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Proactive Project Management: Project Control Strategies for Construction Megaprojects

Chapter 3 of Construction Law in the International Environment

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The goal of any construction project, no matter how large or small, is completion of the project on time, at or under budget, in conformance with the contract requirements, and to the satisfaction of the owner. Managing concurrent design, procurement, and construction activities becomes increasing complex as the size and duration of the project increases. Most large power, infrastructure, or energy projects require several to many years to construct, excluding the predecessor design and procurement activities. Large construction projects require the coordination of thousands of engineering, procurement and construction activities, and frequent schedule updates to strategically accommodate the myriad of changes that will occur in the design, procurement, and construction process.

This chapter focuses on the importance of appropriate project controls and proactive project management on large power, energy, and infrastructure construction projects (Megaprojects). The overall cost of each of these projects is into the billions of United States Dollars (USD), and the time to complete, from the earliest planning stages through project completion and close-out, will be lengthy, and could approach a decade. While certain design, procurement, and construction activities is often done concurrently to minimize the overall project delivery time, these projects nevertheless take a number of years to complete.

Project Delivery Systems and Risk Allocation

While not the primary focus of this chapter, there are many project delivery methodologies for Megaprojects, with the Engineering-Procurement-Construction (EPC or Turnkey) model (or a variant) being the most widely used. Each project delivery methodology has various advantages and disadvantages.[1] Each contracting structure attempts to allocate risk among the parties, i.e., allocate the legal and financial consequences of cost and schedule uncertainty among the contracting parties, including schedule delay, unforeseen conditions, and any other type of situation that could affect project cost or schedule.

There are numerous causes of cost and schedule uncertainty on Megaprojects, some of which are global or

“macro-level” in nature and some of which project specific risks, or “micro-level” in nature. Common macro-level risks that may present challenges on Megaprojects include availability and/or cost of capital, currency fluctuations, supply and/or wage inflation, political and regulatory influences, cultural dynamics, technological issues, availability and cost of skilled labor, availability and cost of skilled managers, and financial market forces. Common project specific construction risks include design or technology novelty or uniqueness, design complexity, market conditions leading to planned schedule acceleration,[2] unforeseen, unexpected, or differing conditions, force majeure events, owner-directed changes, design completion, refinement or enhancement, contractor productivity issues, labor unrest, coordination of contractors and subcontractors, coordination of engineering with procurement and construction activities, skilled labor unavailability, design, procurement, or construction delays, financial wherewithal of contractor and major subcontractors and suppliers, local opposition to project, and other issues.[3]

It is virtually impossible to eliminate all exposure to macro and project level risks over the time duration of a Megaproject. Consequently, contractual risk allocation is of critical importance. Careful contract drafting attempts to allocate the legal consequences of these risks among the parties, and typically attempts to shift risk away from the owner/lender to other project participants.[4] While risks can be allocated and exposure can be controlled to some extent through careful contract drafting, the minimization of project risk also requires appropriate project controls and proactive project management.

Proactive Project Management

Proactive project management is the practice of systematically attempting to preemptively identify and address project schedule and cost issues before they adversely impact the project. Proactive project management can minimize schedule and cost risks on any construction project, but its importance is magnified significantly on Megaprojects. The successful completion of a Megaproject may hinge on the owner’s ability to anticipate that a contractor is running behind schedule, over budget, or financially strapped, is experiencing conflicts with suppliers or subcontractors, or is struggling with other significant issues which, unless promptly addressed, will adversely affect the progress of the project.

In order to further explore these issues, this article will use, as an example, a Megaproject contracted on an EPC basis, and will outline the importance to the owner of establishing appropriate project controls at the outset of a project to monitor and report contract execution on a “real-time” basis.

In an EPC contract, the owner has a single point of contact for the project, a firm referred to as the “EPC Contractor.” This firm handles the design of the project, the procurement of all construction materials, equipment, and construction services, and provides for the ‘turnkey’ delivery of the facility for an agreed contract price.[5] An EPC Contractor takes an active role in the design of the project, the selection of the major equipment, contracting with all of the suppliers and subcontractors, and the integration of the design and procurement schedule into the project construction schedule. This integration, in theory, produces an alignment of team members for optimal project performance.

