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Title: CRITICAL PATH METHOD (CPM) SCHEDULING FOR DOT CONSTRUCTION PROJECTS, ITEM 15637.61 M			
Distribution: <input type="checkbox"/> Manufacturers (18) <input type="checkbox"/> Surveyors (33) <input checked="" type="checkbox"/> Main Office (30) <input checked="" type="checkbox"/> Consultants (34) <input type="checkbox"/> Local Govt. (31) <input checked="" type="checkbox"/> Contractors (39) <input checked="" type="checkbox"/> Regions/Agencies (32) <input type="checkbox"/> _____ ()		Approved:  P. J. CLARK, DEPUTY CHIEF ENGINEER DESIGN DIVISION Date: 8/19/99	

PURPOSE

This Engineering Instruction (EI) supersedes EI 95-023, and transmits a revised contract specification and a revised 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.

Specification item 15637.61 supersedes specification item 15637.60 dated 6/09/95. The Special Note titled "Critical Path Method Schedule" dated L 1/13/2000 supersedes the Special Note of the same title dated 6/9/95.

The specification and the special note issued with this EI will be effective with projects submitted for letting on or after 1/13/2000.

CHANGES FROM PREVIOUS PROVISIONS

A. CPM PROVISION SELECTION CRITERIA

1. Criteria for selecting the appropriate CPM provision (special note or specification pay item) have been clarified.
2. The dollar threshold for requiring the CPM specification pay item has been increased to \$10 million.

B. SPECIFICATION 15637.61

1. The computer and printer have been upgraded.
2. CPM scheduling software to be installed in the field office has been changed from Primavera Project Planner (P3) to Primavera SureTrak Project Manager. Other computer software changes include, PC-Anywhere, Wordperfect Suite 8 & Windows 98 operating system.

3. The requirements for showing labor, material, equipment and costs in the schedule have been modified.

C. SPECIAL NOTE

1. The preferred method of scheduling has been changed to activity on node. The activity on arrow method may be used with the Engineer's approval.

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.

Studies and experience have shown that CPM scheduling techniques are more appropriate for certain projects and that their use during construction to plan work and resolve time related issues can help avoid costly delays and delay claims. Therefore, we have developed project selection criteria to identify those projects where CPM scheduling techniques are most suitable.

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 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 #3500.10, published by the Associated General Contractors of America (AGC) is a good source of information on this topic. A copy of this publication can be reviewed at the Regional Construction Office or the Construction Division Office in Albany. Copies may be purchased from AGC.

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, 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 date with significant liquidated damage provisions. Since early or late completions on contracts with these provisions will have a direct financial impact in the incentive item(s), it's imperative that there is an approved, 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. For projects with very short I/D phases or limited time related work, the CPM requirement may only be required for part of the project. The Designer should contact Regional Construction to develop the appropriate special notes.
- 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. This includes contracts let in stages where adjacent sections must be coordinated, buildings constructed with multiple contracts, i.e., separate contracts for general, plumbing, electrical and HVAC. CPM on these projects will help avoid time related 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 ,multiple construction phases, numerous subcontractors, etc., should be scheduled using CPM due to their size and complexity.

CPM provision selection criteria.

There are 2 methods of providing a CPM schedule provision in a construction contract.

1. By special note
2. By specification pay item

Only one of these two methods shall be used for each contract.

CPM schedule special note.

The special note attached to this EI titled "CRITICAL PATH METHOD SCHEDULE" dated L 1/13/2000 was written primarily for smaller projects and does not require computerization. Project Designers shall insert the Special Note into the PS&E package for projects that meet project selection criteria A, B or C and cost less than or equal to \$10 million.

CPM schedule specification pay item.

The specification attached to this EI "ITEM 15637.61_M CRITICAL PATH METHOD (CPM) NETWORK SCHEDULING SYSTEM" dated L 1/13/2000, was written primarily for larger projects and requires computerization of the CPM schedule. The specification should be used for projects that meet project selection criteria A, B or C and cost more than \$10 million. The specification shall also be used for projects that meet selection criteria D.

The specification contains the requirements for CPM scheduling and includes a field office microcomputer with CPM and other software. The CPM microcomputer system can also function as the standard field office microcomputer system if the RCE wishes to delete the regular specification pay item from the contract.

Design Implementation procedure.

