

SECTION 01311 – CRITICAL PATH METHOD SCHEDULING

PART 1 - GENERAL

1.1 REQUIREMENTS INCLUDED

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1.2 DESCRIPTION

- A. The Contractor shall at its own expense, prepare, maintain and update detailed Critical Path Method (CPM) resource-loaded progress schedules (hereinafter "CPM Schedule") as described in this Section. CPM Schedules shall be prepared in such a manner as to permit the orderly planning, organization, execution of the work, and be sufficiently detailed to accurately depict all the Work required by the Contract. The CPM Schedules shall be updated and/or revised as required, after review by LMDC, no less than once a month during the course of the Work, and shall accurately reflect and report the actual performance and progress of the Work in accordance with the requirements set forth in "Maintenance and Update of the CPM Schedule".
- B. Contractor's attention is directed to the schedule demands of this Project. LMDC anticipates accelerated work schedule to meet same and Contractor should include all costs associated with meeting or exceeding the delivery and completion date requirements (i.e. extended shifts, 2nd shifts, weekends, holidays) to avoid damages. Contractor is to meet or exceed required completion dates regardless of the restrictions. All costs associated are to be inclusive in the amount stipulated on the Contractor's bid.

- C. Contractor must be fully prepared to mobilize and staged to actively work as detailed on the Milestone dates, therefore all submittals, schedules, permits, notifications, protocols, etc. must be expedited and approved prior to commencement of Work.

1.3 Definitions

- A. Activity: A discrete part of a project that can be identified for planning, scheduling, monitoring, and controlling the Project. Activities included in the Project Schedule consume time and resources.
 - 1. Critical activities are activities on the critical path. They must start and finish on the planned early start and finish times.
 - 2. Predecessor Activity: An activity that precedes another activity in the network.
 - 3. Successor Activity: An activity that follows another activity in the network.
- B. Cost Loading: The allocation of the Schedule of Values for the completion of an activity as scheduled. The sum of costs for all activities must equal the total Lump Sum, unless otherwise approved by LMDC.
- C. CPM: Critical path method, which is a method of planning and scheduling a construction project where activities are arranged based on activity relationships. Network calculations determine when activities can be performed and the critical path of Project.
- D. Critical Path: The longest connected chain of interdependent activities through the network schedule that establishes the minimum overall Project duration and contains no float.
- E. Event: The starting or ending point of an activity.
- F. Float: The measure of leeway in starting and completing an activity.
 - 1. Float time is not for the exclusive use or benefit of either Owner or Contractor, but is a jointly owned, expiring Project resource available to both parties as needed to meet schedule milestones and the Final Completion Date.
 - 2. Free float is the amount of time an activity can be delayed without adversely affecting the early start of the successor activity.
 - 3. Total float is the measure of leeway in starting or completing an activity without adversely affecting the Final Completion Date.
- G. Fragnet: A partial or fragmentary network that breaks down activities into smaller activities for greater detail.
- H. Major Area: A story of construction, a separate building, or a similar significant construction element.
- I. Milestone: A key or critical point in time for reference or measurement.
- J. Network Diagram: A graphic diagram of a network schedule, showing activities and activity relationships.
- K. Resource Loading: The allocation of manpower and equipment necessary for the completion of an activity as scheduled.

1.4 COMPUTER SCHEDULING SYSTEM

- A. The Contractor shall utilize a computer scheduling system that is capable of complying with the resource requirements of these specifications and designed specifically for the production of CPM Schedule computer reports, which will validate the detailed logic networks and provide the required schedule analysis and supporting documentation for progress payments. The computer scheduling system shall be Primavera Project Planner, latest issue or equivalent.

