To:		ENGINEERING INSTRUCTION *New York State Department of Transportation*	*95-023* Supersedes: 94-007
SUPERSEDED **BY EI 99-028 EFFECTIVE 1/13/00**			

Title: CRITICAL PATH METHOD (CPM) SCHEDULING FOR DOT CONSTRUCTION PROJECTS ITEM 15637.60 (ENGLISH) & 15637.60 M (METRIC)

Distribution:
☒Main Office(30) ☐Local Gov.(31)
☒Regions(32) ☒Contractors/AGC(39)
☒Consultants(34) ☐_____( )

Approved: P. J. Clark — 6/9/95
P. J. Clark, Deputy Chief Engineer, Design Division — Date

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.

The specifications and the special note supersede those provided with EI 94-007 and will be effective with the letting of 10/19/95.

Specification item 15637.60 supersedes specification item 15637.33 dated 12/07/93. The Special Note titled "Critical Path Method Schedule" dated 6/9/95 supersedes the Special Note of the same title dated 12/14/93.

CHANGES FROM PREVIOUS PROVISIONS

A. SPECIFICATION 15637.60

1. The computer has been upgraded to include more memory, requires both the DOS and Windows operating systems and includes a Fax/Modem.

2. The DOT matrix printer has been replaced with a laser printer.

3. The Contractor will be required to install Primavera Project Planner (P3) for Windows on the field office computer, however the contractor may elect to use another scheduling software package as long as the submitted computer files are compatible with Primavera.

4. A metric version of the specification is also provided.

B. SPECIAL NOTE

1. The special note has been restructured based on the 1993 AASHTO Guide Specification.

2. The Special Note may be used on both English and Metric projects.

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 #1107.1, 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 (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 date 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 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.

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 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 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 6/9/95 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 the selection criteria and cost less than or equal to $5 million.

Cpm schedule specification.

The specifications attached to this EI "ITEM 15637.60 and 15637.60_M CRITICAL PATH METHOD (CPM) NETWORK SCHEDULING SYSTEM INCLUDING MICROCOMPUTER" dated 06/09/95, were 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 15637.34. If 2 computers are not required in the field office, Item 15637.34 may be deleted from the contract with concurrence from the Regional Construction Engineer (RCE).

Design 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 specifications, ITEM 15637.60 and 15637.60_M, are Main Office inserts 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.

Construction Implementation Procedure

Guidelines for construction field personnel have been issued to all Regional Construction Groups in draft form and will be incorporated into the Construction Supervision Manual which is currently under revision.

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

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.

MEMORANDUM
DEPARTMENT OF TRANSPORTATION

TO: P. Bellair, Design Quality Assurance Bureau, 5-408 (MC0750)
R. Dennison, Design Bureau, 4-G-01B (MC0432)
M. Silo, Consultant Management Bureau, 4-G-01 (MC0433)
A. Shirole, Structures Des. & Const. Div.,5-6th Floor (MC 0600)
Regional Design Engineer, Region ___
Regional Construction Engineer, Region ___

FROM: P. T. Wells, Construction Division, 4-101 (MC0410) PTW

SUBJECT: EI 95-023, CRITICAL PATH METHOD (CPM) SCHEDULING FOR DOT CONSTRUCTION PROJECTS, ITEM 15637.60 (ENGLISH) AND 15637.60M (METRIC)

DATE: June 15, 1995

Attached is one copy of the subject Engineering Instruction (EI) with the attachments. Additional copies of this EI without the attachments are being distributed to your office under separate cover. Please refer to "Attachment distribution" on page 4 of the EI.

PTW:DLK:mr

cc: P. Clark, Facilities Design Division, 5-408 (MC0748)

RECEIVED
DESIGN DIVISION
JUN 20 1995

DIRECTOR		CMB	
ASST TO DIR		DQAB	
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FILE		COPY BUREAUS	

INFO

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 arrow diagram. An activity on node 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 arrow diagrams shall include:

Activity Nodes
Activity Description
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 and approvals and fabrication and delivery activities. All network "dummies" are to be shown on the diagram.

