

PS.11

Innovative Approaches to CPM Scheduling Management

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A federal court-ordered consent decree in the 1990's required that the Los Angeles County Sanitation Districts' (LACSD) comply with the Clean Water Act and meet secondary effluent discharge requirements. This required the Districts to undertake a major capital expansion program to add to and retrofit existing plant facilities. As part of the efforts to meet this deadline, the Districts reviewed and significantly altered the manner in which it administers CPM scheduling on major projects. This new approach, which included several innovations, has been implemented on numerous contracts over an eight-year period. LACSD's experience demonstrates that CPM scheduling can serve as an effective tool for managing public works projects in real time and effectively resolving delay issues.

The Los Angeles County Sanitation Districts is a public agency that designs, constructs, operates and maintains facilities that meet the wastewater and solid waste management needs of approximately 5.3 million people in Los Angeles County. This includes eleven wastewater treatment plants that convey and treat approximately 525 million gallons of wastewater per day. The Districts performs most of its' design and construction management work in-house. Construction contracts are competitively bid and awarded to the lowest, responsive, responsible bidder.

The Districts' major water treatment plant, the Joint Water Pollution Control Plant (JWPCP), is located in Carson, California. The treatment capacity of the plant is 400 Million gallons per day. Prior to December 2002, half the plant effluent received secondary treatment. The consent decree required that 100% of the effluent receive secondary treatment. In order to meet the consent decree deadline, the Districts let 14 separate construction contracts at the JWPCP plant with a construction value of over \$300 million. The entire plant was affected. To ensure timely completion, manage the work effectively and minimize the disruption of operating facilities, it was essential that the Districts receive accurate and timely schedules from all contractors.

Unfortunately, the Districts' experience with CPM scheduling in the ten years prior to this major capital upgrade, which was consistent with the experience of many other public agencies, indicated that obtaining accurate and timely schedules

was extremely difficult. The challenges faced by public agencies such as the Districts, included the following.

1. Lack of an approved schedule prior to the start of work. It is not unusual for baseline schedules to be accepted several months after Notice to Proceed. By that time, the monthly updates are so far behind that the schedule is rendered less effective as a tool for managing the project. This also makes it difficult to analyze delay issues that occurred prior to the acceptance of the baseline.
2. The approved baseline is of poor quality and does not reflect the contractor's approach to the work. When projects begin with a poor baseline schedule, it is unlikely that the scheduling process will improve over time.
3. Schedule updates are not timely or of good quality. This makes it difficult to accurately project completion dates and determine when the critical path has been delayed. Without early warning of delays, it is difficult to resolve time extension issues or develop and implement mitigation plans. This is particularly detrimental in cases in which multiple general contractors are operating in a confined work area and may impact one another.
4. Time extension requests are not submitted and resolved in a timely manner. This often results in unsubstantiated job-end delay and acceleration claims that are very difficult to evaluate because of a lack of proper schedule documentation. Due to the high costs of litigation, even one such large claim can dwarf the costs involved in administering CPM scheduling during the course of contracts.
5. Scheduling specifications are inadequate. Scheduling specifications are often vague and do not contain proper enforcement provisions. Many specifications also fail to address the potential misuse of modern scheduling software programs. Specifications can also be too complex or too simple for the project at hand.

6. Owners and contractors do not manage the scheduling process properly. The best-written set of contract documents will be rendered ineffective without capable people implementing them. On many projects, there is a considerable lack of scheduling expertise on both the contractor and owner's side. This problem is compounded by advanced scheduling software programs, which can be dangerous in the hands of unseasoned personnel. The difficulties can be exacerbated by lack of management understanding of and support for CPM scheduling.

The aforementioned problems are amplified on complex projects that include numerous different trades and multiple paths that may become critical during the course of the job.

While it was always the Districts' objective to effectively manage its construction contracts, the consent decree added impetus in several ways:

1. Increased potential exposure to claims due to the high volume of work.
2. Monetary penalties for late completion
3. Public censure for late completion
4. Complexity of the work that was being performed in an operating wastewater treatment plant. This included the potential for disrupting plant operations, which had to produce permit compliant effluent throughout the construction process.
5. Internal resource constraints faced in managing such a large volume of work, in a short time frame within a geographically confined location

Faced with these challenges, the Districts recognized the need to develop an effective means of managing CPM scheduling.

