TO:

ENGINEERING INSTRUCTION

NEW YORK STATE DEPARTMENT OF TRANSPORTATION

SUBJECT: CRITICAL PATH METHOD (CPM) SCHEDULING FOR DOT CONSTRUCTION PROJECTS

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Facilities Design Division

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Supersedes:
MODIFIES EI 85-035 & EI 86-033

PURPOSE

This Engineering Instruction (EI) transmits a contract specification and a special note that requires contractors to use Critical Path Method (cpm) scheduling techniques to plan and control their work, and establishes criteria to select projects that should contain these requirements.

Earlier versions of these provisions have been used on Department contracts on a trial basis since 1992. This EI formalizes the Department policy on the use of cpm during construction and provides the current versions for general use.

BACKGROUND

Standard Specification section 108-01, START AND PROGRESS OF WORK, contains the contract provisions for planning, scheduling and monitoring the work. Our standard scheduling provision leaves the choice of scheduling technique up to the contractor. Therefore, the contractor can meet the requirements by submitting a bar chart, a cpm network diagram or other suitable graphical representation of the proposed work plan. For projects with few activities or activities that can proceed without much interaction, bar charts are normally used and are an acceptable method of communicating the proposed work plan. The disadvantage of bar charts is their inability to depict the interrelationships between activities or identify activities that are critical to project completion. For projects that have many activities that must continuously interact, a cpm network diagram is more appropriate and should be used.

On some large complex projects, contractors have used bar chart schedules to plan and schedule the work when a cpm schedule would have been more appropriate. The lack of proper scheduling has been a cause of schedule delays, time related disputes and delay claims. Using cpm during construction to resolve time-related issues as they arise will help avoid delays and costly delay claims.

What is Cpm scheduling ?

Cpm scheduling is the representation of a project plan by a schematic diagram or network that depicts the sequence and interrelations of all the activities required to complete a project, and the logical analysis and manipulation of this network in determining the best overall approach to successful project completion. It is a technique that has been used by construction managers since the 1960's to coordinate the work of all the contractors and subcontractors required to complete a project.

It is beyond the scope of these guidelines to provide a detailed overview of cpm scheduling techniques. Project designers and engineers are urged to refer to the numerous publications on cpm scheduling and construction management for additional information. Construction Planning & Scheduling, publication # 1107.1, published by the Associated General Contractors of America (AGC) is a good source of information on this topic.

Project selection criteria.

Projects that meet any of the following criteria must contain a cpm scheduling requirement:

A. Projects that contain incentive/disincentive provisions for early completion (Refer to EI85-35 and EI86-33), projects that use cost-plus-time bidding (A+B bidding), lane rental, or have time-related contract provisions such as interim milestone dates or contract completion dates with significant liquidated damage provisions. Since early or late completions on contracts with these provisions will have a financial impact, it's imperative that there is an agreed-upon, detailed schedule. A cpm schedule will help ensure a successful completion by requiring detailed planning and regular updates. Cpm will also help to determine the impact of additional work or unforeseen occurrences on the schedule.

B. Projects that require the contractor to coordinate activities with utility companies, railroad companies or other contractors that are working within or near the contract limits if their work is significant and could potentially delay the contractor, i.e., many activities on the critical path must be coordinated with outside parties. Cpm on these projects will help to coordinate between the different parties and will help avoid disputes and potential delay claims.

C. Projects of regional significance, as determined by the Regional Director, such as projects critical to local safety, traffic or program needs, i.e., projects with long off-site detours or extended lane closures. These projects usually get a lot of attention and may warrant additional effort to insure timely completion.

D. Projects estimated to cost more than $20 million. Large projects with many activities that must continuously interact, such as a major interchange construction or reconstruction project with several bridges and multiple phases, should be scheduled using cpm due to their size and complexity.

Cpm schedule special note.

The special note attached to this EI titled "CRITICAL PATH METHOD SCHEDULE" dated 12/14/93 was written primarily for smaller projects and does not require computerization. It should by used for projects that meet the selection criteria and cost less than or equal to $5 million.