1.5 QUALIFICATIONS OF PERSONNEL

- A. The Contractor will engage, at the Contractor's own expense, a qualified CPM Scheduling consultant (hereinafter "Scheduling Consultant"), approved by LMDC, to assist in the preparation and production of the CPM Schedule. The Contractor may perform these services with the Contractor's own organization if the qualifications of assigned staff are approved by LMDC.
- B. The Scheduling Consultant, or the Contractor's assigned staff, shall provide the following:
 - 1. The name and address of the proposed Scheduling Consultant, if used.
 - 2. Information sufficient to show that the proposed Scheduling Consultant, or the Contractor's own organization, has staff and computer facilities meeting the criteria specified in this Section.
 - 3. A list of at least three (3) projects completed within the past ten (10) years of similar scope and cost to this Project for which the proposed consultant, or Contractor's own organization, or staff thereof has performed services similar to those required under this Contract. The Contractor shall also submit any other pertinent information required by LMDC. LMDC shall have the right to approve or disapprove employment of the consultant proposed, or the performance of the requirements herein by the Contractor's own organization.

1.6 PREPARATION GUIDELINES FOR CPM SCHEDULES

- A. The CPM Schedule shall represent a practical plan to complete the Work within the required time(s) for completion, as defined in the Contract Documents.
 - 1. A CPM Schedule showing completions later than those specified in the Contract Documents will not be accepted.
 - 2. Schedules found to be impractical by LMDC, at his sole discretion, shall be revised and resubmitted by the Contractor.
 - 3. Float is defined as the amount of time between the early start date and the late start date, or the early finish date and the late finish date, of any activity in the project schedule. Total float is defined as the amount of time any given activity or path of activities may be delayed before it will affect the project completion time. Float is not time for the exclusive use or benefit of either LMDC or the Contractor, but must be used in the best interest of completing the Project on time. Extensions of time for performance required under the Contract Documents, if granted pursuant to the Contract, will be granted only

to the extent that the time adjustment exceeds total float in the activity or path of activities affected at the time the extension of time was granted.

- B. The CPM Schedule shall show the sequence and interdependence of submittals, material procurement, construction activities and phasing as described in Annex 6 and elsewhere in the Contract Documents, and shall specifically include as a minimum:
1. The start and completion of all items of the Work, their major components and milestone completion dates, if any.
 2. Submittals and material procurement activities including, but not limited to:
 - a. Shop Drawings, Catalog Cuts & Samples
 - b. Steps required to obtain necessary permits
 - c. Inspections/Surveys
 - d. Safety Plans
 - e. Temporary Facilities & Utilities
 - f. Project Record Documents
 - g. Operations & Maintenance Manuals
 3. These activities in the CPM Schedule shall indicate the following:
 - a. Time of submittals, review and acceptance by LMDC.
 - b. Time of fabrication and delivery of manufactured products.
 - c. The relationship between procurement and construction activities.
 4. Activities for the preparation and submission of as-built documentation.
 5. Activities relating to the start-up and testing of equipment and/or systems for completion of punch list items and training of personnel.
 6. All the relationships to Work of other Contractors, which affect the Work to be performed under this Contract.
- C. The CPM Schedule shall:
1. Be sufficiently detailed to assure adequate planning, execution and progress evaluation of the Work within Contract time(s) for completion. Activities shall generally range in duration from fourteen (14) calendar days or as deemed reasonable by LMDC, based on complexity and criticality of the tasks involved. An exception may be made for procurement items that may have a duration which starts with the approval of shop drawings and ends with delivery of the item to the construction site. The selection and number of activities will be subject to the approval of LMDC. The diagram shall show not only the activities of actual construction work for each trade category of the project, but also all other activities that affect progress, such as including submittal of shop drawings, equipment schedules, samples, coordination drawings, templates, fabrication, delivery and the like, LMDC's review and approval of shop drawings, equipment schedules, samples and templates, and the delivery of Owner-furnished equipment or partition drawings, or both. Show activity duration (i.e., the single best estimate, considering the scope of the activity and the resources planned for the activity) for each activity on the diagram. Failure to include any element of Work required for the performance of this Contract shall not excuse the Contractor from completing all Work

required within any applicable completion date, notwithstanding LMDC's approval of the schedule.