A NEW BEGINNING WHICH INCORPORATED INNOVATIVE APPROACHES

The Districts implemented innovative concepts in the areas of baseline schedule development, monthly updates, and contract time accounting.

A. Baseline Schedule Development

The Districts' approach includes a comprehensive program designed to deliver a high-quality baseline schedule, often prior to the start of work. Major aspects of this program include:

1. Timely Acceptance of the Baseline Schedule

One of the most significant aspects of the Districts' approach was requiring an accepted (not just submitted) baseline schedule prior to the issuance of notice to proceed. This enables updates to be completed in a timely manner each month. This, in turn, permits the use of the schedule to evaluate the timely completion of the work and the mitigation of unforeseen events. This also sets

the tone early in each contract that the Districts is serious about effective CPM scheduling.

Previously, the Districts required 90-day early work schedules prior to the start of work. Often, the baseline schedule was not completed prior to the expiration of the early work schedule. Typically, the contractor continued to work and be paid in the absence of an acceptable baseline. In some cases, it took over a year to receive an acceptable baseline. The project was then faced with the task of a 12-month backlog in updates. This dysfunctional cycle was eliminated by the Districts' new approach.

Depending upon the urgency and nature of each individual project, the Districts makes a determination as to whether the baseline schedule should be accepted prior to Notice to Proceed or prior to the start of physical work in the field.

2. Clear Definition of the Scheduling Product

Because of the lack of standardization of scheduling practices and the variability of scheduling expertise that exists within the industry, the quality of the scheduling product submitted by contractors varies greatly. The Districts expanded the language in its CPM schedule specification to more clearly define the desired product. For example, software settings for features such as logic and cost calculations are defined. Particular attention is paid to features such as schedule constraints that may impact activity float calculations. Redundant logic and float sequestering techniques are prohibited. Each activity description is required to be unique and unambiguous. Activity codes are defined. Specifying this type of detail eliminates ambiguity and increases the enforceability of the specification. It results in a more consistent product from project to project and minimizes debate with those contractors who may not be sophisticated in their approach to CPM scheduling.

The Districts also specifies that if the contractor's baseline shows early completion of contract work, a change order will be issued to reset the completion milestone to the date being forecasted by the contractor. This is done to prevent contractors from submitting unrealistic early completion schedules and then claiming overhead costs when the early date is not met.

It is important to recognize that CPM scheduling is very software dependent. Existing scheduling software is frequently upgraded with new features or with increased flexibility in existing features. The intricacies of the software create the potential for experienced schedulers to manipulate the schedule in ways that are not readily apparent or for inexperienced schedulers to unintentionally distort the schedule. From a practical standpoint, an effective CPM schedule specification has to acknowledge the capabilities of the software and define acceptable ways of implementing those capabilities.

3. Use of a Purchase Order to Begin the Baseline Prior to Contract Award

Many CPM schedule specifications do not explicitly define the beginning and end of the baseline schedule preparation period. Some specifications do identify a scheduling kick-off meeting between the agency and the contractor, usually shortly

after award of the contract. However, such specifications typically do not contain any means of ensuring that the contractor actually has full-time staff and computer facilities dedicated to developing the baseline. The required submittal date for the baseline schedule is usually specified. However, many schedule specifications fail to provide adequate measures for the timely acceptance of the baseline schedule. Consequently, completion of baseline schedules flounder in numerous resubmittals that do not incorporate the agency's requested corrections. The further construction progresses, the greater the pressure on the agency to accept a baseline that does not meet their management needs.

The Districts' approach includes specifying contract milestones that define the beginning and the end of the baseline schedule preparation period. On certain critical projects, the apparent successful bidder is required to meet with the Districts as early as eleven working days after bid to receive a purchase order, which covers the bidder for all costs to prepare the baseline schedule in the event that the contract is not awarded to them. The baseline preparation period begins on the date of receipt of a purchase order. Beginning the scheduling process prior to contract award thereby accelerates completion of the baseline. This minimizes the amount of construction time lost by requiring acceptance of the baseline prior to NTP.

4. Securing Baseline Performance Using a Letter of Credit and Liquidated Damages

Because of the frequency with which owners, contractors or both do not dedicate the resources necessary to administer CPM schedules in accordance with specifications, it is necessary to alert the contractor to the importance that the Districts places on effective CPM scheduling. This fact is emphasized at each pre-bid meeting. The Districts also makes sure that sufficient resources are devoted to administer the schedule as specified. On certain critical projects, the Districts indicates its seriousness regarding the scheduling process by securing performance on the baseline schedule by a letter of credit from the contractor.

