the injury is not counted. If he does not return at that time, it must be counted as a disabling injury.

3. Number of:
   Temporary disabling injuries _____
   Permanent disabling injuries _____
   Deaths _____
   Total disabling injuries for this month _____

For temporary injuries, count the actual calendar days lost, excluding the day of injury. If the injured employee has not returned by the end of the month, make an estimate of projected number of lost days. For deaths and permanent injuries, use the number of days specified in the standard table.

4. Number of days lost as a result of:
   Temporary disabling injuries _____
   Permanent disabling injuries _____
   Death _____
   Total days lost attributable to this month _____

Figure 17.5 Project accident report.

meeting is shown in Figure 17.8. The objective of these meetings is primarily to heighten the safety awareness of supervisors directly in charge of workers. These foreman-level personnel in turn should hold at least one "tool box" safety meeting each week to transfer this awareness to the work force and discuss safety conditions with their crew. The report format includes a record of those in attendance, the first aid report, and a description of the safety topics discussed. In addition to the general safety meetings, each job should have a designated safety committee that meets regularly. The members of the safety committee should include key supervisory personnel and craftsmen with an alertness to potential danger and a genuine desire to prevent accidents and injuries. One of the purposes of the safety committee should be to make suggestions as to how to improve overall job safety. Therefore, the members appointed should be sensitive to safety and innovative in devising safe methods.

August 2, 20xx

PEACHTREE SHOPPING MALL
Atlanta, Georgia

Welcome to the job! ABC Construction Company is interested in you, and during your employment with us, we will exert every effort to make this job pleasant, with a good working atmosphere. On the other hand, your skills, ability, and performance are most important and essential to the successful completion of the project. To set up and complete a good job, certain rules and regulations must be established. For our mutual benefit, these rules and regulations are as follows:

WORKING RULES AND REGULATIONS

Employment
The Project Manager, or his duly authorized representative, will do all the hiring on the job.

Identification
Employees shall wear a company badge at all times, in full view, above the waist, on an outer garment. Badge numbers will be used in gate clearance, payroll, and timekeeping identification.

Hours of Work
The regular workday will begin as per individual instructions, with a lunch period of one-half hour at a designated time. The workweek shall be five days, Monday through Friday.

All employees will be at their work locations, ready to start work at work time. All employees are expected to remain at work until the authorized quitting time, at which time they may put up their tools and leave their place of work. Loitering in the change rooms and/or other places during working hours, or late starting of work and early quitting of work will be subject to proper disciplinary measures.

Checking In and Out
Employees are to check in and out at starting and quitting time. Infractions of this rule will be treated with appropriate disciplinary measures. Employees authorized to leave the project during regular working hours must check out with the timekeeper.

Issuing, Care, and Use of Tools
Certain company tools will be issued to journeymen and apprentices, or the foreman on a check or receipt system. Tools (while issued) must be properly used and maintained. A toolroom clearance will be required on termination. Loss of or damage to tools will be noted on the employee's record.

A Day's Work
Each employee on the job is expected to perform a full day's work. Your willingness, cooperation, and right attitude will go a long way in accomplishing this objective.

Conduct on the Job
Good conduct on the job is essential to the overall welfare of all employees and the daily progress of the job. Therefore, conduct including, but not limited to, the following violations will be subject to appropriate disciplinary action or discharge.

Figure 17.6 Job briefing sheet.

Theft of company's or employees' property
Recurring tardiness
Leaving company's premises without proper authorization
Possession and/or use of intoxicants and/or narcotics on company's premises
Willful damage to company's materials, tools, and/or equipment
Engaging in horseplay (including shouting to passers-by)
Insubordination
Gambling
Fighting on company premises
Sleeping on the job
Failure to observe established safety rules and regulations

Housekeeping

Good housekeeping is essential to the safe and efficient construction of the job and is the responsibility of each employee. Work areas, stairways, walkways, and change rooms shall be kept clean at all times.

Safety Rules

Established safety rules and regulations will be observed and followed by all employees in the best interest of accident-free operations.

All unsafe working conditions should be reported to your immediate foreman, who in turn reports it to the company safety engineer.

All employees will be required to wear proper clothing above and below the waist. Hard hats must be worn by all employees and visitors while on the construction site.

Pay Period

Wednesday thru Tuesday is the pay period, with pay day on Friday of each week.

Use of First Aid Facilities

First aid facilities are available at the job site and direct contracts have been established with local doctors, hospitals, and emergency crews for accidents of a serious nature. All injuries, regardless of severity, must be reported to the employee's supervisor, field safety supervisor, and/or first aid immediately upon occurrence. Insurance regulations make this requirement mandatory.

Sanitary Facilities

Adequate sanitary facilities are provided on the job site and are to be used by all employees. We request your cooperation in maintaining these facilities in a clean and orderly condition.

Raincoats and Boots

Raincoats and boots are supplied to employees where the conditions of the job being performed require them.

Remaining in Work Areas

Each employee must remain on the job site and at his work location at all times during regular working hours, unless authorized to leave by his supervisor.

Absenteeism

Unauthorized absenteeisms will result in termination of employment. An employee who must be absent or late should call 999-9000 and report to timekeeper.

Your cooperation in observing the rules and regulations for the job will show proper consideration for other employees and will be appreciated by the company.

If you agree to and will abide by the above, please sign and return to our field supervisor, Charles Hoarse.

_____

cc: Employee File

Figure 17.6 (*Continued*)

ABC Contractors and Engineers

760 Spring Street, N.W., Atlanta, Georgia 30308
(404) 999-9000

July 30, 20xx

Re: OCCUPATIONAL SAFETY & HEALTH ACT 1970 (Construction) (OSHA)

Employers, owner, contractors, subcontractors, superintendents, or foremen in charge shall not direct or permit an employee to work under conditions that are not in compliance with the above code.

Where one contractor is selected to execute the work of the project, he shall assure compliance with the requirements of this code from his employees as well as all subcontractors.

Every employee shall observe all provisions of the above codes that directly concern or affect his conduct. He shall use the safety devices provided for his personal protection and he shall not tamper with or render ineffective any safety device or safeguard.

1. *Overhead Hazards*	All employees shall be provided with HARD HATS and shall use HARD HATS.
2. *Falling Hazards*	Every hole or opening in floors, roofs, platforms, etc., into or through which a person may fall shall be guarded by a barrier sufficient to PREVENT FALLS.
3. *Slipping Hazards*	Scaffolds, platforms, or other elevated working surfaces covered with ice, snow, grease, or other substances causing slippery footing shall be removed, turned, sanded, etc., to ensure safe footing.
4. *Tripping*	Areas where employees must work shall be kept *reasonably free* from accumulations of dirt, debris, scattered tools, materials, and sharp projections.
5. *Projecting Nails*	Projecting nails in boards, planks, and timbers shall be *removed*, hammered, or *bent over* in a safe way.
6. *Riding of Hoisting Equipment*	No employee shall ride on or in the load bucket, sling, platform, ball, or hook.
7. *Lumber & Nail Fastenings*	Lumber used for temporary structures must be sound. Nails shall be driven full length and shall be of the proper size, length, and number. The proper use of double-headed nails is not prohibited.
8. *Guard Rail or Safety Rail*	Should be 2 × 4 at a height of 35″–37″ plus a midrail of 1 × 4. The hand rail shall be smooth and free from splinters and protruding nails. Other material or construction may be used provided the assembly *assures* equivalent *safety.*
9. *Toe Boards*	Shall extend 4″ above platform level and shall be installed *where needed* for the safety of those working below.
10. *Protection Eye Equipment*	Eye protection shall be provided by employers and *shall* be used for cutting, chipping, drilling, cleaning, buffing, grinding, polishing, shaping, or surfacing masonry, concrete, brick, metal, or similar substances. Also for the use and handling of corrosive substances.
11. *Protective Apparrel*	*Waterproof boots* where required shall have safety insoles unless they are the overshoe type. *Waterproof clothing* shall be supplied to the employee required to work in the rain.

Figure 17.7 Job safety rules and regulations.

12. *Safety Belts & Lines*	Shall be *arranged* so that a free fall of no more than 6″ will be allowed.
13. *Stairways*	Temporary stairways shall not be less than 3 feet in width and shall have treads of no less than 2 inch × 10 inch plank. Must have hand rails. (See #8.)
14. *Smoking*	Prohibited in areas used for gasoline dispensing and fueling operations or other *high hazard fire areas.*
15. *Flammable*	*Flammable liquid shall be kept in safety cans* or approved use and storage containers. Suitable grounding to prevent the buildup of static charges shall be provided on all flammable liquid transfer systems.
16. *Sanitation*	*Toilet facilities* shall be provided and made available in sufficient number to accommodate all employees.
17. *Drinking Water*	A supply of *clean* and *cool* potable water shall be provided in readily accessible locations on all projects.
18. *Salt Tablets*	Shall be made available at *drinking stations* when required.
19. *Excavations*	Material and other superimposed loads shall be placed at least 3 feet back from the edge of any excavation and shall be piled or retained so as to prevent them from falling into the excavation. Sides and slopes of excavation shall be stripped of loose rocks or other material. Slopes shall be at an angle of 45 degrees or less (*1 on 1 slope*).
20. *Structural Steel Erection*	When erection connections are made, 20% of the bolts in each connection must be drawn up wrench tight. At least 2 *bolts* must be used at each end of the member. *No loads* shall be placed on a framework until the permanent bolting is complete. Only employees of the structural steel erector engaged in work directly involved in the steel erection shall be permitted to work under any single-story structural steel framework that is not in true alignment and *permanently bolted.*
21. *Use of Ladders*	Ladders shall be provided to give access to floors, stagings, or platforms. Ladders shall be maintained in a safe condition at all times. Ladders shall be securely *fastened top* and *bottom* as well as braced where required. Ladders leading to floors, roofs, stagings, or platforms shall extend at least 3 feet above the level of such floors, stagings, or platforms.
22. *Scaffolds*	All scaffolding shall be constructed so as to *support* 4 times the anticipated working load, and shall be braced to prevent lateral movement. Planks shall overhang their end supports not less than 6″ or more than 12″. 2″ planking may span up to and including 10′. The minimum *width* of any planked platform shall be 18 inches. *Guard rails* and *toe rails* shall be provided on the open sides and ends of all scaffold platforms more than 8′ high (see #8).
23. *Rigging, Ropes, and Chains*	All rope, chains, sheaves, and blocks shall be of sufficient strength, condition, and size to safely raise, lower, or sustain the imposed load *in any position.* *Wire rope* shall be used with power-driven hoisting machinery. No rope shall be used when visual inspection of the rope shows marked signs of corrosion, misuse, or *damage.* All load hooks shall have *safety clips*. Loads that tend to swing or turn during hoisting shall be controlled by a *tag line* whenever practicable.

Figure 17.7 (*Continued*)

24. *Welding and Cutting*	Oxygen from a cylinder or torch shall never be used for *ventilation.* Shields or goggles must be worn where applicable. *Cradles* shall be used for lifting or lowering cylinders.
25. *Cranes & Derricks*	All cranes and derricks shall be equipped with a properly operating boom angle *indicator* located within the normal view of the operator. Every derrick and crane shall be operated by a designated person. A copy of the *signals in use* shall be posted in a conspicuous place on or near each derrick or crane. Cranes and derricks shall have a *fire extinguisher* attached.
26. *Trucks*	Trucks shall not be backed or dumped in places where men are working nor backed into a hazardous location unless guided by a person so stationed on the side where he can see the truck driver and the space in back of the vehicle.

The above items do not encompass all the construction safety regulations as they pertain to OSHA but are intended as a guide to the ever present hazards and primary causes of accidents in our industry.

Figure 17.7 (*Continued*)

ABC Construction Company
Job 10-100
Peachtree Shopping Mall
Atlanta, Georgia
Sept. 1, 20xx

GENERAL SAFETY MEETING #7

Safety Slogan for the Week:

"Be Alert, Don't Get Hurt."

C. Hoarse—Safety Supervisor
A. Apple—Carpenter Foreman
D. Duck—Surveyor
M. Maus—Laborer
D. Halpin—Field Engineer
R. Woodhead—Tool Room

Subcontractors Present:

Live Wire Electric
Henry Purcell
James Wallace

The First Aid Report for August 15 to August 31 Was Given. There Were:

First Aid	7
Doctor's Cases	0
Lost Time Injuries	0

Figure 17.8 Safety meeting minutes.

SHORTCUTS

All of us, supposedly, at one time or another, have been exposed to possible injury by short cutting when a few extra steps would have meant the safe way. We did so as kids when we jumped the fence instead of using the gate and we do so as men when we cross streets by jaywalking instead of using the intersection. Accident statistics plainly indicate the fact that people disregard the fact that minor safety violations may have very serious results.

In construction work, short cutting can be deadly. All of us know of cases in which this kind of thoughtless act resulted in a serious injury. For instance, an ironworker tried to cross an opening by swinging on reinforcing rods, his hands slipped, and he fell about 20 feet to a concrete floor. If he had bothered to take a few moments to walk around the building, he would still be tying rods.

The safe way is not always the shortest way and choosing the safe way is your *Personal Responsibility.* When you are told to go to work in a particular area, you are expected to take the safe route, not an unsafe short route. We cannot be your guardian angel; that is one thing you will have to do for yourself.

If you are told to go to work in some place that has no safe access, report this fact to your foreman so that necessary means of access can be provided.

Ladders and scaffolds are provided for high work; use them. Even though a high job may take only a few moments, DO NOT CLIMB ON FALSE WORK, or on some improvised platform.

Your first responsibility is to yourself. Remember that ladders, steps, and walkways have been built to save you trouble and to save your neck, too. Use them always.

Gambling a few minutes and a little energy against a possible lifetime of pain and misery is a poor bet.

GENERAL DISCUSSION

Flagmen must control all the back-up operations on this job.

Traffic—Be on the alert for moving vehicles, our area is slippery. *Don't* walk beside moving equipment.

Injuries—Report all injuries to your foreman immediately.

Charlie Hoarse

C. Hoarse, Safety Supervisor

Figure 17.8 (*Continued*)

REVIEW QUESTIONS AND EXERCISES

17.1 What factors should motivate a contractor to have a safe operation and a good safety program?

17.2 What factors influence the rate assigned to a contractor for workmen's compensation insurance?

17.3 What are two major economic benefits of a good construction program?

17.4 Explain organizing for safety.

17.5 What actions could you as the contractor take to instill a sense of safety among your workers?

17.6 Observe several construction sites and ascertain details of their safety program. If possible attend a tool box safety meeting. Then prepare a list of both good and bad examples of safety practice.

17.7 Using OSHA regulations as a guide, determine what are the accepted safety standards for:

a. Guard rails

b. Exposed reinforcing steel

c. Protection of openings

d. Man hoists

17.8 Many construction workers resist the use of safety helmets, goggles, and protective mittens and clothing despite the fact that they are designed to protect them. Give several reasons why this practice persists.

Chapter 18

Construction Operations

PROSIDYC: Simulation Program for Construction Operations

Construction of floating caissons utilized PROSIDYC as a tool to increase production.

The Need

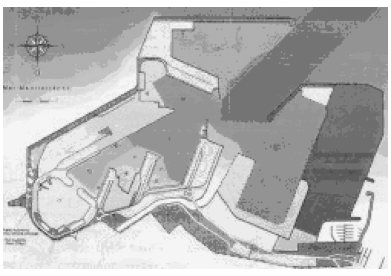
Currently 3D-modelling is the trend in the simulation area. However, developing 3D models of construction operations is very complex and time consuming. In general, the study of construction operations requires a tool that provides solutions without requiring the input of copious amounts of data. In order for a construction company to use a simulation tool, the methodology has to be presented in a very simple and graphical context. Pictorial and schematic tools are easily accepted. In contrast, if the methodology appears to be too theoretical or analytical it will be avoided by construction practitioners.

The Technology

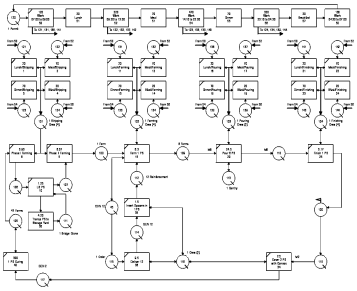
PROSIDYC is a system for simulating construction operations jointly developed by the Planning and Methods Unit of Dragados y Construcciones, Madrid, Spain and the Division of Construction Engineering & Management at Purdue University.

PROject SImulation Dragados Y Construcciones (PROSIDYC) is a computer based system for analyzing construction job site production processes. It is used to improve productivity in the field by studying resource utilization and cycle times and identifying opportunities for production improvement. PROSIDYC uses the CYCLic Operations NEtwork (CYCLONE) modeling format. A set of graphical modeling elements are utilized to develop a network model of the process of interest. The model identifies waiting or delay states as well as active productive states. The computer program allows the modeler to identify resources which are underutilized and bottlenecks in the process.

The use of this approach has achieved 100% success in productivity improvement on the processes studied. Improvements range from 30% to 200%. Data support the fact that



Harbor site layout.



PROSIDYC/CYCLONE
Flow diagram.

Caisson Construction Valencia, Spain.

for every hour of analyst time used, a saving of $2,000 is realized. Therefore, for 100 hours of engineering-time invested, a saving of $200,000 is achieved. PROSIDYC was used to achieve major cost savings in the massive breakwater in Valencia shown here.

18.1 MODELING CONSTRUCTION OPERATIONS

In Chapter 1, the hierarchy of construction management was described as shown in Figure 18.1. Activities define the structure of projects. The basic building block required to understand and analyze construction operations is the work task. A meaningful description of a construction operation requires the definition of the basic work tasks and the manner in which the available resources (e.g., cranes, crews, materials, etc.) perform or process through the work tasks. In this sense individual resources can be said to traverse or flow through work tasks. The sequential and logical relationships between the various work tasks define the technology being used. The actual working of the operation can then be described by locating and monitoring, from time to time, the various resource entities as they dynamically traverse the static structure of the operation. A simple graphical modeling system can be used to analyze the work flow and develop the productivity for a given construction operation.

18.2 BASIC MODELING ELEMENTS

A modeling format for flow modeling construction operations can be developed using four graphical symbols:

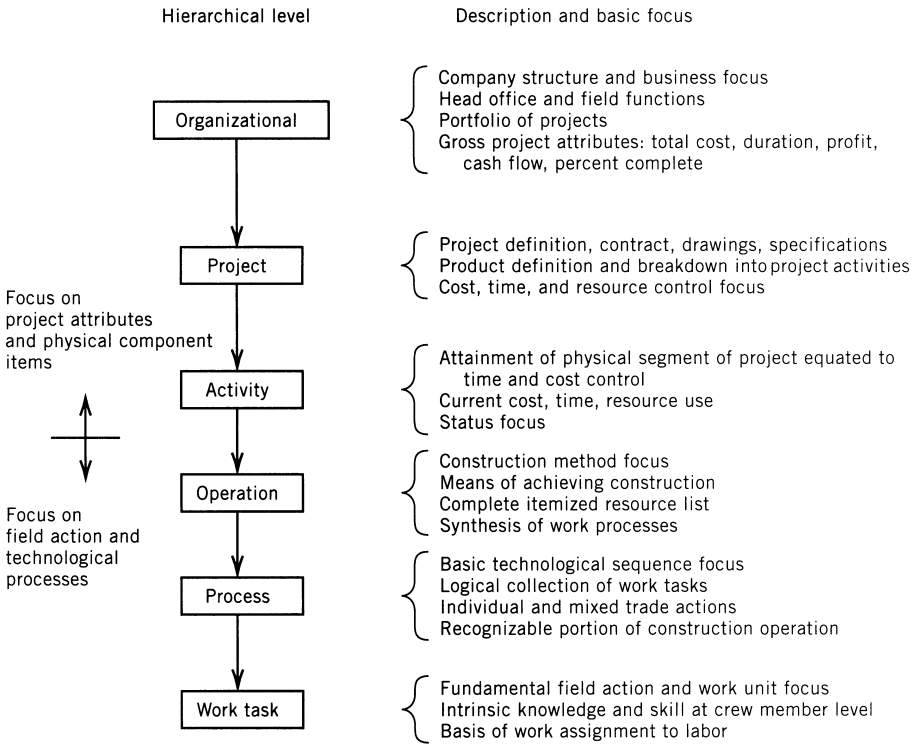


Figure 18.1 Hierarchical levels in construction management.

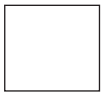
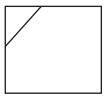
Modeling Element	Name of Element	Description of Modeling Element
	NORMAL	The normal work task modeling element can commence as soon as a unit (e.g. resource) arrives from a preceding element; it is unconstrained.
	COMBI	The constrained work task modeling element requires multiple resources (e.g. cranes, crews) before it can begin. A combination of resources is required to start. Otherwise similar to the normal work task modeling element.
	QUEUE	The idle state of a resource entity symbolically represents a waiting location (i.e. a queue) where resources wait prior to being combined.
	ARROW	The directional flow modeling element shows the logical flow of resources.

Figure 18.2 Basic modeling elements.

1. Active-state square node representing a work task
2. Idle-state circle representing a delay or waiting position for a resource entity
3. Directional flow arrow representing the path of a resource entity as it moves between idle and active states

The symbols used (see Fig. 18.2) for each modeling element are designed to be simple and helpful in developing schematic representations of the construction operation being modeled. Two basic shapes (squares and circles) are used to model active and waiting resource states; together with directed arrows (arcs) for resource flow direction, they help to provide a quick visual grasp of the structure of a construction operation. These symbols are the basic modeling elements of the CYCLONE (CYCLic Operations Network) modeling system. They are used to build networks of active and idle states to represent cyclic construction processes.

It is convenient to distinguish between the unconstrained (i.e., normal) work task and the constrained (i.e., requiring the initial satisfaction of conditions) work task. While all work tasks are modeled schematically as square nodes, the constrained work task is modeled as a square node with a corner slash. Thus a total of four symbols is required for the modeling of the structure and resource entity flow of construction operations (see Fig. 18.2).

The active working-state models are the NORMAL and COMBI modeling elements. Both have a square-node format and model work tasks. Since the work task is the basic component of a construction operation, it should be chosen so that its name or description is sufficient to convey to a crew member or supervisor the nature, technology, work content, and resources needed to fulfill the work task.

Simple examples of work task activities are breaking open brick pallets, preparing column formwork, and loading trucks with front-end loaders. The definition of a work task thus requires a verbal description, an indication of the resource entities involved, and a definition of the time required (duration) to complete the task.

18.3 BUILDING PROCESS MODELS

The relative sequence and logic of the work tasks and processes that make up a construction operation constitute the technological structure of the operation. The modeling elements can be used in a variety of patterns to model construction operations.

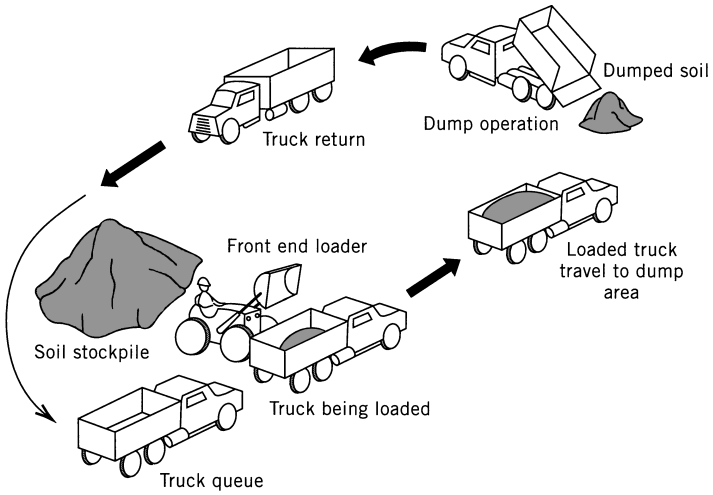


Figure 18.3 Schematic outline of earth-moving operation.

As an example, consider the development of a model for an earth-moving operation that involves the loading of trucks with earth for transport to a dump area. A pictorial representation of the operation is shown in Figure 18.3; it uses a front-end loader, some trucks, and earth.

In order to develop the framework of the earth-moving operation, it is necessary to identify the major resources involved (i.e., trucks, front-end loader, and soil) and establish the various states (i.e., both the active working states and the passive waiting states) that the resources traverse in their work assignment paths and cycles. Finally, the integration of the resource paths and cycles establishes the basic structure of the operation.

Each truck, for example, is idle while it waits (i.e., queues) for loading; it enters active working states when it is being loaded, dumping, traveling loaded to the work site, and returning empty for another load. A simple model of this work cycle is shown in Figure 18.4a using a single COMBI "Load truck" work task that requires earth and a front-end loader for initiation; three NORMAL work task elements, "Loaded truck travel," "Truck dump activity," and "Empty truck return"; a single QUEUE element, "Join truck queue"; and five arrows indicating the logical relationships between the various truck states.

18.4 STRUCTURE OF CONSTRUCTION OPERATIONS

The front-end loader can be initially modeled by a unit cycle involving the active-state COMBI element "FEL (front-end loader) loading," the idle QUEUE element "FEL idle," and two entity flow directional logic arrows (see Fig. 18.4b).

In Figure 18.4c, a soil path model is shown that uses a source QUEUE node "soil stockpile" and a sink destination soil dump QUEUE node together with a COMBI work task "Loaded into truck" and NORMAL work tasks "Transport by truck" and "Dumped" to portray the soil involvement in active work states. Finally, four directional arrows are required to develop the path structure.

The integrated model incorporating the truck and front-end loader cycles together with the soil path from stockpile to dump is shown in Figure 18.4d. Model integration is achieved by combining or "overlaying" active states which are common to two or more resource cycles. For instance, "load truck" in the truck cycle is the same active state (work task) as "loaded into truck" in the soil cycle and "FEL Loading" in the loader cycle. These three states are combined in the integrated model to be one active state "LOAD."