The project designer shall determine if a project meets the criteria for CPM scheduling and indicate in the Advance Detail Plan (ADP) transmittal letter which CPM provision will be used. The Regional Construction Engineer (RCE) will verify that appropriate projects contain the CPM scheduling requirement as part of the constructability review process for all projects. The RCE may adjust the CPM requirements due to unique project conditions such as:

- The RCE may request that the specification pay item be used on a contract with an estimated cost of less than \$ 10 million if computerization of the schedule will assist the EIC during construction.
- The RCE may request that the CPM schedule only be required for part of a project, i.e., a short duration I/D phase. For these situations the CPM special note may be modified to only require partial project CPM scheduling.

For projects that meet selection criteria A, B or C and cost less than \$ 10 million, the Designer shall submit the special note to the Design Quality Assurance Bureau with the PS&E submission.

For projects that meet selection criteria A, B, and C and cost more than \$10 million, and for all projects greater than \$20 million, the Designer shall substitute the computerized CPM special specification ITEM 15637.61_M for the standard field office microcomputer item in the Engineers estimate. The CPM pay item specification will be inserted into proposals by the Design Quality Assurance Bureau. For very large projects, the RCE may request that the standard field office microcomputer specification pay item also be included.

Only one CPM provision is required in each proposal, i.e., either the special note or the specification pay item.

Construction Implementation Procedure

Guidelines for construction field personnel are contained in section 108-01 of the Contract Administration Manual and are unchanged by this issuance.

Cost Impact

This specification update will be cost neutral. Increased costs for the upgraded computer and printer are offset by a reduction in cost due to the change from Primavera P3 to Primavera SurTrak. Other changes are for clarification purpose.

Attachment Distribution.

Distribution of the 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

The specification will also be posted on the Departments server at the following location, Co_design_fs01:\Toolbox\spclspec\metric.

Although this EI is issued by the 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.

The construction of the project shall be planned and recorded with a conventional Critical Path Method (CPM) schedule in the form of an activity on node diagram based on the principles defined by the 1994 issue of the Construction Planning & Scheduling Manual published by the Associated General Contractors of America. An activity on arrow diagram may be used if approved by the Engineer. The schedule shall be used for coordination and monitoring of all work under the contract including all activities of subcontractors, vendors, and suppliers. The Department will use the schedule to monitor the progress of construction, compare the work performed to the Contract time and phasing requirements, and to assign necessary resources for inspection and administration of the Contract.

A. Schedule Submittal

Within 15 calendar days of the Award of Contract, the Contractor shall submit for the Engineer's review a detailed CPM schedule. The schedule will be reviewed to determine whether it meets the requirements under Subsection B below and shall not exceed the Contract time requirements for any milestones or for the entire project.

Following the Engineer's review, revisions to the proposed schedule, if necessary, shall be made by the Contractor. The final proposed schedule must be completed within 30 calendar days of the Contract Award. Failure to provide a final schedule by that date will result in withholding all progress payment estimates pursuant to Article 8 of the contract.

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.

A 60 calendar day preliminary schedule of proposed activities by the Contractor may be submitted to the Engineer to enable beginning of Contract work preparation such as material orders, preparation of working drawings, and mobilization of equipment while the CPM schedule is being prepared.

No Contract work may be pursued on the project site unless there is a 60 calendar day preliminary schedule or a detailed CPM schedule meeting the Contract requirements.

B. Schedule Requirements

All activity on node diagrams shall include:

Activity Nodes with identification numbers
Activity Description
Activity Duration

The activity on node 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 and approvals and fabrication and delivery activities.

No activity duration shall be longer than 15 work days without the Engineer's approval.

The activities are to be described so that the work is readily identifiable and the progress of each activity can be measured. For each activity, the Contractor shall identify the trade or entity performing the work, the duration of the activity in days worked, the resources involved by trade, the equipment involved, the location of the work and the total dollar value.

The Contractor shall also provide the work days per week, holidays, number of shifts per day, number of hours per shift, and major equipment to be used for each activity. 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 activities.

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

The activity on node diagram submitted may either be hand drawn or computer plotted. Regardless of the type of diagram, the network must be legible, readable, and understandable by the Engineer. Network diagrams shall be on 279 mm x 425 mm size sheets and not a continuous diagram.