Cpm schedule specification.

The specification attached to this EI "ITEM 15637.33-CRITICAL PATH METHOD (CPM) NETWORK SCHEDULING SYSTEM INCLUDING MICROCOMPUTER" dated 12/07/93, was written primarily for larger projects and requires computerization of the cpm schedule. The specification should be used for projects that meet the selection criteria and cost more than $5 million.

In addition to the cpm scheduling system requirements, the specification requires that the contractor install a microcomputer with cpm software in the field office. This microcomputer is in addition to the microcomputer required by item 15637.32. If 2 computers are not required in the field office, item 15637.32 may be deleted from the contract with concurrence from the Regional Construction Engineer (RCE).

Implementation procedure.

The project designer shall determine if a project meets the criteria for cpm scheduling and indicate so in the Advance Detail Plan (ADP) transmittal letter. The Regional Construction Engineer will verify that appropriate projects contain the cpm scheduling requirement as part of the constructability review process for all projects. The computerized cpm special specification,ITEM 15637.33, is a Main Office insert and will be inserted into proposals by the Design Quality Assurance Bureau. The special note should be submitted to the Design Quality Assurance Bureau with the PS&E submission.

Attachment distribution

Distribution of the special specification and the special note as attachments to this EI is as follows:

List 30: Main Office

Design Quality Assurance Bureau, 1 copy
Design Bureau, 1 copy
Consultant Management Bureau, 1 copy
Structures Design and Construction Division, 1 copy
Construction Division, 1 copy

List 32: Regions

Regional Design Engineers, 1 copy each
Regional Construction Engineers, 1 copy each

List 34: Consultants

One (1) copy to each consultant

Although this EI is issued by the Facilities Design Division, these provisions have been developed and are administered by the Construction Division. Questions concerning these provisions and/or requests for additional copies of the attachments should be directed to David Kent of the Construction Division at (518) 457-3225.

SPECIAL NOTE

CRITICAL PATH METHOD SCHEDULE

The schedule submitted in accordance with section 108-01 "START AND PROGRESS OF WORK" shall be prepared using the critical path method (cpm). The cost of preparing the cpm schedule shall be included in the total amount bid for all contract items.

A. Schedule Requirements

The Contractor shall use the Activity on Arrow Diagramming Method.

All activity on arrow diagrams provided by the Contractor shall include:

1. activity nodes,
2. activity description, and
3. activity duration

The activity on arrow diagram shall show the sequence and interdependence of all activities required for complete performance of all items of work under this contract, including shop drawing submittals, approvals, fabrication, and delivery activities. All network "dummies" are to be shown on the diagram.

The Contractor shall subdivide the work into individual activities having durations of no longer than 15 (fifteen) working days each. Exceptions to this rule will be reviewed by the Engineer on an activity by activity basis. If requested by the Engineer, the Contractor shall furnish production rates or other information needed to justify the reasonableness of activity time durations.

The activities are to be described so that the work is readily identifiable and the progress on each activity can be readily measured. For each activity, the Contractor shall identify the trade or subcontractor performing the work, the duration of the activity in workdays and the location of the work.

The Contractor shall also provide the following information: workdays per week, holidays, number of shifts per day, number of hours per shift, and major equipment to be used.

Expected seasonal weather conditions, such as precipitation and temperature, shall be included by the Contractor in the planning and scheduling of his activities.

The Contractor shall not constrain the start or completion of any activity unless specifically required by the contract or approved by the Engineer.

B. Contingency Within the Schedule

Any contingency within the Schedule, i.e., a difference in time between the project's early completion and required contract completion date, and "float" in the Approved CPM Construction Schedule belongs to the project and not to any party to the contract.