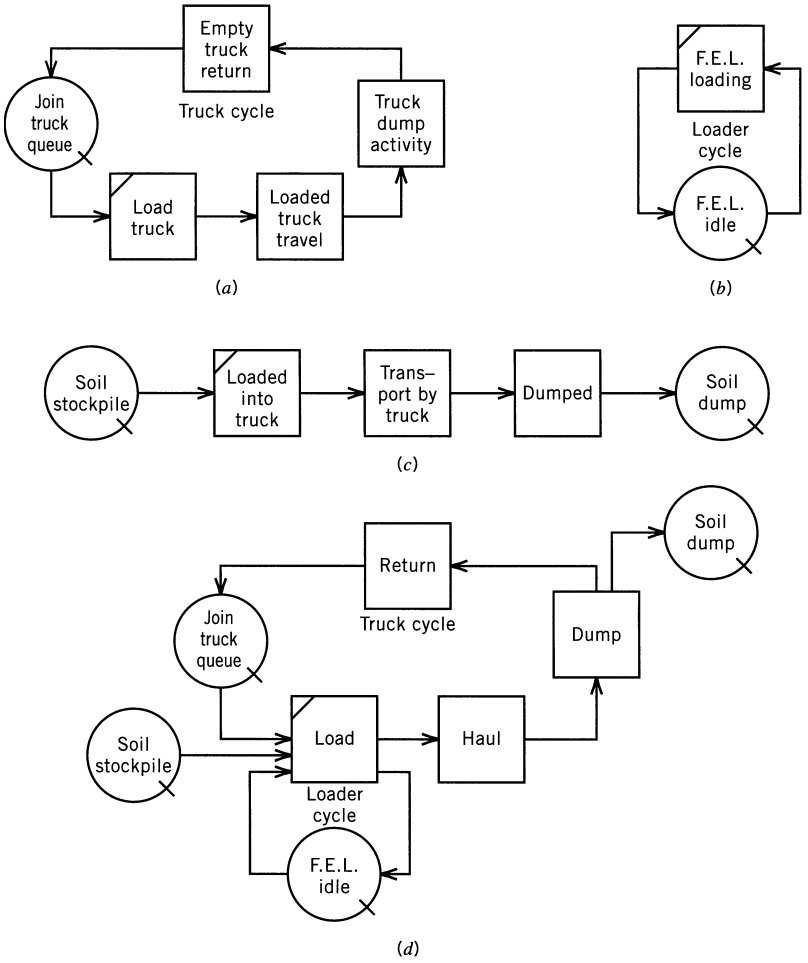


Figure 18.4 Development of operational structure; (a) truck cycle, (b) loader cycle, and (c) earth-moving operation.

This model can be used as the basis for further development involving dump area spotters and queues, dozer stockpiling operations, and truck maintenance, as well as the basis for further detail such as a more precise description of the front-end loader loading cycle. An extension of the skeletal structure of the earth-moving operation to include dozer stockpiling and spreading operations together with a dump spotter foreman is shown in Figure 18.5. A *counter* element (represented by a flag) has been added to note the point in the network at which production will be measured.

The foregoing presentation illustrates that the structure of construction operations can be developed and illustrated through the proper use and labeling of the basic modeling elements. The model structure can be used in explaining the construction technology and construction method of the construction operation to field personnel and managers.

18.5 MODELING PROCEDURE

The procedure for modeling a given construction process involves four basic steps. The steps, as shown in Figure 18.6, are as follows:

1. **Flow Unit Identification**. As a first step, the modeler must identify the system resource flow units (e.g., resources such as earth, cranes, crews, etc.) that are

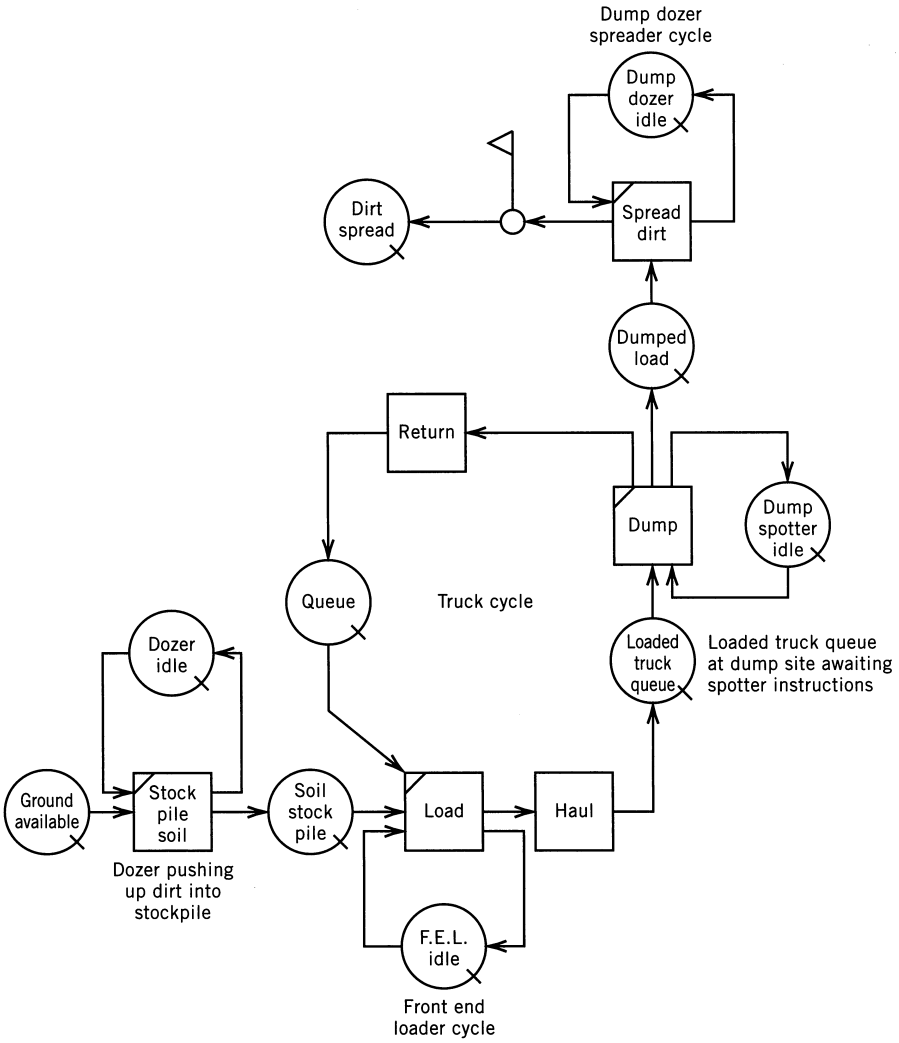


Figure 18.5 Model of earth-moving operation.

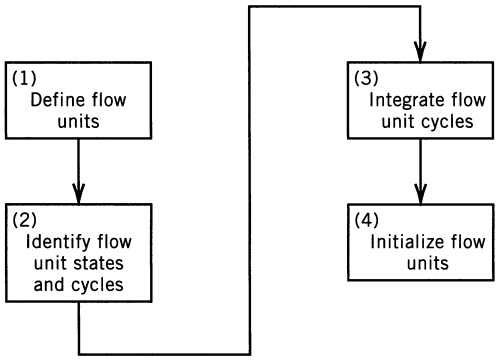


Figure 18.6 Steps in model formulation.

relevant to system performance and for which transit time information is available or obtainable from the field. The selection of the flow entities is very important since it dictates the degree of modeling detail incorporated into the operation model.

2. **Development of Flow Unit Cycles**. Following identification of the flow units that appear relevant to the process being modeled, the next step in model formulation is to identify the full range of possible states that can be associated with each flow unit and to develop the cycle through which each flow unit passes.
3. **Integration of Flow Unit Cycles**. The flow unit cycles provide the elemental building components of the model. The structure and scope of the model are obtained by the integration of activities that are common to two or more flow unit cycles.
4. **Flow Unit Initialization**. In order to analyze the model and determine the response of the system model, the various flow units involved must be initialized, both in number and initial location. Flow units are initialized at idle or waiting states (i.e., Queue Nodes).

Models developed using these basic steps must also be modified to provide for monitoring of system performance. This leads to a fifth stage of system design in which special elements for determining system productivity, flow unit characteristics, and other pertinent information are included in the model structure. These features as well as the use of the Web-CYCLONE program are described on the web at www.wiley.com\college\halpin.

18.6 TYPICAL REPETITIVE OPERATIONS

The key to modeling operations to determine productivity and balance among resources is to identify processes that are linear and repetitive. At the production level many processes are cyclic in nature and can be readily modeled using the CYCLONE modeling format. In general, processes that are linear or evidence linear characteristics are repetitive and good candidates to be modeled using a cyclic modeling environment. Some examples of repetitive or cyclic construction processes are:

1. Concrete pouring
2. Structural steel erection
3. Slurry wall construction
4. Pile Construction (Driven and Augered)
5. Caisson Construction
6. Pipe laying
7. Brick and masonry work
8. Reinforced earth construction
9. Exterior panel installation
10. Window or glass-curtain wall installation
11. Tunneling and tunnel excavation
12. Precast concrete member erection

18.7 CONCRETE POURING USING A CRANE AND BUCKET

Concrete is one of the most commonly used materials in construction. Its versatility and ease of placement have enabled it to hold its place in the market despite the development of more sophisticated materials. Concrete may be used in many different ways on a project to include monolithic foundation pours and precast panels to form the building exterior.

Concrete can be either cast in place on-site or precast off-site and transported to the project for installation. The methods of placement at the site vary and depend on a number of considerations such as (1) the placement location, (2) the desired speed of placement, and (3) the types of equipment available. In this section, a simple model for the placement of cast in place concrete using a crane-bucket system will be discussed.

It is assumed that forms and steel reinforcement are in place and that the system is not constrained by the batch plant (i.e., the quantity of concrete available is not a constraint). Required resources for the model include concrete hauling trucks, a crane with bucket(s), vibrating and finishing apparatus, and a crew of laborers at the placement site.

To provide a context for this model, assume that the concrete is to be placed on a paving job and that the concrete is batched at a site 2 miles from the paving site. Rather than arriving at the site as a wet mix, five-at-a-time dry batches are carried in an open-bay truck (with appropriate compartments) to a mixer near the paving site. The batches are then dumped individually and sequentially into the skip of the mixer and mixed sequentially, starting with batch 1 and ending with batch 5. As each wet batch exits the mixer, it is dumped into a concrete bucket and lifted by a crane to the placement location where it is dumped, spread, vibrated, and finished by a concrete crew. A schematic diagram of the process is shown in Figure 18.7a. Although dry-batching operations of this type are not common, this situation provides a good opportunity to utilize various modeling features. A crane and bucket placement operation is shown in Figure 18.7b.

A CYCLONE model of the process is shown in Figure 18.8. The model consists of six cycles representing the various flow units involved. The units and cycles of interest are:

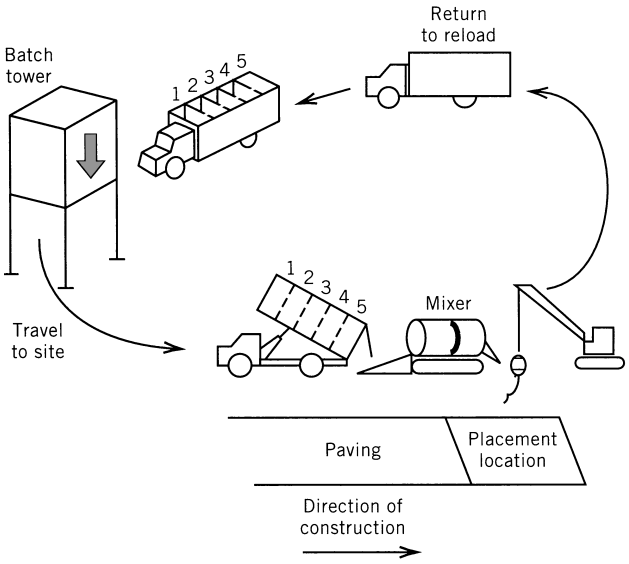
1. Batch plant
2. Trucks
3. Mixer
4. Crane
5. Bucket
6. Laborer crew for spreading, vibrating, and finishing

The process begins with trucks being loaded at the batch tower (COMBI 2). The trucks consist of five compartments, which are defined by baffles or dividers that are pinned in such a way that they can be released individually (one at a time) when the truck bed is elevated. Dry batches are loaded into each of the five compartments. This requires five individual loads at COMBI 2. The demand for five loads is generated using the GENERATE function at QUEUE node 9. The GENERATE function takes a single truck unit arriving at 9 and splits it into 5 units to be processed (i.e., compartments to be loaded).

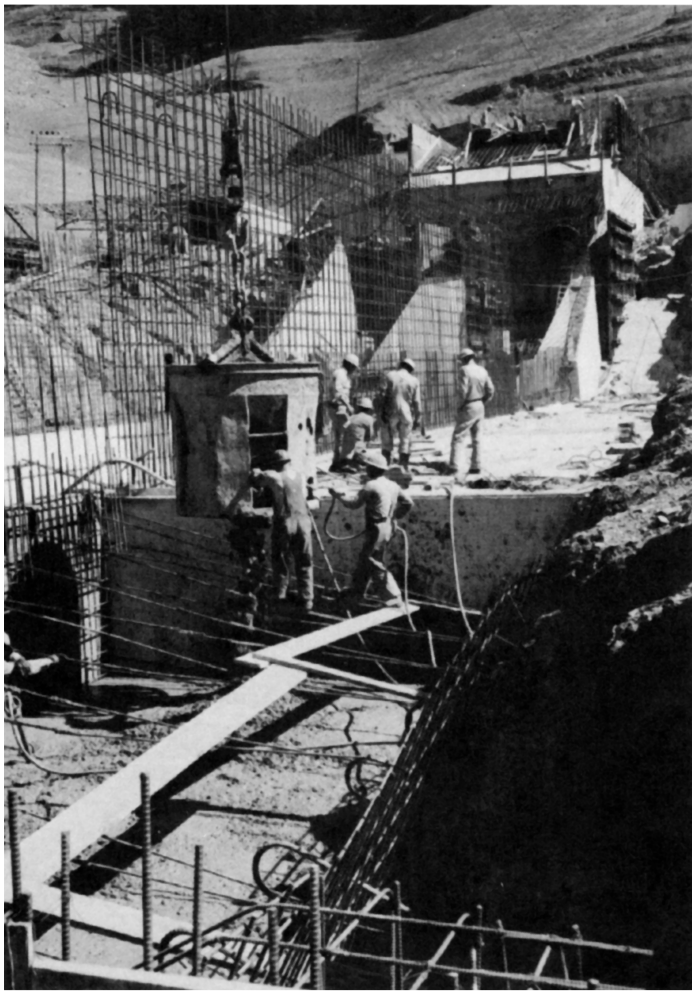
When five batches are loaded, the CONSOLIDATE at FUNCTION node 3 assembles the five loads into a single truck for travel to the mixer. Upon arriving at the mixer, the truck is again reconfigured to represent the five dry batches using the GENERATE function at QUEUE node 5. Each of the five dry batches are dumped sequentially into the skip of the mixer.

The mixer processes the batches in sequence and converts them into wet batches for transport to the placement site. The space in the mixer is represented by a flow unit at QUEUE node 13. If one unit is initialized at QUEUE node 13, this means that the mixer is a single-drum unit and only one batch at a time can be processed. If two units are defined at QUEUE node 13, then the mixer is a dual-drum unit and two batches can be processed simultaneously (in tandem).

Once a batch is dumped into the skip of the mixer, it is moved to the drum, where water is added and it is mixed (NORMAL 10). Following mixing, it occupies space in the drum



(*a*)



(*b*)

Figure 18.7 (a) Dry-batch delivery and placement and (b) crane-bucket concrete placement.

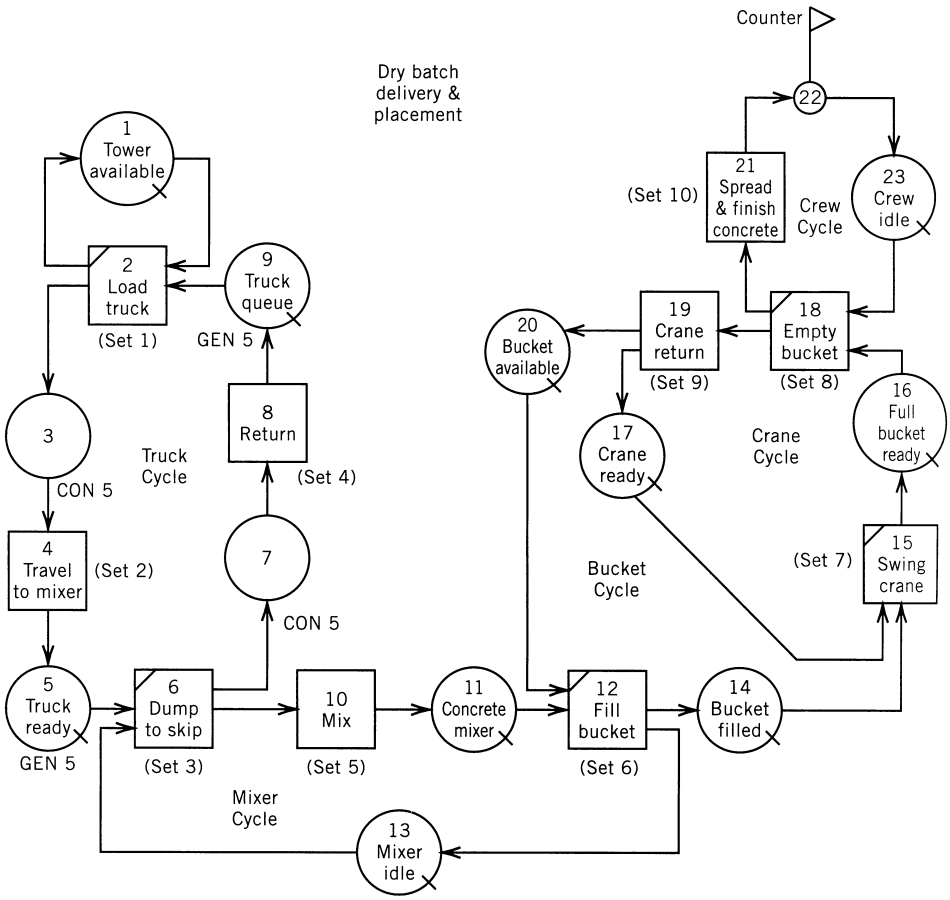


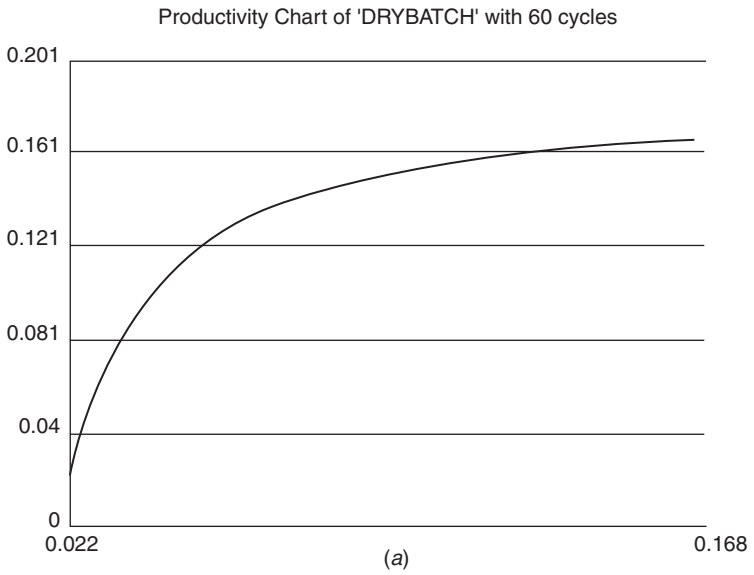
Figure 18.8 Dry-batch and delivery placement model.

(QUEUE node 11) until it can be dumped to the concrete bucket. Therefore, the space in the drum is not free until the bucket is filled at COMBI 12, and this is represented by the feedback loop to QUEUE node 13 (the space QUEUE). That is, space becomes available after the bucket is filled. This availability of space is required before the next dry batch can be loaded into the mixer at COMBI 6.

Once all five batches on the truck have been loaded to the mixer at COMBI 6 is free to return to the batch plant. The fact that the truck is empty (five batches loaded into the mixer) is established by the CONSOLIDATE at FUNCTION node 7. The empty compartments are reassembled into a single empty truck that returns to the batching power.

When the bucket is filled, it is available to be lifted by the crane to the placement location in the pavement. If only one bucket is used, the crane and bucket can be considered a single unit, and the separate QUEUE node 17 for "Crane ready" is redundant. However, if two buckets are used, the crane is a separate unit. After swinging back, it drops one bucket and picks up the other. This is more efficient since the bucket at the mixer can be filled while the crane is swinging and placing the other. The second bucket provides a storage point and keeps the crane active, allowing it to pick up the next loaded bucket without having to wait during the "Fill bucket" activity at 12. For this reason, the crane cycle and the bucket cycles are separated. One cycle is "nested" inside the other.

'DRYBATCH'		
PRODUCTIVITY INFORMATION		
Total Sim. Time Unit	Cycle No.	Prod./Min. (Prod./Hr)
569.8	100	0.17552 (10.53093)



(*a*)

'DRYBATCH'									
CYCLONE PASSIVE ELEMENTS STATISTICS INFORMATION									
Type	No.	Name	Average Units Idle	Max. Idle Units	Times not empty	% Idle	Total Sim Time	Average Wt Time	Units at end
QUEUE	1	TOWER AVAIL	0.0	1	0.0	0.00	569.8	0.0	0
GEN	5	TRK RDY	3.1	9	478.2	83.93	569.8	16.4	7
GEN	9	TRK QUEUE	8.5	20	565.0	99.17	569.8	40.3	6
QUEUE	11	CONC RDY	0.1	1	57.8	10.14	569.8	0.6	1

(*b*)

Figure 18.9 Concrete placement model: (a) production curve and (b) idleness.

Finally the concrete is placed, vibrated, and finished in one activity at NORMAL 21. This model uses only one NORMAL to address the spreading, vibrating, and finishing work. An alternate approach would be to define these work tasks separately. Further, the model, as structured, does not allow the concrete bucket to dump the next batch until the previous batch has been finished. This is not realistic and, therefore, breaking the spreading, vibrating, and finishing into separate tasks would produce a better model. This is left to the reader as a simple exercise.

Production in the system is measured at the COUNTER element 22. The production curve and queue idleness values for the system as simulated by the Web-CYCLONE system are given in Figure 18.9. The initial conditions for this system and the active-state durations are given in Table 18.1. The model described can be simulated and modified by visiting the Web-CYCLONE program at www.wiley.com\college\halpin.

Table 18.1 Concrete Model Initial Conditions

Flow Units	Set No.	Durations
One batch plant at 1	1	Load truck, COMBI 2–5 min
Four trucks at 9	2	Travel to mixer, NORMAL 4–10 min
One mixer at 13	3	Dump to skip, COMBI 6–1 min
Two buckets at 20	4	Return, NORMAL 8–8 min
One crane at 17	5	Mix, NORMAL 10–3 min
One crew at 23	6	Fill bucket, COMBI 12–0.5 min
	7	Swing crane, COMBI 15–0.25 min
	8	Empty bucket, COMBI 18–0.3 min
	9	Crane return, NORMAL 19–0.2 min
	10	Spread and finish, COMBI 21–5 min

18.8 ASPHALT PAVING MODEL

Operations related to road and highway construction are excellent candidates for production modeling since they are highly linear and repetitive. As noted in Chapter 8, the construction is subdivided into stations located along the route of the work. Operations such as rough grading, finish grading, aggregate base preparation, and paving are performed along sections of the right-of-way in a repetitive fashion.

In asphalt paving operations, a paving train consisting of a spreader, a "break-down" roller, and a finish roller move linearly along the area to be paved. Trucks haul hot-mix asphalt from the plant to the job site and dump the material into the spreader skip. The asphalt is distributed via the spreader to the road surface, and the skip becomes available for another batch of asphalt. A pictorial diagram of this situation is shown in Figure 18.10a.

In this model, it will be assumed that a parking lot is being paved and that after 15 spread cycles, the spreader must reposition to make a new pass parallel to the just-completed pass. Further, it will be assumed that after five spread cycles, the spread section is released to the breakdown roller for compaction of the hot-mix asphalt.

The following resources and cycles should be studied when modeling an asphalt paving operation:

1. Spreader
2. Trucks
3. Breakdown roller
4. Finish roller
5. Asphalt plant

The individual cycles for each of these resources are shown in Figure 18.10a-f. The integrated model is shown in Figure 18.11.

This model is similar to that already discussed for concrete placement. Some special features have been introduced, however, to handle the repositioning of the spreader and the release of spread sections for final processing. After 15 loads have been spread, the spreader turns and makes a parallel pass. This continues until the parking lot has been totally paved.

The truck cycle is similar to those encountered in other models. It should be noted, however, that the dump to spreader and the spread work task have been represented separately. This is to allow the truck to depart on its return travel as soon as the asphalt has been dumped. If the dump and spread work tasks are modeled as a single COMBI element, the truck would be required to wait until the spread is complete before departing. If the spreader is self-propelled, this is not necessary.

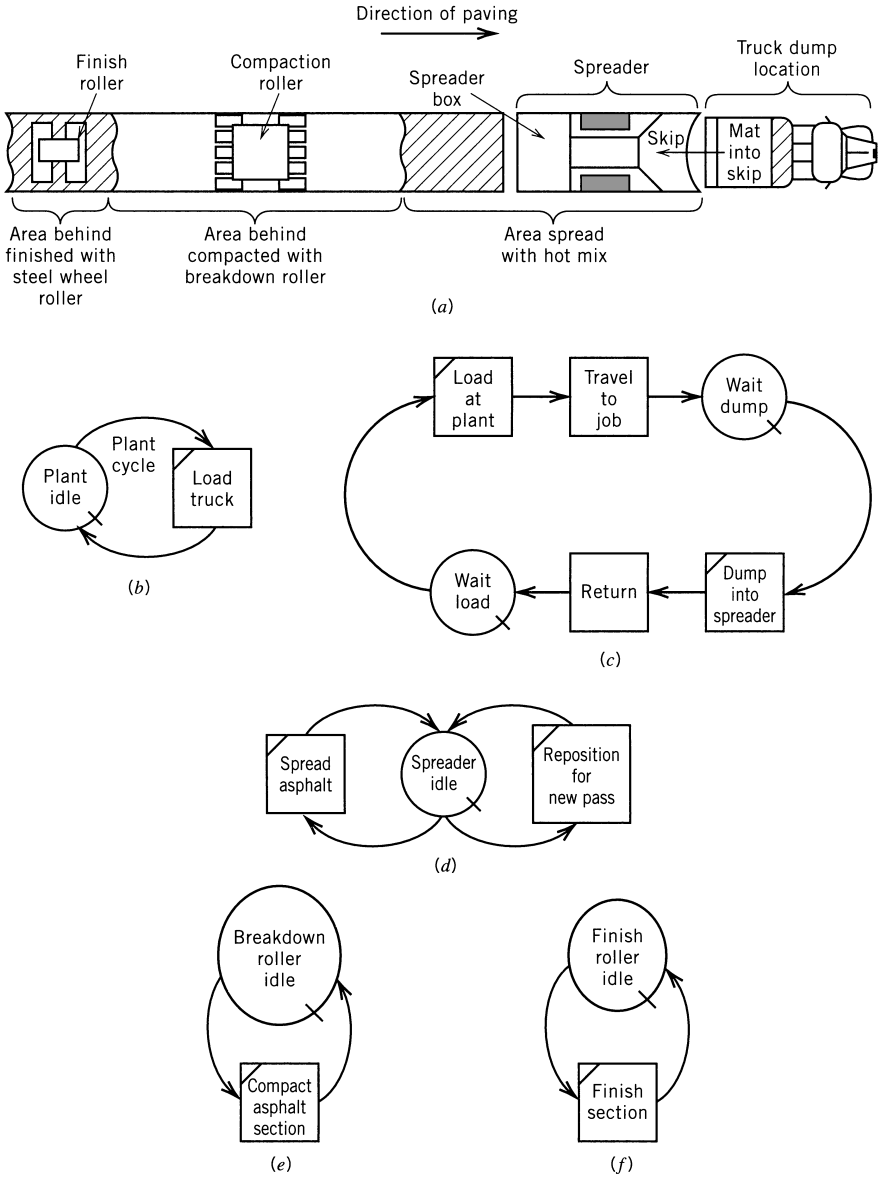


Figure 18.10 (a) Asphalt paving train, (b) plant cycle, (c) truck cycle), (d) spreader cycle, (e) breakdown roller cycle, and (f) finish roller cycle.