The letter of credit must be submitted by the apparent successful bidder within ten working days after bid. Failure to submit the letter of credit results in the bid being determined non-responsive. The amount of the letter of credit varies, but is a minimum of two percent of the contract bid price. If the contractor does not gain acceptance of the baseline schedule within the specified time, liquidated damages are assessed and drawn against the letter of credit.

The Districts' approach significantly heightens the contractor's exposure since damages will be withdrawn from the contractor's current assets. The contractor is also accountable for the quality of the submittal, as opposed to merely making a submittal.

5. Opportunity for Contract Time Bonus/Penalty

The Districts' approach on certain contracts provides the opportunity for the gain or loss of contract time depending upon how quickly the baseline schedule is completed. If the baseline is completed early, the Districts will issue the notice to proceed early

and issue a noncompensable extension to the contract time. The float generated by this time extension will be solely owned by the contractor. All other float on the project is jointly owned. Conversely, if the baseline schedule is completed late, the notice to proceed will be issued late and there will be a corresponding reduction of the contract time. In either case, the specified date for contract completion will not change.

The combination of liquidated damages and a fixed contract end date provides a powerful incentive to complete the baseline schedule on time. The opportunity for sole ownership of float gives the contractor an incentive to complete the baseline even earlier than required.

6. In-Progress Concurrent Reviews of the Baseline Schedule

Holding the contractor accountable for obtaining Districts acceptance of the baseline schedule imposes a duty upon the agency to perform timely reviews. To control the volume of information to be reviewed in a single submittal, and to monitor the contractor's progress towards timely baseline completion, the Districts often specifies interim submittals throughout the baseline preparation period. The Districts' review of each interim submittal is concurrent with the contractor's ongoing preparation of the baseline. This process provides feedback to the contractor early in the schedule development process, which allows corrective action to be taken well before the final schedule is submitted.

It is necessary for the Districts to devote sufficient resources to accommodate these accelerated reviews. This requires a highly qualified scheduling engineer who can perform quality reviews in a compressed time frame. It also requires that project engineers assist in schedule reviews. The engineers verify completeness of scope, reasonableness of work sequences and durations, and compliance with specified constraints. A majority of the Districts' design and field engineers have scheduling software on their PC's and have received training in the use of CPM scheduling and scheduling software.

7. Contractor's Project Management Team for Baseline Preparation

The Districts' approach to the baseline schedule development process requires an open dialogue between the contractor and the agency about the content of the specification and the subsequent expectations of the parties. This dialogue takes the form of periodic meetings and required interim submissions and reviews. Sustaining this dialogue requires the dedication of sufficient resources by both parties.

The contractor is required to have its project management team (PMT), consisting of the project manager, project superintendent, and project scheduler, devoted exclusively to the project within fifteen working days after bid. It is the contractor's responsibility to assess what additional resources will be necessary to support the PMT's effort and communicate its' plan to the Districts at the first meeting held fifteen working days after bid.

The qualifications of the PMT must be accepted by the Districts. In particular, the contractor's scheduler must show a

minimum number of years of experience in preparing schedules of comparable size and complexity. It is not sufficient for the contractor to state that an in-house engineer with relatively little scheduling experience, will prepare the baseline. Each member of the contractor's PMT must submit references from past projects that are then checked by the Districts.

It is imperative that the agency provides quality control for the scheduling effort because contractors often feel that they do not have a need to develop CPM schedules.

"The typical contractor is a planner who generally uses instinctive methods rather than formal scheduling...One of the keys to the success of CPM is that it utilizes the planner's knowledge, experience and instincts in a logical way...CPM can save time through better planning, and in construction, time is money." - James O'Brien.

Out of their own economic interest, contractors ought to develop scheduling expertise within their organizations. It appears that the variability in scheduling expertise and implementation in the industry has caused contractors to mistrust scheduling. Clearly, this situation cries out for the stabilizing presence of scheduling standards. The Districts has found that when it sets clear standards and shows that it is serious about enforcing them, contractors generally follow suit

In the event that the contractor does not devote sufficient resources to preparing an acceptable baseline, as may be indicated by the quality of interim submittals, LACSD can require the replacement of any member of the PMT who is not performing their role.