In an EPC project, therefore, it is imperative that the owner set strict schedule (with liquidated damages) and payment milestones, as well as performance guarantees (with “make-good” obligations and liquidated damages if the facility does not meet explicit performance standards). EPC contracts generally cost more than the sum of its various segments because the owner pays a risk premium to the EPC Contractor in return for (a) a guaranteed

maximum price or fixed price, (b) an established project completion date, (c) strict performance with the performance guarantees, and (d) the aforementioned bundling of the engineering, procurement, and construction segments (as well as testing and commissioning) with the single EPC Contractor.

While the EPC model typically provides the owner with a reasonable degree of cost certainty at the outset of the project, insulation from most disputes arising on the project, including intra-consortium disputes and disputes with equipment vendors and subcontractors, and a reduction in project duration, the owner and/or lender still may face significant consequences in the event of non-performance by the EPC Contractor. The owner has placed "all its eggs in one basket" by ceding control of the engineering, procurement, and construction of the project to a single contracting partner, the EPC Contractor. If that entity faces a default by one of its major subcontractors or suppliers, fails to complete the project, fails to meet minimum performance requirements, goes bankrupt, or otherwise is unable or unwilling to perform or perform satisfactorily, the project will not be completed on time, customer relationships will be jeopardized, and the economic benefits to be derived from the project may well be lost. Depending upon the level and type of bonding and other security provided by the EPC Contractor, the owner will have to address mounting financial losses as the costs to complete the work far exceed the contractually agreed price, and the time for completion marches forward. Therefore, it is important for the owner to establish appropriate project controls and proactively monitor the EPC Contractor to mitigate this risk and maximize the likelihood of satisfactory and timely project completion.

As part of its tender, this EPC Contractor typically submits the initial 'baseline' project schedule, containing thousands of activities to be completed on the project, to the owner for review and approval. Part of the project award involves the owner contractually agreeing to this 'baseline' schedule. Before addressing issues with this 'baseline' schedule and its effects on the project execution phase, it is helpful to understand the entire project life cycle and the role project controls play during each project phase.

The Project Life Cycle

The life cycle of Megaprojects generally consists of the following five phases:[6]

1. *Strategic Planning and Project Development*: Feasibility studies, strategic planning, and project development

2. *Scope Definition*: project definition and refinement of the project's scope

3. *Procurement*: procuring or contracting for the project

4. *Project Execution*: performance and execution of the work by the EPC Contractor, including design, procurement, construction, start-up, commissioning; and commercial operation of the project, and

5. *Project Closeout*: Financial closeout of the project, including resolution of any claims between the owner and the EPC Contractor.

The owner's project control process must provide the framework for effective and prudent project management during the life of the project. The owner should institute internal project controls to document and monitor each step in the project life cycle. While the EPC Contractor is hired to execute the project, the owner's internal project

control process begins during the Strategic Planning and Project Development stage, and is further refined during the Scope Definition stage and as the tenders are evaluated and awarded during the Procurement stage. The owners project controls process should be is established at the award of the tender and before the EPC Contractor begins the Project Execution stage. Beginning at that initial phase, the owner must document the need for the project, its regulatory and financial feasibility, and its overall plan and strategy for the procurement and execution of the project. This ongoing documentation and project management function, while tedious, will prove essential for proactive project management throughout the Project Execution phase, and will be necessary in evaluating any claims that may arise on the project, and in meeting its periodic reporting obligations to its lenders and/or senior management team.

Each phase of the project life cycle has its own unique set of key questions which need to be considered, and the answers to those questions should be documented. During the Strategic Planning and Project Development phase, the owner's answers to the following questions are examples of the types of decisions which must be documented and supported:[7]

1. Have appropriate processes and approvals been established for the selection of technology, the initial scope, the budget and schedule development, and financing decisions?