In order to divert the spreader to the "Reposition for new pass" activity at COMBI 5, a CONSOLIDATE element (11) has been introduced following "Spread" (NORMAL 10). After 15 spreads have occurred, a single unit is released from FUNCTION node 11 to QUEUE node 12. Since the "Reposition" task is a lower numbered COMBI (5) than the "Dump to spreader" COMBI (9),[1] the spreader is diverted to node 5 and held there to represent the duration of the repositioning activity. Once the spreader has been delayed at node 5 for the requisite period to represent positioning, it is returned to QUEUE 8 and becomes available for spreading. In the interim, any trucks arriving at QUEUE node 4 must wait for the repositioning to complete.

[1] Lower numbered activities receive priority.

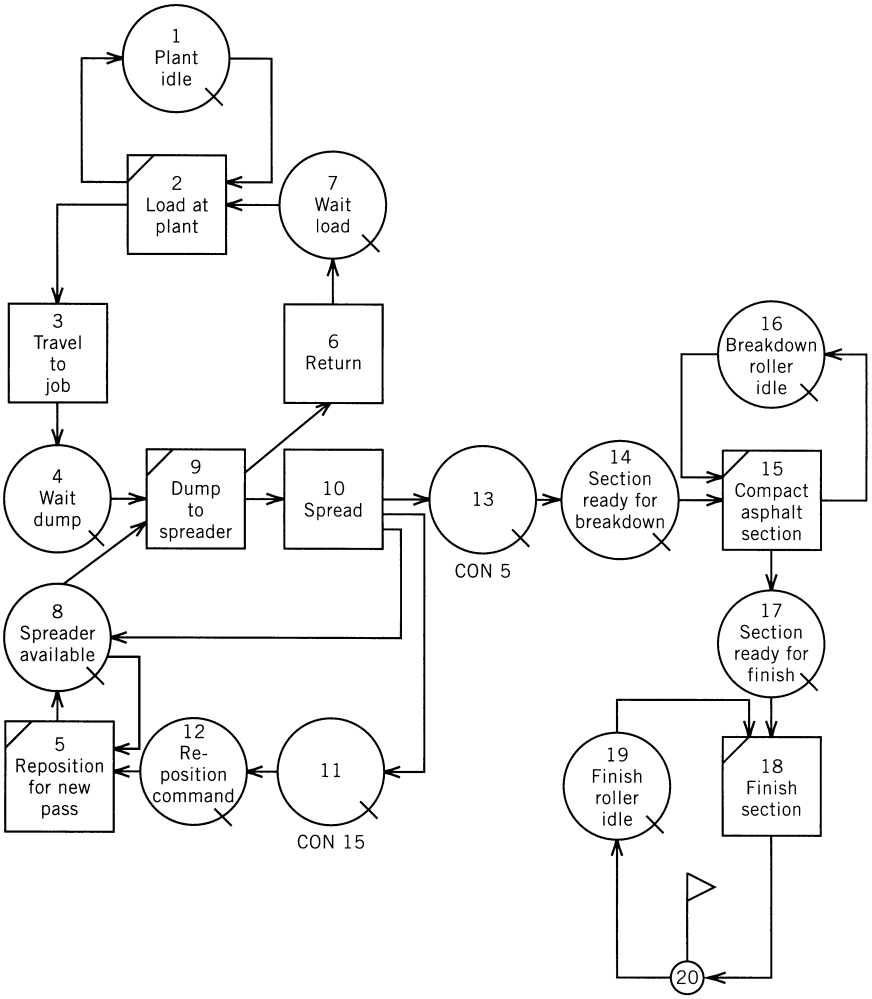


Figure 18.11 Integrated asphalt paving model.

The requirement to release sections to the breakdown roller in five spread packages is implemented by using another CONSOLIDATE at FUNCTION node 13. Each time five spreads have been made, a single unit is released to QUEUE node 14 representing a section ready for compaction. If the roller is available, it will start the compaction work. If it is busy with a previous section, the spread section waits until the roller is available. Once the section is compacted, it is moved to QUEUE node 17 and is ready for finish rolling. The units that arrive at the COUNTER (20) represent five truck loads of hot mix, or 33.3% of a lane of parking lot paving.

The production curve for the model and the QUEUE node idleness information are shown in Figures 18.12 and 18.13. The initial conditions for this model are given in Table 18.2. Again, this operation can be studied using Web-CYCLONE.

18.9 PERT NETWORK SIMULATION

In Section 8.3, it was noted that the total project duration given by PERT network calculations is optimistic due to the merge event bias. The impact of this underestimation of

ASPHALT PAVING		
PRODUCTIVITY INFORMATION		
Total Sim. Time Unit	Cycle No.	Prod./Min. (Prod./Hr)
1617.1	20	0.01237 (0.74208)

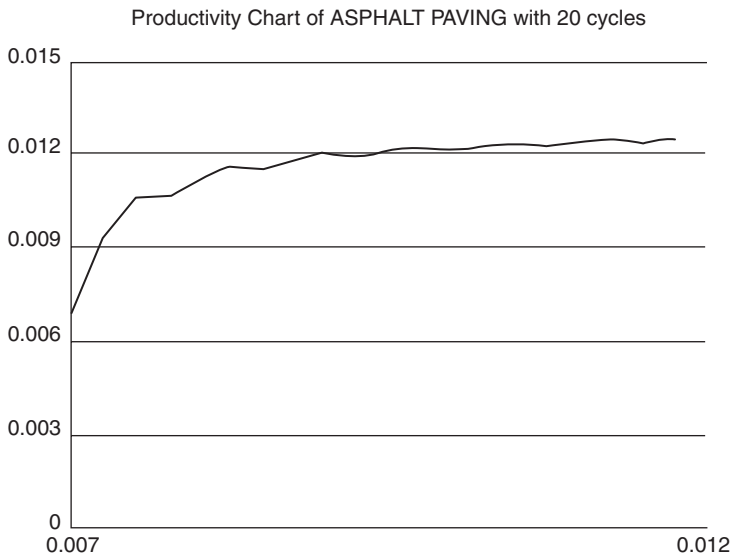


Figure 18.12 Asphalt paving production curve.

the duration can be shown using network simulation. Simulation can be conducted using Web-CYCLONE. PERT networks can be considered non-cyclic or acyclic networks. To simulate the PERT network shown in Figure 8.2, it must be converted from arrow notation to a Web-CYCLONE precedence notation.

The conversion of an arrow notation acyclic network to a CYCLONE network is relatively straight-forward. CPM activities become either NORMAL or COMBI activities in CYCLONE. Figure 18.14 illustrates the correspondence between CPM and CYCLONE. In Figure 18.14a, a CPM activity path between nodes *i*, *j*, and *k* becomes a CYCLONE series of NORMAL work tasks. In this instance, the CYCLONE work task is roughly equivalent to an activity in a precedence network. There is no constraint on activity B other than the completion of activity A in either CPM or CYCLONE. In Figure 18.14b, activity D cannot start until the completion of activities A, B, and C. In the CYCLONE network, this relationship is modeled with a COMBI work task as follows.

ASPHALT PAVING									
CYCLONE PASSIVE ELEMENTS STATISTICS INFORMATION									
Type	No.	Name	Average Units Idle	Max. Idle Units	Times not empty	% Idle	Total Sim Time	Average Wt Time	Units at end
QUEUE	1	PLANT IDLE	0.5	1	759.7	46.98	1617.1	7.3	0
QUEUE	4	WAIT FOR DUMP	0.0	1	40.2	2.48	1617.1	0.4	0
QUEUE	7	WAIT LOAD	0.3	5	328.6	20.32	1617.1	4.0	1
QUEUE	8	SPREADER AVAIL	0.7	1	1172.0	72.48	1617.1	10.9	1

Figure 18.13 Queue node idleness for asphalt paving operation (typical output).

Table 18.2 Initial Conditions for the Asphalt Paving Model

		Durations
1 Plant at 1	COMBI 2	5 min
4 Trucks at 7	NORMAL 3	10 min
1 Spreader at 8	COMBI 5	22 min
	COMBI 6	8 min
1 Compaction roller at 16	COMBI 9	2 min
1 Finish roller at 19	NORMAL 10	12 min
	COMBI 15	35 min
	COMBI 18	20 min

Work tasks A, B, and C all release a single entity to their following QUEUE node. Further, entities must be present in all three QUEUE nodes in order for COMBI D to start. The above considerations are essentially all that are required to convert a CPM network in CYCLONE; however, the relationships in Figure 18.14c may be instructive for the somewhat more complex condition shown. Again (except for the QUEUE nodes), the similarity to precedence networks is evident. And, it should be noted, the similarity to PERT networks is also evident.

A Web-CYCLONE model of the PERT network is shown in Figure 18.15. The 9 activities of the PERT network are shown as NORMAL and COMBI elements (i.e. elements 4, 5, 6, 7, 10, 15, 16, 17, 18). Three of the activities are shown as COMBI elements since they are proceeded by more than one activity. For instance, activity "3-4" (COMBI 10) is preceded by activity "2-3" and activity "1-3". Queue node 8 presents the end of "2-3". Queue node 9

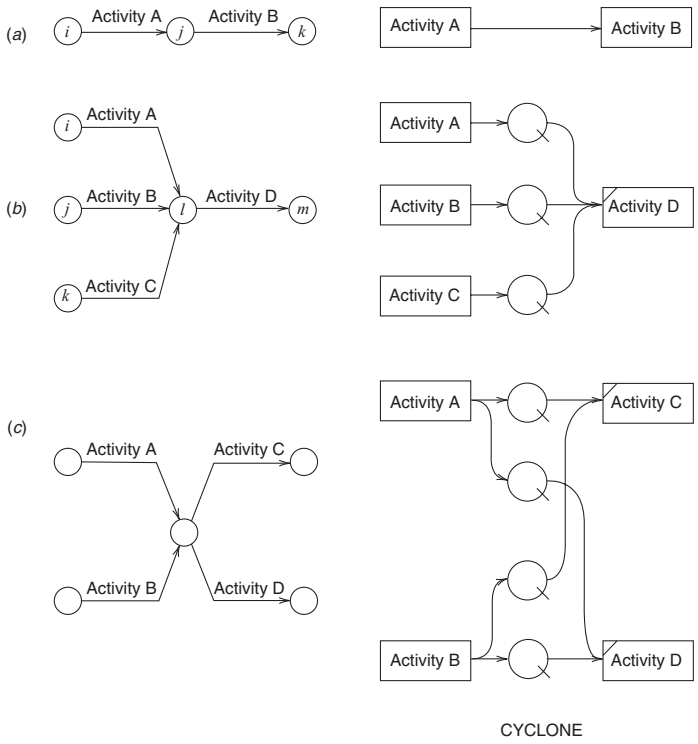


Figure 18.14 CPM-CYCLONE correspondence.

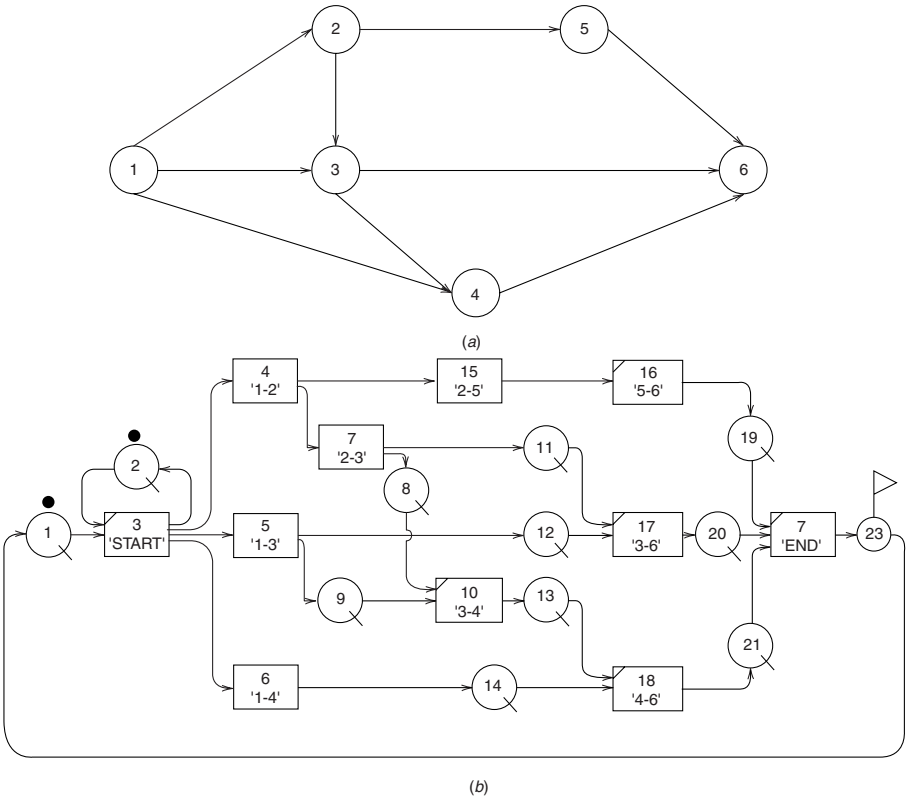


Figure 18.15 PERT Network with Web-CYCLONE equivalent.

represents the end of activity "1-3". COMBI 10 cannot commence until units arrive at both Queue nodes 8 and 9.

Units are initialized into the Web-CYCLONE network at COMBI 3 ("START") and proceed one at a time to the "End" activity (COMBI 7). This network is can be modeled by visiting the CYCLONE simulation home page.

In order to reflect the 3-estimate for each activity, a triangular distribution has been used. A triangular distribution is defined by three parameters as shown in Figure 18.16. t_a is the most optimistic duration, t_b is the most likely duration and t_c is the most pessimistic duration. For activity "1-2" (NORMAL element 4 in the Web-CYCLONE model), the time is defined as TRI 1 3 5, where "1" is the most optimistic value, "3" is the most likely value, and "5" is the most pessimistic value. The individual triangular distribution values for each of the nine PERT activities is as follows:

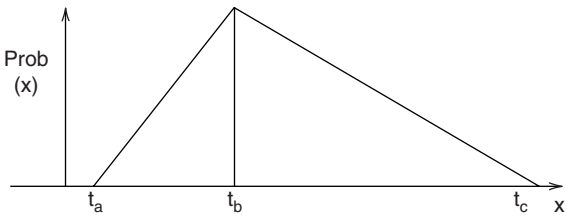


Figure 18.16 Triangular Distribution Parameters.

```
SET 4 TRI 1 3 5
SET 5 TRI 3 6 9
SET 6 TRI 10 13 19
SET 7 TRI 1 3 8
SET 10 TRI 4 7 13
SET 15 TRI 3 9 12
SET 16 TRI 3 6 9
SET 17 TRI 8 9 16
SET 18 TRI 1 3 8
```

After one hundred simulations of the PERT network, the average duration of the project (average of 100 individual runs) is found to be 19.10 days.

Results of Running WebCyclone

SIMPLE PERT PROCESS			
PRODUCTIVITY INFORMATION			
Sim. Time	Cycle No.	Productivity Per Time Unit	Duration (Days)
1909	100	0.052368	19.10

This is considerably higher than the 17.5 day duration determined using the PERT calculations. This supports the fact that the PERT approach, due to the merge event bias, predicts a total project duration which is too optimistic (i.e., shorter than one would expect based on the simulation).

REVIEW QUESTIONS AND EXERCISES

18.1 Three trucks haul material from a loading tower to an airfield construction job. At the fill (i.e., airfield) a spotter shows each truck where to dump. After the trucks dump material, they return to the loading tower. A front loader is used to load the tower. The tower can hold up to three loads. Draw a circle-and-square (CYCLONE) diagram of this system. Indicate all cycles and where the units in the system would be initialized at time zero.

18.2 A number of tractor scrapers are being push-loaded by one pusher dozer. The average push time is 1.5 min. After pushing a scraper, the dozer returns to the push point to await another scraper. If another scraper is available to push, the dozer engages the booster bar and resumes pushing. The return time to push point is 1.0 min. After loading, the average travel time for a scraper to the fill area is 15.0 min. The average empty return time is 10.0 min. Dumping the material at the construction site takes 1.0 min. Draw a model of this system using circle-and-square notation (include a COUNTER flag). What is the balance point of the system?

18.3 Brick pallets are picked up from the supplier and transported by truck to the job site, where they are off-loaded and stockpiled. Draw a model of this process similar to the one developed for the earth-hauling operation shown in Figure 18.5.

18.4 Visit a job site and select a process for investigation. Draw a schematic diagram of the process and/or site layout. Identify the major flow units in the process selected and list the active and waiting states through which each unit passes.

18.5 Develop CYCLONE models similar to that of Figure 18.5 for the following labor and craft situations:

a. Erection of column formwork by a carpenter and laborer crew.

b. Field operation of a drilling machine.

c. Placement of concrete in a slab using buggies and vibrators with a concrete crew made up of laborers, cement finishers, and a supporting ironworker and carpenter.

18.6 Steel sheet piles 12 feet long are being driven using a double-acting compressed-air hammer. The steel is positioned initially using a driving template. A driving cap is placed on the pile once it is in position and driving commences. When the pile has been driven 8 ft, the hammer and cap are withdrawn and another 12-foot section is welded to the first. After this, driving continues. This process continues until four sections have been

welded to the original and driven. The last section is trimmed to a uniform elevation using a cutting torch. The next section of wall is started by positioning the initial sheet pile in the template with interlock to the just-completed drive. Assume that the sheets are stacked initially in a stockpile location. Identify the active and waiting states through which each sheet pile must pass from beginning to end of the process. What resource units might constrain the movement of the pile from stockpile to final driven location?

18.7 Transit mix trucks are hauling to a high-rise building construction where a floor slab pour is in progress. The concrete is lifted from street level using a tower crane-concrete bucket system. Two concrete buckets are used for the lift. After being lifted, the concrete is stored temporarily in a storage hopper at the floor level of the pour. The concrete is removed from the hopper and carried to the placement location by rubber-tired buggies. Determine the major cycles in this system and diagram the active and idle states in each cycle showing the direction of flow of processed units. Integrate the cycles to show transfer points between one cycle and any interface it has with other cycles. What is the effect of having two concrete buckets? How big should the storage hopper be?

Appendices

APPENDIX A Typical Considerations Affecting the Decision to Bid

APPENDIX B Performance and Payment Bond Forms

APPENDIX C Standard Form of Agreement Between Owner and Contractor on the Basis of a Stipulated Price[1]

APPENDIX D Standard Form of Agreement Between Owner and Contractor on the Basis of Cost-Plus[1]

APPENDIX E Arrow Notation Scheduling Calculations

APPENDIX F AGC Builders Association of Chicago: Typical Job Descriptions[2]

APPENDIX G AGC Standard Form Construction Subcontract[3]

APPENDIX H Interest Tables

APPENDIX I Plans for Small Gas Station

APPENDIX J Site Reconnaissance Checklist

APPENDIX K Cumulative Normal Distribution Function

APPENDIX L WebCYCLONE Users Manual (see www.wiley.com/college halpin)

[1] Reprinted by permission of the Engineers Joint Contract Documents Committee (EJCDC). Copyright 2002. National Society of Professional Engineers, 1420 King Street, Alexandria, VA 22314; American Consulting Engineers Council, 1015 15th Street N.W., Washington, DC 20005; American Society of Civil Engineers, 1801 Alexander Bell Drive, Reston, VA 20191-4400. To order AGC contract documents, phone 1-800-AGC-1767 or fax your request to 703-837-5405, or visit the AGC website at www.agc.org.

[2] Builders Association of Chicago, Inc.

[3] Reproduced with the permission of the Associated General Contractors of America.

Appendix A

Typical Considerations Affecting the Decision to Bid

TYPICAL CONSIDERATIONS: THE DECISION TO BID (OR NOT)[1]

A. Goals and Present Capabilities of Your Company (Plans for Growth, Type of Work, Market Conditions)

1. It is quite reasonable to actually want to stay where you are if you are satisfied with a situation of making a good living and staying active in work.
   - If so, is this job the kind you like doing? Does it have a good profit potential?
2. If you wish to grow larger, how fast do you wish to grow? Do you have the people and capital to do so?
   - Will the project to be bid help you in your growth?
   - Or will you have to bid it low just to keep your present men and equipment working, thus tying them up and postponing growth? (If you prefer type 1 goals, this latter strategy may be fine.)
3. *Type of work*. Which type of work do you presently have the capability and experience to do? What types of work do you want to do in the future? Can you handle this particular project now? Will it give you good experience for the type of work you want to do in the future?
4. Consider the present and future competitive market conditions in this type of work.
   - Is it possible to earn a fair and reasonable profit? Or is the competition heavy?
   - Think of the job as an investment of your time, your talent, and your money. It should earn a good return—in money, in satisfaction, and pride; or provide some other return.

B. Location of the Work

1. Is the project located in an area in which you normally like to operate?
2. If not, would too large a portion of your time be consumed traveling to and from this job?
3. Do you have an associate or assistant who you believe can do a good job of supervising the job if you cannot often visit the site yourself?
4. Do you plan to expand your area of operations anyway, and if so, is this job in an area in which you want to expand?

C. Time and Place for Bid

1. When is the bid due (day and hour)? Will you have time to prepare an accurate and careful estimate? (For example, if you need 2 weeks to prepare a good bid and only 4 days remain, don't bid the job.)

[1] Based on material prepared by Prof. Boyd C. Paulson, Jr., Stanford University.

2. Where is the bid to be submitted? How will you get it there? Do you have to allow 2 or 3 days for the mail?
3. Are there special rules for late delivery? For faxing last-minute changes?

D. How to Obtain Plans and Specifications

1. If you are a prime contractor, you must find out who will provide the plans and specifications.
   - Is there a fee? How much?
   - Is there a deposit? How much? Is it refundable?
   - Is a plans room open and available? Where? What hours?
2. If you are a subcontractor, you want to know which prime contractors have plans and specifications.
   - Will they give you a copy of those that apply to your work?
   - Do they have a plans room for subcontractors? Where? What hours?
   - Can you get your plans and specifications directly from the owner? Fees? Deposits? How much? Refunds?

E. Legal and Other Official Requirements

1. *Licensing*. Some states, counties, cities, and towns require that a contractor have a license to work in their area.
   - If required, it is a legal necessity.
   - In some cases, unlicensed contractors can be fined without it.
   - Unlicensed contractors may not have recourse to the courts, even if wronged.
   - Especially note this when working on local government-funded projects.
2. *Prequalification* may be required. If so, documents such as a financial statement, a statement of work in progress and experience, as well as a past litigation and performance history will be required.
3. *Bonding*
   - Does project require (a) bid bond? (b) performance bond? (c) payment bond?
   - What is your bonding limit?
   - Can you qualify for bonds on this project?

F. Scope of Work

1. What is the approximate size of the project (or subcontract):
   (a) In dollars—is it within your financial and bonding limits?
   (b) In major units of work (e.g., earth-moving equipment, cubic yards of concrete, pounds of steel, etc.) is it within the capacity of your available manpower and equipment resources?
2. What are the major types of work on the project or subcontract?
   (a) Are they the kind your company prefers to do?
   (b) Are they the kind your company is qualified to do?
3. How much time is available to complete the work?
   (a) When does it start; when does it finish?
   (b) How much other work do you plan to have going at that time? Can you handle this job as well?

G. Comparison of Resources

Compare the resources available to you to those that will be needed (order of magnitude only) on the job to be bid.

1. *Men*: Do you have a supervisor or foreman for the job? Can you get the laborers and craftsmen that who be needed?
2. *Equipment*: What major items of equipment (truck, crane, loader, etc.) will be needed? Do you own it already? Will it be available? Can you purchase new equipment? Can you rent or lease the equipment you will need?
3. *Money*: Will loans or credit be needed? How much? Can you get the financing needed?

H. Summary

All of these items should be considered in making the decision to bid or not bid on a particular job.

- This is an *executive decision*.
- It is a decision *you* as the contractor must make.

Appendix B

Performance and Payment Bonds

CONTRACT PERFORMANCE BOND*

Bond No. 31-0120-42879-96-2

KNOW ALL MEN: That we Ryan Construction Corp.
P. O. Box 16, Zionsville, IN 46077-0493

(here insert the name and address or legal title of the Contractor) hereinafter called the Principal, and

United States Fidelity and Guaranty Company
135 N. Pennsylvania Street, Indianapolis, IN 46204

hereinafter called the Surety or Sureties, are held and firmly bound unto The Trustees of Indiana University, hereinafter called the Owner, in the sum of:

Eight Hundred Twenty Two Thousand and 00/100 Dollars ($822,000.00)

for payment whereof the Principal and the Surety or Sureties bind themselves, their heirs, executors, administrator, successors and assigns, jointly and severally, firmly, by these presents.