2. Allow for monitoring and evaluation of progress in performance of the Work.
 3. The CPM submittal shall be in the form of Precedence Diagramming Method (PDM).
 - a. The activities shall include:
 - 1) Activity identifier - Maximum length of 8 characters.
 - 2) Concise description of the Work.
 - 3) Duration in calendar days.
 - 4) The dollar value of each activity in the schedule for cash flow purposes.
 - 5) Resources for each activity to include:
 - a) Average labor crew size estimated to install material.
 - b) Major equipment needed to support installation.
 - 6) Responsibility code; identifying who performs the Work by trade.
 - 7) Other codes as designated by LMDC.
 - 8) Include milestone activities as designated by LMDC.
 - b. The network diagram shall show continuous flow from left to right.
 4. Identify workdays per week and shifts per day that the Contractor intends to perform Work.
 5. Include time for LMDC to review submittals in accordance with Section 01330 - Submittals herein and inspect the Work.
 6. Identify activities constituting the controlling operations or Critical Path.
- D. The CPM Schedule shall constitute the representation that:
1. The Contractor and Subcontractors plan to execute the Work in the sequence indicated in the schedule.
 2. The Contractor has distributed the CPM Schedule to his subcontractors for their review and comment. It shall be the Contractor's responsibility to obtain each Subcontractor's written approval and/or concurrence with the CPM Schedule. If a Subcontract has not been awarded for a certain portion of the Work when the CPM Schedule is submitted, the Contractor will modify the CPM data to reflect any changes resulting from the new subcontractual arrangement through the procedure outlined in Section 1.8 herein, "PROJECT SCHEDULE REVISIONS."
 3. All elements of Work required for the performance of the Contract shall be included. Failure by the Contractor to include any element of Work required for performance of the Contract shall not excuse the Contractor from completing all Work in accordance with specified milestones.
 4. Seasonal weather conditions shall be considered and included in the planning and scheduling of all Work influenced by high and low ambient temperatures and/or precipitation to ensure completion of all Work in accordance with specified milestones. Seasonal weather conditions shall be determined by an assessment of average historic

climatic conditions based upon records furnished by the National Oceanic and Atmospheric Administration (NOAA).

5. The Contractor has inspected the Project site and has considered the Work of other contractors.
 6. The Contractor has incorporated any other special conditions in planning the Work such as specified non-work periods or work to be performed during other than Normal Working Hours.
- E. The Contractor will be required to identify and separately code all schedule activities that may be affected by Work in areas of shared access. The Contractor shall provide a separate submission of a CPM Schedule for all coded activities on a monthly basis. The CPM Schedule shall be organized in the order of early start and shall reflect the Contractor's planned start dates and total float for each tagged activity. Meetings will be held as necessary to coordinate activities in common work areas. The Contractor shall provide an individual fully versed in the details and schedule requirements of the Work to attend these meetings. Activities that are determined to be in conflict with interfacing Contract activities will be identified and coordinated at these meetings.

1.7 SUBMITTAL AND REVIEW PROCESS

- A. The CPM Schedule for the entire duration of the Project, with full resource loading, is due 30 calendar days after AWARD of the Contract. LMDC may withhold all or a portion of the progress payments until the Contractor submits a complete CPM Schedule acceptable to LMDC.
- B. For the CPM Schedule submittals and each of the schedule update submittals, the Contractor shall provide the following "CPM reports":
 1. Schedule Reports (copies as required) - includes detailed activity information relating to early start, early finish, late start, late finish, total float, original duration, remaining duration, actual start, actual finish, percent completion, and resource usage.
 - a. Activity Report - all activities sorted by activity identifier.
 - b. Critical Path Report - activities with percent complete less than 100%, sorted by Total Float, then by Early Start.
 - c. Early Start Report - all activities sorted by Actual/Early Start.
 - d. Activity sort by Trade - early start date - total float.
 - e. Total Float report: A list of all activities sorted in ascending order of total float.
 2. Cash Flow - all activities, using the Early Start schedule, by month.
 3. Graphic displays each of the complete Project Schedule - including time display from the beginning to the completion of the Work.
 - a. Network Diagram - all activities on a time scaled diagram displaying each activity number, description and Total Float.
 - b. Summary Bar Chart.
 4. Computer Files - two copies of all CPM Schedules in an electronic readable format capable of being read by Primavera Project Planner ("PRX" or "P3") on CD. Each

Schedule Update, Schedule Revision or Time Impact Analysis must be an individual data file to allow target data comparisons with other CPM submittals.

