

763XXX – Timing Analysis, Critical Path Method (CPM) Project Schedule

Description:

This work shall reflect a Contractor's anticipated work plan for constructing the project using a Critical Path Method Project Schedule (CPM). The CPM shall be used for the Contract Time analysis for all the work specified in the Contract Documents including all activities of subcontractors, vendors, suppliers, utilities, railroads, the Department, and all other parties associated with the construction of the project. All work including but not limited to submittals, major procurement, fabrication, delivery of critical or special materials and equipment, utility construction / relocation, and construction activities shall be included. Any other bid items quantified in the Contract Documents shall be included as activities as required by the Engineer. The CPM shall be based upon the entirety of the Contract Documents. All schedules and / or revisions shall be prepared in Primavera software and submitted in .XER format. The Consultant shall submit a baseline CPM work schedule and written CPM schedule narrative as required below.

The contract time requirement is a key factor to both the Department and the Contractor. All time limits stated in the Contract Documents are of the essence of the Contract. Therefore, observance of the requirements herein is an essential part of the work to be completed under this contract.

Definitions:

Float:

The CPM utilizes float. Float is defined as the amount of time between when an activity "can start or finish" and when an activity "must start or finish". Total float is float shared with all other activities and is defined as the amount of time an activity can be delayed without affecting the overall time of project completion.

Weather Float:

In developing the contract completion time, the calendar day schedule and all calendars defined in the project data dictionary shall reflect the monthly, anticipated adverse weather days as determined by Table 1 below. The total number of these days shall be considered Project Weather Float and reported with the assumptions in the written narrative. Consider and make appropriate scheduling and operational allowances for seasonal weather conditions and ambient temperatures.

Table I: Monthly anticipated adverse weather delay based on a seven (7) calendar day week:

Jan	Feb	Mar	Apr	May	June	July	Aug	Sep	Oct	Nov	Dec
12	10	5	5	4	2	4	3	4	3	2	6

The above table is developed based on the daily weather report log as maintained by the Department’s Materials and Research Section. Severe / adverse weather is defined as daily precipitation equal to or exceeding 0.25 inches and / or maximum daily temperature not exceeding 32 degrees F as recorded at the Wilmington Airport. The work schedule shall be set up to reflect working a seven (7) day week. The adverse weather impact will be accessed using Table I for anticipating the normal weather impact to a project.

Schedule:

The purpose of the project schedule is to:

1. Provide adequate analysis of the project duration for the prosecution and progress of the work in accordance with the Contract Documents including any stated milestones;
2. Illustrate necessary coordination requirements of the contractor, Department, Utilities, and others that may be involved in the project;
3. Assist the Department to coordinate and synchronize construction management functions.

The Consultant shall create a CPM Project Schedule showing the manner of prosecution of work that a prudent contractor would follow in order to complete the contract work requirements. The project schedule shall show the sequence and interdependence of activities required for complete performance of the work. The Consultant shall be responsible for assuring all work sequences are logical and show a coordinated plan of the work requirements. As a minimum, the schedule shall include a work breakdown structure (WBS), working drawing schedule, phasing (staging) schedule, crew deployment (resource) schedule, a bridge construction and erection schedule, a pavement structure schedule, and a utility construction schedule.

The CPM format shall be the Precedence Diagram Method with days as the Planning Unit and shall be based on Calendar Days. Schedules with calendars based in any manner on Working Days will not be allowed. The Consultant is responsible to determine, by adequate planning, the most feasible order of the work commensurate with a Contractor’s anticipated abilities and the work requirements stated in the Contract Documents.

Narrative:

The CPM Schedule Narrative is a written explanation of phasing progression, intervals, assumptions, and coordination with and dependency on completion of utility work and the work of any adjacent contracts. The narrative must conceptualize work plans, modifications, and/or corrections. This information shall describe the anticipated work in an orderly sequence of the construction phasing, anticipated problems, and anticipated project completion dates, in a detailed description. Narratives that are a listing of the work will not be acceptable. Written narratives shall be included with each submission. The Department shall only accept schedule databases that reflect the work plans, modifications, and / or corrections reflected by their respective written narratives.

The Engineer's acceptance is based on a review of general conformity for compliance with the requirements of the Contract Documents. The Consultant is free to make assumptions regarding field conditions, estimated quantities, and / or subsurface conditions. Assumptions shall be described in the written CPM narrative and included as part of the Timing Analysis CPM Project Schedule submittal to the Department. Controls or time restrictions are identified herein and in the Standard Specifications, Special Provisions, and on the Contract Plans as plan notes.

Development of the Timing Analysis, Critical Path Method (CPM) Project Schedule:

The development of the plan is as follows unless specifically approved otherwise by the Department's Master Scheduler: (All timing meetings shall include, as a minimum, the Consultant's Project Manager and Scheduler and also the Department's Project Manager, Construction Engineer, and Master Scheduler.)