2. What type of project delivery system is appropriate for this project? (As discussed above, we assume an EPC project for purposes here; discussions of other project delivery systems are outside the scope of this chapter)

3. Were reasonable alternatives for the project delivery system considered?

4. Have all regulatory requirements and considerations been addressed?

5. Have the appropriate internal and governmental approvals been addressed?

6. Has an appropriate internal project management team been selected? Is it prudent to retain outside expertise to assist the internal project management team (legal, project management, scheduling and project controls, engineering, auditing, risk management, document retention and other functions)?

The following are examples of considerations that should be addressed and documented during the Scope Definition and Procurement phases:[8]

1. Who are the key stakeholders for the project and have they been engaged regarding major project decisions?

2. Have competing technologies been adequately vetted for use in completing the project?

3. How were the project vendors and contractors selected? What criteria were used in the selection process? Are those the appropriate criteria for this project? Are these criteria defensible to later challenge? Was this criteria appropriately followed in all instances?

4. Have project risks been identified and reasonably allocated through the procurement and contracting strategy?

5. Has an auditing or other feedback loop been established? Has an adequate quality assurance and quality control strategy been implemented?

During the Project Execution and Project Closeout phases, the owners' answers to the following questions are examples of the types of decisions that should be addressed and documented:[9]

1. Has an established project management strategy been implemented and how does it function? Is the owner's staffing appropriate?

2. Has an adequate framework of project controls been established and how does it function? Do the cost and scheduling controls address the project's needs? Does this system provide accurate and reliable data?

3. Have communication and reporting systems been established to allow executive management to make timely and informed decisions?

4. Are periodic reviews of the project controls and processes conducted? If so, how often? Are these reviews performed by an independent auditor or an in-house auditor?

5. Do the project controls allow early issue identification? If so, how?Are steps in place to assure compliance with applicable laws?

6. Do the project controls facilitate quality assurance and quality control compliance? How?

7. Has a process been established to document major project decisions, including change management (i.e., the process by which changes to the scope of the project are formally introduced, approved, and recorded)?

8. Is there an independent process in place to provide a continuous improvement loop on identified project issues? Is this process adequately documented?

Internal project controls must be designed to document the decision-making process and must identify risks to schedule, budget and other project specific criteria. In addition, they should be designed to include a feedback loop, so that issues with the project controls, or the types of data or reporting provided, are identified and addressed promptly during the project.

Integrating the Contract Documents with the Owner's Project Control Processes

In drafting and negotiating the contract documents, and in particular the EPC contract, the owner must be mindful of its information needs for the project. During the Strategic Planning and Project Development, Scope Definition and Refinement, and Procurement phases of the project life cycle, most of the information and data that the owner needs to monitor, document, support, and report, including project scope, budget, schedule, the regulatory and financial requirements, staffing, and a myriad of other decisions and analyses, is within its control. Some of the needed information may be provided by the owner's advisors and other professionals (such as legal, accounting,

engineering, risk, and the like), while preliminary pricing information may be provided by engineers, contractors, and vendors. The owner gathers the information that it needs to make decisions, and documents that its decision-making processes are appropriate, and that its decision-making process is prudent.

As the tender is made and the EPC contract is executed, the Project Execution phase begins, and much of the detailed information that the owner needs to proactively manage the project is developed by the EPC Contractor. The owner should independently verify work progress, quantity and quality of materials installed, design maturation, contractor labor and equipment quantities, or any other objective and observable criteria essential for the project's progress and, ultimately, its successful delivery. However, much of this type of information is developed by the EPC Contractor in the first instance, and supplied to the owner on a periodic basis as mandatory support for its payment applications.

It is important that the owner, through the contract documents, require the frequent submittal of such information from the EPC Contractor in a form that can be readily used in its project controls process. The process of integrating the information and submittal requirements of the contract documents with the owner's project controls process is a critical function that is sometimes overlooked during the contract drafting process. In other words, the requirements of the contract documents must meet the structure of the owner's project management and controls process.