5. A detailed narrative explaining the Contractor's means and methods, progress to date, productivity rates, equipment to be used, factors affecting the Work and details of all changes to the Project Schedule.
- C. LMDC will review the Contractor's proposed baseline CPM Schedule and Schedule Update submittals and return them to the Contractor with comments or acceptance within 14 calendar days. If not accepted by LMDC, the Contractor shall revise the CPM Schedule or Schedule Update in accordance with LMDC's comments, and resubmit for LMDC's acceptance, within 7 calendar days of the receipt by the Contractor of LMDC's comments. Until such time as LMDC grants acceptance, the Contractor shall resubmit these CPM Schedules and Schedule Updates by the same time frames and in the same format as required in this paragraph for the initial resubmission. LMDC's approval of a CPM Schedule or a Schedule Update shall not be deemed an approval of any extension of time, which are governed by Article 12 of the General Conditions.
- D. The Contractor shall certify that both the CPM Schedule and subsequent Schedule Update submittals correctly represent the sequence, means, methods, techniques and procedures in which it plans to execute the Work, and the actual execution of the Work.
- E. At the discretion of LMDC, the Contractor's applications for payment may either be withheld or modified due to the Contractor's failure to submit an acceptable CPM Schedule within the stated number of calendar days from AWARD of the Contract, or to the lack of acceptance by LMDC of such CPM Schedule or subsequent Schedule Update submittals, in accordance with this Section.

1.8 MAINTENANCE AND UPDATE OF THE CPM SCHEDULE

- A. LMDC shall conduct a monthly progress meeting attended by representatives of the Contractor, Scheduling Consultant or Contractor's assigned staff, LMDC, and others as deemed necessary by LMDC. The focus of the meeting is to assess Project status and develop solutions to items hindering progress. The attendees shall review:
 1. Progress during the period.
 2. Progress scheduled during the next period, as forecasted and as originally planned.
 3. Anticipated problems and proposed solutions.
 4. Discussion of each of the logic revisions to the CPM Schedule.
 5. Analysis and discussion of alternative methods to mitigate accumulated delays.
- B. At the monthly progress meetings the Contractor shall submit to LMDC for review a detailed 6 week look ahead bar chart Progress Schedule from the current CPM Schedule.
- C. LMDC will prepare meeting notes summarizing schedule status, problems hindering progress and actions to be taken to maintain planned progress (action item list designating action, person responsible, and date action to be taken).
- D. Within 5 days of the conclusion of the monthly progress meeting, the Contractor shall submit, based on the schedule status information discussed and accepted at the monthly progress meeting, an updated CPM Schedule (a "Schedule Update"). Reported progress for each affected activity will include:

Actual Start Date

Actual Finish Date (for completed activities)

Remaining Duration (for Activities in progress)

Percent Complete

Calculations for the updated schedule must be based on retained logic.

Each Schedule Update submission will include all materials as described in Section 1.5 herein.

- E. As frequently as deemed necessary, LMDC may require, at no additional cost to LMDC, the Contractor to expand in further detail any part of the Schedule Update or the CPM Schedule in order to explain and demonstrate the construction sequence forecasted therein. This expanded CPM Schedule shall be in sufficient detail and shall comply with the following requirements:
1. Be in CPM format
 2. Identify the Work being performed
 3. Be submitted within 15 calendar days from receipt of LMDC's request

In order to complement the information provided in these expanded/detail schedules the Contractor may also be requested to prepare and submit marked-up drawings such as cross sections, profiles and plan views of the area under analysis.