- (a) The initial Timing Analysis CPM Schedule shall be submitted with the Semi-Final Construction Plan submission. Submit a Network Logic Diagram that shows the logical interrelationships of activities and activity durations in a legible, easy to understand, computer plotted format. Include a disc and one (1) print on D size sheets, (22-inch) x (36-inch), with all network diagram submissions.
- (b) The final Timing Analysis CPM Schedule shall be submitted (as shown above) with the Final Construction Plan submission.
- (c) A timing meeting shall be scheduled approximately thirty (30) days after receipt of the construction plan submissions.
- (d) A partially predetermined Coding Structure (CS) having a minimum of sixteen (16) breakdown levels will be used. . The Coding Structure (CS) is a specific listing that illustrates the hierarchy of work needed to complete the project. The hierarchy is categorized into levels or classifications. The CS classifications organize activities into manageable

groups through each level of the project, for example; roadway sections and bridge structures; footings, columns, and caps; contractor and subcontractor. The Scheduler shall determine the breakdown from South to North and West to East and the classification, breakdown, and breakdown titles and codes for level 17 and any lower level of the CS. Activity code values shall be perspicuous for the activities included in a grouping. Coding enables generation of organized reports and graphics that can summarize any level of the project schedule.

Note: Do not use an activity description to describe more than one (1) activity throughout the duration of the project. Keep activities with duration times in excess of fifteen (15) calendar days to a minimum. As a guiding factor, provide enough activities to demonstrate the necessary interdependencies and limit the fineness of detail, where possible, to a minimum of a five (5) day activity duration.

Include the following, as a minimum, in all CPM schedule submittals:

- Activity number;
- Activity description;
- Duration of Activity, in calendar days;
- Earliest start date, by calendar date and by work day;
- Earliest finish date, by calendar date and by work day;
- Latest start date, by calendar date and by work day;
- Latest finish date, by calendar date and by work day;
- Activity float;
- Work days per week, holidays, number of shifts per day, and number of hours per shift;
- A list of resources (labor and equipment), by operation;
- Planned production data for each activity;
- Weather days shown each month in accordance with the chart herein;
- Indicate relationships between administrative activities, preconstruction activities and all related construction activities;
- A working drawing schedule correlated with the activities of the CPM Schedule;
- A detailed phasing (staging) schedule if the work has phasing or is to be performed in phases;
- Utility Bar Chart;
- Written Narrative.

The Timing Analysis CPM Project Schedule shall be submitted to the Department's Project Manager and Master Scheduler for acceptance and shall be accompanied by the written narrative. Any information required by the Department's Master Scheduler for analysis of the CPM schedule and / or

revisions, clarification of charts and other schedules; shall be prepared and provided by the Scheduler.

Other Timing Analysis CPM Schedule Information and Requirements:

The Scheduler shall prepare and provide the anticipated General Contractor's work schedule information in the form of work step and controlling activities:

- (a) Work step activities are single step construction elements,
- (b) Controlling activities are not construction elements but affect the start of other activities.

Note: Constraints shall not be used unless specifically approved in advance by the Department's Master Scheduler.

The breakdown setting work steps and controls shall address the following:

- 1. Work at locations done at different times or requiring different crews;
- 2. Work Step factors affecting the duration and / or sequence of activities;
- 3. Work requiring different materials;
- 4. Work requiring different crew or craft requirements;
- 5. Work requiring different equipment;
- 6. Work requiring different responsibility (subcontractors);
- 7. Structural work having distinct subdivisions;
- 8. Labor and equipment resource availability;
- 9. Work as reflected in the state's breakdown for bidding or payment;
- 10. Public, private and / or Contractor utility work and limiting or outage schedules of public and / or private utility organizations; and
- 11. Maintenance of traffic.

Controlling factors affecting the start of other activities:

- 1. Preparation of working drawing and materials submittals;
- 2. Approval, return, and / or re-submittal of working drawings and materials;
- 3. Specialized material testing;
- 4. Long lead purchases – material and equipment availability;
- 5. Material and equipment fabrication time;
- 6. Testing of special equipment and in place testing;
- 7. Delivery of unusual shipment or scarce material;
- 8. Dependency on completion of utility work;
- 9. Dependency on completion of another contract (contiguous or not);
- 10. Protection and restoration of property, forest protection, special traffic controls, erosion control and water pollution, environmental controls and suspensions, safety, and foreseeable archeological and / or historical evidence delays;
- 11. Procurement of permits; and

12. Conditions as set forth in Standard Specification Subsection 107.01.

Activities shall be identified by a name, symbol, and coding, and have a duration, Phase / Stage, sequence, responsibility, and resources. Activity duration, or Original Duration, shall be reasonable and representative of the scope of the activity. Activity durations shall be based on Calendar Days and shall reflect all time necessary to complete the activity for a single resource unit. Original Durations may not exceed fifteen (15) calendar days unless approved by the Master Scheduler. Productivity rates used to establish durations shall reflect the time periods when work can be scheduled and exclude the non-work period of the activity's calendar.