C. Review of the CPM Construction Schedules

Within fifteen (15) days following the contract award, the Contractor shall submit to the Engineer five copies of an Activity on Arrow Diagram and five copies of the following activities' listings:

- I node J node Sort
- Total Float Sort

The Engineer will review the CPM Construction Schedule and then hold a discussion meeting with the Contractor. Within two weeks from this meeting the Contractor shall make adjustments to the CPM Construction Schedule to eliminate conflicts, objections, and ambiguities found by the Engineer. The Contractor shall submit for review five copies of the revised schedule materials as described above.

Approval of the schedule by the Engineer shall not be construed to imply approval of any particular method or sequence of construction or to relieve the Contractor of providing sufficient materials, equipment and labor to guarantee completion of the project in accordance with the contract proposal, plans and specifications. Approval shall not be construed to modify or amend the agreement or the date of completion therein.

Failure by the Contractor to include in the CPM Construction Schedule any element of work required for the performance of the contract shall not excuse the Contractor from completing all work required within the completion date(s) specified in the contract notwithstanding approval of the Schedule by the Engineer.

D. List of Submittals

Within thirty (30) calendar days of the contract award, the Contractor shall provide a list of submittals required under the contract, i.e., shop drawings, required permits, erection/demolition plans, etc. The list shall show a scheduled submission date for each submittal and identify the earliest activity affected by each of these submittals. This list shall be revised and updated monthly with each schedule submission.

E. Schedule Updating

The Contractor shall update the schedule monthly. Each update shall show actual dates of activities started and completed, the percent of work completed to date on each activity started but not yet completed, the current allocation of manpower and major equipment and the status of procurement of critical materials. The Contractor also shall provide updated I node J node sorts, total float sorts, and a narrative report. The narrative report shall include a description of problem areas, current and anticipated delaying factors and their estimated impact on performance of other activities and mandated contract dates, and the explanation of corrective action taken or proposed.

The Engineer shall conduct a monthly review of the updated schedule. The review shall occur after receipt of the Contractor's updated information and shall serve as the forum to discuss slippages, remedies, revisions, and other relevant issues. The Contractor's appropriate field and scheduling personnel shall attend these working sessions. These reviews may result in the need for submission of revised schedules.

F. Changes to the Approved Project Schedules

The CPM Construction Schedule shall accurately reflect the manner in which the Contractor intends to proceed with the project and shall incorporate the impact of delays and Orders-on-Contract when these factors can be accurately determined. All changes made to the schedule, i.e., the addition of activities, or changes in activity durations shall be submitted in writing and are subject to approval by the Engineer before inclusion in the CPM Construction Schedule.

To initiate changes to the approved schedules, the Contractor shall meet with the Engineer and provide the information necessary to prepare a revised (updated) Activity on Arrow Diagram.

No revision to any contract milestones, or contractually mandated schedule provision will be permitted, without written authorization from the Engineer.

G. Compliance with the Schedule

The Contractor shall employ and supply a sufficient force of workers, materials and equipment and shall prosecute the work with such diligence so as to maintain the rate of progress indicated on the approved schedule to prevent work stoppage and ensure completion of the project within the contract time. Any additional or unanticipated costs or expense required to maintain the schedule shall be solely the Contractor's obligation and shall not be charged to the Department unless provided for in other provisions of the contract.

In the event a notice is received of a change to the contract which is likely to cause or is causing delays, the Contractor shall notify the Engineer in writing within 10 days, of the effect, if any, of such change, or extra work, or suspension or other conditions upon the Project Construction Schedule and shall state in what respects, if any, the Approved CPM Construction Schedule should be revised with the reasons therefore. The reasons for these revisions must be succinct, comprehensive, and factual to merit consideration.

If the Contractor fails to comply with the provisions of this special note, the Engineer may withhold approval of all progress payment estimates pursuant to Article 8 of the contract.

ITEM 15637.33 - CRITICAL PATH METHOD (CPM) NETWORK SCHEDULING SYSTEM INCLUDING MICROCOMPUTER AND SOFTWARE

DESCRIPTION:

Section 108-01, Start and Progress of Work, is hereby amended to require that the Contractor furnish and participate in a Computerized CPM Network Scheduling System.