WHEREAS, the Principal has, by means of a written Agreement, dated: June 10, XXXX, entered into a contract with the Owner for

Lilly Clinic Expansion at Adult Outpatient Center
Indiana University Medical Center, Indianapolis, IN
Bid Package No. 3
IUPUI#961-5262-3

a copy of which Agreement is by reference made a part hereof:

NOW THEREFORE, the condition of this Obligation is such that, if the Principal shall faithfully perform the Contract on his part and shall fully indemnify and save harmless the Owner from all cost and damage which he may suffer by reason of failure to do so and shall fully reimburse and repay the Owner all outlay and expense which the Owner may incur in making good any such default, then this Obligation shall be null and void, otherwise it shall remain in full force and effect.

CONTRACT PERFORMANCE BOND
(Page 1 of 2 Pages)

Disclaimer:
*This document is representative. Language in actual bonding documents should be verified by a legal professional.

The said surety for value received hereby stipulates and agrees that no change, extension of time, alteration or addition to the terms of the contract, or to the work to be performed thereunder or the specifications accompanying them, shall in any way affect its obligations on this bond, and it does hereby waive notice of any such change, extension of time, alteration, or addition to the terms of the contract, or to the work or to the specifications.

PROVIDED, however that no suit, action or proceeding by reason of any default whatever shall be brought on this Bond after two years from the date of final payment.

AND PROVIDED, that any alterations which may be made in the terms of the Contract, or in the work to be done under it, or the giving by the Owner of any extension of time for the performance of the Contract, or any other forbearance on the part of either the Owner or the Principal to the other shall not in any way release the Principal and the Surety or Sureties, or either or any of them, their heirs, executors, administrators, successors or assigns from their liability hereunder, notice to the Surety or Sureties of any such alterations, extension or forbearance being hereby waived.

Signed and Sealed this 10th day of June, XXXX

In presence of:

Michael Ryan)
Corporate Secretary) as to

Ryan Construction Corp. (SEAL)

By: Daniel Ryan
Daniel Ryan, President

_____)
) as to
_____)

United States Fidelity and Guaranty Company (SEAL)

By: U S Grant
U. S. Grant, Attorney-In-Fact

_____)
) as to
_____)

_____(SEAL)

_____

CONTRACT PERFORMANCE BOND
(Page 2 of 2 Pages)

LABOR AND MATERIAL PAYMENT BOND*

Bond No. 31-0120-42879-96-3

KNOW ALL MEN BY THESE PRESENTS, THAT _____
Ryan Construction Corp., P. O. Box 16, Zionsville, IN 46077-0493

as Principal, hereinafter called Principal, and _____
United States Fidelity and Guaranty Company, 135 N. Pennsylvania St., Indianapolis, IN 46204

as Surety, hereinafter called Surety, are held and firmly bound unto The Trustees of Indiana University

as Obligee, for the use and benefit of claimants as hereinbelow defined, in the amount of Eight Hundred Twenty Two Thousand and 00/100 Dollars ($822,000), for the payment whereof Principal and Surety bind themselves, their heirs, executors, administrators, successors and assigns, jointly and severally, firmly by these presents.

WHEREAS, Contractor has by written agreement dated June 10, XXXX, entered into a contract with the Obligee, for

Lilly Clinic Expansion at Adult Outpatient Center
Indiana University Medical Center, Indianapolis, IN
Bid Package No. 3
IUPUI#961-5262-3

which contract is by reference made a part hereof, and is hereinafter referred to as the contract.

NOW, THEREFORE, THE CONDITION OF THIS OBLIGATION is such that, if principal shall promptly make payment to all claimants as hereinafter defined, for all labor and material used or reasonably required for use in the performance of the Contract, then this obligation shall be void; otherwise, it shall remain in full force and effect, subject, however, to the following conditions:

1. A claimant is defined as one having a direct contract with the Principal or with a Subcontractor of the Principal for labor, material, or both, used or reasonably required for use in the performance of the Contract, labor and material being construed to include that part of water, gas, power, light, heat, oil, gasoline, telephone service or rental of equipment directly applicable to the Contract.

2. The above named Principal and Surety hereby jointly and severally agree with that every claimant as herein defined, who has not been paid in full before the expiration of a period of ninety (90) days after the date on which the last of such claimant's work or labor was done or performed, or materials were furnished by such claimant, may sue on this bond for the use of such claimant, prosecute the suit to final judgment for such sum or sums as may be justly due claimant, and have execution thereon. Obligee shall not be liable for the payment of any costs or expenses of any such suit.

Disclaimer:
*This Document is representative. Language in actual bonding documents should be verified by a legal professional.

3. No suit action shall be commenced hereunder by any claimant:

   a) Unless claimant, other than one having a direct contract with the Principal, shall have given written notice to any two of the following: the Principal, Obligee or the Surety above named, within ninety (90) days after such claimant did or performed the last of the work or labor, or furnished the last of the materials for which said claim is made, stating with substantial accuracy the amount claimed and the name of the party to whom the materials were furnished, or for whom the work or labor was done or performed. Such notice shall be served by mailing the same by registered mail or certified mail, postage prepaid, in an envelope addressed to the Principal, Obligee or Surety, at any place where an office is regularly maintained for the transaction of business, or served in any manner in which the legal process may be served in the state in which the aforesaid project is located, save that such service need not be made by a public officer.

   b) After the expiration of one (1) year following the date on which Principal ceased Work on said Contract, it being understood, however, that if any limitation embodied in this bond is prohibited by any law controlling the construction hereof such limitation shall be deemed to be amended so as to equal to the minimum period of limitation permitted by such law.

   c) Other than in a state court of competent jurisdiction in and for the county or other political subdivision of the state in which the Project, or any part thereof, is situated, or in the United States District Court for the District in which the Project, or any part thereof, is situated, and not elsewhere.

4. The amount of this bond shall be reduced by and to the extent of any payment or payments made in good faith hereunder, inclusive of the payment by Surety of Mechanics' Liens which may be filed of record against said improvement, whether or not claim for the amount of such lien be presented under and against this bond.

Signed and sealed this 10th day of June, XXXX

Michael Ryan
(Witness)

(RYAN CONSTRUCTION CORPORATION
((Principal) (Seal)
(
(BY: Daniel Ryan
Title: Daniel Ryan, President

(UNITED STATES FIDELITY & GUARANTY CO.
((Surety) (Seal)
(
(BY: U S Grant
Title: U.S. Grant,
Attorney-In-Fact

(Witness)

Appendix C

Standard Form of Agreement Between Owner and Contractor on the Basis of a Stipulated Price

This document has important legal consequences; consultation with an attorney is encouraged with respect to its use or modification.

SUGGESTED FORM OF AGREEMENT BETWEEN OWNER AND CONTRACTOR FOR CONSTRUCTION CONTRACT (STIPULATED PRICE)

Prepared by

ENGINEERS JOINT CONTRACT DOCUMENTS COMMITTEE

and

Issued and Published Jointly By

ACEC
American Council of Engineering Companies

National Society of Professional Engineers
Professional Engineers in Private Practice

ASCE American Society of Civil Engineers

PROFESSIONAL ENGINEERS IN PRIVATE PRACTICE
a practice division of the
NATIONAL SOCIETY OF PROFESSIONAL ENGINEERS

AMERICAN COUNCIL OF ENGINEERING COMPANIES

AMERICAN SOCIETY OF CIVIL ENGINEERS

This document has been approved and endorsed by

The Associated General Contractors of America

Knowledge for Creating and Sustaining the Built Environment

Construction Specifications Institute

This Suggested Form of Agreement has been prepared for use with the Standard General Conditions of the Construction Contract (C-700, 2002 Edition). Their provisions are interrelated, and a change in one may necessitate a change in the other. The language contained in the Suggested Instructions to Bidders (C-200, 2002 Edition) is also carefully interrelated with the language of this Agreement. Their usage is discussed in the Commentary on EJCDC Construction Documents. See also Guide to the Preparation of Supplementary (C-800, 2002 Edition).

National Society of Professional Engineers
1420 King Street, Alexandria, VA 22314-2715

American Council of Engineering Companies
1015 15th Street, N.W., Washington, DC 20005

American Society of Civil Engineers
1801 Alexander Bell Drive, Reston, VA 20191-4400

Introduction

This Suggested Form of Agreement between Owner and Contractor for Construction Contract (Stipulated Price) ("Agreement") has been prepared for use with the Guide to the Preparation of Instructions to Bidders ("Instructions")(C-200, 2002 Edition) and

with the Standard General Conditions of the Construction Contract ("General Conditions")(C-700, 2002 Edition). Their provisions are interrelated, and a change in one may necessitate a change in the others. For guidance in the preparation of Supplementary Conditions and coordination with Instructions to Bidders, see Guide to the Preparation of Supplementary Conditions ("Supplementary Conditions")(C-800, 2002 Edition). See also Suggested Bid Form ("Bid Form") (C-410, 2002 Edition). The EJCDC has not prepared a suggested form of Advertisement or Invitation to Bid because such documents will vary widely to conform to statutory requirements.

This form and the other Bidding Documents prepared and issued by the EJCDC assume acceptance of the Project Manual concept of the Construction Specifications Institute which provides for an organizational format for location of all bound documentary information for a construction project, namely: Bidding Requirements (which term refers to the Advertisement or Invitation to Bid, the Instructions, and any Bid Form that may be suggested or prescribed, all of which provide information and guidance for all Bidders) and the Contract Documents (defined in Article 1 of the General Conditions), which include the Agreement, bonds and certificates, the General Conditions, the Supplementary Conditions, the Drawings, and the Specifications. The Bidding Requirements are not considered part of the Contract Documents because much of their substance pertains to the relationships prior to the award of the Contract and has little effect or impact thereafter and because many contracts are awarded without going through the bidding process. In some cases, however, the actual Bid may be attached as an exhibit to the Agreement to avoid extensive retyping. (The terms "Bidding Documents" and "Bidding Requirements" are defined in Article 1 of the General Conditions.) The Project Manual concept is explained in the Manual of Practice issued by the Construction Specifications Institute.

Suggested language is presented herein with "Notes to User" to assist in preparing the Agreement. Much of the language should be usable on most projects, but modifications and additional provisions will often be necessary. The suggested language has been coordinated with the other standard forms produced by the EJCDC. When modifying the suggested language or writing additional provisions, the user must check the other documents thoroughly for conflicts and coordination of language usage and make appropriate revisions in all affected documents.

Refer to the discussions in EJCDC's Recommended Competitive Bidding Procedures for Construction Projects ("Bidding Procedures") (No. 1910-9-D, 1987 Edition) (to be reissued in 2002) on the particular paragraphs of which frequent reference is made below.

For brevity, paragraphs of the Instructions to Bidders are referenced with the prefix "I," those of the Bid Form are referenced with the prefix "BF," and those of this Agreement are referenced with the prefix "A."

NOTES:

1. EJCDC publications may be ordered from:

NSPE headquarters
1420 King Street
Alexandria VA 22314-2715
703-684-2800
www.nspe.org

ASCE headquarters
1801 Alexander Bell Drive
Reston, VA 20191-4400
800-548-2723
www.asce.org

ACEC headquarters
1015 15th Street NW
Washington DC 20005
202-347-7474
www.acec.org

EJCDC
SUGGESTED FORM OF AGREEMENT
BETWEEN OWNER AND CONTRACTOR FOR

CONSTRUCTION CONTRACT(STIPULATED PRICE)

THIS AGREEMENT is by and between _____

(Owner) and _____

(Contractor).

Owner and Contractor, in consideration of the mutual covenants set forth herein, agree as follows:

ARTICLE 1 - WORK

1.01 Contractor shall complete all Work as specified or indicated in the Contract Documents. The Work is generally described as follows:

ARTICLE 2 - THE PROJECT

2.01 The Project for which the Work under the Contract Documents may be the whole or only a part is generally described as follows:

ARTICLE 3 - ENGINEER

3.01 The Project has been designed by

(Engineer), who is to act as Owner's representative, assume all duties and responsibilities, and have the rights and authority assigned to Engineer in the Contract Documents in connection with the completion of the Work in accordance with the Contract Documents.

ARTICLE 4 - CONTRACT TIMES

4.01 Time of the Essence

A. All time limits for Milestones, if any, Substantial Completion, and completion and readiness for final payment as stated in the Contract Documents are of the essence of the Contract.

4.02 Dates for Substantial Completion and Final Payment

A. The Work will be substantially completed on or before _____, _____, and completed and ready for final payment in accordance with Paragraph 14.07 of the General Conditions on or before _____, _____.

[or]

4.02 Days to Achieve Substantial Completion and Final Payment

A. The Work will be substantially completed within _____ days after the date when the Contract Times commence to run as provided in Paragraph 2.03 of the General Conditions, and completed and ready for final payment in accordance with Paragraph 14.07 of the General Conditions within _____ days after the date when the Contract Times commence to run.

4.03 Liquidated Damages

A. Contractor and Owner recognize that time is of the essence of this Agreement and that Owner will suffer financial loss if the Work is not completed within the times specified in Paragraph 4.02 above, plus any extensions thereof allowed in accordance with Article 12 of the General Conditions. The parties also recognize the delays, expense, and difficulties involved in proving in a legal or arbitration proceeding the actual loss suffered by Owner if the Work is not completed on time. Accordingly, instead of requiring any such proof, Owner and Contractor agree that as liquidated damages for delay (but not as a penalty), Contractor shall pay Owner $_____ for each day that expires after the time specified in Paragraph 4.02 for Substantial Completion until the Work is substantially complete. After Substantial Completion, if Contractor shall neglect, refuse, or fail to complete the remaining Work within the Contract Time or any proper extension thereof granted by Owner, Contractor shall pay Owner $_____ for each day that expires after the time specified in Paragraph 4.02 for completion and readiness for final payment until the Work is completed and ready for final payment.

NOTES TO USER

1. *Where failure to reach a Milestone on time is of such consequence that the assessment of liquidated damages for failure to reach one or more Milestones on time is to be provided, appropriate amending or supplementing language should be inserted here.*

ARTICLE 5 - CONTRACT PRICE

5.01 Owner shall pay Contractor for completion of the Work in accordance with the Contract Documents an amount in current funds equal to the sum of the amounts determined pursuant to Paragraphs 5.01.A, 5.01.B, and 5.01.C below:

A. For all Work other than Unit Price Work, a Lump Sum of:

_____ ($_____)
(words) (numerals)

All specific cash allowances are included in the above price and have been computed in accordance with paragraph 11.02 of the General Conditions.

B. For all Unit Price Work, an amount equal to the sum of the established unit price for each separately identified item of Unit Price Work times the estimated quantity of that item as indicated in this paragraph 5.01.B:

As provided in Paragraph 11.03 of the General Conditions, estimated quantities are not guaranteed, and determinations of actual quantities and classifications are to be made by Engineer as provided in Paragraph 9.07 of the General Conditions. Unit prices have been computed as provided in Paragraph 11.03 of the General Conditions.

UNIT PRICE WORK

Item No.	Description	Unit	Estimated Quantity	Unit Price	Estimated

TOTAL OF ALL ESTIMATED PRICES _____ $_____
(words) (numerals)

C. For all Work, at the prices stated in Contractor's Bid, attached hereto as an exhibit.

NOTES TO USER

1. *If adjustment prices for variations from stipulated Base Bid quantities have been agreed to, insert appropriate provisions. See BF-4.*

2. *Depending upon the particular Bid Form used, use A-5.01.A alone, A-5.01.A and A-5.01.B together, A-5.01.B alone, or A-5.01.C alone, deleting those not used and renumbering accordingly. If A-5.01.C is used, Contractor's Bid is attached as an exhibit and listed in A-9.*

ARTICLE 6 - PAYMENT PROCEDURES

6.01 Submittal and Processing of Payments

A. Contractor shall submit Applications for Payment in accordance with Article 14 of the General Conditions. Applications for Payment will be processed by Engineer as provided in the General Conditions.

6.02 Progress Payments; Retainage

A. Owner shall make progress payments on account of the Contract Price on the basis of Contractor's Applications for Payment on or about the _____ day of each month during performance of the Work as provided in Paragraphs 6.02.A.1 and 6.02.A.2 below. All such payments will be measured by the schedule of values established as provided in Paragraph 2.07.A of the General Conditions (and in the case of Unit Price Work based on the number of units completed) or, in the event there is no schedule of values, as provided in the General Requirements:

1. Prior to Substantial Completion, progress payments will be made in an amount equal to the percentage indicated below but, in each case, less the aggregate of payments previously made and less such amounts as Engineer may determine or Owner may withhold, including but not limited to liquidated damages, in accordance with Paragraph 14.02 of the General Conditions:

a. _____ percent of Work completed (with the balance being retainage). If the Work has been 50 percent completed as determined by Engineer, and if the character and progress of the Work have been satisfactory to Owner and Engineer, Owner, on recommendation of Engineer, may determine that as long as the character and progress of the Work remain satisfactory to them, there will be no additional retainage; and

b. _____ percent of cost of materials and equipment not incorporated in the Work (with the balance being retainage).

2. Upon Substantial Completion, Owner shall pay an amount sufficient to increase total payments to Contractor to _____ percent of the Work completed, less such amounts as Engineer shall determine in accordance with Paragraph 14.02.B.5 of the General Conditions and less _____ percent of Engineer's estimate of the value of Work to be completed or corrected as shown on the tentative list of items to be completed or corrected attached to the certificate of Substantial Completion.

6.03 Final Payment

A. Upon final completion and acceptance of the Work in accordance with Paragraph 14.07 of the General Conditions, Owner shall pay the remainder of the Contract Price as recommended by Engineer as provided in said Paragraph 14.07.

ARTICLE 7 - INTEREST

7.01 All moneys not paid when due as provided in Article 14 of the General Conditions shall bear interest at the rate of _____ percent per annum.

ARTICLE 8 – CONTRACTOR'S REPRESENTATIONS

8.01 In order to induce Owner to enter into this Agreement Contractor makes the following representations:

A. Contractor has examined and carefully studied the Contract Documents and the other related data identified in the Bidding Documents.

B. Contractor has visited the Site and become familiar with and is satisfied as to the general, local, and Site conditions that may affect cost, progress, and performance of the Work.

C. Contractor is familiar with and is satisfied as to all federal, state, and local Laws and Regulations that may affect cost, progress, and performance of the Work.

D. Contractor has carefully studied all: (1) reports of explorations and tests of subsurface conditions at or contiguous to the Site and all drawings of physical conditions in or relating to existing surface or subsurface structures at or contiguous to the Site (except Underground Facilities) which have been identified in the Supplementary Conditions as provided in Paragraph 4.02 of the General Conditions and (2) reports and drawings of a Hazardous Environmental Condition, if any, at the Site which has been identified in the Supplementary Conditions as provided in Paragraph 4.06 of the General Conditions.

NOTES TO USER

1. *If the reports and/or drawings referred to in A-8.01.D do not exist, either modify A-8.01.D or delete A-8.01.D and renumber accordingly.*

E. Contractor has obtained and carefully studied (or assumes responsibility for doing so) all additional or supplementary examinations, investigations, explorations, tests, studies, and data concerning conditions (surface, subsurface, and Underground Facilities) at or contiguous to the Site which may affect cost, progress, or performance of the Work or which relate to any aspect of the means, methods, techniques, sequences, and procedures of construction to be employed by Contractor, including any specific means, methods, techniques, sequences, and procedures of construction expressly required by the Bidding Documents, and safety precautions and programs incident thereto.

NOTES TO USER

1. *If the reports and/or drawings referred to in A-8.01.D do not exist, delete the phrase "additional or supplementary" in the first sentence of A-8.01.E.*

F. Contractor does not consider that any further examinations, investigations, explorations, tests, studies, or data are necessary for the performance of the Work at the Contract Price, within the Contract Times, and in accordance with the other terms and conditions of the Contract Documents.

G. Contractor is aware of the general nature of work to be performed by Owner and others at the Site that relates to the Work as indicated in the Contract Documents.

H. Contractor has correlated the information known to Contractor, information and observations obtained from visits to the Site, reports and drawings identified in the Contract Documents, and all additional examinations, investigations, explorations, tests, studies, and data with the Contract Documents.

I. Contractor has given Engineer written notice of all conflicts, errors, ambiguities, or discrepancies that Contractor has discovered in the Contract Documents, and the written resolution thereof by Engineer is acceptable to Contractor.

J. The Contract Documents are generally sufficient to indicate and convey understanding of all terms and conditions for performance and furnishing of the Work.

ARTICLE 9 - CONTRACT DOCUMENTS

9.01 Contents

A. The Contract Documents consist of the following:

1. This Agreement (pages 1 to _____, inclusive).
2. Performance bond (pages _____ to _____, inclusive).
3. Payment bond (pages _____ to _____, inclusive).
4. Other bonds (pages _____ to _____, inclusive).
   a. _____ (pages _____ to _____, inclusive).
   b. _____ (pages _____ to _____, inclusive).
   c. _____ (pages _____ to _____, inclusive).
5. General Conditions (pages _____ to _____, inclusive).
6. Supplementary Conditions (pages _____ to _____, inclusive).
7. Specifications as listed in the table of contents of the Project Manual.

8. Drawings consisting of _____ sheets with each sheet bearing the following general title: _____ [or] the Drawings listed on attached sheet index.

9. Addenda (numbers _____ to _____, inclusive).

10. Exhibits to this Agreement (enumerated as follows):

a. Contractor's Bid (pages _____ to _____, inclusive).

b. Documentation submitted by Contractor prior to Notice of Award (pages _____ to _____, inclusive).

c. _____.

11. The following which may be delivered or issued on or after the Effective Date of the Agreement and are not attached hereto:

a. Notice to Proceed (pages _____ to _____, inclusive).

b. Work Change Directives.

c. Change Order(s).

B. The documents listed in Paragraph 9.01.A are attached to this Agreement (except as expressly noted otherwise above).

C. There are no Contract Documents other than those listed above in this Article 9.

D. The Contract Documents may only be amended, modified, or supplemented as provided in Paragraph 3.04 of the General Conditions.

ARTICLE 10 - MISCELLANEOUS

10.01 Terms

A. Terms used in this Agreement will have the meanings stated in the General Conditions and the Supplementary Conditions.

10.02 Assignment of Contract

A. No assignment by a party hereto of any rights under or interests in the Contract will be binding on another party hereto without the written consent of the party sought to be bound; and, specifically but without limitation, moneys that may become due and moneys that are due may not be assigned without such consent (except to the extent that the effect of this restriction may be limited by law), and unless specifically stated to the contrary in any written consent to an assignment, no assignment will release or discharge the assignor from any duty or responsibility under the Contract Documents.

10.03 Successors and Assigns

A. Owner and Contractor each binds itself, its partners, successors, assigns, and legal representatives to the other party hereto, its partners, successors, assigns, and legal representatives in respect to all covenants, agreements, and obligations contained in the Contract Documents.

10.04 Severability

A. Any provision or part of the Contract Documents held to be void or unenforceable under any Law or Regulation shall be deemed stricken, and all remaining provisions shall continue to be valid and binding upon Owner and Contractor, who agree that the Contract Documents shall be reformed to replace such stricken provision or part thereof with a valid and enforceable provision that comes as close as possible to expressing the intention of the stricken provision.

10.05 Other Provisions

NOTES TO USER

1. If Owner intends to assign a procurement contract (for goods and services) to the Contractor, see Notes to User at Article 23 of Suggested Instructions to Bidders for Procurement Contracts (EJCDC No. P-200, 2000 Edition) for provisions to be inserted in this Article.

2. Insert other provisions here if applicable.

IN WITNESS WHEREOF, Owner and Contractor have signed this Agreement in duplicate. One counterpart each has been delivered to Owner and Contractor. All portions of the Contract Documents have been signed or identified by Owner and Contractor or on their behalf.

NOTES TO USER

1. See I-21 and correlate procedures for format and signing between the two documents.

This Agreement will be effective on _____, _____ (which is the Effective Date of the Agreement).

OWNER:	CONTRACTOR:
_____	_____
By: _____	By: _____
Title: _____	Title: _____
[CORPORATE SEAL]	[CORPORATE SEAL]
Attest: _____	Attest: _____
Title: _____	Title: _____
Address for giving notices:	Address for giving notices:
_____	_____
_____	_____
_____	_____
(If Owner is a corporation, attach evidence of authority to sign. If Owner is a public body, attach evidence of authority to sign and resolution or other documents authorizing execution of Owner-Contractor Agreement.)	License No.: _____ (Where applicable)
	Agent for service or process: _____
	_____
	(If Contractor is a corporation or a partnership, attach evidence of authority to sign.)

Engineers Joint Documents Committee
Design and Construction Related Documents
Instructions and License Agreement

Instructions

Before you use any EJCDC document:

1. Read the License Agreement. You agree to it and are bound by its terms when you use the EJCDC document.

2. Make sure that you have the correct version for your word processing software.

How to Use:

1. While EJCDC has expended considerable effort to make the software translations exact, it can be that a few document controls (e.g., bold, underline) did not carry over.

2. Similarly, your software may change the font specification if the font is not available in your system. It will choose a font that is close in appearance. In this event, the pagination may not match the control set.

3. If you modify the document, you must follow the instructions in the License Agreement about notification.

4. Also note the instruction in the License Agreement about the EJCDC copyright.

License Agreement

You should carefully read the following terms and conditions before using this document. Commencement of use of this document indicates your acceptance of these terms and conditions. If you do not agree to them, you should promptly return the materials to the vendor, and your money will be refunded.

The Engineers Joint Contract Documents Committee ("EJCDC") provides **EJCDC Design and Construction Related Documents** and licenses their use worldwide. You assume sole responsibility for the selection of specific documents or portions thereof to achieve your intended results, and for the installation, use, and results obtained from **EJCDC Design and Construction Related Documents**.

You acknowledge that you understand that the text of the contract documents of **EJCDC Design and Construction Related Documents** has important legal consequences and that consultation with an attorney is recommended with respect to use or modification of the text. You further acknowledge that EJCDC documents are protected by the copyright laws of the United States.

License:

You have a limited nonexclusive license to:

1. Use **EJCDC Design and Construction Related Documents** on any number of machines owned, leased or rented by your company or organization.

2. Use **EJCDC Design and Construction Related Documents** in printed form for bona fide contract documents.

3. Copy **EJCDC Design and Construction Related Documents** into any machine readable or printed form for backup or modification purposes in support of your use of **EJCDC Design and Construction Related Documents**.

You agree that you will:

1. Reproduce and include EJCDC's copyright notice on any printed or machine-readable copy, modification, or portion merged into another document or program. All proprietary rights in **EJCDC Design and Construction Related Documents** are and shall remain the property of EJCDC.

2. Not represent that any of the contract documents you generate from **EJCDC Design and Construction Related Documents** are EJCDC documents unless (i) the document text is used without alteration or (ii) all additions and changes to, and deletions from, the text are clearly shown.