Project Controls: the Project Execution Phase and the EPC Contractor

One of the goals of the owner's project controls process in the EPC environment is to minimize the risk that project delivery will fail under the EPC Contractor's stewardship. Project controls should allow the early identification of performance, budget, and schedule risks, and allow the owner to make prudent decisions in light of the issues identified. The level of detail and the definition of the owner's project controls system and staff varies based on the size, location, complexity, contract type, and risk profile of the project. However, the owner's project control process should be designed to timely identify and address issues as they develop.

On most large capital projects, the owner needs to perform the following functions during the Project Execution phase:

1. Report the costs to date and forecast the costs to completion

2. Monitor, verify, and document project status against various metrics, including budget, schedule and payments

3. Verify schedule status, including the schedule status of major engineering, procurement and construction activities

4. Monitor the progress and status of the major subcontractors

5. Monitor and perform change management, including design maturation, and

6. Internal and external reporting of project data.

EPC Contractors should typically be required to submit the following types of information on a monthly basis as preconditions to invoice approval and payment: (a) contract and payment status; (b) schedule status; (c) schedule progress; (d) quantities installed; (e) quantities stored; (f) work-in-progress; (g) periodic and cumulative project costs; (h) project progress and other project metrics; (i) submittal logs; (j) drawing logs; (k) status of pending changes; (l) status of requests for information; and (m) a myriad of other project metrics (determined on a project-by-project basis). This information is typically provided through a detailed monthly progress report and monthly submittal process as a precondition to payment. The key here, from the owner's perspective, is to ensure that the contract provisions require the contractor to submit the quantity and quality of information that the owner needs in the form most useful to the owner. At a minimum, the information must meet the tracking and reporting needs of the owner and must be sufficient to allow the owner to verify the validity of the construction and schedule progress. The project control process should work on a nearly 'real-time' basis to allow the owner to proactively address any identified schedule or cost issues. Generally, the owner would implement, at a minimum, the following internal processes for information, reporting and project management purposes:

- Project cost and budget controls
- Schedule management
- Earned value or other progress management
- Change management, and
- Risk management.

Establishing the Owner's Project Control Process

The project delivery method, size and complexity of the project, internal corporate requirements, regulatory review and/or approval, and the contractor's execution strategy affect the structure of the project control processes implemented on a particular Megaproject. AACE International (AACE) has established recommended practices for developing a project controls plan.[10] One of the initial steps is to establish an adequate Work Breakdown Structure (WBS), which separates the project scope into logical work tasks. The owner will also create an Organizational Breakdown Structure (OBS) identifying the individual managers and clearly defining their roles and responsibilities. The team should then integrate the WBS, OBS, budget and resources through control accounts relating directly to WBS components, which will form the basis for the project control system. A project communication plan, including meeting requirements and reporting structures, should also be developed.

These components of the project controls system are discussed in more detail below.

Cost Baseline

The cost estimate should be credible, well-documented, accurate, and comprehensive.[11] Historical cost data from similar projects is a good starting point for a parametric cost estimate. In addition to the estimates typically performed at the design stage, it is recommended that a third party independent cost estimate be performed near design completion. Such an estimate should review the original estimate assumptions, as well as indicate areas of potential risks in the contractor's bid. Care should also be taken in establishing the contingency and the management reserve for the project, which will be based on management's assessment of risks that should take into consideration numerous factors including the duration of the project, the maturity of the design, familiarity with the project type, geographic location, and similar factors.

Baseline Schedule

The schedule is ultimately a communication tool through which the contractor communicates the planned sequence of construction and the status of the project. The owner and contractor typically agree to a "baseline schedule" contemporaneously with project award, and the agreed "baseline schedule" will form the basis for all commercial purposes, including measuring the project's progress, accessing liquidated damages, delay or disruption claims, or any other commercial purpose.[12] The baseline schedule represents a mutually agreed plan that must accurately model the planned prosecution of the work.