The purpose of the Computerized CPM Network Scheduling System is to assure adequate planning and execution of the work, assist the Engineer in evaluating the reasonableness of the Contractor's proposed schedule and to measure progress of the work. The Contractor shall furnish, maintain and operate a system that can produce a CPM network diagram using the Precedence Diagramming Method and other reports and graphics as more fully described within these provisions. In addition, the Contractor shall provide a microcomputer with CPM scheduling software for use by the Engineer in monitoring the scheduling system.

MATERIALS:

The Contractor shall provide a microcomputer system to operate the CPM software used to meet this scheduling requirement. The system shall be installed in the Engineer's field office and be fully operational before the start of any contract work. The system shall include a microcomputer, printer, microcomputer software programs and a hard-disk. The Contractor also may be required to provide, install, and maintain various other microcomputer hardware components and software packages. If required, additional items will be incorporated by Order-on-Contract with compensation made per specification section I09-05. However, profit and overhead shall be computed at 5% instead of the 20% specified in specification section I09-05 B2(6).

The Contractor shall be responsible for all modifications to the Engineer's field office, such as, but not limited to, the office electrical system, necessary to make it compatible with the Microcomputer System. The system shall remain in service until the Engineer requests its removal in writing or the State relinquishes the Engineer's field office in which the system is installed.

The Contractor shall maintain all furnished equipment and software in good working condition and shall provide replacement due to breakdown, damage, or theft within ten working days.

ITEM 15637.33 - CPM NETWORK SCHEDULING

All equipment and software furnished shall be subject to approval by the Engineer.

A. Microcomputer

The Contractor shall provide the Engineer with a microcomputer that meets the following specifications:

1. A minimum of an 80-486 DX based Central Processor Unit (CPU) operating at a minimum clock speed of 33 MHZ.
2. A minimum of 4.0 megabyte Random Access Memory (RAM) expandable to 8.0 megabyte.
3. Two (2) disk drives (One 5.25 inch disk drive @ 360K, one 3.5inch disk drive @ 1440K), labeled A & B, w/controller card. Only one (1) disk drive may be external.
4. MS-DOS 5.0 or higher, with system manuals & diskettes or approved equal as required to operate the disk drive configuration supplied.
5. IBM Basica, GW Basic or QBasic diskette and manual.
6. Parallel, Serial, and Mouse interface ports, with Mouse.
7. Battery operated clock and calendar functions.
8. High resolution graphic capabilities such as provided by an IBM Video Graphic Array, SVGA (800 X 600) or EVGA (1024 X 768).
9. Eighty (80) column display function.
10. Operations manual.
11. Enhanced Keyboard with 101 Keys and number pad with key on-off indicator lights.
12. High Resolution (SVGA or EVGA) color 14-inch (minimum) monitor with a minimum dot pitch of .28 supporting the required microcomputer graphic capabilities.
13. SURGE PROTECTOR, 15 amps, four outlets w/circuit breaker control and surge failure indicator light.
14. Clear plastic dust cover for microcomputer and a separate dust cover for the keyboard.

* 15. 100 diskettes, which are compatible with the specified disk drives.

* 16. Diskette storage containers, 2-100 count & 5-10 count.

* The Contractor shall replenish these items as required by the Engineer and be of a type, size and capacity acceptable to the Engineer. These items shall remain the property of the State.

B. Printer

The Contractor shall provide the Engineer with a printer compatible with the microcomputer, software and hard-disk provided. The printer shall meet the following specifications:

1. A 24 Pin, 132-column (15-inch carriage) dot matrix printer w/IBM Graphics Character Set capabilities, tractor and friction feed, rear and bottom paper path, with a minimum draft mode of 180 cps (characters per second) and a minimum near letter quality (NLQ) mode of 30 cps. An Operator- Accessible Selector (control panel) with functions of paper feed, mode, and pitch.
2. Horizontal density Bit-Image Graphics capability of 360 dots per inch minimum.
3. Vertical density dot printing capability of 180 dots per inch minimum.
4. Line feed and form feed functions.
5. Variable pitch characters per inch, (both 10 and 12 cpi) with compressed print function (17 cpi).
6. Variable lines per inch (both 6 and 8 lpi).
7. Interface cable (parallel port).
8. Latest user manuals.
9. Clear plastic dust cover for printer.
10. Steel table-top printer stand with bottom paper feed slot.
* 11. Two replacement printer ribbons or cartridges.
* 12. One box each of 132-column (14 7/8" x 11") and 80-column (9 1/2" x 11") continuous feed, 20 # bond weight printer paper (min. 2000 sheets per box). The 80-column paper shall be letter quality with disappearing perforations on the edges.
* 13. 250 mailing labels on continuous form paper for use in the printer (1 1/2" X 4" minimum label size).

* The Contractor shall replenish these items as required by the Engineer and be of a type acceptable to the Engineer.

C. Software

The Contractor shall furnish and install the latest available DOS version of the following microcomputer software packages.

1. The software package that will be used by the Contractor to meet the CPM network scheduling system requirements outlined in this specification. Product literature and specifications for the software package shall be submitted to the Engineer for review and approval before purchase/installation.
2. Professional Write.
3. Professional File.
4. Lotus 1-2-3, Version 2.xx
5. Norton Anti-Virus

All software shall be compatible with the microcomputer, printer, and hard-disk provided.

It is the Contractor's responsibility to ensure that the microcomputer also operates the Departments' Computerized Engineers Estimate System (CEES) software package.

D. Hard-disk

The Contractor shall provide the Engineer with a hard-disk, labeled C drive, which is compatible with the microcomputer, printer, and software programs provided. The hard disk shall meet the following specifications:

1. An external or internal unit may be provided.
2. Formatted capacity of 180 megabytes minimum, labeled C drive.
3. All cables, controller card(s) and software necessary to make the unit fully operational.
4. Bit transfer rate: > 5.0 M bits/sec.
5. Average Access Time: < 20 Milliseconds
6. Direct microcomputer-booting from hard-disk.
7. Partitioning command for hard-disk.
8. Automatic hard-disk safe zone landing when unit is turned off and/or power is cut from unit.
9. Head-Parking command for unit relocation.
10. Latest guide to operations and/or user manuals.

CONSTRUCTION METHODS:

A. 90-Day Schedule

Within fifteen (15) calendar days following the contract award, the Contractor shall submit to the Engineer a detailed schedule for the first ninety (90) days of construction and a generalized schedule for the balance of the work. The detailed portion of this schedule shall meet the requirements of section B of this specification, "Detailed CPM Construction Schedule."

The 90-Day Schedule will be reviewed by the Engineer and revised by the Contractor to incorporate the Engineer's comments and to correct deficiencies. Upon acceptance by the Engineer the 90-Day Schedule shall be used for all project scheduling activities, and updated monthly until the issuance of the Approved Detailed CPM Construction Schedule.

B. Detailed CPM Construction Schedule

Within sixty (60) calendar days following the contract award, the Contractor shall prepare and submit to the Engineer a Detailed CPM Construction Schedule for the entire project.

The Contractor will incorporate into this Schedule, all site construction activities, activities for the placement of orders and anticipated delivery dates of materials and equipment, activities assigned to the Department or the Engineer and other outside agencies (such as shop drawing reviews, permit reviews, etc.), all private utility work or work by other Contractors within or near the contract limits and activities for all subcontractors.

1. Schedule Requirements

The Contractor's Detailed CPM Construction Schedule shall meet the following requirements:

a. CPM Schedule Format

The Contractor shall use the Precedence Diagramming Method.

b. Project Calendars

Holidays and non-working days shall be established in coordination with the Engineer. Additional project calendars shall be used for activities that have contract imposed time restrictions such as seasonal limitations for asphalt paving.

c. Activities Data

Activity Identification Number - Each activity shall have a unique identification number.