You may not use, copy, modify, or transfer EJCDC Design and Construction Related Documents, or any copy, modification or merged portion, in whole or in part, except as expressly provided for in this license. Reproduction of EJCDC Design and Construction Related Documents in printed or machine-readable format for resale or educational purposes is expressly prohibited.

If you transfer possession of any copy, modification or merged portion of EJCDC Design and Construction Related Documents to another party, your license is automatically terminated.

Term:

The license is effective until terminated. You may terminate it at any time by destroying **EJCDC Design and Construction Related Documents** altogether with all copies, modifications and merged portions in any form. It will also terminate upon conditions set forth elsewhere in this Agreement or if you fail to comply with any term or condition of this Agreement. You agree upon such termination to destroy **EJCDC Design and Construction Related Documents** along with all copies, modifications and merged portions in any form.

Limited Warranty:

EJCDC warrants the CDs and diskettes on which **EJCDC Design and Construction Related Documents** is furnished to be free from defects in materials and workmanship under normal use for a period of ninety (90) days from the date of

delivery to you as evidenced by a copy of your receipt.

There is no other warranty of any kind, either expressed or implied, including, but not limited to the implied warranties of merchantability and fitness for a particular purpose. Some states do not allow the exclusion of implied warranties, so the above exclusion may not apply to you. This warranty gives you specific legal rights and you may also have other rights which vary from state to state.

EJCDC does not warrant that the functions contained in **EJCDC Design and Construction Related Documents** will meet your requirements or that the operation of **EJCDC Design and Construction Related Documents** will be uninterrupted or error free.

Limitations of Remedies:
EJCDC's entire liability and your exclusive remedy shall be:

1. the replacement of any document not meeting EJCDC's "Limited Warranty" which is returned to EJCDC's selling agent with a copy of your receipt, or

2. if EJCDC's selling agent is unable to deliver a replacement CD or diskette which is free of defects in materials and workmanship, you may terminate this Agreement by returning EJCDC Document and your money will be refunded.

In no event will EJCDC be liable to you for any damages, including any lost profits, lost savings or other incidental or consequential damages arising out of the use or inability to use **EJCDC Design and Construction Related Documents** even if EJCDC has been advised of the possibility of such damages, or for any claim by any other party.

Some states do not allow the limitation or exclusion of liability for incidental or consequential damages, so the above limitation or exclusion may not apply to you.

General:
You may not sublicense, assign, or transfer this license except as expressly provided in this Agreement. Any attempt otherwise to sublicense, assign, or transfer any of the rights, duties, or obligations hereunder is void.

This Agreement shall be governed by the laws of the State of Virginia. Should you have any questions concerning this Agreement, you may contact EJCDC by writing to:

Arthur Schwartz, Esq.
General Counsel
National Society of Professional Engineers
1420 King Street
Alexandria, VA 22314

Phone: (703) 684-2845
Fax: (703) 836-4875
e-mail: aschwartz@nspe.org

You acknowledge that you have read this agreement, understand it and agree to be bound by its terms and conditions. You further agree that it is the complete and exclusive statement of the agreement between us which supersedes any proposal or prior agreement, oral or written, and any other communications between us relating to the subject matter of this agreement.

Appendix D

Standard Form of Agreement Between Owner and Contractor on the Basis of Cost-Plus

This document has important legal consequences; consultation with an attorney is encouraged with respect to its use or modification.

SUGGESTED FORM OF AGREEMENT BETWEEN OWNER AND CONTRACTOR FOR CONSTRUCTION CONTRACT (COST-PLUS)

Prepared by

ENGINEERS JOINT CONTRACT DOCUMENTS COMMITTEE

and

Issued and Published Jointly By

ACEC
American Council of Engineering Companies

National Society of Professional Engineers
Professional Engineers in Private Practice

ASCE American Society of Civil Engineers

PROFESSIONAL ENGINEERS IN PRIVATE PRACTICE
A practice division of the
NATIONAL SOCIETY OF PROFESSIONAL ENGINEERS

AMERICAN COUNCIL OF ENGINEERING COMPANIES

AMERICAN SOCIETY OF CIVIL ENGINEERS

This document has been approved and endorsed by

The Associated General Contractors of America

Knowledge for Creating and Sustaining the Built Environment
Construction Specifications Institute

This Suggested Form of Agreement has been prepared for use with the Standard General Conditions of the Construction Contract (C-700, 2002 Edition). Their provisions are interrelated, and a change in one may necessitate a change in the other. The language contained in the Suggested Instructions to Bidders (C-200, 2002 Edition) is also carefully interrelated with the language of this Agreement. Their usage is discussed in the Commentary on EJCDC Construction Documents. See also Guide to the Preparation of Supplementary (C-800, 2002 Edition).

National Society of Professional Engineers
1420 King Street, Alexandria, VA 22314-2715

American Council of Engineering Companies
1015 15th Street, N.W., Washington, DC 20005

American Society of Civil Engineers
1801 Alexander Bell Drive, Reston, VA 20191-4400

Introduction

This Suggested Form of Agreement between Owner and Contractor (Cost-Plus) ("Agreement") has been prepared for use with the Guide to the Preparation of Instructions to Bidders ("Instructions")(C-200, 2002 Edition) and with the Standard General Conditions of the Construction Contract ("General Conditions")(C-700, 2002 Edition). Their provisions are interrelated, and a change in one may necessitate a change in the others. For guidance in the preparation of Supplementary Conditions and coordination with Instructions to Bidders, see Guide to the Preparation of Supplementary Conditions ("Supplementary Conditions")(C-800, 2002 Edition). See also Guide to Preparation of the Bid Form ("Bid Form")(C-400, 2002 Edition). The EJCDC has not prepared a suggested form of Advertisement or Invitation to Bid because such documents will vary widely in response to statutory requirements.

This form and the other Bidding Documents prepared and issued by the EJCDC assume acceptance of the Project Manual concept of the Construction Specifications Institute which provides for an organizational format for location of all bound documentary information for a construction project, namely: Bidding Requirements (which term refers to the Advertisement or Invitation to Bid, the Instructions, and any Bid Form that may be suggested or prescribed, all of which provide information and guidance for all Bidders) and the Contract Documents (defined in Article 1 of the General Conditions), which include the Agreement, bonds and certificates, the General Conditions, the Supplementary Conditions, the Drawings, and the Specifications. The Bidding Requirements are not considered part of the Contract Documents because much of their substance pertains to the relationships prior to the award of the Contract and has little effect or impact thereafter and because many contracts are awarded without going through the bidding process. In some cases, however, the actual Bid may be attached as an exhibit to the Agreement to avoid extensive retyping. (The terms "Bidding Documents" and "Bidding Requirements" are defined in Article 1 of the General Conditions.) The Project Manual concept is explained in the Manual of Practice issued by the Construction Specifications Institute.

Suggested language is presented herein with "Notes to User" to assist in preparing the Agreement. Much of the language should be usable on most projects, but modifications and additional provisions will often be necessary. The suggested language has been coordinated with the other standard forms produced by the EJCDC. When modifying the suggested language or writing additional provisions, the user must check the other documents thoroughly for conflicts and coordination of language usage and make appropriate revisions in all affected documents.

Refer to the discussions in EJCDC's Recommended Competitive Bidding Procedures for Construction Projects ("Bidding Procedures") (No. 1910-9-D, 1987 Edition) (to be reissued in 2002) on the particular paragraphs of which frequent reference is made below.

For brevity, paragraphs of the Instructions to Bidders are referred to with the prefix "I," and those of this Agreement with the prefix "A."

NOTES:

1. EJCDC publications may be ordered from:

NSPE headquarters
1420 King Street
Alexandria VA 22314-2715
703-684-2800
www.nspe.org

ACEC headquarters
1015 15th Street NW
Washington DC 20005
202-347-7474
www.acec.org

ASCE headquarters
1801 Alexander Bell Drive
Reston, VA 20191-4400
800-548-2723
www.asce.org

EJCDC
SUGGESTED FORM OF AGREEMENT
BETWEEN OWNER AND CONTRACTOR FOR CONSTRUCTION
CONTRACT (COST-PLUS)

THIS AGREEMENT is by and between _____ (Owner)

and _____ (Contractor).

Owner and Contractor, in consideration of the mutual covenants set forth herein, agree as follows:

ARTICLE 1 - WORK

1.01 Contractor shall complete all Work as specified or indicated in the Contract Documents. The Work is generally described as follows:

ARTICLE 2 - THE PROJECT

2.01 The Project for which the Work under the Contract Documents may be the whole or only a part is generally described as follows:

ARTICLE 3 - ENGINEER

3.01 The Project has been designed by

(Engineer), who is to act as Owner's representative, assume all duties and responsibilities, and have the rights and authority assigned to Engineer in the Contract Documents in connection with the completion of the Work in accordance with the Contract Documents.

ARTICLE 4 - CONTRACT TIMES

4.01 Time of the Essence

A. All time limits for Milestones, if any, Substantial Completion, and completion and readiness for final payment as stated in the Contract Documents are of the essence of the Contract.

4.02 Dates for Substantial Completion and Final Payment

A. The Work will be substantially completed on or before _____, _____, and completed and ready for final payment in accordance with Paragraph 14.07 of the General Conditions on or before _____,_____.

[or]

4.02 Days to Achieve Substantial Completion and Final Payment

A. The Work will be substantially completed within _____ days after the date when the Contract Times commence to run as provided in Paragraph 2.03 of the General Conditions, and completed and ready for final payment in accordance with Paragraph 14.07 of the General Conditions within _____ days after the date when the Contract Times commence to run.

4.03 Liquidated Damages

A. Contractor and Owner recognize that time is of the essence of this Agreement and that Owner will suffer financial loss if the Work is not completed within the times specified in Paragraph 4.02 above, plus any extensions thereof allowed in accordance with Article 12 of the General Conditions. The parties also recognize the delays, expense, and difficulties involved in proving in a legal or arbitration proceeding the actual loss suffered by Owner if the Work is not completed on time. Accordingly, instead of requiring any such proof, Owner and Contractor agree that as liquidated damages for delay (but not as a penalty), Contractor shall pay Owner $_____ for each day that expires after the time specified in Paragraph 4.02 for Substantial Completion until the Work is substantially complete. After Substantial Completion, if Contractor shall neglect, refuse, or fail to complete the remaining Work within the Contract Time or any proper extension thereof granted by Owner, Contractor shall pay Owner $_____ for each day that expires after the time specified in Paragraph 4.02 for completion and readiness for final payment until the Work is completed and ready for final payment.

NOTES TO USER

1. *Where failure to reach a Milestone on time is of such consequence that the assessment of liquidated damages for failure to reach one or more Milestones on time is to be provided, appropriate amending or supplementing language should be inserted here.*

ARTICLE 5 - CONTRACT PRICE

5.01 Owner shall pay Contractor for completion of the Work in accordance with the Contract Documents an amount in current funds equal to the sum of the amounts determined pursuant to Paragraphs 5.01.A, 5.01.B, and 5.01.C below:

A. For all Work other than Unit Price Work, the Cost of the Work plus a Contractor's fee for overhead and profit, both of which shall be determined as provided in Articles 6 and 7 below, subject to additions and deletions as provided in the Contract Documents and subject to the limitations set forth in Article 8 below.

B. For all Unit Price Work, an amount equal to the sum of the established unit price for each separately identified item of Unit Price Work times the estimated quantity of that item as indicated in this Paragraph 5.01.B:

UNIT PRICE WORK

Item No.	Description	Unit	Estimated Quantity	Unit Price	Estimated

TOTAL OF ALL ESTIMATED PRICES _____ $_____
(words) (numerals)

As provided in Paragraph 11.03 of the General Conditions, estimated quantities are not guaranteed, and determinations of actual quantities and classifications are to be made by Engineer as provided in Paragraph 9.07 of the General Conditions. Unit prices have been computed as provided in Paragraph 11.03 of the General Conditions.

C. For all Work, at the prices stated in Contractor's Bid, attached hereto as an exhibit.

NOTES TO USER

1. *Depending upon the particular project bid form used, use A-5.01.A alone, A-5.01.A and A-5.01.B together, A-5.01.B alone, or A-5.01.C alone, deleting those not used and renumbering accordingly. If A-5.01.C is used, Contractor's Bid is attached as an exhibit and listed in A-14.*

ARTICLE 6 - COST OF THE WORK

6.01 Cost of the Work shall be determined as provided in Paragraph 11.01 of the General Conditions.

ARTICLE 7 – CONTRACTOR'S FEE

7.01 Contractor's fee shall be determined as follows:

A. A fee based on the following percentages of the various portions of the Cost of the Work:

1. Payroll costs (see Paragraph 11.01.A.1 of General Conditions) _____.
2. Material and equipment costs (see Paragraph 11.01.A.2 of General Conditions) _____.
3. Amounts paid to subcontractors (see Paragraph 11.01.A.3 of General Conditions) _____.
4. Amounts paid to special consultants (see Paragraph 11.01.A.4 of General Conditions) _____.
5. Supplemental costs (see Paragraph 11.01.A.5 of General Conditions) _____.
6. No fee will be payable on the basis of costs itemized in Paragraph 11.01.B of the General Conditions.
7. The provisions in Paragraph 11.01.C of the General Conditions will apply only to changes in the Work.

B. Contractor guarantees that the maximum amount payable by Owner in accordance with Paragraph 7.01.A as a percentage fee will not exceed $_____, subject to increases or decreases for changes in the Work as provided in Paragraph 9.01.B below.

[or]

C. A fixed fee of $_____, which shall be subject to increases or decreases for changes in the Work as provided in Paragraph 9.01.A below.

NOTES TO USER

Depending on the fee agreement selected or negotiated, select 7.01.A (percentage fee), or 7.01.A and 7.01.B (percentage fee up to guaranteed maximum), or 7.01.C (fixed fee).

ARTICLE 8 - GUARANTEED MAXIMUM PRICE

8.01 Contractor guarantees that the maximum amount payable (Guaranteed Maximum Price) by Owner for the sum of the Cost of the Work plus Contractor's fee under Article 7 will not exceed $_____, subject to increases or decreases for changes in the Work. The Guaranteed Maximum Price will not apply to Unit Price Work.

ARTICLE 9 - CHANGES IN THE CONTRACT PRICE

9.01 The amount of any increases or decreases in Contractor's fee, in any Guaranteed Maximum Price, or in any guaranteed maximum fee which results from a Change Order shall be set forth in the applicable Change Order subject to the following:

A. If Contractor's fee is a fixed fee, any increase or decrease in the Contractor's fee resulting from net additions or decreases in the Cost of the Work shall be determined in accordance with Paragraph 12.01.C of the General Conditions.

[or]

A. If Contractor's fee is a percentage fee not subject to any guaranteed maximum limitation, Contractor's fee will adjust automatically as the Cost of the Work changes.

NOTES TO USER

Select one of the two provisions above for Paragraph 9.01.A.

B. Wherever there is a Guaranteed Maximum Price or Fee:

1. In the case of net additions in the Work, the amounts of any increase in either guaranteed maximum shall be determined in accordance with Paragraphs 11.01 through 11.02, inclusive, of the General Conditions.

2. In the case of net deletions in the Work, the amount of any such decrease shall be determined in accordance with Paragraph 11.02.C of the General Conditions, and any Guaranteed Maximum (Price or Fee) shall be reduced by mutual agreement.

ARTICLE 10 - PAYMENT PROCEDURES

10.01 Submittal and Processing of Payments

A. Contractor shall submit Applications for Payment in accordance with Article 14 of the General Conditions. Applications for Payment will indicate the amount of Contractor's fee then payable. Applications for Payment will be processed by Engineer as provided in the General Conditions.

10.02 Progress Payments; Retainage

A. Owner shall make progress payments on account of the Contract Price on the basis of Contractor's Applications for Payment as recommended by Engineer on or about the _____ day of each month during construction as provided in Paragraphs 10.02.A.1 and 10.02.A.2 below. All such payments will be measured by the schedule of values established as provided in Paragraph 2.07.A of the General Conditions (and in the case of Unit Price Work based on the number of units completed) or, in the event there is no schedule of values, as provided in the General Requirements:

1. For Cost of Work: Progress payments on account of the Cost of the Work will be made:

a. Prior to Substantial Completion, progress payments will be made in an amount equal to the percentage indicated below but, in each case, less the aggregate of payments previously made and less such amounts as Engineer may determine or Owner may withhold, including but not limited to liquidated damages, in accordance with Paragraph 14.02 of the General Conditions:

(1) _____ percent Cost of Work completed (with the balance being retainage). If the Work has been 50 percent completed as determined by Engineer, and if the character and progress of the Work have been satisfactory to Owner and Engineer, Owner, on recommendation of Engineer, may determine that as long as the character and progress of the Work remain satisfactory to them, there will be no retainage; and

(2) _____ percent of cost of materials and equipment not incorporated in the Work (with the balance being retainage).

b. Upon Substantial Completion, Owner shall pay an amount sufficient to increase total payments to Contractor to _____ percent of the Work completed, less such amounts as Engineer shall determine in accordance with Paragraph 14.02.B.5 of the General Conditions and less _____ percent of Engineer's estimate of the value of Work to be completed or corrected as shown on the tentative list of items to be completed or corrected attached to the certificate of Substantial Completion.

2. For Contractor's fee: Progress payments on account of the Contractor's fee will be made:

a. If Contractor's fee is a fixed fee, payments prior to Substantial Completion will be in an amount equal to _____ percent of such fee earned to the date of the approved Application for Payment (less in each case payments previously made on account of such fee) based on the progress of the Work measured by the schedule of values established as provided in Paragraph 2.07.B of the General Conditions (and in the case of Unit Price Work on the number of units completed), and upon Substantial Completion in an amount sufficient to increase total payments to Contractor on account of his fee to _____ percent of Contractor's fee. In the event there is no schedule of values the progress of the Work will be measured as provided in the General Requirements.

b. If Contractor's fee is a percentage fee, payments prior to Substantial Completion will be in an amount equal to _____ percent of such fee (less in each case payments previously made on account of such fee) based on the Cost of the Work completed, and upon Substantial Completion in an amount sufficient to increase total payments to Contractor on account of that fee to _____ percent of Contractor's fee.

10.03 Final Payment

A. Upon final completion and acceptance of the Work in accordance with Paragraph 14.07 of the General Conditions, Owner shall pay the remainder of the Contract Price as recommended by Engineer as provided in said Paragraph 14.07.

ARTICLE 11 - INTEREST

11.01 All moneys not paid when due as provided in Article 14 of the General Conditions shall bear interest at the rate of percent per annum.

ARTICLE 12 – CONTRACTOR'S REPRESENTATIONS

12.01 In order to induce Owner to enter into this Agreement Contractor makes the following representations:

A. Contractor has examined and carefully studied the Contract Documents and the other related data identified in the Bidding Documents.

B. Contractor has visited the Site and become familiar with and is satisfied as to the general, local, and Site conditions that may affect cost, progress, and performance of the Work.

C. Contractor is familiar with and is satisfied as to all federal, state, and local Laws and Regulations that may affect cost, progress, and performance of the Work.

D. Contractor has carefully studied all: (1) reports of explorations and tests of subsurface conditions at or contiguous to the Site and all drawings of physical conditions in or relating to existing surface or subsurface structures at or contiguous to the Site (except Underground Facilities) which have been identified in the Supplementary Conditions as provided in Paragraph 4.02 of the General Conditions and (2) reports and drawings of a Hazardous Environmental Condition, if any, at the Site which has been identified in the Supplementary Conditions as provided in Paragraph 4.06 of the General Conditions.

NOTE TO USER

1. If the reports and/or drawings referred to in A-12.01.D do not exist, either modify A-12.01.D or delete A-12.01.D and renumber accordingly.

E. Contractor has obtained and carefully studied (or assumes responsibility for having done so) all additional or supplementary examinations, investigations, explorations, tests, studies, and data concerning conditions (surface, subsurface, and Underground Facilities) at or contiguous to the Site which may affect cost, progress, or performance of the Work or which relate to any aspect of the means, methods, techniques, sequences, and procedures of construction to be employed by Contractor, including applying the specific means, methods, techniques, sequences, and procedures of construction, if any, expressly required by the Contract Documents to be employed by Contractor, and safety precautions and programs incident thereto.

NOTES TO USER

1. *If the reports and/or drawings referred to in A-12.01.D do not exist, delete the phrase "additional or supplementary" in the first sentence of Paragraph A-12.01.E.*

F. Contractor does not consider that any further examinations, investigations, explorations, tests, studies, or data are necessary for the performance of the Work at the Contract Price, within the Contract Times, and in accordance with the other terms and conditions of the Contract Documents.

G. Contractor is aware of the general nature of work to be performed by Owner and others at the Site that relates to the Work as indicated in the Contract Documents.

H. Contractor has correlated the information known to Contractor, information and observations obtained from visits to the Site, reports and drawings identified in the Contract Documents, and all additional examinations, investigations, explorations, tests, studies, and data with the Contract Documents.

I. Contractor has given Engineer written notice of all conflicts, errors, ambiguities, or discrepancies that Contractor has discovered in the Contract Documents, and the written resolution thereof by Engineer is acceptable to Contractor.

J. The Contract Documents are generally sufficient to indicate and convey understanding of all terms and conditions for performance and furnishing of the Work.

ARTICLE 13 - ACCOUNTING RECORDS

13.01 Contractor shall check all materials, equipment, and labor entering into the Work and shall keep such full and detailed accounts as may be necessary for proper financial management under this Agreement, and the accounting methods shall be satisfactory to Owner. Owner shall be afforded access to all Contractor's records, books, correspondence, instructions, drawings, receipts, vouchers, memoranda, and similar data relating to the Cost of the Work and Contractor's fee. Contractor shall preserve all such documents for a period of three years after the final payment by Owner.

ARTICLE 14 - CONTRACT DOCUMENTS

14.01 Contents

A. The Contract Documents consist of the following:

1. This Agreement (pages 1 to _____, inclusive).
2. Performance bond (pages _____ to _____, inclusive).
3. Payment bond (pages _____ to _____, inclusive).
4. Other bonds (pages _____ to _____, inclusive).
   a. _____ (pages _____ to _____, inclusive).
   b. _____ (pages _____ to _____, inclusive).
   c. _____ (pages _____ to _____, inclusive).

5. General Conditions (pages _____ to _____, inclusive).

6. Supplementary Conditions (pages _____ to _____, inclusive).

7. Specifications as listed in the table of contents of the Project Manual.

8. Drawings consisting of a cover sheet and _____ sheets with each sheet bearing the following general title: _____ [or] the Drawings listed on attached sheet index.

9. Addenda (numbers _____ to _____, inclusive).

10. Exhibits to this Agreement (enumerated as follows):

a. Contractor's Bid (pages _____ to _____, inclusive).

b. Documentation submitted by Contractor prior to Notice of Award (pages _____ to _____, inclusive).

c. _____

11. The following which may be delivered or issued on or after the Effective Date of the Agreement and are not attached hereto:

a. Notice to Proceed (pages _____ to _____, inclusive).

b. Work Change Directives.

c. Change Order(s).

B. The documents listed in Paragraph 14.01.A are attached to this Agreement (except as expressly noted otherwise above).

C. There are no Contract Documents other than those listed above in this Article 14.

D. The Contract Documents may only be amended, modified, or supplemented as provided in Paragraph 3.04 of the General Conditions.

ARTICLE 15 - MISCELLANEOUS

15.01 Terms

A. Terms used in this Agreement will have the meanings stated in the General Conditions and the Supplementary Conditions.

15.02 Assignment of Contract

A. No assignment by a party hereto of any rights under or interests in the Contract will be binding on another party hereto without the written consent of the party sought to be bound; and, specifically but without limitation, moneys that may become due and moneys that are due may not be assigned without such consent (except to the extent that the effect of this restriction may be limited by law), and unless specifically stated to the contrary in any written consent to an assignment, no assignment will release or discharge the assignor from any duty or responsibility under the Contract Documents.

15.03 Successors and Assigns

A. Owner and Contractor each binds itself, its partners, successors, assigns, and legal representatives to the other party hereto, its partners, successors, assigns, and legal representatives in respect to all covenants, agreements, and obligations contained in the Contract Documents.

15.04 Severability

A. Any provision or part of the Contract Documents held to be void or unenforceable under any Law or Regulation shall be deemed stricken, and all remaining provisions shall continue to be valid and binding upon Owner and Contractor, who agree that the Contract Documents shall be reformed to replace such stricken provision or part thereof with a valid and enforceable provision that comes as close as possible to expressing the intention of the stricken provision.

15.05 Other Provisions

NOTES TO USER

1. *If Owner intends to assign a procurement contract (for goods and services) to Contractor, see Note to User at Article 23 of Suggested Instructions to Bidders for Procurement Contracts (EJCDC No. P-200, 2000 Edition) for provisions to be inserted in this Article.*
2. *Insert other provisions here if applicable.*

D-12

IN WITNESS WHEREOF, Owner and Contractor have signed this Agreement in duplicate. One counterpart each has been delivered to Owner and Contractor. All portions of the Contract Documents have been signed or identified by Owner and Contractor or on their behalf.

NOTES TO USER

1. *See I-21 and correlate procedures for format and signing between the two documents.*

This Agreement will be effective on _____, _____ (which is the Effective Date of the Agreement).

OWNER:

By:_____

Title: _____

Address for giving notices:

_____

_____

_____

(If Owner is a corporation, attach evidence of authority to sign. If Owner is a public body, attach evidence of authority to sign and resolution or other documents authorizing execution of Owner-Contractor Agreement.)

CONTRACTOR:

_____

By: _____

Title: _____

Address for giving notices:

_____

_____

_____

License No.: _____
(Where applicable)

Agent for service of process: _____

_____

(If Contractor is a corporation or a partnership, attach evidence of authority to sign)

Appendix E

Arrow Notation Scheduling Calculations

E.1. CPM CALCULATIONS (ARROW NOTATION)

In making calculations with arrow notation, the arrow and its two associated nodes have attributes that are formally defined as symbols for mathematical purposes. This formal notation associated with the arrow is shown in Figure E.1.

The left-hand node on the arrow represents the event time at which the activity begins. It is referred to as the i node. The right-hand node represents the end time of the activity. It is referred to as the j node. Associated with each node is an earliest time, which is shown as $T^E{}_i$ for the i node and $T^E{}_j$ for the j node. Similarly, each node can have a latest event time, which is shown in the figure as $T^L{}_i$ for the i node and $T^L{}_j$ for the j node. This establishes four events, two associated with starting and two with ending nodes, which are of interest in calculating the critical path of the network. The duration of the activity (as shown in the figure) is given as t_{ij}. Because the starting and ending nodes in arrow notation are referred to as i and j, arrow notation is sometimes referred to as i-j notation.