The development of the initial project schedule is the result of coordination of multiple departments within the EPC Contractor.[13] As such, from the EPC Contractor's perspective, it is imperative that this coordinated development process be documented, as a reference during schedule reviews and as a basis for later evaluating the impact of changes. The schedule basis should document the assumptions made in the schedule development process, the scope of work, the items included and excluded in the schedule, the execution strategy, the planning methodology and any issues or concerns.

From the owner's perspective, the schedule review meetings prior to the establishment of the "baseline schedule" should be well documented. At a minimum, the minutes from the schedule review meetings should document the assumptions made in the schedule development process, the scope of work, the items included and excluded in the schedule, the execution strategy, and the planning methodology. The schedule review meeting minutes should also document the level of participation by each of the major vendors of the EPC Contractors, including all affiliated companies, and should specifically document the integration of design and procurement of major systems and equipment into the project schedule. While it is axiomatic the E (engineering) and P (procurement) come before C (construction), the importance of the integration of engineering and procurement activities into the baseline schedule is sometimes overlooked. In order to minimize schedule risk, the owner's project controls process must closely monitor engineering and procurement activities, particularly long lead items and major equipment vendors.

Engineering and procurement of major equipment or other components should be reflected in the schedule baseline. The basis for the duration estimates for procurement items should be documented. The status of procurement activities should be verified and updated on a regular basis. Special care should be taken in this regard as the contractor may not have direct knowledge of the manufacturing status.

Good scheduling practices should be followed in creating the schedule baseline. These include eliminating activities without predecessors or successors, minimizing the use of constraints and minimizing activities with durations longer than the update period. Presence of open ended activities and constraints will compromise the accuracy of the schedule and create artificial float values. In some scheduling software, activities with no successors may automatically be shown as critical. Constraints may be needed in some cases. For example, a "start no earlier than" constraint is often used when the activity is not planned to be worked on until a later period. Also, activities with durations longer than the update period should be minimized. Determining the level of completion of an activity in progress is subjective and hence will introduce errors while updating the schedules. Making the activity durations shorter than the update period will minimize the number of activities in progress in any individual schedule update. However, this consideration should be balanced with the level of complexity of the schedule and its usefulness in managing the project.

The critical path should be reviewed to confirm that it makes logical sense. A review should identify the required logical ties (hard logic) on the critical path and the preferential logical ties (soft logic). Use of preferential logical ties to place any individual work item on the critical or near critical path should be analyzed and documented. The percentage of critical and near critical activities should also be reviewed. As a rule of thumb, if the percentage of critical or near critical path activities is higher than 20 percent, further review of the schedule logic is warranted.

The schedule should also be reviewed for constructability.[14] The constructability review will include identification of means and methods or construction sequence that will result in unnecessarily increasing the cost of the project. Another aspect will be a review to confirm that any site restrictions including restrictions to access and work periods are incorporated in the project schedule.

Monthly Project Updates

The owner dictates by contract the schedule and cost information is to be submitted on a periodic basis, and the format of the information to be submitted. From an owner's perspective, a high level of transparency is preferable. Timely submittal and review of periodic project updates (usually monthly) will minimize disagreements over project status. Providing timely and accurate reviews of contractor schedules is an integral part of proactive schedule management.[15]

The monthly schedule update submittals usually contains a narrative describing the changes made to the schedule along with an electronic copy of the schedule update database and printed reports. Both the schedule narrative and reports should enable the reviewer to accurately assess the project's progress and the changes in the schedule. Typical information in a monthly schedule narrative include activities that were started or completed in the update period, status of major procurement items, identification and explanation of any critical or near critical delays in the update period, identification and explanation of changes to schedule logic or planned durations and any potential schedule concerns or issues.[16]

The project's WBS should to be established such that the codes match with the payment application at a higher level. If the project is set up in this way, the progress percentage updates to cost loaded activities can be compared with the monthly payment applications to verify the accuracy of the updates.

There is often a tendency to revise the logic to accelerate the remaining activities in a schedule to recover any prior delays. Such schedule revisions need to be reviewed to ensure that these are practical and not just "wishful thinking." The contract should specify that the monthly reports address any schedule logic revisions and the reasons for it in a separate section.