All network diagram submissions shall include three copies. The Contractor shall also provide three copies of the following sorts:

Activity number sort
Total Float / Early Start sort

C. 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.

D. 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.

E. 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.

F. 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 staff resources and major equipment and the status of procurement of critical materials. The Contractor also shall provide updated activity number sorts, total float early start sorts, a 60 day look ahead bar chart, 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.

G. 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-Contracts when these factors can be accurately determined. All changes made to the schedule, i.e., the addition of activities, changes in logic or changes in the 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 schedule, the Contractor shall meet with the Engineer and provide the information necessary to prepare a revised (updated) Activity on Node Diagram.

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

H. 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 calendar 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.

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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 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 described within this specification. In addition, the Contractor shall provide a microcomputer with CPM scheduling software for use by the Engineer in monitoring the scheduling system. The CPM schedule shall be prepared based on the principles defined by the 1994 issue of the Construction Planning & Scheduling Manual published by the Associated General Contractors of America.

MICROCOMPUTER SYSTEM

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 109-05. However, profit and overhead shall be computed at 5% instead of the 20% specified in specification section 109-05 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.

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MICROCOMPUTER SYSTEM SPECIFICATION

The Contractor shall provide the Engineer with one Personal Microcomputer that is 100% IBM compatible and which also meets the following specifications. A WINDOWS-98 environment (with ability to execute DOS programs) is required.

Specifications:

- A) A minimum of an 80-586, or Pentium, based Central Processor Unit (CPU) operating at a minimum clock speed of 400 MHZ with an internal hard disk having a formatted capacity of a minimum of 6.0 Gigabytes labeled C drive. The hard disk must allow for direct microcomputer booting.
- B) A minimum of 32.0 Megabyte RAM (Random Access Memory) with 640k directly addressable, expandable to 64.0 Megabyte.
- C) One (1) 1440K, 89 mm internal disk drive, labeled A, w/controller card
- D) A minimum 12X-32X CD-ROM Drive
- E) Parallel and Serial interface ports
- F) Battery operated clock and calendar functions
- G) A minimum resolution color graphic capabilities of (1024 X 768), with 4 Megabyte of video RAM
- H) Eighty (80) column display function
- I) Latest operations manual & diskettes
- J) Latest WINDOWS-98 Version system manual & diskettes. System configuration must allow for execution of DOS based programs.
- K) A two (2) Button Mouse
- L) Enhanced Keyboard with 101 Keys and number pad with key on-off indicator lights.

Additional Items:

- 1) High Resolution (EVGA) color 425 mm (minimum) monitor with a maximum DOT Pitch of .28 supporting the required microcomputer graphic capabilities
- 2) PHONE/LINE SURGE PROTECTOR, 15 amps, four outlets w/circuit breaker control and surge failure indicator light
- 3) Clear plastic dust cover for microcomputer and a separate dust cover for the keyboard
- *4) 100 diskettes, which shall remain the property of the State, and are compatible with the specified disk drive
- *5) Diskette storage containers, 2-100 count & 5-10 count, which shall remain the property of the State.
- 6) A 56,000 Baud Fax/Modem meeting the following requirements:

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Windows/DOS Environment Compatible
Hayes-compatible AT command set
Group III Fax compatible

7) Fax/Modem/Phone automatic switch

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

PRINTER SPECIFICATION

The Contractor shall provide the Engineer with a color printer, which is totally compatible with the microcomputer, and software provided. The printer must function in both a WINDOWS and DOS environment. Any necessary software shall be included.

Specifications:

- A) A Hewlett Packard Printer Control Language (HP PCL) Compatible Ink Jet or Laser Printer with a minimum letter quality mode of 4 ppm (pages per minute). A minimum 16 dot-per-millimeter (both horizontal and vertical) printing resolution for text and graphics. An Operator-Accessible Selector (control panel) with functions of paper feed/size, form feed function and other menu selections.
- B) A minimum paper tray capacity of 50 sheets
- C) Variable pitch characters per 25.4 millimeters (both 10 and 12) with compressed print (17). The internal typefaces shall offer both scalable and nonscalable fonts.
- D) Variable lines per 25.4 millimeters (both 6 and 8)
- E) Interface cable (parallel port)
- F) Latest user manuals
- G) Clear plastic dust cover for printer
- H) Steel table-top printer stand
- *I) Two replacement toner/print cartridges
- *J) 2000 sheets of 75 grams per square meter bond weight, letter quality printer paper (216 mm x 279 mm).
- *K) 500 laser printer mailing labels for use in the printer (38 mm x 102 mm label size)

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

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SOFTWARE SPECIFICATION

The Contractor shall furnish the latest available version of SureTrak Project Manager for Windows and install it on the field office computer.