1.9 PROJECT SCHEDULE REVISIONS

- A. Updating the CPM Schedule to reflect actual progress made to the date of a Schedule Update shall not be considered revisions to the CPM Schedule. All other changes to the CPM Schedule, including but not limited to the following, shall be considered a "Schedule Revision":
1. Adding and/or deleting activity relationships.
 2. Adding and/or deleting activities.
 3. Changes to original durations.
 4. Changes to Milestone dates.
 5. Performance of Work out of sequence.
- B. If, as a result of the monthly Schedule Update, it appears the CPM Schedule no longer represents the actual prosecution and progress of the Work, LMDC will request, and the Contractor shall submit, a revision to the CPM Schedule in accordance with Article 1.7 herein.
- C. All revisions shall be subject to review and approval by LMDC prior to incorporation into the CPM Schedule.

1.10 CPM SCHEDULE RECOVERY

- A. Whenever the Contractor fails to achieve a Milestone established in the Project Schedule, or the Contractor's progress is not commensurate with that required to adhere to the Final Completion Date or Milestone(s), the Contractor shall promptly undertake appropriate action at no additional cost to LMDC to recover the CPM Schedule.

- B. The Contractor shall submit with the next application for payment (following recognition of the problem) a written recovery statement to LMDC describing the cause for the slippage and the actions planned by the Contractor to recover the CPM Schedule within the shortest reasonable time.
- C. Appropriate recovery actions may include, but not be limited to, assignment of additional labor, subcontractors or equipment shift or overtime work, expediting of submittal or deliveries, or any combinations of them. Overlapping of activities or sequencing changes to increase activity concurrence shall be deemed appropriate only if properly substantiated in the submittal.
- D. The Contractor's refusal, failure or neglect to take appropriate recovery action or to submit a written recovery statement shall constitute reasonable evidence that the Contractor is not prosecuting the Work, or separable part, with the diligence that will insure its completion by the Final Completion Date, and shall constitute sufficient basis for LMDC to withhold any payment otherwise due, or identify and order alternate recovery actions on the basis of the information in the CPM Schedule.

1.11 TIME IMPACT ANALYSIS FOR CHANGES, DELAYS AND CONTRACTOR REQUESTS

- A. When changes are initiated or delays are experienced, or the Contractor, in accordance with Article 1.8 herein, desires to revise the CPM Schedule, the Contractor shall submit to the LMDC as part of the documentation required by Article 12 of the General Conditions (if Contractor is seeking an extension of time for an Excusable Delay), a written time impact analysis illustrating the influence of each change, delay, or Contractor request on any Milestone (a "Time Impact Analysis"). Each Time Impact Analysis shall include a Fragmentary Network (Network Analysis) demonstrating how the Contractor proposes to in-corporate the change, delay or Contractor request into the CPM Schedule. The Time Impact Analysis shall demonstrate the time impact to each and every affected Activity in the CPM Schedule utilizing the most recent Schedule Update as the basis for the analysis. The date of the most recent Schedule Update shall be a date prior to the date the change is given to the Contractor, the date the delay occurred or the date the Contractor submits a request for a change. The event time used in the Time Impact Analysis shall be included in the most recent Schedule Update or as adjusted by mutual agreement. The Time Impact Analysis shall include a computer diskette which shall contain the details of the change including, but not limited to, added, changed or deleted data for Activities, logic restraints, resources or costs.
- B. Activity delays shall not necessarily mean that an extension of any Milestone is warranted or due the Contractor—all such matters are governed by Article 12 of the General Conditions. A change or delay may not affect existing critical Activities or cause non critical Activities to become critical. A change or delay may result in only absorbing a part of the available total float that may exist within an Activity chain of the Network, thereby not causing any effect on any Milestone.
- C. Total float is defined as the amount of time between the early start date and the late start date, or the early finish date and the late finish date, for each and every activity in the CPM Schedule. Float is not for the exclusive use or benefit of either LMDC or the Contractor.
- D. Four copies of each Time Impact Analysis shall be submitted within 10 calendar days after the commencement of a delay or the notice of direction for a change is given to the Contractor, along with the documentation required by the General Conditions.

- E. In cases where the Contractor does not submit a Time Impact Analysis within 10 calendar days, the Contractor agrees that the particular change, delay or Contractor request does not require an extension of time to a Milestone, and the Contractor hereby waives its right to subsequently request a time extension.
- F. Upon acceptance, a copy of the Time Impact Analysis approved by LMDC shall be returned to the Contractor, and incorporated into the CPM Schedule at the next monthly Schedule Update. The Time Impact Analysis shall be incorporated into and attached to any relevant Change Order(s).