Whenever work is prosecuted out of sequence, the schedule is no longer accurately modeling the project. However, most projects do not follow the planned sequence. A contractor may perform activities out of sequence for various reasons, including mitigation of delays, resource considerations, slippage of predecessor activates, including engineering or procurement, or other changes in the planned sequence. Whatever the reason, it is essential that the schedule logic be revised to reflect the actual sequence followed in the field so that the schedule remains an accurate model of the project.

Owners should review the numerous scheduling options available in newer scheduling software. A schedule will

forecast different completion dates based on different schedule settings, even if the underlying schedule status and logic are the same. For example, common software settings to incorporate out of sequence progress include “retained logic,” “progress override” and “actual dates,” each of which will calculate a different completion date for the project. The scheduling options used in each schedule update should be documented as part of the monthly update process, so that the schedules could be recreated for review using electronic copies of the schedule database.

In case of disputes or claims, the as-built dates are often relied upon to quantify the delays. In the absence of accurate as-built dates in the schedule, considerable resources and money will have to be spent in determining these dates for a forensic schedule analysis. Thus, care should also be taken in documenting the actual dates of an activity. The actual start date is typically not the date on which preparatory work was started on the activity, but rather should reflect the date on which substantial work was started. Similarly, actual finish date is typically when the activity was substantially completed so that the successor activity could start. If only minor tasks are remaining on an activity, it may be prudent to separate it out as a separate task that is not critical or to incorporate it into a project-wide punch-list activity, whose subtasks are tracked outside of the schedule.

Earned Value Management

The project control plan should identify the processes necessary to perform a performance assessment on a periodic basis.[17] The goal is to identify variances, opportunities and risks in a timely manner. The earned value management system integrates the project information, including cost, schedule, resources and productivity, and communicates it to the project stakeholders. Heightened visibility of cost and schedule performance is the primary benefit of earned value reports. The earned value system also helps identify project trends and establish a reasonable estimate of project cost at completion. Its predictive value includes identification of areas with potential cost or schedule overruns and thus helps manage risks on the project. Even on fixed price contracts, an earned value system is recommended as it provides an early warning system on any significant potential project issues.

Risk Management

Risk management involves risk identification, assessment, analysis, mitigation and contingency planning.[18] Risk identification is often best performed by the senior project staff and typically includes a short description of the risk and may include a quantification of the risk. Historical change order and claims data on similar projects is a good source for risk identification and/or quantification. While identifying the risks, it is preferable to be over inclusive by identifying reasonably probable potential risks. The risk identification should be performed keeping the goals of the business in mind. These may be project goals like cost or schedule or may include broader corporate or strategic goals.

Risk assessment involves establishing the relative importance of the risk item by identifying its probability of occurrence as well as its potential impact. This is best done in a group where the underlying assumptions could be critically examined. The significance of potential impacts may be tied to the project approval criteria and triggers for additional reviews or approvals.

Risk analysis involves a review and analysis of the identified risks. Various quantitative processes could be used for this, but the ultimate aim is to identify the risks that could be mitigated. Risk analysis also includes the

categorization of risks based on common root causes and impacts and the relationships between risks. Contingency, both cost and schedule, is derived from the risk analysis.

Risk mitigation may involve various strategies including prevention, transfer, hedging or insurance, or even "rebaselining" of the project.[19] Risk management plan should be a dynamic document that defines these processes and is refined as required. The foundation of the risk management plan is the contractual allocation of risk set forth in the contract documents.

Change Management

Failure to timely resolve and incorporate individual changes into the project schedule is a certain recipe for claims, as the effect of the interaction of a multitude of individual issues will become more difficult to resolve later in the project.[20] The contract should define the processes for managing changes in scope, time and cost. The contract typically defines the notice requirements from the contractor as well as the timeframes for providing cost and schedule estimates. It should also define the timeframe for owner's review of the proposed changes, the change approval process, and the dispute resolution process if the parties cannot agree on the change or its impact.