Activity Description - Each activity shall be clearly described. Use of descriptions referring to percent of a multi-element item (i.e., construct deck 50%) will not be acceptable. Separate activities shall represent different elements of multi-element items (i.e., construct forms, install rebars, pour concrete, etc.) Multiple activities with the same work description shall include a location description.

Activity Duration - the Contractor shall subdivide the work into individual activities having durations of no longer than 15 (fifteen) working days each. Exceptions to this rule will be reviewed by the Engineer on an activity by activity basis. If requested by the Engineer, the Contractor shall furnish production rates or other information needed to justify the reasonableness of activity time durations.

Expected seasonal weather conditions, such as precipitation and temperature, shall be included by the Contractor in the planning and scheduling of his activities.

Start and Finish Dates - The earliest start date, earliest finish date, latest start date and latest finish date shall be shown for each activity.

Total float shall be shown for each activity. Total float is the full amount of time by which the start on an activity may be delayed without causing the project to last longer.

Activity Codes - Activities shall be coded to allow for the following summaries:

- Responsible party for the accomplishment of each activity, i.e., Prime Contractor, Subcontractor, Department of Transportation, Utility Co. etc. Only one party can be responsible for an activity.
- Phase/stage during which activity is planned to be accomplished
- Area/Location, i.e., Bridges, Ramps, Mainline station, etc.

Activity Constraints - The Contractor shall not constrain the start or completion of any activity unless specifically required by the contract or approved by the Engineer.

Activity Resources - The required labor, materials and equipment shall be shown for each activity. Labor may be shown as person-workdays or crew-workdays. If crew workdays are used the crew make up shall be submitted to the Engineer. Material resources shall be defined by specification item number and be in the appropriate units of measure, i.e., hot mix asphalt concrete paving material may be described as item number 403.xx, unit of measure - tons. Major equipment such as pile drivers, large cranes, asphalt paving equipment, concrete finishing machines etc. shall be shown for each activity.

d. Sequence of Operations

The Time-scaled Logic Diagram shall show the sequence and interdependence of activities required for complete performance.

2. Contingency Within the Schedule

Any contingency within the Schedule, i.e., a difference in time between the project's early completion and required contract completion date, and "float" in the Approved Detailed CPM Construction Schedule belongs to the project and not to any party to the contract.

3. Float Manipulation Not Permitted

The Contractor shall not sequester "float" through such strategies as calendar manipulation, or extending durations to fill up available float time.

4. Review of the Detailed CPM Construction Schedules

The Contractor shall submit to the Engineer five copies of the Time-scaled Logic Diagram and five copies of the following activities' listings:

- Activity Number Sort - Activities listed in ascending order of their numbers.
- Total Float/Early Start Sort - Activities listed inascending order based on amount of their float with consideration of activity Early Start dates.

Diskettes with a back-up copy of the computerized Detailed CPM Construction Schedule also shall be provided.

The Engineer will review the Detailed CPM Construction Schedule and then hold a discussion meeting with the Contractor. Within two weeks from this meeting the Contractor shall make adjustments to the Detailed CPM Construction Schedule to eliminate conflicts, objections, and ambiguities found by the Engineer. The

Contractor shall submit for review five copies of the revised schedule materials as described above.

Upon completion of the final review by the Engineer, the Contractor shall incorporate the final revisions and submit two copies of the schedule diskettes containing the computerized Detailed CPM Construction Schedule and five copies of each of the revised Time-scaled Logic Diagram and computer printouts. In addition, a copy of the Time- scaled Logic Diagram on reproducible media, i.e., mylar or sepia, shall be provided. This final submission shall be submitted for approval within one week of the Contractor's receipt of the revisions.

Approval of the schedule by the Engineer shall not be construed to imply approval of any particular method or sequence of construction or to relieve the Contractor of providing sufficient materials, equipment and labor to guarantee completion of the project in accordance with the contract proposal, plans and specifications. Approval shall not be construed to modify or amend the agreement or the date of completion therein.

Failure by the Contractor to include in the 90-Day or Detailed CPM Construction Schedule any element of work required for the performance of the contract shall not excuse the Contractor from completing all work required within the completion date(s) specified in the contract notwithstanding approval of the Schedule by the Engineer.