1.12 GENERAL

- A. The Contractor's attention is specifically directed to the fact that submission and acceptance of the CPM Schedule as well as CPM Schedule progress updates are required for LMDC to certify the approximate amount of Work performed by the Contractor.
- B. Neither the review nor acceptance of the Contractor's CPM Schedule or other data submitted by the Contractor pursuant to this Section, nor any other action on the part of LMDC under this Section shall in any way be deemed as a representation by LMDC that the Contractor can or will be permitted to follow a particular schedule or sequence of operations or that, by following any such schedule or sequence, he can or will complete the Work by the time(s) required by the Contract or by any other time(s). Nor shall the acceptance of any CPM Schedule or other such data relieve the Contractor of his obligation to complete the Work by the time(s) required in the Contract, even though such CPM Schedule approved may be inconsistent with such completion.
- C. Any acceptance under this Section shall be construed merely to mean that LMDC knew of no good reason at that time to object thereto. No review or acceptance or any other action under this Section shall be construed to constitute an extension of the Final Completion Date, nor shall limit, affect or impair the Contractor's obligation to perform all the Work by time(s) required by the Contract and in accordance with all other provisions of the Contract.
- D. The performance of the Work by the time(s) required in the Contract after taking into account extensions to which the Contractor may be entitled under the Contract, may require the use by the Contractor of overtime labor, additional shifts or additional plant and equipment and/or other measures. In any event, the Contractor shall anticipate, avoid and mitigate the effects of all delays, whether or not such delays involve Excusable Delays or Activities with positive float. When in the judgment of the Contracting Officer, the Work is not proceeding in accordance with the CPM Schedule, or it is likely that the Work might not be completed by the time(s) required in the Contract, the Contracting Officer may order the Contractor, without additional compensation, to employ additional shifts, to increase the number of men employed, to use additional plant or equipment, or to take such steps as may be necessary or required to assure the completion of the various operations within the time(s) allotted therefore in the approved CPM Schedule, or by the aforesaid completion time(s).

No action on the part of the Contractor pursuant to this Section shall be construed as a request for an extension of the time(s) for completion required by the Contract. A request for an extension of time shall be deemed made only if it complies with the requirements of the General Conditions. No extension of the time(s) for completion shall be inferred because of any action, failure to act, or statement on behalf of LMDC pursuant to this Section.

1.13 PAYMENT

- A. No separate payment will be made for Work under this Section. The cost of Work described in this Section shall be included in the Lump Sum.

1.14 SUBMITTAL SCHEDULE

- A. General: Immediately after the development and acceptance of the fully developed Progress Schedule, prepare a complete schedule of work-related submittals. Submit this schedule within ten (10) days of the date required for establishment of Progress Schedule.
- B. Form: Prepare the schedule in chronological order of submittals. Show category of the submittal, name of subcontractor, a generic description of work covered, related section numbers, the activity or event number on the Progress Schedule, the scheduled date for first submittal, resubmittal, and the final release or approval by LMDC.
- C. Schedule submissions to insure that submissions will be without concentrations, in time to enable LMDC to retain same for review in the scheduled period of time. LMDC shall review the submittal for possible excessive submittal concentrations. Periods of excessive submittal concentrations identified by LMDC shall be rescheduled in accordance with LMDC's requirements.
 - 1. Submit the Schedule of Submittals, keyed to the CPM Schedule.
 - 2. Provide time in the CPM Schedule for resubmission of all submittals.
 - 3. Create and manage a priority system to establish the proper priority of submittals based upon the original and updated Progress Schedule. Update the priority system every two weeks.
 - 4. Identify the submission time required for each individual submittal, giving greater time to more complicated submittals and/or submittals of greater magnitude and review time. Subdivide large submittals into smaller packages for review.

PART 2 - PRODUCTS (Not Applicable)

PART 3 - EXECUTION (Not Applicable)

END OF SECTION 01311