During project execution, changes should be identified early to minimize risk. The project control plan should also address the different types of changes as well as the approval process. Changes must be carefully evaluated, and after approval must be incorporated into the revised performance measurements.

The change order log should track all proposed change orders, whether approved or not. The cost and schedule impact of each proposed change order should be tracked separately, so that discrete impacts could be segregated and quantified to assist resolution. Documenting the identification of the change, any relevant discussions and segregating the cost and schedule impacts is also critical in case of claims.

Project Closeout

Project closeout is an often overlooked as a part of the project control process. At project closeout, the project staff should document the lessons learned, as well as collect as-built documentation including final as-built schedule, final change order log, final cost report, and all other applicable close-out information. The as-planned documentation should also be preserved, including budget, cost estimates, schedule baseline and assumptions. Performing this data collection and evaluating it will help improve the delivery of future projects.

Conclusion

A principal goal of the owner's project control function on a Megaproject is to timely identify and address cost, schedule, and other performance issues as they develop. Given the EPC nature of this type of project (i.e., the owner only interacts with the EPC Contractor on the project), the need for the owner to remain informed on all aspects of the project's progress is paramount. The contract documents should be drafted so that adequate reporting requirements are incorporated to meet the needs of the owner's project control system. The contract documents should likewise reflect the risk management plan. The contract provisions for scheduling, schedule updates, earned values, project costs, and project progress must assist in managing project risks at the appropriate level by meeting the information, tracking and reporting needs of the owner.

Endnotes

[1] "Project delivery system" means the manner in which an owner contracts for engineering, procurement, and construction services on a project. While there are many variants, three common delivery methods are the general contractor model, the EPC or Turnkey model, or a hybrid approach while divides the work into multiple contracts. *See* Bates, "Strategic Considerations in North American Megaprojects," *Managing Gigaprojects: Advice from Those Who've Been There and Done That* (American Society of Civil Engineers 2012). *See also* "EPC Contracts in the Power Sector," *DLA Piper 2012.*

[2] In order to complete the project in the shortest available time, an owner may contract to have construction proceed on an accelerated basis, such as working 50 to 60 or more hours per work week, planned second shifts for all or significant portions of the project, increasing manpower above optimal levels, increased modularization, or other techniques. Due to the labor inefficiencies inherent with extended overtime, techniques such as these are typically implemented only if directed and paid for by the owner.

[3] McGraw Hill Construction, working in conjunction with the American Institute of Architects Large Firm Roundtable and other industry partners, surveyed more than 1,500 owners, architects, and contactors to ascertain their perceptions on which factors lead to the greatest degree of uncertainty on construction projects. Their research identified the following as the top seven causes of uncertainty on construction projects: 1) implementation of an accelerated design and construction schedule; 2) changes made by the owner during design and construction; 3) design errors; 4) design omissions; 5) contractor and subcontractor coordination issues; 6) contractor-caused delays; and, 7) unforeseen site or construction conditions. *See* Managing Uncertainty and Expectations in Design and Construction," SmartMarket Report (2014) (available at www.construction.com). Several other factors rated very low in this survey (identified by less than 7 percent of respondents), including project delivery system, project complexity, and regulatory permitting processes.

[4] Owners/lenders typically attempt to contractually allocate all or substantially all of the project risks to the EPC Contractor in order to minimize their exposure to cost and schedule risk. *See* Bates, *supra* note 1, at 365 – 368.

[5] Price certainty is typically required in order to obtain project financing. In other words, the project must be "bankable," with the EPC Contractor usually bearing the risk of any cost overruns or schedule delays. The contract price may be a lump sum, a guaranteed maximum price ("GMP"), an initial "open-book period" that leads to the establishment of a fixed price, a GMP with shared "savings," a GMP to be established based upon unit prices or agreed rates, or various other methods, but the contract must be bankable if external financing is involved. The method of arriving at the agreed contract price may be influenced by the nature of the project and the level of design completeness and/or owner requirements at the time of contracting, but the owner/lender will typically require contract price certainty with an appropriate contingency. For a more robust discussion of EPC pricing structures, *see* "EPC Contracts in the Power Sector," *infra* at note 1; Lamberski, "EPC Agreement Pricing Issues in First of a Kind Power Plant Projects," Construction Users Roundtable Voice (Fall 2012).