5. List of Submittals

Within sixty (60) calendar days of the contract award, the Contractor shall provide a list of submittals required under the contract, i.e., shop drawings, required permits, erection/demolition plans, etc. The list shall show a scheduled submission date for each submittal and identify the earliest activity affected by each of these submittals. This list shall be revised and updated monthly with each schedule submission.

C. Schedule Updating

1. Monthly Progress Reports & Projections

The Contractor shall update the schedule monthly. Each update shall show actual dates of activities started and completed, the percent of work completed to date on each activity started but not yet completed, the current allocation of manpower and major equipment and the status of procurement of critical materials. The updated schedule data shall be submitted to the Engineer on computer disk. The

Contractor also shall provide updated Activity Number and Total Float/Early Start sorts, a 60-day look ahead bar chart by early start and a narrative report. The narrative report shall include a description of problem areas, current and anticipated delaying factors and their estimated impact on performance of other activities and mandated contract dates, and the explanation of corrective action taken or proposed.

The Engineer shall conduct a monthly review of the updated schedule. The review shall occur after receipt of the Contractor's updated information and shall serve as the forum to discuss slippages, remedies, revisions, and other relevant issues. The Contractor's appropriate field and scheduling personnel shall attend these working sessions. These reviews may result in the need for submission of revised schedules.

2. Time-Scaled Logic Diagram Updates

The time-scaled logic diagram shall be updated by the Contractor every four months.

D. Changes to the Approved Project Schedules

The Detailed CPM Construction Schedule shall accurately reflect the manner in which the Contractor intends to proceed with the project and shall incorporate the impact of delays and Orders- on-Contract when these factors can be accurately determined. All changes made to the schedule, i.e., the addition of activities, or changes in activity durations shall be submitted in writing and are subject to approval by the Engineer before inclusion in the Detailed CPM Construction Schedule.

To initiate changes to the approved schedules, the Contractor shall meet with the Engineer and provide the information necessary to prepare a revised (updated) Time-scaled Logic Diagram and computer-generated schedule listing.

No revision to any contract milestones, or contractually mandated schedule provision will be permitted, without written authorization from the Engineer.

E. Compliance with the Schedule

The Contractor shall employ and supply a sufficient force of workers, materials and equipment and shall prosecute the work with such diligence so as to maintain the rate of progress indicated on the approved schedule to prevent work stoppage and ensure completion of the project within the contract time. Any additional or unanticipated costs

or expense required to maintain the schedule shall be solely the Contractor's obligation and shall not be charged to the Department unless provided for in other provisions of the contract.

In the event a notice is received of a change to the contract which is likely to cause or is causing delays, the Contractor shall notify the Engineer in writing within 10 days, of the effect, if any, of such change, or extra work, or suspension or other conditions upon the Project Construction Schedule and shall state in what respects, if any, the Approved Detailed CPM Construction Schedule should be revised with the reasons therefore. The reasons for these revisions must be succinct, comprehensive, and factual to merit consideration.

METHOD OF MEASUREMENT:

The critical path method scheduling system will be measured for payment on the Lump Sum Basis.

BASIS OF PAYMENT:

The lump sum price bid for the critical path method scheduling system shall include the cost of furnishing, installing, maintaining, and removing the microcomputer system, preparation and submission of the 90-day schedule, preparation and submission of the detailed CPM construction schedule, and preparation and submission of monthly updates. Payment will be made as follows:

A. Upon installation of the microcomputersystem in the field office.	10 %
B. Upon acceptance of the 90-day schedule.	10 %
C. Upon acceptance of the Detailed CPM Construction schedule.	10 %
D. The balance will be paid in equal monthly payments distributed over the contract life. These payments will be contingent upon the submission of acceptable monthly updates.	70 %

If the Contractor fails to comply with the provisions of this specification, the Engineer may withhold approval of any milestone payment shown above or all progress payment estimates pursuant to Article 8 of the contract.