A schematic diagram representing the application of the forward-pass algorithm using arrow notation is shown in Figure E.2. The objective of the forward-pass algorithm is to calculate the earliest point in time at which a given event can occur. That is, the algorithm calculates the earliest event time of a given node. The earliest event time for a given node is controlled by the earliest event times of each of the set of events that precede it. The algorithm is given as follows:

$$T^E{}_j = \max_{\substack{\text{All i} \\ i \epsilon M}} [T^E{}_i + t_{ij}]$$

where M is the set of all i events that immediately precede j.

The earliest event time for a given node j is controlled by the earliest event times of each of the i nodes that precede it. Each i node plus the duration of the associated activity, t_{ij} which links it to the j node, must be investigated. The maximum of the preceding i node early event times plus the durations of the appropriate activity ij controls the earliest time at which a given event j, can occur.

To demonstrate this, consider Figure E.2. Node 30 is preceded by nodes 22, 25, and 26. The durations of the activities emanating from each of these nodes are as follows:

$$\begin{aligned} &\text{Act 22,30} \quad t_{22,30} = 7 \text{ days} \\ &\text{Act 25,30} \quad t_{25,30} = 2 \text{ days} \\ &\text{Act 26,30} \quad t_{26,30} = 6 \text{ days} \end{aligned}$$

The earliest event times for each of the preceding nodes are as follows:

$$\begin{aligned} T^E{}_{22} &= 10 \\ T^E{}_{25} &= 13 \\ T^E{}_{26} &= 15 \end{aligned}$$

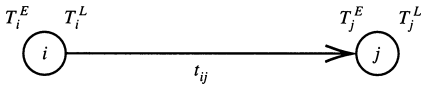


Figure E.1 Arrow notation symbols.

The algorithm for the early event time for node 30 is then

$$T^E_{30} = \max(T^E_{22} + t_{22,30}, T^E_{25} + t_{25,30}, T^E_{26} + t_{26,30})$$

or

$$T^E_{30} = \max(10 + 7, 13 + 2, 15 + 6) = 21$$

E.2. CALCULATING THE EARLY EVENT TIMES (ARROW NOTATION)

In order to understand how the forward-pass algorithm is applied, consider the arrow notation network model of the small gas station in Figure E.3. In order to record the calculated values of the early event time (T^E_i), a partitioned oval is located above each node. The calculated early event time is recorded in the left side of the oval. During the backward pass, the late event times for each node will be recorded in the right side.

The forward-pass algorithm is applied repetitively starting with the source node (node A) and moving from left to right in a "bootstrapping" fashion. The starting node A is given an early event time of zero (0). Moving to node B, the set of preceding events consists of only one event. Therefore, T^E_B is max $(T^E_A + t_{AB}) = \max(0 + 10) = 10$. Calculations for all of the nodes are shown in Table E.1. The values for each node are shown in Figure E.3.

The earliest time at which each activity can begin is given by the T^E_i value for the i node associated with the activity of interest. In addition to this information, it is now clear that the minimum duration of the project is 96 days since the earliest time at which node S can be realized has been calculated as 96 time units.

E.3. BACKWARD-PASS ALGORITHM (ARROW NOTATION)

A schematic diagram representing the application of the backward-pass algorithm is shown in Figure E.4. The backward-pass algorithm calculates the latest time at which each event can occur. The latest event time for a node i is controlled by the latest event times of the set of events that follow it. The late event time of each j node minus the duration of the associated activity, ij, must be investigated. The minimum of the following j node late event times minus the duration of activity ij controls the latest time at which the i event can occur. To demonstrate this, consider Figure E.4.

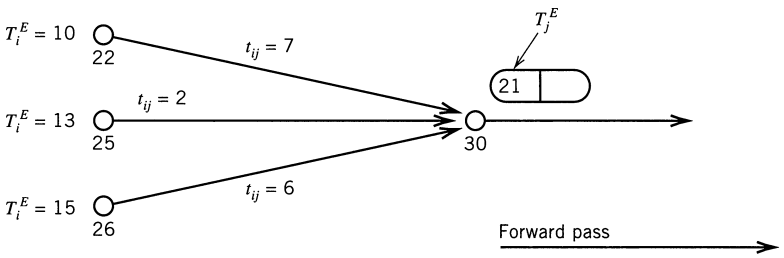
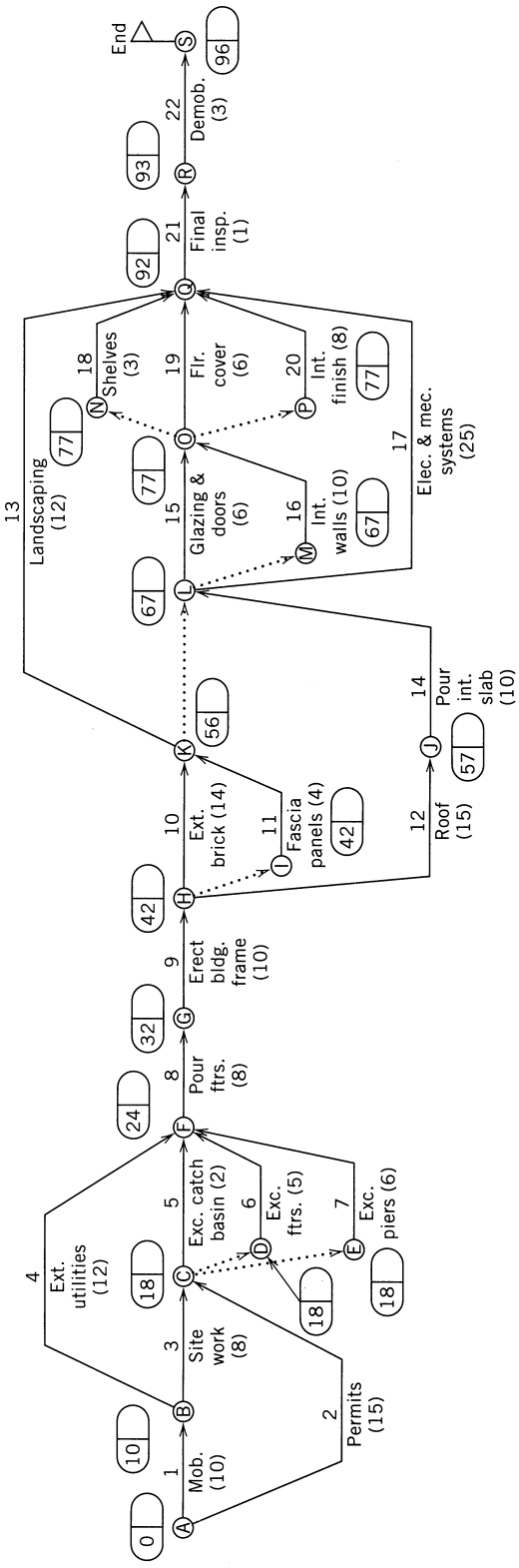


Figure E.2 Schematic of forward-pass calculation.



Note: Activity durations are shown in parentheses, e.g., (10).

Figure E.3 Expanded Project Model with Early Event Times.

Table E.1 Calculation of Early Event Times

Node	Formula	Numerical Value	T_i^E
A	N/A	N/A	0
B	$T_B^E = \max(T_A^E + t_{AB})$	$\max(0 + 10)$	10
C	$T_C^E = \max(T_B^E + t_{BC}, T_A^E + t_{AC})$	$\max(10 + 8, 0 + 15)$	18
D	$T_D^E = \max(T_C^E + t_{CD})$	$\max(18 + 0)$	18
E	$T_E^E = \max(T_C^E + t_{CE})$	$\max(18 + 0)$	18
F	$T_F^E = \max(T_B^E + t_{BF}, T_C^E + t_{CF}, T_D^E + t_{DF}, T_E^E + t_{EF})$	$\max(10 + 12, 18 + 2, 18 + 5, 18 + 6)$	24
G	$T_G^E = \max(T_F^E + t_{FG})$	$\max(24 + 8)$	32
H	$T_H^E = \max(T_G^E + t_{GH})$	$\max(32 + 10)$	42
I	$T_I^E = \max(T_H^E + t_{HI})$	$\max(42 + 0)$	42
J	$T_J^E = \max(T_H^E + t_{HJ})$	$\max(42 + 15)$	57
K	$T_K^E = \max(T_H^E + t_{HK}, T_I^E + t_{IK})$	$\max(42 + 14, 42 + 4)$	56
L	$T_L^E = \max(T_J^E + t_{JL}, T_K^E + t_{KL})$	$\max(57 + 10, 56 + 0)$	67
M	$T_M^E = \max(T_L^E + t_{LM})$	$\max(67 + 0)$	67
N	$T_N^E = \max(T_O^E + t_{ON})$	$\max(77 + 0)$	77
O	$T_O^E = \max(T_L^E + t_{LO}, T_M^E + t_{MO})$	$\max(67 + 6, 67 + 10)$	77
P	$T_P^E = \max(T_O^E + t_{OP})$	$\max(77 + 0)$	77
Q	$T_Q^E = \max(T_K^E + t_{KQ}, T_N^E + t_{NQ}, T_O^E + t_{OQ}, T_P^E + t_{PQ}, T_L^E + t_{LO})$	$\max(56 + 12, 77 + 3, 77 + 6, 77 + 8, 67 + 25)$	92
R	$T_R^E = \max(T_Q^E + t_{QR})$	$\max(92 + 1)$	93
S	$T_S^E = \max(T_R^E + t_S)$	$\max(93 + 3)$	96

Node i, labeled 18, is followed by nodes 21, 23, and 25. The durations of the associated ij activities are:

$$\begin{aligned} &\text{Act } 18,21 \quad t_{18,21} = 12 \\ &\text{Act } 18,23 \quad t_{18,23} = 3 \\ &\text{Act } 18,25 \quad t_{18,25} = 10 \end{aligned}$$

The latest event times for each of the following nodes are as follows:

$$\begin{aligned} T^L{}_{21} &= 52 \\ T^L{}_{23} &= 46 \\ T^L{}_{25} &= 53 \end{aligned}$$

The expression for the late event time of node 18 is:

$$T^L{}_{18} = \min(52 - 12, 46 - 3, 53 - 10) = 40$$

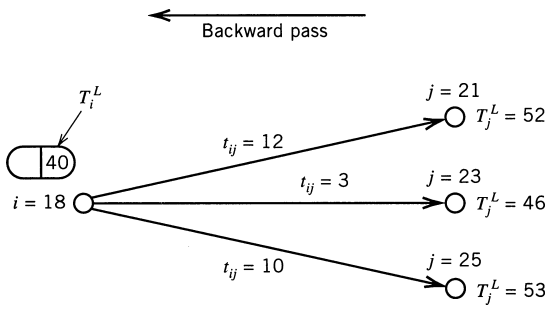
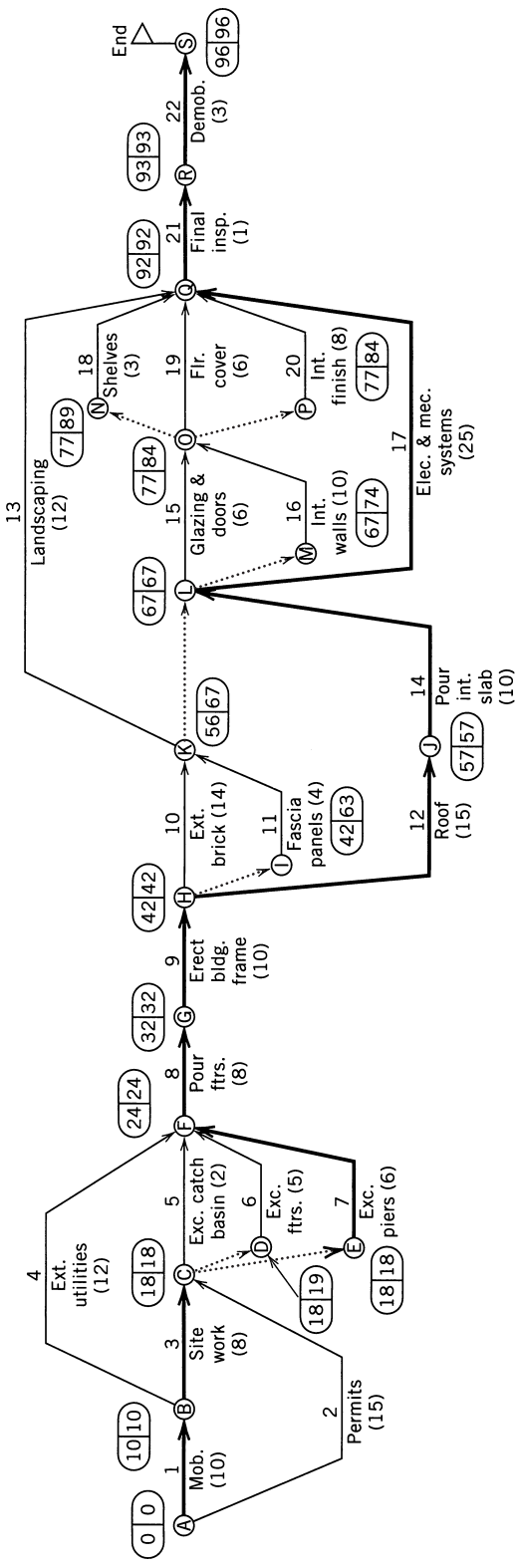


Figure E.4 Schematic of backward-pass algorithm.



Note: Activity durations are shown in parentheses, e.g., (10).

Figure E.5 Expanded Project Arrow Notation Model with Early and Late Event Times.

Again considering the small gas station arrow notation network, the same bootstrapping approach used to work stepwise through the network is used to determine late event times (see Figure E.5). In this case we start at the last node (right side) of the network and step from right to left. In order to commence calculations, a late event time is needed for node S. The late event time of S will be set to the early event time (i.e., 96). Since we wish to complete the project in the minimum period of time, it is logical to set the early and late event times of S to 96. If we were to use a greater number, the finish date for the project would be extended. Since 96 time units (e.g., days) is the minimum duration of the project, a lesser value is not feasible.

Walking the network from right to left, we would start with node R. Node R is followed only by node S. The backward-pass algorithm reduces to:

$$T^L{}_R = \min(96 - 3) = 93$$

Similarly, the late event time of Node Q can be calculated as 92. Again, the late event times for nodes N and P can be calculated as:

$$T^L{}_N = \min(92 - 3) = 89$$
$$T^L{}_P = \min(92 - 8) = 84$$

Node O is followed by nodes N, and Q. Therefore, its late event time is calculated as:

$$T^L{}_O = \min(89 - 0, 84 - 0, 92 - 6) = 84$$

All of the late event times are shown in the right side of the ovals above each node in Figure E.5. It should be noted that the late event time for the beginning node A is 0. The early and late event times of the source or beginning node must be equal (i.e., zero). Otherwise, a mistake in calculating the backward-pass values has occurred.

E.4. IDENTIFYING THE CRITICAL PATH

As previously stated, the set of critical activities that form the critical path(s) cannot be delayed without causing an extension of the project duration. Therefore, they can be identified as the activities that have early and late event times (associated with their i and j nodes) that are equal. Activities with i and j node early and late times that are not equal can be delayed a certain amount without extending the duration of the project. By looking at Figure E.5 it can be determined that the following activities are critical.

AB, BC, CE, EF, FG, GH, HJ, JL, LQ, QR, RS

This is both the critical and longest path through the network. The duration of this path must be equal to the minimum project duration calculated using the forward-pass algorithm. All other paths will have durations that are less than the minimum project duration. Check to see that the critical path has a duration of 96 and that all other paths have a duration less than 96 time units.

Appendix F

AGC Builders Association of Chicago: Typical Agent Job Descriptions

PROJECT MANAGER

A. General Functions

The project manager in the construction industry is usually an "inside" and "outside" man. The position may vary considerably from company to company. The project manager in some companies may be an estimator, and expeditor, and even handle some duties normally done by the job superintendent, while with other companies he may merely supervise superintendents.

B. Detailed Functions

1. May procure the invitation to bid on jobs.
2. May, when working as an estimator, prepare bids.
3. May handle the legal requirements for a contract.
4. May negotiate the specialty contractor's arrangements and agreements.
5. Set up completion schedules by bar graph or critical path method.
6. Supervise subcontractors and coordinate their material deliveries.
7. Arrange for sufficient manpower for the project.
8. Supervise superintendents on the job—"walk the job" each day to see progress being made and, during this time, review the work with a superintendent.
9. Control the movement of workers from one job to another.
10. Arrange for permits from the city, county, and so forth.
11. Hire and fire superintendents, foremen, engineers, and other personnel under his supervision.
12. Set up occupancy dates for buildings.
13. Act as public relations representative.
14. Coordinate with architect and owner requested revisions or errors found in drawings.

ESTIMATOR

A. General Functions

An estimator makes as close an estimate as possible of what the costs will be. In order to do so, he must itemize all of the building materials and calculate labor costs for the entire

project—the cost estimate may also include a percentage for profit, though this may be done with or by top management.

B. Detailed Functions

1. Mail or telephone bid proposals to subcontractors.
2. Follow up with subcontractors on submission of their bids.
3. Review bid with subcontractors.
4. Prior to bid, inspect job site to determine access and that the land is the same as on the plans. Look for water conditions and other problems that might arise.
5. Analyze plans and specifications, that is, "learn the job."
6. Make a takeoff for each type of work to be done by general contractor forces.
7. Does takeoff for subcontractors when necessary.
8. May sit in on owner, architect, and contractor conferences.
9. May check on other estimator's work or have his work checked by another estimator.
10. Price the quantity takeoffs.
11. Read prints, noting discrepancies.
12. Make itemized lists of prices for materials.
13. Review and preview subcontractors' bids.
14. In some companies, purchase steel, lumber, and all other materials necessary for the job.
15. Compute a percentage for overhead and profit, which would be added to estimated cost.
16. Arrive at final bid price or cost price.
17. Prepare change order (estimates cost of changes) as needed or required—if major item and not handled by field personnel.
18. Expedite distribution of plans, including general and mechanical.
19. Serve in quality control capacity, because of position in purchasing, and plan review.
20. Make bar graphs, network, or CPM for scheduling.
21. Make cost breakdown of work performed by company forces for cost control purposes.

EXPEDITOR

A. General Functions

An expeditor may schedule or coordinate job material requirements. He serves as a troubleshooter when there is a breakdown in delivery schedule. He foresees problems by reviewing plans and specifications of the subcontractors and coordinating these with the plans and specifications of the architect.

B. Detailed Functions

1. In some companies receives the plans and specifications and breaks the specifications down by trade.

2. In some companies writes to all subcontractors advising them what is necessary to do on their plans.
3. Follows up on drawings, that is, shop drawings or the detailed drawings of project.
4. Submits drawings to the architect after having checked them to see if they match, that the job is correct, that the materials used are those specified, and analyzes the drawings.
5. Maintains constant follow-up on plans and drawings to ensure documents reach the proper place at the proper time.
6. Distributes approved plans to subs or to anyone else who should get them. Has to order enough plans from subcontractors so that entrusted parties will have sufficient documentation for project schedule.
7. In some companies establishes delivery time for materials, equipment, or labor, based on when they will be required and when they can be acquired, and determines the lead time required for acquisition.
8. May follow a CPM printout, make out delivery schedules, use a bar graph method or the critical path method. Makes sure the shop items are on the critical path method or the bar graph.
9. In some companies does small buying such as purchasing mailboxes, signs, and finish items.
10. Maintains constant follow-up to ensure that schedule is accomplished.
11. Checks all incoming tests to ensure they meet specifications.
12. In some companies checks the concrete design, that is, the mix or fixed formula of the concrete used.
13. Plans material delivery and schedules with job superintendents.
14. Keeps in contact each day with subcontractors.
15. Writes memos as needed to architects, superintendents, subcontractors, and so forth.
16. Follows up daily on trouble areas, that is, those places where delivery of materials may be lagging.
17. In some companies accumulates change order information.
18. Generally troubleshoots, especially for delivery problems.

EQUIPMENT SUPERINTENDENT

A. General Functions

Maintains and repairs equipment owned by company. To do this, he supervises garage and yard personnel and coordinates delivery of equipment to the specific job sites and expedites repairs and deliveries.

B. Detailed Functions

1. Supervises, maintains, and repairs.
2. Purchases parts for maintenance and repairs.
3. Expedites repairs of equipment that cannot be done in the company garage.

4. Keeps detailed records of equipment, including maintenance costs for each piece of equipment.
5. Keeps track of equipment, that is, which job is using it at any given time.
6. Makes recommendations concerning purchase of new equipment.
7. Provides delivery of equipment to job sites, helps to plan the time, provides means of delivery to the site, and provides equipment setup at site.
8. Keeps weekly repair costs on his crew.
9. Prepares an annual budget for operation.

FIELD SUPERINTENDENT

A. General Functions

Builds the building. Manages men and materials on the job site so that the project is built for profit. Coordinates schedules so that men and materials are available to promote efficient erection of the building at a profit level.

B. Detailed Functions

1. "Learns the building." Studies plans and specifications so that he can plan the work to be accomplished.
2. Tries to anticipate problems.
3. Studies the costs.
4. Arranges scheduling and manufacture of building parts or components.
5. Coordinates building when the manufactured items become available for the building.
6. Does survey and layout work or supervises technical or field engineer who does this.
7. Keeps constant check on all trades, overseeing workmanship and materials.
8. Hires and fires workmen.
9. Supplies information to accounting department so that records of costs can be maintained.
10. Supervises men directly or indirectly (i.e., through the foreman).
11. May be responsible for deliveries.
12. Is responsible for drawings and seeing that drawings are made of changes or incomplete items.
13. Arranges for plan changes as needed.
14. May be responsible for written schedules or physical schedules.
15. Does on-the-spot estimating (material or labor).
16. May price out extra items or charges.
17. Does limited buying (supplies and items missed by the purchasing department).
18. Makes daily safety inspections.
19. May record daily field activities in a log.

MECHANICAL SUPERINTENDENT

A. General Functions

The mechanical superintendent coordinates subcontractor's work with that of the general contractor to ensure that project remains on schedule and quality is maintained.

B. Detailed Functions

1. Compiles listing of major mechanical electrical equipment required.
2. Expedites shop drawings and equipment deliveries.
3. Assists in preparation of project schedules.
4. Prepares weekly progress reports on electrical and mechanical work.
5. Coordinates subcontractors' work with general contractor.
6. Checks schedule to ensure project is on schedule.
7. Supervises general contractor's work done for subcontractors (equipment production, excavations, etc.).
8. Processes and distributes shop drawings.
9. Supervises, inspects, and evaluates work performed by subcontractors—ensures there is compliance with plans and specifications.
10. Supervises project closely to ensure that the owner is getting his money's worth on subcontractor work.

SCHEDULING ENGINEER (FIELD ENGINEER)

A. General Functions

Scheduling engineer schedules and coordinates. He serves as a troubleshooter when there is a breakdown in delivery schedule. He maintains a constant follow-up on the schedule to ensure progress as previously planned.

B. Detailed Functions

1. Receives plans and specifications and breaks them down by trade.
2. Writes to all subcontractors telling them when their work is necessary on the schedule.
3. Expedites follow-up for drawings, that is, shop drawings or detailed drawings. Checks with own staff for follow-up.
4. Keeps a close follow-up to ensure that plans and drawings reach the right people at the right time.
5. Establishes delivery times for materials, equipment, or labor, based on when they can be acquired, and determines the lead time required for acquisitions.
6. Makes out delivery schedules, using a bar graph method or critical path method. Makes sure that the shop items are on the bar graph or CPM.
7. Discusses material delivery and scheduling with job superintendent.
8. Keeps in touch with subcontractors as needed.
9. Writes memos as needed to superintendents, subcontractors, and so forth.

10. Follows up daily on trouble areas, where delivery of materials may be lagging.
11. Generally troubleshoots.

TIMEKEEPER

A. General Functions

A timekeeper is primarily concerned with maintaining cost control of labor force on a project. He maintains payroll records and may also maintain records on material deliveries.

B. Detailed Functions

1. Ensures that the men are on the job, checks what specific tasks they are performing, and checks this against job sheets given to him daily by the foreman.
2. Checks with the foreman to determine exact job and classification of work each man is doing so that the work can be coded and entered against the correct amount.
3. Walks the job a few times each day.
4. Computes previous day's work sheets to obtain costs.
5. Projects daily costs to determine if work was completed within the allocated budget.
6. Talks over costs with superintendent.
7. Posts workers' hours to the payroll on a daily basis.
8. Types a cost report each week. In some companies this may be done by central office staff.
9. Types payroll each week. In some companies this may be done by central office staff.
10. Types paychecks each week. In some companies this may be done by central office staff.
11. Types all back charges and time tickets.
12. Estimates costs of requests from subcontractors for sheds, shanties, carpenters, and concrete work performed for them.
13. May compile subcontractors' invoices for payment and discuss these with architect to determine accuracy.
14. Codes all delivery tickets to maintain costs on all building parts.
15. Keeps records of all reinforcing steel deliveries.
16. Records all concrete pours.
17. May assist superintendent by ordering labor, lumber, and other materials.
18. On certain big load days may call the union halls for extra men; will sign these men for the day and pay them by check at night.
19. Signs up all new workmen (W-4 forms, applications, etc.) and submits originals to central office.
20. Enters new employees' names and proper wage rate for the particular trade on payroll.
21. Types monthly report on welfare and pension. In some companies this may be done at the central office.
22. Balances the payroll and types it each Monday. Submits it to the main office so that checks can be made out and returned to the job site by Wednesday. In some companies this may be done at central office.

23. May travel to various job sites and perform same duties for each of the projects.

24. On projects involving federal funds, he collects payroll data from subcontractors for submission to the government in compliance with their regulations.