[6] These stages may occur concurrently to some extent. For example, in the EPC context, the Scope Definition and Procurement phases may blur, as alternative technologies or other alternative means of accomplishing the owner's objectives are considered. Similarly, an owner may procure turbines or other long lead supply items prior to finalization of a contract with an EPC Contractor, and assign all obligations under the supply contract to the

EPC Contractor (sometimes called an “EPC-wrap”).

[7] These are merely examples of the types of decisions that must be made, documented, and supported during the Strategic Planning and Project Development stage. This is not intended to be an exhaustive list of the issues faced during this stage.

[8] These are merely examples of the types of decisions that must be made, documented, and supported during the Scope Definition and Procurement stages. This is not intended to be an exhaustive list of the issues faced during these phases.

[9] These are merely examples of the types of decisions that must be made, documented, and supported during the Project Execution and Project Closeout stages. This is not intended to be an exhaustive list of the issues faced during these phases.

[10] *See generally* Developing the Project Controls Plan, AACE International Recommended Practice No. 60R-10, December 21, 2011; Project Planning – As Applied in Engineering and Construction for Capital Projects, AACE International Recommended Practice No. 39R-06, December 8, 2011.

[11] *See generally* Kul B. Uppal, Best Practice of Cost Estimates, AACE International Transactions, 2003.

[12] The importance of agreeing to a “baseline schedule” at project award cannot be overstated. The “baseline schedule” is critical component of the commercial agreement, and is the foundation of delay and disruption claims, assessment of liquidated damages, and various other commercial undertakings. Nevertheless, all too often time is spent in arbitration or litigation attempting to establish which schedule should be used as the “baseline schedule” because the “baseline schedule” was not yet agreed at the time of award.

[13] Various portions of the design, procurement, and construction schedules are typically developed by different project partners and must be integrated by the EPC Contractor. This is a major task that is critical for project execution. Gaining a meaningful understanding of the proposed schedule prior to award can be a daunting task for an owner. Nevertheless, the owner must develop an meaningful understanding of the EPC schedule in order to evaluate and agree to the project “baseline schedule.”

[14] *See generally Schedule Constructability Review*, AACE International Recommended Practice No. 48R-06, August 28, 2009.

[15] *See generally* Scheduling Claims Protection Methods, AACE International Recommended Practice No. 45R-08, June 1, 2009; *Schedule Update Review – As Applied in Engineering, Procurement and Construction*, AACE International Recommended Practice No. 53R-06, August 14, 2008.

[16] Owner’s use a software utility such as “Claim Digger” to compare the electronic schedule update with the prior update to document month to month changes in schedule logic or activities. EPC Contractors are sometimes required to submit such an electronic comparison with schedule updates or with significant change order proposals.

[17] *See generally* Joseph J. Orczyk, *Progress Measurement and Earned Value*, Skills and Knowledge of Cost Engineering 5th Ed., 2004, at 14.1; Robert A. Marshall, *The Contribution of Earned Value Management to Project Success on Contracted Efforts*, Journal of Contract Management, Summer 2007.

[18] See generally Allen C. Hamilton, *Risk Management*, Skills and Knowledge of Cost Engineering 5th Ed., 2004, at 31.1; Eric Esperne, *Translating Risk Management into Contract Management*, Contract Management, Aug. 2010, at 56.

[19] "Rebaselining" is the process of establishing a revised "baseline schedule" for a project during construction, typically as part of the resolution of a series of disputes. Essentially, as part of the consideration for resolving the dispute, the parties agree to a rebaselined schedule that will, from that date forward, govern their commercial relationship.

[20] *See generally* Marlene M. Hyde, John P. Orr & Michael A. Peek, *Best Practices by Owners for Controlling Cost and Schedules on Large Projects*, AACE International Transactions (2010).

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