B. Cooperation Between Design and Field Construction Personnel

In many organizations, there is a lack of communication and an adversarial relationship between design and field construction management staff that often has an adverse impact on CPM schedule management. The Districts has attempted to foster communication and coordination in the following areas:

1. Joint Development of Standard Schedule Specification Language:

The Districts has drafted 3 standard CPM scheduling specifications, each with a varying degree of complexity. They were developed jointly by design and field construction management personnel. This cooperation ensured that lessons learned from the field were incorporated into the specifications. This is in contrast to many other organizations, in which scheduling specifications are developed primarily by design personnel without much input from the field. Field and design personnel also jointly determine which scheduling specification is appropriate for each project.

2. Design Input on Baseline Schedule Reviews:

The Districts is also in the process of implementing a procedure whereby certain baseline schedules are reviewed jointly by field and design personnel. Design staff is generally far more familiar with a project at its outset and is therefore able to perform a thorough review of the schedule to ensure that contract requirements regarding scope and sequencing have been properly incorporated. Field personnel, who are generally more attuned to constructability and implementation issues, can often more effectively review these aspects of the schedule.

C. Monthly Updates

It is common for CPM schedule specifications to link the submission of the monthly update with release of the contractor's monthly progress payment. In fact, it is often difficult for an agency to enforce this requirement in the aftermath of a late baseline schedule completion. When the baseline schedule is completed many months after the start of physical work, the updates are then many months behind. The agency may retreat from requiring the contractor to finance the project until such time as the backlog of monthly updates is eliminated. This points back to the significance of completing the baseline schedule prior to the start of physical work.

1. Enforcement of timely schedule updates

The Districts specifies that the monthly update is the contractor's application for payment. Until the contractor submits a proper application, they are not eligible to receive payment.

The Districts also specifies liquidated damages for the late submission of an acceptable monthly update. This includes submittal of time extension requests and mitigation plans when work is delayed. The objective is to make explicit the damage to the agency of not having access to a current project schedule that may serve as the basis for management decisions for that contract, as well as for other contracts. This is something that is not commonly done by other agencies.

2. Two step update process with contractor record of objections

To ensure acceptability of the update, the update process occurs in two steps. First, update data is submitted, identifying all update information and any proposed revisions. The update data is essentially a preliminary version of the update and the Districts reviews and comments on it. Actual dates are checked and the contractor's plan is reviewed to ensure that it reflects the manner in which work is being performed in the field. All Districts comments must be incorporated into the update. If the contractor disagrees with the Districts' comments, it must document its objections in writing and in a schedule file submitted with the monthly update. This record of the contractor's objections is kept running for the duration of the project. It forces the articulation by the contractor of its viewpoint at the time that events occur, rather than at the end of the project with the benefit of hindsight. Because both parties have the opportunity to document their views, there is no need to delay

submission of the monthly update pending a resolution. This approach recognizes that the parties will not always agree and that both parties have an interest in documenting their view.

Making the contractor's objections part of the formal process removes the incentive for the contractor to use a shadow schedule. Very rarely has the Districts seen a contractor submit an "objections" file. Over the past 5 years, only one contractor has maintained and submitted a dual schedule file as the basis of a claim.

Proper reviews of monthly schedule updates are a critical component of effective schedule management. This includes:

1. Review as-built information for the update period.
2. Ensuring that the schedule reflects the manner in which work is being performed in the field. This requires the contractor to revise schedule logic to reflect their current plan.
3. Timely and proper documentation of ongoing delays and mitigation plans in the schedule update.
4. Reviewing technical aspects of the schedule such as out-of-sequence progress, constraints, calendars, autocost rules, logic settings and other issues to ensure that the scheduling software is being used properly.
5. A formal schedule review letter is written to the contractor each month that documents the Districts' position regarding issues such as delays, areas of concern and other Districts' comments regarding the schedule. If the contractor refuses to implement the Districts' comments, the schedule can be rejected.

3. Employment of qualified field scheduling personnel by the Districts

This approach is predicated upon the use of qualified scheduling engineers in the field. It was determined that scheduling personnel should ideally have the following knowledge and abilities:

1. Thorough knowledge of the principles of CPM scheduling.
2. Thorough knowledge of scheduling software including Primavera Project Planner, which is the dominant system in the industry.
3. Excellent oral and written communication skills. This is critical to interfacing with Districts management as well as contractors.
4. Intimate understanding of the principles of construction and construction management. This can only be learned through significant field experience.
5. Sufficient knowledge of construction contracts and law as it applies to scheduling issues.