25. Maintains time record on company truck drivers when material deliveries are made.

26. May supervise "time checkers" on larger project.

Appendix G

AGC Standard Form Construction Subcontract

THE ASSOCIATED GENERAL CONTRACTORS OF AMERICA

INSTRUCTIONS FOR COMPLETION OF AGC DOCUMENT NO. 650 STANDARD FORM OF AGREEMENT BETWEEN CONTRACTOR AND SUBCONTRACTOR (Where the Contractor Assumes the Risk of Owner Payment)

This document is endorsed by The Associated Specialty Contractors, Inc. (ASC)

1998 EDITION (FINAL)

The Standard Form of Agreement Between Contractor and Subcontractor (Where the Contractor Assumes the Risk of Owner Payment), AGC Document No. 650 (AGC 650), has been written to be generally compatible with both The American Institute of Architects General Conditions of the Contract for Construction, A201-1997, and AGC Document No. 200, Standard Form of Agreement and General Conditions Between Owner and Contractor (Where the Contract Price is a Lump Sum), 1997 Edition. In this document, AGC 650, payment to the Subcontractor is not conditioned on the Contractor having received, from the Owner, payment for Subcontract Work satisfactorily performed. See the discussion in these Instructions of Article 8, below. AGC Document No. 655, Standard Form of Agreement Between Contractor and Subcontractor (Where the Contractor and Subcontractor Share the Risk of Owner Payment), can be used when conditioned payment is valid in the jurisdiction and elected by the parties.

This document replaces AGC Document No. 650I, which was published on an interim basis for use until publication of this final version. AGC 650 benefited from an inclusive development process in which contractors, subcontractors and others offered comments and constructive feedback on its language.

Among the participants was The Associated Specialty Contractors, Inc. (ASC), an umbrella organization composed of the following eight specialty contractor groups: Mason Contractors Association of America, Mechanical Contractors Association of America, National Electrical Contractors Association, National Insulation Association, National Roofing Contractors Association, Painting and Decorating Contractors of America, Plumbing-Heating-Cooling Contractors—National Association, and Sheet Metal and Air Conditioning Contractors' National Association.

ASC has approved and endorsed this document, AGC 650.

SPECIAL NOTE: Care should be taken to ensure that the terms of this Subcontract Agreement coordinate with the general conditions of the prime contract. Particular attention should be paid to coordinating indemnity and insurance provisions.

GENERAL INSTRUCTIONS

Standard Form

These instructions are for the information and convenience of the users of AGC 650, 1998 Edition. They are not part of the Agreement nor a commentary on or interpretation of the contract form. It is the intent of the parties to a particular agreement that controls its meaning and not that of the writers and publishers of the standard form. As a standard form, this Agreement has been designed to establish the relationship of the parties in the standard situation. Rec-

organizing that every project is unique, modifications may be required. See the following recommendations for modifications.

Legal and Insurance Counsel

This Agreement has important legal and insurance consequences. Consultation with an attorney and an insurance adviser is encouraged with respect to its completion or modification.

COMPLETING THE AGREEMENT

Completing Blanks

Diamonds in the margins indicate provisions requiring the parties to fill in blanks with information.

Modifications

Supplemental conditions, provisions added to the printed agreement, may be adopted by reference. It is always best for supplements to be attached to the agreement. Provisions in the printed document that are not to be included in the agreement may be deleted by striking through the word, sentence or paragraph to be omitted. It is recommended that unwanted provisions not be blocked out so that the deleted materials are illegible. The parties should be clearly aware of the material deleted from the standard form.

It is a good practice for both parties to sign and date all modifications and supplements.

Photocopying the Completed Agreement

The purchaser of this copyrighted document may make up to nine (9) photocopies of a completed document, whether signed or unsigned, for distribution to appropriate parties in connection with a specific project. Any other reproduction of this document in any form is strictly prohibited, unless the purchaser has obtained the prior written permission of The Associated General Contractors of America.

OBTAINING ADDITIONAL INFORMATION

To obtain additional information about AGC standard form contract documents and the AGC Contract Documents Program, contact AGC at 333 John Carlyle Street, Suite 200, Alexandria, VA 22314; phone (703) 548-3118; fax (703) 548-3119, or visit AGC's web site at www.agc.org.

AGC 650

The provisions of this standard form Agreement are organized by article closely following the order in the AGC 200 and approximately in the same order as in the AIA A201-1997 to facilitate determining the coordination of these documents. For example, the responsibilities of the parties are in the early articles; time, price, changes and payment are discussed in that order, and dispute resolution and miscellaneous provisions are in the last few articles.

Article 1 AGREEMENT

The date of the Agreement and identification of the parties and the Project are essential information to be accurately inserted in this article.

Article 2 SCOPE OF WORK

The relationship of the parties, the extent of the Agreement, and the definitions of some terms are described in this Article.

2.1 This Paragraph obligates the Subcontractor to perform the Subcontract Work in accordance with and reasonably inferable from that "indicated" in the Subcontract Documents, consistent with the Progress Schedule, and under the general direction of the Contractor.

Article 3 SUBCONTRACTOR'S RESPONSIBILITIES

3.1 This Paragraph addresses mutuality in the flow-down of rights and responsibilities.

3.3 This Paragraph addresses the Subcontractor's responsibilities for review and analysis of the Subcontract Documents. The Subcontractor's comparison of drawings, specifications, and other documents is "solely for the purpose of facilitating the Subcontract Work" and not for the purpose of "discovery of errors, inconsistencies or omissions."

3.4 This Paragraph addresses site visitation. Prior to performing the Work, the Subcontractor is responsible for visiting the Project site and "shall conduct a visual inspection of the Project site to become generally familiar with local conditions and to correlate site observations with the Subcontract Documents."

3.8 Design delegation is an important new concept in the AIA A201-1997. This Paragraph addresses design delegation consistent with the A201-1997. Whether or not design has been delegated will be determined in the relevant drawings and specifications. The Designer is retained by the Subcontractor as permitted by the law of the jurisdiction. The Designer is named in Subparagraph 3.8.2. See Subparagraph 9.2.3 for the Professional Liability Insurance issues related to the delegated design.

3.11 The Subcontractor designates a representative.

3.13 This Paragraph states the Subcontractor's responsibility for cleanup relative to the Contractor's and others' responsibilities.

3.14 The importance of the safe performance of the Subcontractor's Work is emphasized in this section. The Subcontractor is required to designate an individual at the site as the Subcontractor's safety representative (3.14.6). Establishment of a safety program by the Contractor does not relieve the Subcontractor of its safety responsibilities (3.14.9). The Contractor and Subcontractor assume a mutual indemnification obligation for fines or penalties arising from safety violations (3.14.9).

3.22.2 This Subparagraph addresses the Subcontractor's responsibility to correct defective work.

3.27 Subcontract Bond requirements, if required, are inserted in blanks at this Paragraph.

3.30 Confidentiality provisions in the Owner-Contractor agreement flow down to the Subcontractor.

3.32 Provisions relative to labor relations must be inserted or incorporated by reference. Legal counsel is recommended. If there are no labor provisions, the parties should so indicate in order that it is clear their omission was not an oversight.

Article 4 CONTRACTOR'S RESPONSIBILITIES

4.1 The Contractor designates a representative.

4.2 The Contractor indicates whether a payment bond has been provided the Owner. If so, the bond will be made available for the Subcontractor to review and copy.

4.3 The Owner's ability to pay is, obviously, crucial to the successful completion of the Project. It also can be the source of problems between the Contractor and Subcontractor. These provisions give the Subcontractor the right to request the information the Contractor has about the Project financing. If the Subcontractor does not receive information about the Owner's ability to pay as required in the Contract Documents, the Subcontractor may request the information from the Owner and/or the Owner's lender. The Subcontractor also has a right to request and receive any changes in the information relating to the Owner's financial capability.

AGC Document No. 690, *Guidelines for Obtaining Owner Financial Information, AGC Document No. 690.1, Owner Financial Questionnaire,* and AGC 3514, Private Work: Managing the Risks, a joint publication with the National Association of Surety Bond Producers, offer help on assessing and managing the financial risks inherent in contracting with private owners.

Article 5 PROGRESS SCHEDULE

5.2 Although the Contractor prepares the schedule for performance of the work, the Progress Schedule provision requires communication between the Subcontractor and the Contractor with regard to the schedule.

5.3 There is a distinction between Claims Relating to the Owner (5.3.2) and Claims Relating to the Contractor (5.3.4).

5.4 The Contractor and Subcontractor waive claims for consequential damages. Similarly, the Subcontractor shall obtain from its sub-subcontractors mutual waivers of consequential damages that correspond to the Subcontractor's waiver of consequential damages herein. Also, this Paragraph provides, "to the extent the Owner-Contractor agreement provides for a mutual waiver of consequential damages by the Owner and the Contractor, damages for which the Contractor is liable to the Owner including those related to Subparagraph 9.1.1 are not consequential damages for the purpose of this waiver. Similarly, to the extent the Subcontractor sub-subcontractor agreement provides for a mutual waiver of consequential damages by the Owner and the Contractor, damages for which the Subcontractor is liable to lower-tiered parties due to the fault of the Owner or Contractor are not consequential damages for the purpose of this waiver."

Article 6 SUBCONTRACT AMOUNT

The Subcontract Amount provisions offer specific options: fixed price, unit prices, or time and material rates.

Article 7 CHANGES IN THE SUBCONTRACT WORK

7.2 There is provision for the Construction Change Directive concept, to the extent it is provided for in the Subcontract Documents.

7.3 This Paragraph addresses the Subcontractor's responsibility for unknown conditions encountered at the site.

Article 8 PAYMENT

8.1 The Subcontractor is required to submit a schedule of values satisfactory to the Contractor.

There are provisions for Retainage (8.2.2), and Stored Materials (8.2.4).

8.2.5 This Subparagraph does not condition the Subcontractor's payment on receipt of payment by the Contractor from the Owner. Progress payments to the Subcontractor are to be made within seven days after the Contractor receives payment from the Owner for the Subcontractor's Work. If, through no fault of the Subcontractor, the Owner does not pay the Contractor for the Subcontractor's Work,

AGC DOCUMENT NO. 650 • STANDARD FORM OF AGREEMENT BETWEEN CONTRACTOR AND SUBCONTRACTOR
(Where the Contractor Assumes the Risk of Owner Payment)

the Contractor assumes that liability "within a reasonable time." A "reasonable time" enables the Contractor to attempt to secure the payment from the Owner; what is "reasonable" for a particular project will depend on a variety of project-specific factors.

8.2.7 The Subcontractor's application for payment may be rejected for any of the seven reasons indicated. The Contractor must give the Subcontractor written notice of the specific reasons for disapproving an application.

8.3 The Final Payment provisions at Subparagraphs 8.3.3 and 8.3.4 are consistent with the Progress Payment provisions.

8.6 This Paragraph addresses payment use restrictions placed on the Contractor and Subcontractor.

8.8 This Paragraph addresses partial lien waivers and affidavits and states that the Subcontractor shall not be compelled to provide an unconditional waiver of lien or claim prior to receiving payment.

Article 9 INDEMNITY, INSURANCE AND WAIVER OF SUBROGATION

9.1 This Paragraph addresses claims for bodily injury and property damage on a comparative fault basis. Contractual indemnification is governed by state law. The states differ as to the types of indemnification agreements they will enforce. Consultation with insurance and legal counsel with knowledge of the jurisdiction is recommended.

9.2.2 The minimum limits of the Subcontractor's liability insurance are to be provided in an exhibit to this Agreement.

9.2.3 If design has been delegated to the Subcontractor as described in Paragraph 3.8, professional liability insurance coverage is provided as defined in this Paragraph.

9.2.6 Completed Operations coverage requirements are described in this Paragraph.

Article 10 CONTRACTOR'S RIGHT TO PERFORM SUBCONTRACTOR'S RESPONSIBILITIES AND TERMINATION OF AGREEMENT

10.1 This Paragraph governs the Contractor's recourse when the Subcontractor fails to perform, including notice to cure and termination of the Subcontractor by the Contractor for cause. If the Contractor performs work under these provisions or subcontracts its performance, it has the right to use the Subcontractor's materials and equipment at the project site to complete the Subcontractor's Work (10.1.3).

10.7 This Paragraph includes reasonable overhead and profit on the Subcontract Work not executed, and other costs incurred by reason of such action, in the Subcontractor's recoverable costs for the Contractor's wrongful exercise of rights.

Other provisions govern the event of Bankruptcy (10.2), Suspension by the Owner (10.3), Termination by the Owner (10.4), the Contingent Assignment of this Agreement (10.5), and Suspension by the Contractor (10.6).

Article 11 DISPUTE RESOLUTION

The parties are encouraged to settle their disputes through direct discussions. If these discussions are not successful, the subcontract provides for mediation as a condition precedent to any other form of binding dispute resolution. Any disputes not resolved by mediation are to be decided by the dispute resolution process selected in the agreement between the Owner and the Contractor.

11.5 This Paragraph addresses Disputes Between Contractor and Subcontractor.

Article 12 MISCELLANEOUS PROVISIONS

These provisions include the Governing Law (12.1), Severability (12.2), and Other Provisions and Documents (12.5).

Article 13 EXISTING SUBCONTRACT DOCUMENTS

The exhibits in this Article may include the Subcontract Work, Drawings, Specifications, General and other conditions, the Progress Schedule, alternates and unit prices, temporary services, insurance or others as appropriate.

AGC DOCUMENT NO. 650 • STANDARD FORM OF AGREEMENT BETWEEN CONTRACTOR AND SUBCONTRACTOR
(Where the Contractor Assumes the Risk of Owner Payment)

THE ASSOCIATED GENERAL CONTRACTORS OF AMERICA

AGC DOCUMENT NO. 650
STANDARD FORM OF AGREEMENT BETWEEN CONTRACTOR AND SUBCONTRACTOR
(Where the Contractor Assumes the Risk of Owner Payment)

This document is endorsed by The Associated Specialty Contractors, Inc. (ASC)

The Associated Specialty Contractors, Inc. (ASC) is an umbrella organization composed of the following eight specialty contractor groups: Mason Contractors Association of America, Mechanical Contractors Association of America, National Electrical Contractors Association, National Insulation Association, National Roofing Contractors Association, Painting and Decorating Contractors of America, Plumbing-Heating-Cooling Contractors-National Association, and Sheet Metal and Air Conditioning Contractors' National Association. ASC has approved and endorsed this document, AGC 650.

TABLE OF ARTICLES

1. AGREEMENT
2. SCOPE OF WORK
3. SUBCONTRACTOR'S RESPONSIBILITIES
4. CONTRACTOR'S RESPONSIBILITIES
5. PROGRESS SCHEDULE
6. SUBCONTRACT AMOUNT
7. CHANGES IN THE SUBCONTRACT WORK
8. PAYMENT
9. INDEMNITY, INSURANCE AND WAIVER OF SUBROGATION
10. CONTRACTOR'S RIGHT TO PERFORM SUBCONTRACTOR'S RESPONSIBILITIES AND TERMINATION OF AGREEMENT
11. DISPUTE RESOLUTION
12. MISCELLANEOUS PROVISIONS
13. EXISTING SUBCONTRACT DOCUMENTS

This Agreement has important legal and insurance consequences. Consultation with an attorney and an insurance consultant is encouraged with respect to its completion or modification.

AGC DOCUMENT NO. 650
STANDARD FORM OF AGREEMENT
BETWEEN CONTRACTOR AND SUBCONTRACTOR
(Where the Contractor Assumes the Risk of Owner Payment)

ARTICLE 1

AGREEMENT

This Agreement is made this _____ day of _____, ♦

in the year _____, by and between the ♦

CONTRACTOR ♦
(Name and Address)

and the
SUBCONTRACTOR ♦
(Name and Address)

for services in connection with the
SUBCONTRACT WORK ♦

for the following
PROJECT ♦

whose
OWNER is ♦
(Name and Address)

The **ARCHITECT/ENGINEER** for the Project is ♦
(Name and Address)

Notice to the parties shall be given at the above addresses.

ARTICLE 2

SCOPE OF WORK

2.1 SUBCONTRACT WORK The Contractor contracts with the Subcontractor as an independent contractor to provide all labor, materials, equipment and services necessary or incidental to complete the work described in Article 1 for the Project in accordance with, and reasonably inferable from, that which is indicated in the Subcontract Documents, and consistent with the Progress Schedule, as may change from time to time. The Subcontractor shall perform the Subcontract Work under the general direction of the Contractor and in accordance with the Subcontract Documents.

2.2 CONTRACTOR'S WORK The Contractor's work is the construction and services required of the Contractor to fulfill its obligations pursuant to its agreement with the Owner (the Work). The Subcontract Work is a portion of the Work.

2.3 SUBCONTRACT DOCUMENTS The Subcontract Documents include this Agreement, the Owner-Contractor agreement, special conditions, general conditions, specifications, drawings, addenda, Subcontract Change Orders, amendments and any pending and exercised alternates. The Contractor shall make available to the Subcontractor, prior to the execution of the Subcontract Agreement, copies of the Subcontract Documents to which the Subcontractor will be bound. The Subcontractor similarly shall make copies of applicable portions of the Subcontract Documents available to its proposed subcontractors and suppliers. Nothing shall prohibit the Subcontractor from obtaining copies of the Subcontract Documents from the Contractor at any time after the Subcontract Agreement is executed. The Subcontract Documents existing at the time of the execution of this Agreement are set forth in Article 13.

2.4 CONFLICTS In the event of a conflict between this Agreement and the other Subcontract Documents, this Agreement shall govern.

2.5 EXTENT OF AGREEMENT Nothing in this Agreement shall be construed to create a contractual relationship between persons or entities other than the Contractor and Subcontractor. This Agreement is solely for the benefit of the parties, represents the entire and integrated agreement between the parties, and supersedes all prior negotiations, representations, or agreements, either written or oral.

2.6 DEFINITIONS

.1 Wherever the term *Progress Schedule* is used in this Agreement, it shall be read as Project Schedule when that term is used in the Subcontract Documents.

.2 Whenever the term *Change Order* is used in this Agreement, it shall be read as Change Document when that term is used in the Subcontract Documents.

.3 Unless otherwise indicated, the term *Day* shall mean calendar day.

ARTICLE 3

SUBCONTRACTOR'S RESPONSIBILITIES

3.1 OBLIGATIONS The Contractor and Subcontractor are hereby mutually bound by the terms of this Subcontract. To the extent the terms of the prime contract between the Owner and Contractor apply to the work of the Subcontractor, then the Contractor hereby assumes toward the Subcontractor all the obligations, rights, duties, and redress that the Owner under the prime contract assumes toward the Contractor. In an identical way, the Subcontractor hereby assumes toward the Contractor all the same obligations, rights, duties, and redress that the Contractor assumes toward the Owner and Architect under the prime contract. In the event of an inconsistency among the documents, the specific terms of this Subcontract shall govern.

3.2 RESPONSIBILITIES The Subcontractor agrees to furnish its best skill and judgment in the performance of the Subcontract Work and to cooperate with the Contractor so that the Contractor may fulfill its obligations to the Owner. The Subcontractor shall furnish all of the labor, materials, equipment, and services, including but not limited to, competent supervision, shop drawings, samples, tools, and scaffolding as are necessary for the proper performance of the Subcontract Work. The Subcontractor shall provide the Contractor a list of its proposed subcontractors and suppliers, and be responsible for taking field dimensions, providing tests, obtaining required permits related to the Subcontract Work and affidavits, ordering of materials and all other actions as required to meet the Progress Schedule.

3.3 INCONSISTENCIES AND OMISSIONS The Subcontractor shall make a careful analysis and comparison of the drawings, specifications, other Subcontract Documents and information furnished by the Owner relative to the Subcontract Work. Such analysis and comparison shall be solely for the purpose of facilitating the Subcontract Work and not for the discovery of errors, inconsistencies or omissions in the Subcontract Documents nor for ascertaining if the Subcontract Documents are in accordance with applicable laws, statutes, ordinances, building codes, rules or regulations. Should the Subcontractor discover any errors, inconsistencies or omissions in the Subcontract Documents, the Subcontractor shall report such discoveries to the Contractor in writing within three (3) days. Upon receipt of notice, the Con-

[illegible] to be taken, and the Subcontractor shall comply with the Contractor's instructions. If the Subcontractor performs work knowing it to be contrary to any applicable laws, statutes, ordinances, building codes, rules or regulations without notice to the Contractor and advance approval by appropriate authorities, including the Contractor, the Subcontractor shall assume appropriate responsibility for such work and shall bear all associated costs, charges, fees and expenses necessarily incurred to remedy the violation. Nothing in this Paragraph 3.3 shall relieve the Subcontractor of responsibility for its own errors, inconsistencies and omissions.

3.4 SITE VISITATION Prior to performing any portion of the Subcontract Work, the Subcontractor shall conduct a visual inspection of the Project site to become generally familiar with local conditions and to correlate site observations with the Subcontract Documents. If the Subcontractor discovers any discrepancies between its site observations and the Subcontract Documents, such discrepancies shall be promptly reported to the Contractor.

3.5 INCREASED COSTS AND/OR TIME The Subcontractor may assert a Claim as provided in Article 7 if Contractor's clarifications or instructions in responses to requests for information are believed to require additional time or cost. If the Subcontractor fails to perform the reviews and comparisons required in Paragraph 3.3 and 3.4, above, to the extent the Contractor is held liable to the Owner because of the Subcontractor's failure, the Subcontractor shall pay the costs and damages to the Contractor that would have been avoided if the Subcontractor had performed those obligations.

3.6 COMMUNICATIONS Unless otherwise provided in the Subcontract Documents and except for emergencies, Subcontractor shall direct all communications related to the Project to the Contractor.

3.7 SUBMITTALS

3.7.1 The Subcontractor promptly shall submit for approval to the Contractor all shop drawings, samples, product data, manufacturers' literature and similar submittals required by the Subcontract Documents. The Subcontractor shall be responsible to the Contractor for the accuracy and conformity of its submittals to the Subcontract Documents. The Subcontractor shall prepare and deliver its submittals to the Contractor in a manner consistent with the Progress Schedule and in such time and sequence so as not to delay the Contractor or others in the performance of the Work. The approval of any Subcontractor submittal shall not be deemed to authorize deviations, substitutions or changes in the requirements of the Subcontract Documents unless express written approval is obtained from the Contractor and Owner authorizing such deviation, substitution or change. In the event that the Subcontract Documents do not contain submittal requirements pertaining to the Subcontract Work, the Subcontractor agrees upon request to submit in a timely fashion to the Contractor for approval any shop drawings, samples, product data, manufacturers' literature or similar submittals as may reasonably be required by the Contractor, Owner or Architect.

3.7.2 The Contractor, Owner, and Architect are entitled to rely on the adequacy, accuracy and completeness of any professional certifications required by the Subcontract Documents concerning the performance criteria of systems, equipment or materials, including all relevant calculations and any governing performance requirements.

3.8 DESIGN DELEGATION

3.8.1 If the Subcontract Documents (1) specifically require the Subcontractor to provide design services and (2) specify all design and performance criteria, the Subcontractor shall provide those design services necessary to satisfactorily complete the Subcontract Work. Design services provided by the Subcontractor shall be procured from licensed design professionals retained by the Subcontractor as permitted by the law of the place where the Project is located (the Designer). The Designer's signature and seal shall appear on all drawings, calculations, specifications, certifications, Shop Drawings and other submittals prepared by the Designer. Shop Drawings and other submittals related to the Subcontract Work designed or certified by the Designer, if prepared by others, shall bear the Subcontractor's and the Designer's written approvals when submitted to the Contractor. The Contractor shall be entitled to rely upon the adequacy, accuracy and completeness of the services, certifications or approvals performed by the Designer.

3.8.2 If the Designer is an independent professional, the design services shall be procured pursuant to a separate agreement between the Subcontractor and the Designer. The Subcontractor-Designer agreement shall not provide for any limitation of liability, except to the extent that consequential damages are waived pursuant to Paragraph 5.4, or exclusion from participation in the multiparty proceedings requirement of Paragraph 11.4. The Designer(s) is (are) _____. The Subcontractor shall notify the ♦ Contractor in writing if it intends to change the Designer. The Subcontractor shall be responsible for conformance of its design with the information given and the design concept expressed in the Subcontract Documents. The Subcontractor shall not be responsible for the adequacy of the performance or design criteria required by the Subcontract Documents.

3.8.3 The Subcontractor shall not be required to provide design services in violation of any applicable law.

3.9 TEMPORARY SERVICES Subcontractor's responsibilities for temporary services are set forth in Exhibit _____. ♦

3.10 COORDINATION The Subcontractor shall:

.1 cooperate with the Contractor and all others whose work may interface with the Subcontract Work;

.2 specifically note and immediately advise the Contractor of any such interface with the Subcontract Work; and

.3 participate in the preparation of coordination drawings and work schedules in areas of congestion.

3.11 SUBCONTRACTOR'S REPRESENTATIVE The Subcontractor shall designate a person, subject to Contractor's approval, who shall be the Subcontractor's authorized representative. This representative shall be the only person to whom the Contractor shall issue instructions, orders or directions, except in an emergency. The Subcontractor's representative is _____ ♦ _____ who is agreed to by the Contractor.

3.12 TESTS AND INSPECTIONS The Subcontractor shall schedule all required tests, approvals and inspections of the Subcontract Work at appropriate times so as not to delay the progress of the work. The Subcontractor shall give proper written notice to all required parties of such tests, approvals and inspections. The Subcontractor shall bear all expenses associated with tests, inspections and approvals required of the Subcontractor by the Subcontract Documents which, unless otherwise agreed to, shall be conducted by an independent testing laboratory or entity approved by the Contractor and Owner. Required certificates of testing, approval or inspection shall, unless otherwise required by the Subcontract Documents, be secured by the Subcontractor and promptly delivered to the Contractor.

3.13 CLEANUP

3.13.1 The Subcontractor shall at all times during its performance of the Subcontract Work keep the Work site clean and free from debris resulting from the Subcontract Work. Prior to discontinuing the Subcontract Work in an area, the Subcontractor shall clean the area and remove all its rubbish and its construction equipment, tools, machinery, waste and surplus materials. Subcontractor shall make provisions to minimize and confine dust and debris resulting from its construction activities. The Subcontractor shall not be held responsible for unclean conditions caused by others.

3.13.2 If the Subcontractor fails to commence compliance with cleanup duties within forty-eight (48) hours after written notification from the Contractor of non-compliance, the Contractor may implement appropriate cleanup measures without further notice and the cost thereof shall be deducted from any amounts due or to become due the Subcontractor.

3.14 SAFETY

3.14.1 The Subcontractor is required to perform the Subcontract Work in a safe and reasonable manner. The Subcontractor shall seek to avoid injury, loss or damage to persons or property by taking reasonable steps to protect:

.1 employees and other persons at the site;

.2 materials and equipment stored at the site or at offsite locations for use in performance of the Work; and

.3 all property and structures located at the site and adjacent to work areas, whether or not said property or structures are part of the Project or involved in the Work.

3.14.2 The Subcontractor shall give all required notices and comply with all applicable rules, regulations, orders and other lawful requirements established to prevent injury, loss or damage to persons or property.