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 and the location of the work.

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 arrow 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 standard D size sheets and not a continuous diagram.

All network diagram submissions shall include one reproducible sepia and three copies.

The Contractor shall provide three copies of the following sorts:

I node - J node
Total Float
Early Start

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 sequestor "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 I node J node sorts, total float 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 Arrow 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.

ITEM 15637.60 - 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 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.

A. Microcomputer

The Contractor shall provide the Engineer with one Personal Microcomputer that is 100% IBM compatible and which also meets the following specifications.

ITEM 15637.60 - CRITICAL PATH METHOD (CPM) NETWORK SCHEDULING

1. A minimum of an 80-486 DX based Central Process Unit (CPU) operating at a minimum clock speed of 50 MHZ

2. A minimum of 16.0 Megabyte RAM (Random Access Memory) with 640k directly addressable, expandable to 32.0 Megabyte

3. Two (2) 1.44MB, 3.5 inch internal disk drives, labeled A & B, w/controller card

4. Parallel and Serial interface ports

5. Battery operating clock and calendar functions

6. High resolution graphic capabilities such as provided by an IBM Extended Video Graphic Array, EVGA (1024 X768)

7. Eighty (80) column display function

8. Latest operations manual & diskettes

9. Minimum of MS-DOS 5.0 system manual & diskettes or approved equal as required to properly operate disk drive configuration supplied

10. Minimum of Windows 3.1 system manual & diskettes

11. QBasic program and documentation

12. Enhanced Keyboard with 101 Keys and number pad with key on-off indicator lights.

13. High Resolution (EVGA) color 14-inch (minimum) monitor with maximum DOT Pitch of .31 supporting the required microcomputer graphic capabilities.

14. SURGE PROTECTOR, 15 amps, four outlets w/circuit breaker control and surge failure indicator light

15. Clear plastic dust cover for microcomputer and a separate dust cover for the keyboard

* 16. 100 1.44MB formatted diskettes, which shall remain the property of the State, and are compatible with the specified disk drives.

* 17. Diskette storage containers, 2-100 count & 5-10 count, which shall remain the property of the State

18. A 2400/4800/9600 Baud Fax/Modem meeting the following requirements:

Hayes-compatible AT command set
Group III Fax compatible

19. 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.**

B. Laser Printer

The Contractor shall provide the Engineer with a laser printer, which is totally compatible with the microcomputer, software and hard-disk provided. The printer shall meet the following requirements:

1. Capable of printing at a resolution of 600 dots per inch.

2. Capable of printing 8 pages per minute minimum.

3. Capable of printing on both letter and legal size paper.

4. Minimum paper capacity of 100 sheets.

5. Minimum RAM = 4MB.

6. Latest user manuals shall be provided.

7. Interface cable (parallel port) shall be provided.

* 8. One replacement toner cartridge shall be provided.

* 9. One box of 80-column (8 1/2" x 11") laser quality printer paper (min. 2000 sheets per box) shall be provided.

* 10. 100 mailing labels for use in the printer (1-1/2" x 4" minimum label size) shall be provided.

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

C. Software

The Contractor shall furnish and install on the field office computer the latest available version of Primavera Project Planner (P3) for windows.

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 P3 for windows. Any data conversions required to import files into P3 for windows shall be the responsibility of the Contractor.

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

1. Professional Write
2. Professional File
3. Lotus 1-2-3, Version 2.xx
4. Norton Anti-Virus
5. Close-up: Customer/Terminal Version

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 totally compatible with the microcomputer, printer, and software programs provided.

1. Only an internal unit may be provided
2. Formatted capacity of a minimum of 300 Mega-Bytes labeled C drive
3. All cables, controller card(s) and software necessary to make the unit fully operational
4. Average Access Time (Milliseconds): <20
5. Direct microcomputer booting from hard disk
6. Partitioning command for hard disk
7. Automatic hard disk safe zone landing when unit is turned off and/or power is cut from unit
8. Head-Parking command for unit relocation
9. Latest guide to operations and/or user manuals

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 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.

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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 tot his 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.