Without the presence of such personnel, it would be difficult to implement the required approach. The well-intentioned efforts of many agencies are thwarted due to the use of less-than-qualified personnel.

D. Contract Time Accounting & Time Extension Analysis

Contract time accounting is performed for each monthly update period after acceptance of the corresponding monthly update and review of any time eligibility request submitted by the contractor. The eligibility request is the contractor's request for time and/or compensation for delays occurring during the update period. The eligibility request includes a schedule analysis for each delayed milestone that must conform to the specified format.

The specification defines time-related terms, such as, "unforeseen event," "float," "delay," "non/compensable delay," and "concurrent delay." Rules governing float-sharing expand upon the usual notion of "jointly owned float" and provide a structure within which schedule analyses are performed. Terms such as these are part of the scheduler's vocabulary, however, they have different nuances in different contexts. It is essential to define their meaning as they are to be applied to the specific contract.

1. Clear Definition of Schedule Analysis

Traditionally it has been very difficult to get contractors to submit timely schedule analyses for claimed delays. Of those analyses received by the agency, many do not adhere to a reasoned, organized approach. In addition to stipulating the definitions of terms and the method for performing a schedule analysis, the Districts has available a sample of the required eligibility request documentation. This detailed approach to contract time accounting sends the message that the Districts takes time very seriously and compels the contractor to provide credible documentation of delay claims. This preempts the typical claims game of generating a great deal of nonsensical data on multiple claims that can be rolled into one huge claim at the end of the project.

2. Timely Delay Notification and Submittal of Time Extension Request

A critical component of successful construction scheduling is timely notification of delays by the contractor, followed by timely submittal of a schedule analysis if appropriate. This provides the owner the opportunity to mitigate the delay to the extent possible and for both parties to discuss and attempt to resolve the time issues involved expeditiously.

The Districts' scheduling specification requires the contractor to notify the Districts in writing within 48 hours of recognizing a potential delay. In addition, within 2 weeks after the due date for a monthly update, the contractor is required to submit a schedule analysis for all delays occurring during that month for which they are seeking a time extension. The Districts makes it a priority to attempt to enforce these requirements and has been largely successful in avoiding significant job end delay claims.

3. Submittal of a mitigation plan

The Districts' scheduling specification also requires the contractor to submit a mitigation plan when work falls behind

schedule. This plan must be submitted, regardless of the party responsible for the delay. This prevents the contractor from balking at submitting a mitigation plan because they feel that a particular delay is the Districts' responsibility. The contract documents state that monthly updates will not be accepted without an acceptable mitigation plan. This approach recognizes that the contractor is generally in the best position to develop a plan to mitigate delays.

4. Clear definition of concurrent delay

The Districts also specifically defines concurrent delay and includes a table in the specification that delineates which different combinations of delays are compensable or non-compensable. This definition of concurrent delay is often missing in scheduling specifications and can lead to disputes regarding the compensability of certain combinations of delays.

5. Use of a 'floating record' for delay eligibility

When faced with a legitimate contractor request for compensable time during the performance of a contract, owners are often caught in a quandary. Do they grant the time and overhead and risk the contractor completing on time and essentially receiving a "bonus" in the form of an unneeded time extension and unexpended overhead? Or, do they defer the determination of all time issues until the end of the project, incur the hostility of the contractor due to lack of resolution of the issue and risk a large job-end delay and constructive acceleration claims?

The Districts has attempted to handle this matter by implementing an innovative 'floating record' time accounting approach on some of its large contracts. The contractor's eligibility for time and/or compensation for delay is determined each month. If the Districts feels that the contractor is eligible for time and/or extended overhead, this is acknowledged officially in the monthly time accounting letter, thereby eliminating the need for the contractor to accelerate. However, the execution of a change order is deferred until the end of the project when it is determined whether the contractor was actually late and actually expended additional overhead due to the delay. This concept has been successfully used in at least two significant cases to date. On projects where this approach has not been fully implemented, specifying the floating record has spurred contractors to resolve delay claims in a timely manner.

Successful implementation of CPM scheduling requires a comprehensive scheduling specification, qualified personnel implementing the system and the support of design and field management.

The approach to CPM scheduling outlined above can significantly improve an owner's ability to: understand the contractor's plan to prosecute the work, effectively control projects, resolve time related claims in a timely and mutually acceptable manner, provide early warning of delays, effectively mitigate the impact of unforeseen events, and reduce frivolous time related claims.

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