3.14.3 The Subcontractor shall implement appropriate safety measures pertaining to the Subcontract Work and the Project, including establishing safety rules, posting appropriate warnings and notices, erecting safety barriers, and establishing proper notice procedures to protect persons and property at the site and adjacent to the site from injury, loss or damage.

3.14.4 The Subcontractor shall exercise extreme care in carrying out any of the Subcontract Work which involves explosive or other dangerous methods of construction or hazardous procedures, materials or equipment. The Subcontractor shall use properly qualified individuals or entities to carry out the Subcontract Work in a safe and reasonable manner so as to reduce the risk of bodily injury or property damage.

3.14.5 Damage or loss not insured under property insurance which may arise from the performance of the Subcontract Work, to the extent of the negligence attributed to such acts or omissions of the Subcontractor, or anyone for whose acts the Subcontractor may be liable, shall be promptly remedied by the Subcontractor. Damage or loss attributable to the acts or omissions of the Contractor and not to the Subcontractor shall be promptly remedied by the Contractor.

3.14.6 The Subcontractor is required to designate an individual at the site in the employ of the Subcontractor who shall act as the Subcontractor's designated safety representative with a duty to prevent accidents. Unless otherwise identified by the Subcontractor in writing to the Contractor, the designated safety representative shall be the Subcontractor's project superintendent.

3.14.7 The Subcontractor has an affirmative duty not to overload the structures or conditions at the site and shall take reasonable steps not to load any part of the structures or site so as to give rise to an unsafe condition or create an unreasonable risk of bodily injury or property damage. The Subcontractor shall have the right to request, in writing, from the Contractor loading information concerning the structures at the site.

3.14.8 The Subcontractor shall give prompt written notice to the Contractor of any accident involving bodily injury requiring a physician's care, any property damage exceeding Five Hundred Dollars ($500.00) in value, or any failure that could have resulted in serious bodily injury, whether or not such an injury was sustained.

3.14.9 Prevention of accidents at the site is the responsibility of the Contractor, Subcontractor, and all other subcontractors, persons and entities at the site. Establishment of a safety program by the Contractor shall not relieve the Subcontractor or other parties of their safety responsibilities. The Subcontractor shall establish its own safety program implementing safety measures, policies and standards conforming to those required or recommended by governmental and quasi-governmental authorities having jurisdiction and by the Contractor and Owner, including, but not limited to, requirements imposed by the Subcontract Documents. The Subcontractor shall comply with the reasonable recommendations of insurance companies having an interest in the Project, and shall stop any part of the Subcontract Work which the Contractor deems unsafe until corrective measures satisfactory to the Contractor shall have been taken. The Contractor's failure to stop the Subcontractor's unsafe practices shall not relieve the Subcontractor of the responsibility therefor. The Subcontractor shall notify the Contractor immediately following an accident and promptly confirm the notice in writing. A detailed written report shall be furnished if requested by the Contractor. Each party to this Agreement shall indemnify the other party from and against fines or penalties imposed as a result of safety violations, but only to the extent that such fines or penalties are caused by its failure to comply with applicable safety requirements.

3.15 PROTECTION OF THE WORK The Subcontractor shall take necessary precautions to properly protect the Subcontract Work and the work of others from damage caused by the Subcontractor's operations. Should the Subcontractor cause damage to the Work or property of the Owner, the Contractor or others, the Subcontractor shall promptly remedy such damage to the satisfaction of the Contractor, or the Contractor may remedy the damage and deduct its cost from any amounts due or to become due the Subcontractor, unless such costs are recovered under applicable property insurance.

3.16 PERMITS, FEES, LICENSES AND TAXES The Subcontractor shall give timely notices to authorities pertaining to the Subcontract Work, and shall be responsible for all permits, fees, licenses, assessments, inspections, testing and taxes necessary to complete the Subcontract Work in accordance with the Subcontract Documents. To the extent reimbursement is obtained by the Contractor from the Owner under the Owner-Contractor agreement, the Subcontractor shall be compensated for additional costs resulting from taxes enacted after the date of this Agreement.

3.17 ASSIGNMENT OF SUBCONTRACT WORK The Subcontractor shall not assign the whole nor any part of the Subcontract Work without prior written approval of the Contractor.

3.18 HAZARDOUS MATERIALS To the extent that the Contractor has rights or obligations under the Owner-Contractor agreement or by law regarding hazardous materials as defined by the Subcontract Document within the scope of the Subcontract Work, the Subcontractor shall have the same rights or obligations.

3.19 MATERIAL SAFETY DATA (MSD) SHEETS The Subcontractor shall submit to the Contractor all Material Safety Data Sheets required by law for materials or substances necessary for the performance of the Subcontract Work. MSD sheets obtained by the Contractor from other subcontractors or sources shall be made available to the Subcontractor by the Contractor.

3.20 LAYOUT RESPONSIBILITY AND LEVELS The Contractor shall establish principal axis lines of the building and site, and benchmarks. The Subcontractor shall lay out and be strictly responsible for the accuracy of the Subcontract Work and for any loss or damage to the Contractor or others by reason of the Subcontractor's failure to lay out or perform Subcontract Work correctly. The Subcontractor shall exercise prudence so that the actual final conditions and details shall result in alignment of finish surfaces.

3.21 WARRANTIES The Subcontractor warrants that all materials and equipment furnished under this Agreement shall be new, unless otherwise specified, of good quality, in conformance with the Subcontract Documents, and free from defective workmanship and materials. Warranties shall commence on the date of Substantial Completion of the Work or a designated portion.

3.22 UNCOVERING/CORRECTION OF SUBCONTRACT WORK

3.22.1 UNCOVERING OF SUBCONTRACT WORK

3.22.1.1 If required in writing by the Contractor, the Subcontractor must uncover any portion of the Subcontract Work which has been covered by the Subcontractor in violation of the Subcontract Documents or contrary to a directive issued to the Subcontractor by the Contractor. Upon receipt of a written directive from the Contractor, the Subcontractor shall uncover such work for the Contractor's or Owner's inspection and restore the uncovered Subcontract Work to its original condition at the Subcontractor's time and expense.

3.22.1.2 The Contractor may direct the Subcontractor to uncover portions of the Subcontract Work for inspection by the Owner or Contractor at any time. The Subcontractor is required to uncover such work whether or not the Contractor or Owner had requested to inspect the Subcontract Work prior to it being covered. Except as provided in Clause 3.22.1.1, this Agreement shall be adjusted by change order for the cost and time of uncovering and restoring any work which is uncovered for inspection and proves to be installed in accordance with the Subcontract Documents, provided the Contractor had not previously instructed the Subcontractor to leave the work uncovered. If the Subcontractor uncovers work pursuant to a directive issued by the Contractor, and such work upon inspection does not comply with the Subcontract Documents, the Subcontractor shall be responsible for all costs and time of uncovering, correcting and restoring the work so as to make it conform to the Subcontract Documents. If the Contractor or some other entity for which the Subcontractor is not responsible caused the nonconforming condition, the Contractor shall be required to adjust this Agreement by change order for all such costs and time.

3.22.2 CORRECTION OF WORK If the Architect or Contractor rejects the Subcontract Work or the Subcontract Work is not in conformance with the Subcontract Documents, the Subcontractor shall promptly correct the Subcontract Work whether it had been fabricated, installed or completed. The Subcontractor shall be responsible for the costs of correcting such Subcontract Work, any additional testing, inspections, and compensation for services and expenses of the Architect and Contractor made necessary by the defective Subcontract Work.

3.22.2.2 In addition to the Subcontractor's obligations under Paragraph 3.21, the Subcontractor agrees to promptly correct, after receipt of a written notice from the Contractor, all Subcontract Work performed under this Agreement which proves to be defective in workmanship or materials within a period of one year from the date of Substantial Completion of the Subcontract Work or for a longer period of time as may be required by specific warranties in the Subcontract Documents. Substantial Completion of the Subcontract Work, or of a designated portion, occurs on the date when construction is sufficiently complete in accordance with the Subcontract Documents so that the Owner can occupy or utilize the Project, or a designated portion, for the use for which it is intended. If, during the one-year period, the Contractor fails to provide the Subcontractor with prompt written notice of the discovery of defective or nonconforming Subcontract Work, the Contractor shall neither have the right to require the Subcontractor to correct such Subcontract Work nor the right to make claim for breach of warranty. If the Subcontractor fails to correct defective or nonconforming Subcontract Work within a reasonable time after receipt of notice from the Contractor, the Contractor may correct such Subcontract Work pursuant to Subparagraph 10.1.1.

3.22.3 The Subcontractor's correction of Subcontract Work pursuant to this Paragraph 3.22 shall not extend the one-year period for the correction of Subcontract Work, but if Subcontract Work is first performed after Substantial Completion the one-year period for corrections shall be extended by the time period after Substantial Completion and the performance of that portion of Subcontract Work. The Subcontractor's obligation to correct Subcontract Work within one year as described in this Paragraph 3.22 does not limit the enforcement of Subcontractor's other obligations with regard to the Agreement and the Subcontract Documents.

3.22.4 If the Subcontractor's correction or removal of Subcontract Work destroys or damages completed or partially completed work of the Owner, the Contractor or any separate contractors, the Subcontractor shall be responsible for the cost of correcting such destroyed or damaged construction.

3.22.5 If portions of Subcontract Work which do not conform with the requirements of the Subcontract Documents are neither corrected by the Subcontractor nor accepted by the Contractor, the Subcontractor shall remove such Subcontract Work from the Project site if so directed by the Contractor.

3.23 MATERIALS OR EQUIPMENT FURNISHED BY OTHERS In the event the scope of the Subcontract Work includes installation of materials or equipment furnished by others, it shall be the responsibility of the Subcontractor to exercise proper care in receiving, handling, storing and installing such items, unless otherwise provided in the Subcontract Documents. The Subcontractor shall examine the items provided and report to the Contractor in writing any items it may discover that do not conform to requirements of the Subcontract Documents. The Subcontractor shall not proceed to install non-conforming items without further instructions from the Contractor. Loss or damage due to acts or omissions of the Subcontractor shall be deducted from any amounts due or to become due the Subcontractor.

3.24 SUBSTITUTIONS No substitutions shall be made in the Subcontract Work unless permitted in the Subcontract Documents, and only upon the Subcontractor first receiving all approvals required under the Subcontract Documents for substitutions.

3.25 USE OF CONTRACTOR'S EQUIPMENT The Subcontractor, its agents, employees, subcontractors or suppliers shall use the Contractor's equipment only with the express written permission of the Contractor's designated representative and in accordance with the Contractor's terms and conditions for such use. If the Subcontractor or any of its agents, employees, subcontractors or suppliers utilize any of the Contractor's equipment, including machinery, tools, scaffolding, hoists, lifts or similar items owned, leased or under the control of the Contractor, the Subcontractor shall defend, indemnify and be liable to the Contractor as provided in Article 9 for any loss or damage (including bodily injury or death) which may arise from such use, except to the extent that such loss or damage is caused by the negligence of the Contractor's employees operating the Contractor's equipment.

3.26 WORK FOR OTHERS Until final completion of the Subcontract Work, the Subcontractor agrees not to perform any work directly for the Owner or any tenants, or deal directly with the Owner's representatives in connection with the Subcontract Work, unless otherwise approved in writing by the Contractor.

3.27 SUBCONTRACT BONDS

3.27.1 The Subcontractor ❑ shall ❑ shall not furnish to the Contractor, as the named Obligee, appropriate surety bonds to secure the faithful performance of the Subcontract Work and to satisfy all Subcontractor payment obligations related to Subcontract Work.

3.27.2 If a performance or payment bond, or both, are required of the Subcontractor under this Agreement, the bonds shall be in a form and by a surety mutually agreeable to the Contractor and Subcontractor, and in the full amount of the Subcontract Amount, unless otherwise specified.

3.27.3 The Subcontractor shall be reimbursed, without retainage, for the cost of any required performance or payment bonds simultaneously with the first progress payment. The reimbursement amount for the subcontractor bonds shall not exceed _____ percent ♦ (_____%) of the Subcontract Amount, ♦ which sum is included in the Subcontract Amount.

3.27.4 In the event the Subcontractor shall fail to promptly provide any required bonds, the Contractor may terminate this Agreement and enter into a subcontract for the balance of the Subcontract Work with another subcontractor. All Contractor costs and expenses incurred by the Contractor as a result of said termination shall be paid by the Subcontractor.

3.28 SYSTEMS AND EQUIPMENT STARTUP With the assistance of the Owner's maintenance personnel and the Contractor, the Subcontractor shall direct the check-out and operation of systems and equipment for readiness, and assist in their initial startup and the testing of the Subcontract Work.

3.29 COMPLIANCE WITH LAWS The Subcontractor agrees to be bound by and at its own costs comply with, all federal, state and local laws, ordinances and regulations (the Laws) applicable to the Subcontract Work, including but not limited to, equal employment opportunity, minority business enterprise, women's business enterprise, disadvantaged business enterprise, safety and all other Laws with which the Contractor must comply. The Subcontractor shall be liable to the Contractor and the Owner for all loss, cost and expense attributable to any acts of commission or omission by the Subcontractor, its employees and agents resulting from the failure to comply with Laws, including, but not limited to, any fines, penalties or corrective measures, except as provided in Subparagraph 3.14.9.

3.30 CONFIDENTIALITY To the extent the Owner-Contractor agreement provides for the confidentiality of any of the Owner's proprietary or otherwise confidential information disclosed in connection with the performance of this Agreement, the Subcontractor is equally bound by the Owner's confidentiality requirements.

3.31 ROYALTIES, PATENTS AND COPYRIGHTS The Subcontractor shall pay all royalties and license fees which may be due on the inclusion of any patented or copyrighted materials, methods or systems selected by the Subcontractor and incorporated in the Subcontract Work. The Subcontractor shall defend, indemnify and hold the Contractor and Owner harmless from all suits or claims for infringement of any patent rights or copyrights arising out of such selection. The Subcontractor shall be liable for all loss, including all costs, expenses, and attorneys' fees, but shall not be responsible for such defense or loss when a particular design, process or product of a particular manufacturer or manufacturers is required by the Subcontract Documents. However, if the Subcontractor has reason to believe that a particular design, process or product required by the Subcontract Documents is an infringement of a patent, the Subcontractor shall promptly furnish such information to the Contractor or be responsible to the Contractor and Owner for any loss sustained as a result.

3.32 LABOR RELATIONS (Insert here any conditions, obligations or requirements relative to labor relations and their effect on the project. Legal counsel is recommended.) ♦

ARTICLE 4

CONTRACTOR'S RESPONSIBILITIES

4.1 CONTRACTOR'S REPRESENTATIVE The Contractor shall designate a person who shall be the Contractor's authorized representative. The Contractor's representative shall be the only person the Subcontractor shall look to for instructions, orders and/or directions, except in an emergency. The Contractor's representative is _____

_____.

4.2 PAYMENT BOND REVIEW The Contractor ❑ has ❑ has not provided the Owner a payment bond. The Contractor's payment bond for the Project, if any, shall be made available by the Contractor for review and copying by the Subcontractor.

4.3 OWNER'S ABILITY TO PAY

4.3.1 The Subcontractor shall have the right upon request to receive from the Contractor such information as the Contractor has obtained relative to the Owner's financial ability to pay for the Work, including any subsequent material variation in such information. The Contractor, however, does not warrant the accuracy or completeness of the information provided by the Owner.

4.3.2 If the Subcontractor does not receive the information referenced in Subparagraph 4.3.1 with regard to the Owner's ability to pay for the Work as required by the Contract Documents, the Subcontractor may request the information from the Owner and/or the Owner's lender.

4.4 CONTRACTOR APPLICATION FOR PAYMENT Upon request, the Contractor shall give the Subcontractor a copy of the most current Contractor application for payment reflecting the amounts approved and/or paid by the Owner for the Subcontract Work performed to date.

4.5 INFORMATION OR SERVICES The Subcontractor is entitled to request through the Contractor any information or services relevant to the performance of the Subcontract Work which is under the Owner's control. To the extent the Contractor receives such information and services, the Contractor shall provide them to the Subcontractor. The Contractor, however, does not warrant the accuracy or completeness of the information provided by the Owner.

4.6 STORAGE AREAS The Contractor shall allocate adequate storage areas, if available, for the Subcontractor's materials and equipment during the course of the Subcontract Work. Unless otherwise agreed upon, the Contractor shall reimburse the Subcontractor for the additional costs of having to relocate such storage areas at the direction of the Contractor.

4.7 TIMELY COMMUNICATIONS The Contractor shall transmit to the Subcontractor, with reasonable promptness, all submittals, transmittals, and written approvals relative to the Subcontract Work. Unless otherwise specified in the Subcontract Documents, communications by and with the Subcontractor's subcontractors, materialmen and suppliers shall be through the Subcontractor.

4.8 USE OF SUBCONTRACTOR'S EQUIPMENT The Contractor, its agents, employees or suppliers shall use the Subcontractor's equipment only with the express written permission of the Subcontractor's designated representative and in accordance with the Subcontractor's terms and conditions for such use. If the Contractor or any of its agents, employees or suppliers utilize any of the Subcontractor's equipment, including machinery, tools, scaffolding, hoists, lifts or similar items owned, leased or under the control of the Subcontractor, the Contractor shall defend, indemnify and be liable to the Subcontractor as provided in Article 9 for any loss or damage (including bodily injury or death) which may arise from such use, except to the extent that such loss or damage is caused by the negligence of the Subcontractor's employees operating the Subcontractor's equipment.

ARTICLE 5

PROGRESS SCHEDULE

5.1 TIME IS OF THE ESSENCE Time is of the essence for both parties. They mutually agree to see to the performance of their respective obligations so that the entire Project may be completed in accordance with the Subcontract Documents and particularly the Progress Schedule as set forth in Exhibit _____.

5.2 SCHEDULE OBLIGATIONS The Subcontractor shall provide the Contractor with any scheduling information proposed by the Subcontractor for the Subcontract Work. In consultation with the Subcontractor, the Contractor shall prepare the schedule for performance of the Work (the Progress Schedule) and shall revise and update such schedule, as necessary, as the Work progresses. Both the Contractor and the Subcontractor shall be bound by the Progress Schedule. The Progress Schedule and all subsequent changes and additional details shall be submitted to the Subcontractor promptly and reasonably in advance of the required performance. The Contractor shall have the right to determine and, if necessary, change the time, order and priority in which the various portions of the Work shall be performed and all other matters relative to the Subcontract Work.

5.3 DELAYS AND EXTENSIONS OF TIME

5.3.1 OWNER CAUSED DELAY Subject to Subparagraph 5.3.2, if the commencement and/or progress of the Subcontract Work is delayed without the fault or responsibil-

ity of the Subcontractor, the time for the Subcontract Work shall be extended by Subcontract Change Order to the extent obtained by the Contractor under the Subcontract Documents, and the Progress Schedule shall be revised accordingly.

5.3.2 CLAIMS RELATING TO OWNER The Subcontractor agrees to initiate all claims for which the Owner is or may be liable in the manner and within the time limits provided in the Subcontract Documents for like claims by the Contractor upon the Owner and in sufficient time for the Contractor to initiate such claims against the Owner in accordance with the Subcontract Documents. At the Subcontractor's request and expense to the extent agreed upon in writing, the Contractor agrees to permit the Subcontractor to prosecute a claim in the name of the Contractor for the use and benefit of the Subcontractor in the manner provided in the Subcontract Documents for like claims by the Contractor upon the Owner.

5.3.3 CONTRACTOR CAUSED DELAY Nothing in this Article shall preclude the Subcontractor's recovery of delay damages caused by the Contractor.

5.3.4 CLAIMS RELATING TO CONTRACTOR The Subcontractor shall give the Contractor written notice of all claims not included in Subparagraph 5.3.2 within seven (7) days of the Subcontractor's knowledge of the facts giving rise to the event for which claim is made; otherwise, such claims shall be deemed waived. All unresolved claims, disputes and other matters in question between the Contractor and the Subcontractor not relating to claims included in Subparagraph 5.3.2 shall be resolved in the manner provided in Article 11.

5.3.5 DAMAGES If the Subcontract Documents provide for liquidated or other damages for delay beyond the completion date set forth in the Subcontract Documents, and such damages are assessed, the Contractor may assess a share of the damages against the Subcontractor in proportion to the Subcontractor's share of the responsibility for the delay. However, the amount of such assessment shall not exceed the amount assessed against the Contractor. This Paragraph 5.3 shall not limit the Subcontractor's liability to the Contractor for the Contractor's actual delay damages caused by the Subcontractor's delay.

5.4 MUTUAL WAIVER OF CONSEQUENTIAL DAMAGES

5.4.1 To the extent the Owner-Contractor agreement provides for a mutual waiver of consequential damages by the Owner and the Contractor, the Contractor and Subcontractor waive claims against each other for consequential damages arising out of or relating to this Agreement, including to the extent provided in the Owner-Contractor agreement, damages for principal office expenses and the compensation of personnel stationed there; loss of financing, business and reputation; and for loss of profit. Similarly, the Subcontractor shall obtain from its sub-subcontractors mutual waivers of consequential damages that correspond to the Subcontractor's waiver of consequential damages herein. To the extent applicable, this mutual waiver applies to consequential damages due to termination by the Contractor or the Owner in accordance with this Agreement or the Owner-Contractor agreement. To the extent the Owner-Contractor agreement does not preclude the award of liquidated damages, nothing contained in this Paragraph 5.4 shall preclude the imposition of such damages, if applicable in accordance with the requirements of the Subcontract Documents.

5.4.2 To the extent the Owner-Contractor agreement provides for a mutual waiver of consequential damages by the Owner and the Contractor, damages for which the Contractor is liable to the Owner including those related to Subparagraph 9.1.1 are not consequential damages for the purpose of this waiver. Similarly, to the extent the Subcontractor-sub-subcontractor agreement provides for a mutual waiver of consequential damages by the Owner and the Contractor, damages for which the Subcontractor is liable to lower-tiered parties due to the fault of the Owner or Contractor are not consequential damages for the purpose of this waiver.

ARTICLE 6

SUBCONTRACT AMOUNT

As full compensation for performance of this Agreement, Contractor agrees to pay Subcontractor in current funds for the satisfactory performance of the Subcontract Work subject to all applicable provisions of the Subcontract:

(a) the fixed-price of _____ ♦
Dollars ($ _____) subject ♦
to additions and deductions as provided for in the Subcontract Documents; and/or

(b) unit prices in accordance with the attached schedule of Unit Prices and estimated quantities, which is incorporated by reference and identified as Exhibit _____; and/or ♦

(c) time and material rates and prices in accordance with the attached Schedule of Labor and Material Costs which is incorporated by reference and identified as Exhibit _____. ♦

The fixed-price, unit prices and/or time and material rates and prices are referred to as the Subcontract Amount.

ARTICLE 7

CHANGES IN THE SUBCONTRACT WORK

7.1 **SUBCONTRACT CHANGE ORDERS** When the Contractor orders in writing, the Subcontractor, without nullifying this Agreement, shall make any and all changes in the Subcontract Work which are within the general scope of this Agreement. Any adjustment in the Subcontract Amount or Subcontract Time shall be authorized by a Subcontract Change Order. No adjustments shall be made for any changes performed by the Subcontractor that have not been ordered by the Contractor. A Subcontract Change Order is a written instrument prepared by the Contractor and signed by the Subcontractor stating their agreement upon the change in the Subcontract Work.

7.2 **CONSTRUCTION CHANGE DIRECTIVES** To the extent that the Subcontract Documents provide for Construction Change Directives in the absence of agreement on the terms of a Subcontract Change Order, the Subcontractor shall promptly comply with the Construction Change Directive and be entitled to apply for interim payment if the Subcontract Documents so provide.

7.3 **UNKNOWN CONDITIONS** If in the performance of the Subcontract Work the Subcontractor finds latent, concealed or subsurface physical conditions which differ materially from those indicated in the Subcontract Documents or unknown physical conditions of an unusual nature, which differ materially from those ordinarily found to exist, and not generally recognized as inherent in the kind of work provided for in this Agreement, the Subcontract Amount and/or the Progress Schedule shall be equitably adjusted by a Subcontract Change Order within a reasonable time after the conditions are first observed. The adjustment which the Subcontractor may receive shall be limited to the adjustment the Contractor receives from the Owner on behalf of the Subcontractor, or as otherwise provided under Subparagraph 5.3.2.

7.4 **ADJUSTMENTS IN SUBCONTRACT AMOUNT** If a Subcontract Change Order requires an adjustment in the Subcontract Amount, the adjustment shall be established by one of the following methods:

.1 mutual acceptance of an itemized lump sum;

.2 unit prices as indicated in the Subcontract Documents or as subsequently agreed to by the parties; or

.3 costs determined in a manner acceptable to the parties and a mutually acceptable fixed or percentage fee; or

.4 another method provided in the Subcontract Documents.

7.5 **SUBSTANTIATION OF ADJUSTMENT** If the Subcontractor does not respond promptly or disputes the method of adjustment, the method and the adjustment shall be determined by the Contractor on the basis of reasonable expenditures and savings of those performing the Work attributable to the change, including, in the case of an increase in the Subcontract Amount, an allowance for overhead and profit of the percentage provided in Paragraph 7.6. The Subcontractor may contest the reasonableness of any adjustment determined by the Contractor. The Subcontractor shall maintain for the Contractor's review and approval an appropriately itemized and substantiated accounting of the following items attributable to the Subcontract Change Order:

.1 labor costs, including Social Security, health, welfare, retirement and other fringe benefits as normally required, and state workers' compensation insurance;

.2 costs of materials, supplies and equipment, whether incorporated in the Subcontract Work or consumed, including transportation costs;

.3 costs of renting machinery and equipment other than hand tools;

.4 costs of bond and insurance premiums, permit fees and taxes attributable to the change; and

.5 costs of additional supervision and field office personnel services necessitated by the change.

7.6 Adjustments shall be based on net change in Subcontractor's reasonable cost of performing the changed Subcontract Work plus, in case of a net increase in cost, an agreed upon sum for overhead and profit not to exceed _____ percent (_____%). ◆

7.7 **NO OBLIGATION TO PERFORM** The Subcontractor shall not perform changes in the Subcontract Work until a Subcontract Change Order has been executed or written instructions have been issued in accordance with Paragraphs 7.2 and 7.9.

7.8 **EMERGENCIES** In an emergency affecting the safety of persons and/or property, the Subcontractor shall act, at its discretion, to prevent threatened damage, injury or loss. Any change in the Subcontract Amount and/or the Progress Schedule on account of emergency work shall be determined as provided in this Article.