Calendars allow activities to be scheduled only when allowed by the nature of or restraints on the work. Calendars shall include weekends, holidays, or other Contractor non-work periods. All activities shall be identified by entry of their appropriate Calendar. A minimum of six (6) Calendars shall be used and the first six (6) shall be ordered and entitled as follows: 1) Full schedule, 2) Winter conditions, 3) Concrete Paving, 4) Asphalt Base, 5) Asphalt Surface, and 6) Environmental. Calendar non-work periods shall reflect the environmental regulations for the location of the Contract work, customary days during the week that the Contractor does not work, expected normal weather delays from Table 1, and all legal holidays and other restrictions as set forth in Standard Specification Subsection 101.91.

Activity sequencing shall be typical of proficient scheduling practice. The sequence must be logical and representative of a Contractor's anticipated order of work. Successors and predecessors determine the job logic or activity sequence. Successors are activities that follow an activity. Predecessors are activities that precede an activity. A given activity cannot start until all predecessors have been completed. Only finish to start dependency relationships (links) shall be used; lag time may not be used unless specifically approved by the Department's Master Scheduler in advance. Activities shall be sequenced to reflect resource apportionment. When one crew (resource) is being utilized to perform all of many similar activities, these activities must be linked together in some sequence to reflect that one crew is performing the work.

Activity responsibility shall be identified for each activity. Utility companies, performers of other contracts, and performers of adjoining work on other advertised contracts shall be identified by coding as required.

Activity resource loading shall not be required. However, coding for crew assignments and production rate data for each activity shall always be required.

Phasing (staging) shall be included as activities. Each phase (stage) in the phasing schedule shall be included as a zero (0) duration Start and Complete milestone activities. These activities shall also be correlated with the utility schedule. A separate activity shall be used to start / finish utility work.

Surcharge durations and special testing, if applicable, shall also be included as activities. Sufficient duration times for these activities will be allowed as agreed to by the Department's Master Scheduler.

Date constraints, float and duration constraints, and / or flags for activities will not be allowed. Milestones that do not constrain the schedule shall be allowed as agreed to by the Department's Master Scheduler when unique or unusual events cause a restraint to the Contractor's work schedule.

A critical path is defined as the series of activities in a CPM schedule network that has the longest path in time as indicated in the Primavera software. The submitted activity sequence and durations must generate a CPM schedule having only one (1) critical path. A schedule with multiple critical paths is not acceptable. Work, as in project wide Maintenance of Traffic, Temporary Erosion Control, and Construction Engineering that, by their nature, are ongoing for long durations or the duration of the project and are basically complementary to other activities, shall be divided and condensed into "establish" and "conclude" activities to prevent this type of work from being the major portion of the critical path or its entirety.

The Project Start Date, or initial Data Date, of the Original Timing Analysis CPM Schedule shall be the anticipated project advertisement date. The first schedule activity related to productive work shall be entitled "First Chargeable Day" and shall have a zero duration. Nonproductive work activities may begin and / or end prior to the First Chargeable day and shall be statused as such in the original Timing Analysis CPM Project Schedule. The submitted activity sequence and durations will generate a CPM Schedule showing the anticipated Contract Time and a critical path having zero total float.

Schedule calculations of CPM databases shall be based on retained logic, contiguous durations, and total float as finish float.

Inaccurate and / or faulty databases of any CPM schedule and / or revisions are unacceptable and shall be summarily corrected and resubmitted. Databases submitted may be in zipped files, however, a compressed format will be unacceptable and shall be summarily resubmitted. Re-submittals shall be labeled "2nd Draft", "3rd Draft", etc. as appropriate.

Any other related activity(s) or schedule information necessary to generate a Timing Analysis CPM Project Schedule acceptable to the Department's Master Scheduler shall be prepared and provided by the Scheduler.

Revisions of the Timing Analysis CPM Project Schedule:

The CPM schedule shall be revised / finalized and submitted with the Final Construction Plans and also if there is a significant change in the scope or sequence of work due to plan changes after the Final Construction Plan submission.

The revision shall reflect the current order of work and include new and / or previous activities affected by the change and shall include a detailed written narrative of these changes. The CPM schedule database revision shall reflect its written narrative. Revisions inconsistent with their written narratives will not be acceptable.

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