The Contractor may use any software package that can produce the schedule and reports in accordance with this specification, however all computer files submitted to the Engineer must be in a format that can be imported directly into SureTrak Project Manager for Windows. Any data conversions required to import files into SureTrak Project Manager for windows shall be the responsibility of the Contractor. The Contractor may submit for review and approval use and installation of a different scheduling software package on the field office computer that can meet the scheduling requirements of this specification. Any such proposals shall include a cost analysis and provisions for software training for the Engineer at no additional cost to the Department. Approval of alternate software will be made on a project by project basis.

The Contractor shall provide the Engineer with the latest available WINDOWS-98 version of the following microcomputer software packages, which are totally compatible with the microcomputer and printer provided. The software shall be loaded/installed on the microcomputer and be functioning properly. All user manuals for installed software shall be provided to the Engineer.

- A) Windows-98
- B) Wordperfect Suite 8
- C) PC Anywhere 32 for Windows

It is the Contractor's responsibility to ensure that the Personal Microcomputer supplied also operates the following Software Applications:

- 1) NYSDOT's Computerized Engineer's Estimate System, CEES
- 2) NYSDOT's Automated Construction Engineering System, ACES
- 3) Bentley's Microstation 5.0

CONSTRUCTION NEEDS

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

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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 subcontractors, activities assigned to the Department or the Engineer and other outside agencies (such as shop drawing reviews, permit reviews, etc.), and all private utility work or work by other Contractors within or near the contract limits.

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.

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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 rebar, 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 multiple shifts and/or overtime are anticipated during the development of activity durations, a list of affected activities and the shift/overtime assumptions shall be provided to the Engineer. 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 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. The name of each Subcontractor shall be included as soon as they are approved by the Department. Only one party can be

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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 and equipment shall be shown for each activity.

- Labor may be shown by trade, however as a minimum the Engineer will accept total person-workdays per activity or crew-workdays per activity. If crew workdays are used the crew size shall be indicated in the coding, i.e., a crew designated as PAVE4 = 4 person paving crew.
- Major equipment such as pile drivers, large cranes, asphalt paving equipment, concrete finishing machines, etc. shall be shown for each activity.

Material Quantities - Material quantities for each activity shall be indicated in the resource fields. Material descriptions such as concrete, asphalt, guide railing, signs, etc. shall be used. Material quantities will be used to verify the reasonableness of the activity durations and to ensure that all work required by the contract is accounted for within the schedule.

Contract pay item designations - Contract pay item designations for labor material and equipment shall be included in the cost account fields for each activity resource. It is not intended that each and every pay item designation in the contract be identified. Similar items installed during an operation may be combined and a prefix identifier included, i.e., Box beam guide railing = 606.10, signs = 645.7x, planting = 611.0x etc.

Activity cost - The total budgeted cost per activity shall be included. A labor, material and equipment cost breakdown is not required but may be provided at the contractors option.

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d. Sequence of Operations

The Logic Diagram or PERT chart 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 three copies of the Logic Diagram (PERT chart) and three copies of the following activities' listings:

- Activity Number Sort - Activities listed in ascending order of their numbers.
- Total Float/Early Start Sort - Activities listed in ascending 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 three 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 three

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copies of each of the revised Logic Diagram (PERT chart) and computer printouts. The Logic Diagram (PERT chart) shall be on 279 mm x 425 mm size sheets and not a continuous diagram. 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 of 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 schedule 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 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

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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. Logic Diagram (PERT chart) Updates

The logic diagram (PERT chart) 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 Order-on-Contract when these factors can be accurately determined. All changes made to the schedule, i.e., the addition of activities, changes in logic 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) Logic Diagram (PERT chart) and computer-generated schedule listing.

No revision to any contract milestones, or contractually mandated schedule provisions 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

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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 calendar 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 detailed CPM construction schedule, and preparation and submission of monthly updates. Payment will be made as follows:

- | | | |
|----|---|-----|
| A. | Upon installation of the microcomputer system 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 provision 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.